Abstracts from the secretariat's technical paper on

Barriers and opportunities related to the transfer of technology

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I. GENERAL DISCUSSION

A. Introduction

1. Environmentally sound technologies (ESTs) and know-how,[1] in the climate change context can be divided into two categories: mitigation technologies to reduce emissions by sources or to enhance removals by sinks of greenhouse gases and adaptation technologies to reduce the adverse impacts of climate change.[2]

2. The international transfer of ESTs and know-how can be considered as a process originating from the countries and the companies that developed and produced them to the countries and subjects that will receive and facilitate their effective implementation and dissemination. This process follows different pathways and in each case there are different entities that can intervene and influence the process.

3. A typical technology transfer process can be divided into the steps summarized in table 1 below, according to the different participants in the process. This is not a strict division of roles, and action may be taken by both sides.[3]

Table 1. Steps in the technology transfer process

Supplier side	***Recipient side***
a) research and development	a) create awareness of the need for ESTs
b) project preparation	b) develop capacity for the adoption of ESTs
c) demonstrations	c) assess technological options
d) project implementation or technology commercialization	d) implement and operate technology
e) feedback analysis	e) feedback analysis

4. The implementation of the above processes calls for the involvement and commitment of different actors. There are six main actors who may enter the process at different stages: Governments, private sector businesses, multilateral financial institutions, international

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[1] Environmentally sound and economically viable technologies and know-how conducive to mitigating and adapting to climate change. The term 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 GHG in the energy, transportation, forestry, agriculture, industry and waste management sectors, to enhance removals by sinks, and to facilitate adaptation (FCCC/SBSTA/1996/4).

[2] In the context of this paper, to the extent possible, we will refer to all categories giving specific mention when only one group is concerned.

[3] Steps in table 1 are not directly linked between the supplier and recipient sides.

organizations, non-governmental organizations (NGOs) and consumers/households. These actors often perform multiple functions; for example, the private sector develops, manufactures, markets, finances, and operates technologies. However, the boundaries between actors are not rigid and may differ for different types of technologies.[4]

5. All the above actors participate in the process. Nevertheless, the process itself depends upon the varying conditions, in both developed and developing countries. To be able to facilitate the adoption and implementation of ESTs it is essential to consider specific regional, national and sectoral barriers and incentives. Encouraging key actors to value the medium- and long-term economic and competitive benefits of sustainable development over the short-term costs of shifting production and consumption patterns remains one of the most important objectives to be achieved.

B. Barriers

6. Barriers may generally be defined as factors that inhibit the technology transfer process. Examples of barriers are abundant in the literature.[5] However, the following is a short list of barriers relevant to the transfer of ESTs:

(a) Institutional: lack of legal and regulatory frameworks, limited institutional capacity, and excessive bureaucratic procedures;

(b) Political: instability, interventions in domestic markets (for example, subsidies), corruption and lack of civil society;

(c) Technological: lack of infrastructure, lack of technical standards and institutions for supporting the standards, low technical capabilities of firms and lack of a technology knowledge base;

(d) Economic: instability, inflation, poor macroeconomic conditions and disturbed and/or non-transparent markets;

(e) Information: lack of technical and financial information and of a demonstrated track record for many ESTs;

(f) Financial: lack of investment capital and financing instruments;

(g) Cultural: consumer preferences and social biases;

(h) General: intellectual property protection, and unclear arbitration procedures.

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4 In some of the groups it is possible to find suppliers and users. The actors will behave differently depending on whether they represent the supplier's or receiver's side.

5 See for example: World Investment Report 1996, UNCTAD, and Technology and Finance: new opportunities and innovative strategies for sustainable development, UNDP (1994.)

7. A first step in the process of overcoming barriers is to identify and assess them according to the technologies chosen and the targeted categories of users. An example of such a process is the technology and technology information needs survey conducted by the secretariat with the cooperation of the University of Amsterdam (FCCC/SBSTA/1998/INF.5).[6]

8. In that survey Parties were requested to provide information on past experiences and projects, and to list the perceived barriers encountered in formulating and implementing them. The results are presented in table 2 .

Table 2. Barriers to the transfer of technology as identified by Parties

Reporting Countries	***Key barriers***	***Category***
Belize, Guinea, Latvia, Mali Poland, Republic of Korea	Lack of finance, terms of funding	Financial
Mali	Inability to obtain international finances for dissemination of indigenous technologies	Financial
Mali, Kiribati	High investment cost	Economic
Mali, Poland	High cost of service and maintenance	Economic
Zimbabwe	Affordability for technology end-users	Economic
Albania, Panama	Lack of/access to technical information	Technological
Mali	Lack of supply of spare parts	Technological
Egypt	Lack of technical capacity	Technological
Egypt, Guinea, Indonesia	Lack of local management skills, training of personnel	Institutional
Barbados, Costa Rica	Lack of public acceptance: low level of public awareness	Institutional
Mali	Cultural, including perceived comfort.	Cultural

Source: see footnote 9.

9. The conclusions from the data provided in the survey are limited by the number of projects reported. Therefore it is not possible to give a general assessment of the comparative importance of various types of barriers. However, the key barriers, in order of decreasing importance, appear to be: financial, economic, technological, institutional and cultural. In particular, access to national and international sources of financing is seen as a major obstacle.

C. Opportunities

[6] See also R. van Berkel, E. Arkesteijn, Transfer of Environmentally Sound Technologies and Practices under the Climate Convention: survey of experiences, needs and opportunities among non-Annex II countries. IVAM Environmental Research, 1998.

10. Agenda 21 provides a list of activities that can create opportunities to promote the transfer of technology, these include: a) government policies creating favourable conditions for both public-sector and private-sector transfers; b) institutional support and training for assessing, developing, and managing new technologies; c) information networks and clearinghouses that disseminate information and provide advice and training; d) collaborative networks of technology research and demonstration centers; e) international programmes for cooperation and assistance in research and development and capacity building; f) technology-assessment capabilities among international organizations; and g) long-term collaborative arrangements between private businesses for foreign direct investment and joint ventures.[7]

11. Many governments are undertaking such actions by developing legal instruments, tax regimes that reward technology upgrading, targeted lending programmes from public and private banks, public/private partnerships to support the import/export of ESTs, tax refunds or subsidies for the import and implementation of ESTs, subsidized infrastructure, tariff protection, and providing clear information about government programmes and actions. Some governments are also using economic instruments together with traditional command and control regulations (for example, emission standards) to achieve environmental goals and to encourage the transfer of technologies. Case studies suggest that no single policy instrument is likely to be sufficient to address environmental problems, and that, therefore, a combination of instruments is likely to be needed. To be effective, economic instruments also need strong institutions, the active support of economic, financial and industrial authorities, and few bureaucratic restrictions.

12. Further examples of recent activities undertaken by non-Annex II Parties can be drawn from the results of the technology and technology information needs survey, where Parties were requested to provide details on enabling measures adopted by their governments to facilitate the transfer and implementation of ESTs in different sectors relevant to climate change in their countries. The responses of Parties are summarized in table 3.

Table 3. Enabling measures initiated by non-Annex II Parties

Creating awareness	**Disseminating information**	**Providing technical assistance**	**Creating a fiscal environment**	**Removing trade barriers**
Albania	Albania	Bangladesh	Barbados	Bulgaria

[7] There is general recognition that the private sector plays an important role in introducing and implementing environmentally sound technologies and know-how, and that the relationship between the public and private sectors is particularly important and needs to be further explored. In this context, the secretariat is preparing a technical paper that will be available in 1999, on the role of the private sector in developing and promoting clean technologies, including problems and prospects.

Barbados	Bolivia	Barbados	Bulgaria	Mali
Belize	Costa Rica	Bolivia	Lithuania	Poland
Benin	Ecuador	Botswana	Mali	Senegal
Bhutan	Egypt	Bulgaria	Poland	Uruguay
Bolivia	Georgia	Guinea	Republic of Korea	
Botswana	Guinea	Indonesia	Uruguay	
Bulgaria	Indonesia	Mali		
Costa Rica	Lithuania	Poland		
Ecuador	Mali	Uruguay		
Egypt	Philippines			
Georgia	Poland			
Guinea	Republic of Korea			
Guyana	Senegal			
Jamaica	Singapore			
Latvia	Trinidad & Tobago			
Lesotho	Uruguay			
Lithuania	Venezuela			
Mali	Zimbabwe			
Nigeria				
Philippines				
Poland				
Republic of Korea				
Senegal				
Singapore				
South Africa				
Syria				
Trinidad & Tobago				
Uruguay				
Venezuela				
Zimbabwe				

Source: see footnote 9 (Responses from national focal points or other national climate change coordinators have been considered for this table).

D. Some lessons learned from case studies

13. Section III of this document includes case studies of technology transfer processes in a few developing countries. From these case studies it is possible to draw only some preliminary lessons, since only a limited number of cases and countries have been

considered.

14. The African case studies provide some useful lessons for future technology development and transfer in Africa. For example, there is a need for the developers of technology who enter the market at an early stage to provide for awareness building, demonstrations, initial training, and financial support. This was crucial when introducing solar photovoltaic (PV) systems in Kenya, where donor agencies, working with local companies, provided for such activities.

15. Rapid technology learning, substantial cost savings, materials substitution, and enhancing local capability can be achieved by the involvement of local staff during the development cycle, and for process and product improvements, as in the case of the Zimbabwe ethanol programme. Also, technical “after-sales” support and maintenance facilities can help the performance and dissemination of the technology as the case of Senegal demonstrates; and low-interest loans and other subsidies to early users encourage the penetration of new technologies. The revolving fund in Zimbabwe helped to disseminate PV technology in the country.

16. The importance of tax reductions and subsidies needs further study. At present, the final price of ESTs in Africa is very high due to a number of factors, including the lack of competition. The cost of a PV system in Kenya is almost three times that in Indonesia. Taxes (15 per cent import duty and 20 per cent VAT) contribute to this cost, but the base cost is also high. It is not clear whether a reduction of taxes alone would reduce the market cost.

II. CASE STUDIES

A. Africa

1. Introduction

17. Africa, with a population estimated at 743 million, is made up of 53 countries with diverse socio-economic and political conditions, and very different resource endowments among countries. The continent accounts for about 7 per cent of global greenhouse gas emissions, and only about 4 per cent of total $C0_2$ emissions.

18. According to the African Development Bank, Africa’s annual GDP growth in 1996 was 4.8 per cent compared to 2.8 per cent in 1995, with some countries’ GDP growth exceeding 7 per cent. This is a change from the past when the GDP growth rate lagged behind the population growth rate that is now just under 3 per cent. Another positive feature is the increase in foreign direct investments (FDI) to the continent, from US$ 0.9 billion in 1990 to US$ 3.4 billion in 1994 and US$ 5.0 billion in 1996. However, Africa’s percentage share of total financial flows to developing countries has decreased from 11 per cent in 1990 to 3.8 per cent in 1996 and these flows are skewed to only a few countries.

19. African countries, as other developing countries, are utilizing ESTs in various

economic sectors, such as energy, industry, forestry, transportation, and waste management, though climate change concerns have not been the main driving force behind this. In the energy supply area, these technologies are used mostly by the power sector, while for energy demand they are used in the household, industrial and transport sectors. Improved agricultural practices are being tried in a few countries as a means of improving production and minimizing the use of organic fertilizers. Improved forestry practices are being used in several countries with the aim of increasing the forest cover.

20. The technologies used in the energy sector, which is by far the most dominant, can be summarized as follows:

(a) Improved technologies are being adopted for production and waste management in the exploitation of natural gas. New gas pipelines are being constructed for supply within and outside the continent. Nigeria and Algeria are examples of countries undertaking these exercises.

(b) South Africa and Zimbabwe are examples of countries using improved methods for extracting coal and cleaner coal processing methods;

(c) Tunisia and Ghana are among countries using modern and efficient power production technologies, such as combined cycles, and cogenerating plants are under construction;

(d) Different economic sectors are adopting energy efficient technologies, using both software and hardware options. Senegal and Kenya are good examples where this is happening in the industrial sector, while Côte d’Ivoire is an example for the household and transport sectors;

(e) Utilization of biomass as a high energy source in the power sector through the use of agricultural waste is widespread in countries with wood, palm crops and sugar industries. In Mauritius, excess power produced is sold to the national grid, and represents as much as 14 per cent of the total.

(f) Zimbabwe and Kenya use ethanol made from molasses (sugar waste) to blend gasoline in the transport sector; and

(g) The use of renewable energy technologies in the form of solar electrical and thermal systems is widespread throughout the continent.

21. The following discussion will analyse the activities in three countries – Senegal in the west, Kenya in the east, and Zimbabwe in the south of the continent. They are representative of countries in the region that are embarking on several climate change-related activities as part of their development programmes.

2. Examples of government enabling activities

22. Resource flows to all three countries have been dominated by official development

assistance (ODA) and long-term debts. For example in 1994, these constituted 77 per cent and 22 per cent respectively of all resource flows in Senegal, 65 per cent and 35 per cent in Kenya, and 41 per cent and 53 per cent in Zimbabwe, with hardly any difference in the total resource flows. Foreign direct investment has been minimal in all countries, nil in Senegal, 0.4 per cent of the total resource flows in Kenya and just under 6 per cent in Zimbabwe, while equity flows from outside are nil in all countries.[8]

23. Government enabling activities are aiming to attract investors in all sectors through a variety of policies. Specific laws focusing on the transfer of ESTs or climate-relevant technologies are not priorities, however they are considered in the general context of broad economic development policies. Some measures directly related to ESTs are presented below.

24. In general, investment laws in African countries have changed since the late 1980s and early 1990s, when countries had to undertake economic reform programmes to boost their administrative and economic efficiencies. As a result, they instituted policy changes to attract foreign investors by reducing or removing legal and regulatory obstacles on the activities of foreign companies. In addition, most African countries now provide benefits to foreign companies, such as generous conditions for profit repatriation and tax-free salaries. However, countries are yet to benefit significantly from these actions as the amount of foreign investment to Africa is still comparatively small. To date there is a relatively low level of new investments by large foreign investors, especially the transnational corporations (TNCs).

25. A major change, which might attract foreign investments in African countries, is the removal of many restrictions on foreign participation in local equity markets and the easing of exchange controls. Despite the continent's economic problems, capitalization in stock markets has been growing. At the end of 1995, capitalization in the continent was just over US$265 billion, with South Africa accounting for 90 per cent, northern Africa 5.5 per cent and the other countries the remaining 4.5 per cent. However, there are signs that the emerging stock exchanges will grow at a faster pace as laws restricting foreign and regional investments are reduced or removed.

3. Barriers related to the transfer of environmentally sound technologies

26. There are still serious barriers that will affect the rate of technology acquisition in African countries, especially, for the least developed countries. They can be classified as technological, institutional, information, financial and market barriers. At the same time, there are overlaps among them because of the inter-relationships between these sectors. A significant number of African countries do not have an explicit national policy that supports technology development (acquisition of skills and knowledge from external

[8] Human Development Report 1997, UNDP, and World Development Report, World Bank, 1997.

sources and upgrading of indigenous skills). This absence creates obstacles for all the stakeholders, including government institutions, because actions by these stakeholders often requires a national policy.

27. Another barrier is the inadequate enabling environment for non-government stakeholders. Many believe that this obstacle contributes greatly to the low flow of foreign investments to the continent. Factors contributing to the lack of an enabling environment include inadequate macro-economic policies, and lack of communications, suitable small and medium scale firms for sub-contracting, appropriate financial systems and insufficient highly skilled workers.

28. Current efforts that started in the early 1990s in most African countries are making major changes in the macro-economic environment with improved financial and administrative efficiencies. However, more attention is needed to improve productivity through streamlining of government functions and provision of support for productive activities in the economy. The absence of such a macro-economic environment is a major deterrent to foreign investments because it can increase transaction costs.

29. Another general obstacle is the absence of feasible and appropriate standards based on local conditions in many countries, though most countries have institutions that are expected to perform this function. Lack of adequate support facilities and management has eroded their performance significantly, resulting in poor technology sourcing, selection and assessment. Investments by governments in this area and establishing effective linkages with the national education system could reduce this obstacle by ensuring that standards are regularly updated.

30. The relatively low level of technological capability in African countries compared with other developing countries is the greatest technical barrier to technology transfer and development in the continent. The major reason for the low capability is inadequate highly-skilled technical manpower. A critical mass of human capital with the needed technical knowledge and skills is crucial for technology development and transfer. Developing this critical mass is urgent because at each stage of the technology transfer process such a capability is required, and it is part of the enabling environment. Appropriate policies by governments and adequate support for the national education systems can assist greatly in tackling this issue. One important obstacle that has resulted from this barrier is that normal engineering procedures for testing, commissioning, and supporting equipment purchases are often lacking. This is a common problem for renewable energy technologies and contributes to their poor performance in many applications. It also contributes to poor maintenance programmes and poorly operating equipment. As a result, many newly introduced technologies appear dysfunctional.

31. Non-transparent legal systems and relatively weak enforcement mechanisms for laws relating to investments and companies also discourage both external and local investors, especially the former. For example, very long arbitration processes, unclear property rights and high legal fees can undermine business confidence.

32. Institutional inertia, or the resistance to change, is another obstacle and is worse in a

relatively uncompetitive environment as is the case in many African countries. This deters the introduction of new methods and techniques into the productive sector and generates inefficiencies.

33. The poor technical information base in many African countries is an important barrier because it seriously affects their capacity for effective sourcing and selecting of technologies, which is the very first phase in undertaking the technology transfer process. Many technically competent personnel in these countries lack access to global information, and this results in sub-optimal choices. Also, often there is a lack of local data required for the design of good investment projects. These data, such as performance data, supporting banking information and insurance information, are crucial for helping to make investments decisions.

34. The overall poor economic situation in African countries is the most important financial barrier in addition to the lack of external investments. It creates low perceptions of the economy leading to higher discount rates, which restrict investments. The poor economic base and low incomes lead to low savings potential which reduces the chances for local investments. The continued debt problem of many countries restricts their capacity to access external finance for projects and other financial needs, and this affects technology development. It also limits the participation of local entrepreneurs wishing to collaborate with external partners. Local banks are not always supportive of new areas, such as ESTs, because they view them as being too risky.

35. In addition, the size of the market is very small in African countries for two reasons: first, the majority of African countries are small, with over 50 per cent having populations under 15 million; secondly, many economies are dependant on rural agriculture, so the market size for many goods is limited to the urban areas. A small market size poses a problem to business as it signifies lower rates of return on investments.

36. Finally, the structure of markets, often monopolistic or oligopolistic, is a barrier to establishing a fair pricing system. In many cases, the financial systems fail to give price signals, therefore energy efficiency measures may not be introduced. As a result, further development of the technological base of related industries becomes unnecessary.

4. Solar photovoltaic systems

37. The use of solar photovoltaic (PV) systems is widespread in virtually every country in Africa. Presently, Africa produces more than150,000 units with a total power output of about 5 MWp, which represents an estimated 10 per cent share of the world market. They are used mainly for lighting in remote areas not supplied by the electricity grid, for preservation of medicines in rural clinics and for telecommunication centres and back-up systems.

Kenya

38. Solar PV systems were introduced into Kenya as a response to the 1970s oil shocks and to the intense search for more reliable alternatives that followed. The cost of such systems during the early period, US$30 - US$40/peak watt, was far higher than people could afford. However, due to the decline in global prices and the interest of donor agencies, the use of PV systems for lighting, water pumping and village medical clinics has increased. International companies, such as Siemens and BP, have set up offices in Nairobi, and a few local entrepreneurs have emerged. This has led to market segmentation in which the donor agencies have concentrated on home systems while the TNCs have concentrated on large installations. Early market development, including confidence building among users through awareness campaigns, training and demonstrations, was done by the donor agencies. The combination of early donor investments, the development of local expertise trained by these companies, and an increase in solar PV globally leading to declining prices, has provided the basis for the solar PV boom that has followed.

39. The cumulative sales of solar PV systems in Kenya rose from 80 kWp in 1987 to 600 kWp in 1992. An estimated 40,0000 units have been installed today.[9] Apart from the global progress leading to efficiency improvement and price decline, the growth in the PV market can be attributed to the following:

(a) Battery production was started locally in the mid-1980s by the Associated Battery Manufacturers, a major producer of batteries in Kenya. The impact of this activity on technological capability was very positive as this led to greater use of locally-produced and assembled components. Also the cost is between 33 to 50 per cent lower than imported batteries after the initial period of learning and quality control;

(b) Electric grids have not penetrated into rural areas significantly, with access at less than 4 per cent. Prospects for more rapid penetration are due to high initial cost, low incomes of intended users, and large bureaucracies. Hence, decentralized systems with little government intervention become attractive; and

(c) Low-interest credit systems have been established to help users to pay the high initial cost over time. An example is the Solar Energy for Rural Kenyan Business programme that provides loans to business and community groups along with training and management support.

Zimbabwe

40. The use of solar PV systems in Zimbabwe started in earnest in the 1980s, mainly as a result of the search for alternatives in rural areas. Activities are many, but not as intensive as in Kenya; for example, by 1990 while Kenya had over 300 kWp of rural systems

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[9] INFORSE, 1997.

installed, Zimbabwe had less than a third.

41. A Global Environment Facility (GEF) solar project costing US$7.4 million is one of the most important projects in Zimbabwe. This is a 5-year project, which aims to demonstrate the benefits of solar energy through the provision of power for lighting, radio and television and the commercialization of solar systems. The main components of the project include easy access to foreign exchange, low interest credits for end-users, training of installers and users, and local purchasing of components. The project has installed approximately 8,500 solar home systems (SHS), and now supports 50 local companies that employ over 500 technicians. The major driving force for the project's achievement is the revolving fund managed by the Agricultural Finance Corporation, which provides low-interest loans to potential PV owners. Four thousand such loans have been disbursed so far.. The project has been using local manufacturing companies for charge controllers, batteries, lights and assembled solar panels. Also technical manuals have been produced for installers and users in addition to a price guide.

Senegal

42. The use of solar PV systems in rural areas of Senegal is significant though not as high as in Kenya and Zimbabwe. Introduced in a significant way about 8 years ago, about 1,600 SHS are currently in use in rural Senegal. However, there is a potential market for 130,000 households, which represents 30 per cent of the 420,000 rural households in the country. Two main obstacles affect the penetration of these systems: lack of finance to cover the high initial cost and poor maintenance. The lack of finance is being addressed by a financial initiative by ENDA, an international NGO, and FOPEN Solaire, a national NGO formed in 1994 by local co-operatives. FOPEN, formed mainly to provide advice and maintenance for the dissemination of SHS, now trains technicians and disseminates about 100 systems a year in a market for about 300 a year after import tax removal. In addition it provides spare parts. To improve maintenance FOPEN established a credit scheme for users to purchase major components, such as batteries, and it provides workshop facilities for its member associations.

Approaches for financing

43. The relatively high front-end cost of PV technology and the low income of the intended end-users (rural communities) is a major barrier to the penetration of this technology. Government intervention is needed because the normal banking system cannot provide credit facilities to these end-users due to their strict adherence to banking rules. They normally require feasibility studies at the applicant's expense, land titles as collateral, and accounting management documents moreover, banks charge high interests rates as was shown in the case of Uganda.[10]

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[10] Turyareeba, 1993.

44. In some countries, such as Kenya, private companies have set up “hire-purchase” schemes with down payments of 40 per cent and the remaining 60 per cent paid in monthly instalments, but the success has been limited due to repayment problems.[11] In Botswana, government intervention has proved useful. The Government entered into an agreement with a village cooperative, Rural Industries Innovation Centre, to undertake a financial and technical feasibility study for the use of photovoltaic systems for lighting in the village of Kanye. The Government contributes 70 per cent to the revolving loan fund and the Renewable Energy for Africa contributes 30 per cent. Loans are amortized over two years with monthly payments of $8.75 for two-light systems and $31.25 for six-light systems. Only five out of 42 recipients in the programme defaulted and they have promised to pay at a later date. The success of the scheme led to its replication in four other villages. The flexibility of repayments under this scheme, which was due to the Government’s intervention, contributed to its being viewed by many as a success.[12] Zimbabwe also has a revolving fund through the GEF project, but this has shown limited success.

45. The successful operation of renewable energy technologies require specialized training to ensure proper operation and after-sales service. All three countries are carrying out this type of training mainly through the NGO community. For example, Zimbabwe has a five-year training program for farmers in River Estate, which has 26 solar homes. In this programme, operated by the NGO, Development Aid for People to People (DAPP), users are trained to operate and maintain PV systems. Also, there are several specialized courses in different renewable energy technologies, and some specifically on PV installation, including one conducted by KARADEA, an NGO in Tanzania.

46. Promoters of this technology have advocated removal of import duties and taxes as a means of providing subsidies to users of PV technology. Government responses have been mixed owing to the resultant loss of revenue and because most of the current users are from the middle and higher classes, which they are unwilling to subsidize. However, the impact of duties and taxes on the final pricing of home units can be significant. In Kenya, compact fluorescent lamps (CFLs) carry a 37 per cent import duty and 18 per cent VAT, the same as other electric bulbs. Locally-produced batteries are charged 18 per cent VAT, and imported batteries 37 per cent import duty and 18 per cent VAT. PV panels have a slightly lower import duty of 31 per cent, but a VAT of 18 per cent. The import duty on D.C. generators is only 12 per cent and VAT is only 5 per cent. In Zambia, the Government in 1994 provided incentives to purchase PV by Statute 114, which removed duty and sales tax on PV, but the impact is yet to be reported. In Uganda, a 58 per cent tax on PV systems was removed in 1992/93 and re-introduced in 1993. However, since most governments in the region subsidize kerosene because it is used mainly by the poor, reducing tax for PV in a reasonably large market will lower the final price. Table 4 provides examples of financing programmes in selected African countries.

[11] Kimani, 1993.

[12] J. Geche and J. Irvine, 1996.

Table 4. Financing programmes for PV in selected countries

Country	Financing condition
Botswana	- 45 per cent duty on PV removed in June 1986 - VAT and duty exemption on all PVs imported by donors - Government grants for wind pumps
Kenya	- Government grants for renewable energy development.
Senegal	- Removal of import duties on PVs. Devaluation of local currency by 100 per cent affected sales.
Seychelles	- Tax exemption on solar devices
Zambia	- Removal of import tax and VAT
Zimbabwe	- Soft loans for PV users under GEF project. Reduced taxes and import duties

5. Ethanol programmes

47. Of the three countries in Africa reported to be using ethanol as an additive to gasoline for transport fuel, Kenya, Malawi and Zimbabwe, only Zimbabwe has proved successful. Hence most of the discussions in this section will focus on the use of ethanol in Zimbabwe. However, the activities in Kenya are also reported because its experiences provides some lessons for other countries in the region.

Zimbabwe

48. The ethanol production programme which was started in Zimbabwe in 1979, is one of the world's most successful programmes, second only to Brazil.[13] Ethanol production for transport fuel is an innovative programme between the Government and the private sector resulting from a conscious effort to cope with economic pressures to reduce imports. The private sector company involved is Triangle Ltd. It uses molasses from sugar cane production in Zimbabwe and Zambia to produce enough ethanol to displace over 40 million litres of gasoline imports annually. The Triangle Ltd. plant was locally planned, controlled and operated. The plant was established during a period when Zimbabwe could afford to convert sugar to ethanol due to low export prices and a large molasses supply. Local construction benefited the country because the control systems were adapted to cope with local skills, and substantial local materials were used in place of imports, resulting in a 60 per cent local content of the plant. This led to substantial cost savings. Currently, ethanol is sold to the Government-controlled Oil Corporation, which then sells it to various oil companies for blending (up to 13 per cent in gasoline) and distribution.[14]

49. The ethanol programme in Zimbabwe provided the following benefits: it produced

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[13] Scurlock et al, 1991.

[14] Rosenchein, 1991.

ethanol with an energy ratio of 1:1.9 in an ethanol/gasoline mixture (13 per cent); it is the only fuel available for use in spark ignition engines in the country; it has produced significant foreign exchange savings by reducing the need for imported gasoline; it has improved human resources capacity, increased rural employment; and stimulated the private sector.

Kenya

50. A similar ethanol programme for transport fuel production was introduced in Kenya in 1977 with the objective of reducing oil imports, but the results were different from those in Zimbabwe. Only one of the three envisaged projects got started, and that was operated by a private company, Agro-Chemical and Food Company. The ethanol produced was used to blend with gasoline of up to 10 per cent.[15] The project had several technical problems, such as frequent blender breakdowns and fluctuating molasses supplies. Other problems affecting the programme included: subsidies that undermined efficient production even though the private sector was also involved, technical and management problems resulting from the limited involvement of local personnel in the project design, construction and operation; and the lack of well-developed manufacturing and technological capabilities made the programme very expensive.

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[15] INFORSE,1997.