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NEW TECHNOLOGIES AND METHODOLOGIES FOR INTERVENTION TO PROMOTE DEVELOPMENT

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What do we mean by technology transfer?

Technology transfer can be defined as a broad set of processes covering the flows of know-how, experience and equipment for mitigating and adapting to change amongst different stakeholders, such as governments, private sector entities, financial institutions, non-governmental organizations and research/education institutions. It covers technology transfer processes among developed countries, developing countries and countries with economies in transition. It involves learning to understand, utilise and replicate the technology, including the capacity to choose and adapt to local conditions and integrate it with indigenous technologies.

Stakeholders, pathways and stages

Technology transfer results from actions taken by various stakeholders. Key stakeholders include developers, owners, suppliers, buyers, recipients and users of technology, such as private firms, State enterprises, individual consumers, financiers and donors, governments, international institutions, non-governmental organizations and community groups. Some technology is transferred directly between government agencies or wholly within vertically integrated firms, but increasingly technology flows depend also on the coordination of multiple organizations such as networks of information service providers, business consultants and financial firms. Although stakeholders play different roles, there is a need for partnerships among stakeholders to create successful transfers. Governments can facilitate such partnerships. The rate of technology transfer is affected both by motivations that induce more rapid adoption of new techniques and by barriers that impede such transfers. Both types of factors can be influenced by policy. However, an analysis of policies in the Caribbean, particularly science and technology policy has revealed some deficiencies in this area. The study concluded that "*whether in finance or know-how, the emphasis continues to be on how to lure resources into the subregion, with minimal indigenous investment. Hence the policies have focused on incentives to foreign investors rather than on research and development and indigenous capacity building.*" *(Comparative study of policies on technology and industry in the Caribbean and their effects on development – General LC/CAR/G.752. 29 September 2003.)* In some cases certain regulations may prescribe the use of specific technologies, while approval of new, more efficient or effective technologies must go through lengthy legal processes. In addition, relevant government agencies may be fragmented, which impedes decision-making at all aspects of technology transfer. Effective technology transfer depends on the ability of the technology supplier to deliver the desired technology and on the capabilities of the technology recipient to employ it.

Building capacity

Capacity building is required at all stages in the process of technology transfer. It is a slow and complex process to which long-term commitments must be made for resources and to which the host country must also be committed if results are to bear fruit. The focus should be on building human, organizational and information assessment capacity. Moreover, integrating human skills, organizational development and information networks is the key to effective technology transfer. Social structures and personal values evolve with a society's physical infrastructure, institutions and the technologies embodied within them. New technological trajectories for an economy therefore imply new social challenges. This requires a capacity of people and organizations to continuously adapt to new circumstances and to acquire new skills. Governments can support the establishment of dynamic flexible learning mechanisms not only at the national level, but also at a level of subnational regions.

Human capacity

There are many failures of technology transfer that result from an absence of human and institutional capacity. This makes adequate human capacity essential at every stage of every transfer process. Technology demands a wide range of technical, business and regulatory skills. Capacity is needed to assess, select, import, develop and adapt appropriate technologies. Accumulated technology transfer experience indicates that developing countries' enterprises are not always able to effectively exploit the diversity of available technological options and services. Policies aimed at ensuring the availability of these skills locally can enhance private international investments through which much technology is diffused.

Many ways of developing capabilities for the assessment, agreement, and implementation stages of technology transfer are suggested by development experience: (a) formal training of employees, (b) technological gatekeeping, by keeping informed of technical literature, forming links with other enterprises, professional and trade organizations, and research institutions; (c) learning by doing-operational experience such as through twinning arrangements with other firms. Examples of the above abound in the region, but whether they were due to a stated long-term development policy was the subject of another study on technological competitiveness in the region.

Developing country governments can build local capacities to gear them for technology transfer. Training and human resource development have been popular development assistance activities. Future approaches can be more effective by better stressing the integration of a total package of technology transfer, focusing less exclusively on developing technical skills and more on creating improved and accessible competence in associated services, organizational know-how, and regulatory management.

Organizational capacity

The historical legacy of development efforts, i.e. the failure of top-down, technology focused development, has provoked a reassessment of the appropriate roles of the community, government and private sector in development and technology transfer. It is now widely

recognised that involvement of community institutions is an essential part of successful sustainable development. The involvement of local government agencies, consumer groups, industry associations and non-governmental organizations can ensure that adopted technologies are consistent with sustainable development goals. Besides the involvement of such community institutions, lessons from technology-intensive economies teach that technology increasingly flows through private networks of information and assessment services, management consultants, financial firms, lawyers and accountants, and technical specialist groups. These new insights make it important for governments to strengthen the networks in which these diverse organizations can contribute to technology transfer.

Information assessment and monitoring capacity

Information access and assessment are essential to technology transfer. However, focusing too narrowly on information barriers while ignoring the later stages of the transfer process can be counter-productive. Technology information programmes should be demand driven and results oriented to the degree possible. Information is most useful when it supports an actual technology choice and investment decision.

Enabling environment and extra efforts to enhance technology transfer

Successful, sustainable technology transfer requires a multi-faceted enabling environment. An enabling environment for technology transfer includes macroeconomic conditions, the involvement of social organizations, national institutions for technology innovation, human and institutional capacities for selecting and managing technologies, the underpinnings of sustainable markets for environmentally-sound technologies, national legal institutions that reduce risk and protect intellectual property rights, codes and standards, research and technology development, and the means for addressing equity issues and respecting existing property rights.

Governments can aid in establishing an environment which promotes markets by considering what is the set of institutions which underlie markets and what are appropriate public interventions to shape those institutions. They define the property rights, contract enforcement mechanisms, and many of the rules for transactions that are necessary for markets to work well. Policies that build or facilitate markets can have a strong influence on the characteristics of those markets, for example, the relative sales share of domestic versus foreign products, the segments of consumers participating in the market, the ability of domestic producers to participate in the market, the technologies available, and how regulations govern market behaviour.

Actions for all governments

Macroeconomic conditions

Macroeconomic conditions that can favour the flourishing of private sector development include low inflation, stable and realistic exchange rates, deregulation, free movement of capital, promotion of competitive markets, open trade policies and transparent foreign investment policies.

Availability of and access to financing

Further efforts are needed to encourage banks and other lending institutions to finance environmentally-sound technologies and projects. Such efforts may consist of stimulating innovative financial mechanisms, public-private partnerships and the involvement of intermediaries. There is a wide variety of types of traditional private sector debt and equity finance available depending on the scale and type of the project. The most flexible finance debt is secured loan and leasing. Just as supporting scientific and technical innovation is seen as an appropriate use of public funds, so can financial innovation. A number of worthwhile initiatives have been undertaken to date (such as micro-credit, project finance, green finance and also the use of strategic investors) and there is scope to replicate and extend these as well as develop new concepts. Different financing arrangements are often required at both the production and acquisition stages. Public private partnerships are increasingly seen as an effective way in which the public sector can achieve public policy objectives by working with the private sector. For the public sector they have the potential of harnessing the efficiency of the private sector, as well as overcoming budget restrictions and leveraging limited public funds. For the private sector, they aim to help overcome some of the internal and external barriers which prevent appropriate technology transfer from taking place, and to create interesting business opportunities.

Legal systems

Uncertain, slow and expensive enforcement of contracts by national courts or international arbitration and insecure property rights can discourage investment. Three broad types of legal risk are likely to influence decisions to invest in advanced technologies by foreign and domestic actors:

(a) Contract risk refers to the likelihood and costs of enforcing legal obligations with suppliers, partners, distributors, managers, labour forces, construction organizations or licensors.

(b) Property risk refers both to more familiar risks associated with interference in asset ownership and to less visible, but also to essential questions of corporate governance including shareholder rights and competition laws that determine how decision-making within the firm is divided and whether firms will be able to operate in competitive markets.

(c) Regulatory risk arises from the behaviour of public administrations, which influence economic returns through licensing, tariff setting, taxation, and foreign exchange and trade controls.

To reduce contract, property and regulatory risk, governments can strengthen national, legal institutions for intellectual property protection; strengthen administrative and law processes to assure transparency, participate in regulatory policy-making and independent review; and strengthen legal institutions to reduce risks and corruption and to ensure that public regulation is accessible to stakeholders and subject to review by independent authorities.

Intellectual property rights

For harnessing the bulk of international investment, intellectual property rights (IPR) regimes are an important consideration. Overall the literature is diverse concerning the relationship between IPRs and technology transfer. Strong IPR regimes generally lead to increased innovation and "vertical" technology transfer and increased foreign investment, although it should be kept in mind that it is not the only factor affecting investment decisions. Strong IPR regimes could, however, depending on the holder of the patents, slow down the dissemination of certain technologies, the so-called horizontal technology transfer. Where this is the case, countries may address this concern by taking appropriate measures. For example, the risk of unlicensed patents may be reduced by charging increasing annual maintenance fees. If the fee becomes high enough by 5 to 10 years after patent issuance, the owner might let an uncommercialised patent lapse. Another option is compulsory licensing as specified under the international Trade Related Aspects of Intellectual Property (TRIP) agreement and in decisions contained in Agenda 21, provided that correct procedures are followed (generally, they require the user first to seek a license through regular venues, to pay reasonable compensation for the license and to practice the invention on a limited non-exclusive basis).

Consumer awareness, and product standards, industry codes and certification

Governments can work with the private sector and non-governmental organizations to establish codes, standards and labels. This provides a framework which can work to the benefit of industry and consumers. This route can help build markets for dispersed, small-scale technologies where technologies are diverse, vendors are many and consumers face high risks in evaluating and selecting technologies and suppliers. Codes and standards also provide a means for representing the interests of end-users who are absent from purchase or construction decisions. Standards also reduce risk for consumers with regard to the equipment they are purchasing.

With regard to energy use, information programmes have proven successful in assisting energy consumers to understand and employ technologies and practices to use energy more efficiently. These programmes aim to increase consumers' awareness, acceptance and use of particular technologies or utility energy conservation programmes. Examples of information programmes include educational brochures, hotlines, videos, design/assistance programmes, audits, energy use feedback programmes and labelling programmes.

For industry, energy audit programmes are a more targeted type of information transaction than simple advertising. Industrial customers that have undergone audits have reduced their electricity use by an average of 2% to 8%, with the higher savings rates achieved when utilities followed up their initial recommendations with strong marketing, repeated follow-up visits, and financial incentives to implement the recommended measures.

Developing countries actions

Assessment of local technology needs and meeting of local demands

Participatory development is now widely recognised as a way of achieving effective technology transfer at all levels of development endeavour. This has grown from a perceived need to move from donor-driven technology transfer to national needs-driven approaches. It can facilitate market transformation through the involvement of firms and consumers. Governments are the most direct and influential actors for promoting a favourable environment for participation among the private sector, public sector organizations, non-governmental organizations and grassroots organizations at regional and local levels. In the Caribbean, there is considerable participation in assessing local technology needs and meeting local demands by all of the sectors, but the significant step towards mainstreaming these activities in government and development agencies still has to be made.

Meeting local demands also includes examining what the social impacts of technology transfer will be and how negative impacts can be reduced. There is a particular need for developing guidelines for ensuring that technology transfer projects do not disempower or negatively influence weaker social groups in a society. Such guidelines could draw from guidelines on integrating gender issues in technology development.

Participatory development can thus achieve:

(a) Better choices and identification of possibilities and opportunities in local systems;

(b) Better commitment to projects which improves implementation and sustainability;

(c) Opportunities to negotiate conflicts;

(d) Empowerment- which raises awareness about the need for stakeholders to achieve solutions themselves.; and

(e) Access to additional resources for the project raised from the target project beneficiaries through payments, and time.

Property right issues and ownership

The experience in agriculture, forestry and use of other natural resources has shown that the successful introduction of new technologies often depends on recognition of the existing forms of ownership, or on taking steps to create an improved property rights regime. With an understanding of existing - legal and actual - forms of ownership, technologies or modified resource uses can be adapted to fit this existing system. If property issues are taken into account, those introducing new technologies or proposing modifications in land or resource use can be more assured of the support of the target populations or groups.

Mechanisms for technology transfer

National systems of innovation

In recent years it has become clear that technology intermediation is needed to reduce barriers to technology transfer associated with information, management, technology and financing. Research on technology innovation also highlights the role of intermediaries in the innovation process. They operate between users and suppliers of technology and help to create the links within networks and systems through bridging between institutions, encouraging interaction within the system and assisting with undertaking search, evaluation and dissemination tasks. They ensure that technological know-how is broadly dispersed within the system and can provide a compensating mechanism for weaknesses or "holes" in the system.

Examples of technology intermediaries include specialised government agencies, energy-service companies, non-governmental organizations, university liaison departments, regional technology centres, research and technology organizations, electric power utilities, and cross-national networks. Non-governmental organizations, in particular, are playing a greater role in technology intermediation; for example, there are many cases where technology intermediation by non-governmental organizations played a key role in the success of particular technology transfer efforts for renewable energy.

The key lesson which can be learnt from the literature on technology intermediaries is the importance of mechanisms in which actions are integrated to make them more effective. Technology transfers are influenced greatly by national systems of innovation--the institutional and organizational structures which support technological development and innovation. Governments can build or strengthen scientific and technical educational institutions and modify the form or operation of technology networks-the interrelated organizations generating, diffusing, and utilising technologies.

National systems of innovation (NSI) integrate the elements of capacity building, access to information and an enabling environment into a mechanism for technology transfer that adds up to more than the individual components. Subsystems and the quality of interconnections within them can successfully influence technology transfer. NSIs can be enhanced through partnerships sponsored by international consortia. Partnerships would be system oriented, encompass all stages of the transfer process, and ensure the participation of private and public stakeholders, including business, legal, financial and other service providers from developed and developing countries.

NSI activities may include:

(a) Targeted capacity building, information access and training for public and private stakeholders and support for project preparation;

(b) Strengthening scientific and technical educational institutions in the context of technology needs;

(c) Collection and assessment of specific technical, commercial, financial and legal information;

(d) Identification and development of solutions to technical, financial, legal, policy and other barriers to use of technologies;

(e) Technology assessment, promotion of prototypes, demonstration projects and extension services through linkages between manufacturers, producers and end users;

(f) Innovative financial mechanisms such as public/private sector partnerships and specialised credit facilities;

(g) Local and regional partnerships between different stakeholders for the transfer.

NSI offer a new solution to the challenge of technology transfer and offer a cost-effective, flexible way of enhancing technology transfer. Governments and multinational organizations should consider developing programmes to support NSI activities, either individually or jointly.

Multilateral development banks

The Multilateral Development Banks (MDB) consider technology transfer as part of their mission to encourage development. More recently they started to focus on the challenges of the environment and the specific problems involved in transferring environmental technology. In response, many have started to develop a range of initiatives and activities.

In particular, development banks have become aware of the role they can play in helping to mobilise private capital to help meet the needs of sustainable development and the environment, and of the potential to use financial innovation to encourage environmental projects and initiatives. While much of the earlier work they did was sporadic, the private sector arms of the MDB are now seeking to identify ways they can work with international private capital to help address environmental and developmental needs.

Technology transfer: A sectoral analysis

Domestic actions, and those taken in cooperation with other countries, will require an increased penetration of environmentally-sound technologies, many of which are particularly important in their application to each sector. What is the potential for the penetration of mitigation and adaptation technologies? What barriers exist to the increased penetration of such technologies? Can these be overcome through the implementation of a mix of judicious policies, programmes and other measures? What can we learn from past experience in promoting these, or similar, technologies? Is it better to intervene at the research and development stage or during the end-use of fuels and technology? Technology transfer activities may be evaluated at three levels - macro or national, sector-specific and project-specific.

Technology transfer includes steps within and across countries by actors who are engaged in promoting the use of a particular technology along one or more pathways. The market penetration of a technology proceeds from research, development, and demonstration (RD&D) to adoption, adaptation, replication and development. At a project-specific level, the elements of the pathway are different and may proceed from project formulation, feasibility studies, loan appraisals, implementation, monitoring and evaluation and verification. The pathways that differ from sector to sector usually include many actors, starting with laboratories for RD&D, manufacturers, financiers and project developers, and eventually the customer whose production capacity or welfare is hopefully enhanced through their use. This presumption needs to be carefully established through an assessment of technology needs of the customer. A poor needs assessment can result in ineffective technology transfer that could have been avoided had the assessment fully captured the social, and other attributes of the technology. The actors may make specific types of arrangements - joint ventures, public-private parnerships, and licensing, that are mutually beneficial. These arrangements will define the particular pathway chosen for technology transfer.

The spread of a technology may occur through transfer within a country and then transfer to other countries. Both may occur simultaneously, or transfer across countries may precede that within a country. Generally, the spread of a technology is more likely to proceed along the first option rather than the other two, since the transfer of technologies to markets within a country is likely to be less expensive given the proximity to the market, and lower barriers to the penetration of that technology in the indigenous markets. Transfer of technology from one country to another will generally face trade and other barriers both in the initiating and recipient country, which may dissuade manufacturers and suppliers from implementing such transfer.

Many market barriers prevent the adoption of cost-effective mitigation options in developing countries. Market barriers can be divided in more common barriers which are more or less relevant for all sectors. On the other hand, barriers such as drought, fire and pests are very sector-specific and mostly affect the forestry and agriculture sectors.

What conditions and policies are necessary to overcome these barriers and successfully put in place technologies for mitigation and adaptation? There is no pre-set answer to enhancing technology transfer. The combination of barriers and actors in each country creates a unique set of conditions, requiring "custom" implementation strategies.

Adaptation technologies

The general dynamics of technology transfer apply to the transfer of climate mitigation and adaptation technologies. Nevertheless, it is important to note the special characteristics of adaptation technologies that distinguish them from mitigation technologies. Many impacts of climate change will impinge on collective goods and systems, such as food and water security, biodiversity and human health and safety. These impacts could affect commercial interests indirectly, but usually the strongest and most direct incentives to adapt are with the public sector. The use and transfer of many adaptation technologies world-wide has occurred because of societal interventions, not as a result of market forces. Examples of such interventions include

direct governmental expenditures, regulations and policies and public choices. Adaptation technologies will often address site-specific issues, and will therefore have to be designed and implemented keeping local considerations in mind. This could hamper large-scale technology repetition.

In spite of adaptation often not being considered a development objective, governments have a number of clear incentives and opportunities to start planning for adaptation. Strengthening technological, institutional, legal and economic capacities as well as raising awareness are important for effective adaptation and technology transfer, for no adaptation option will be successful when it is implemented in an environment that is not ready, willing or able to receive the option.

Renewables

In the renewable sector, technology transfer has been constrained by the lack of investment and high costs. Investment has been generally limited to niche or protected markets, because of technical, institutional and economic barriers. Governments need to provide incentives for investment and to remove policies that hinder the application of renewable energy as described in the general policy measures above. They also need to promote the development of improved and more cost-effective renewable technologies amongst others, by:

(a) Developing human and institutional capacities;

(b) Fostering joint research and technology development;

(c) Promoting assessment of the potential of renewables;

(d) Involving local communities, mainly in small size energy supply projects.

Solid waste management and wastewater treatment

Methane is generated from solid waste and wastewater through anaerobic decomposition. Together, solid waste and wastewater disposal and treatment represent about 20 per cent of human-induced methane emissions. Emissions are expected to grow in the future, with the largest increases coming from developing countries. Methane emissions can be reduced in many ways, including reducing waste generation (source reduction), diverting waste away from disposal sites (i.e., through composting, recycling, or incineration), recovering methane generated from the waste, or ensuring that waste does not decompose in an anaerobic environment. In general, any technique or technology that reduces methane generation or converts methane into carbon dioxide through combustion will reduce greenhouse gases. The most effective mitigation approaches are those that either reduce overall methane generation (because methane collection efficiencies rarely approach 100 per cent) or ensure that the combusted methane is substituted for fossil-based energy.

Extensive technology transfer aimed at improving waste management is underway both within and among countries, although most activities have been, and will likely continue to be, domestic in nature. In many regions, large investments are still required to provide adequate

waste management services. Governments play a predominant role for technology transfer in the waste management sector , with several levels of government (from the national to the municipal level) participating. Key government priorities include the establishing of appropriate policy and regulatory frameworks, supporting the expansion of private sector participation, taking part in technical assistance and capacity-building activities, particularly with community groups and, in some cases, providing incentives to catalyse desirable actions.

Historically, the private sector (including both domestic and multinational firms, as well as more informal local enterprises) and community-based organizations have been limited participants in government-driven technology transfer. The private sector has an increasingly important role, however, because meeting future waste management needs depends on expanded private investment. Private sector driven pathways are already used routinely for some types of investments (such as methane recovery at landfills), and efforts are underway to expand private sector participation across the full range of waste management services and technologies. The involvement of community organizations is also increasing as the link between community support and project sustainability has become clear. Soliciting local input and providing local training are two ways of ensuring sustainability.

Challenges

The challenge of successfully transferring environmentally sustainable technologies must be seen in the context of sustainable development. Sustainable development does not have to restrict growth but can stimulate the emergence of a vibrant, industrial economy, a process in which technology transfer is likely to play a major role. Sustainable industrialisation is especially a challenge for developing countries, because their low initial level of development provides them with an opportunity to follow a technological trajectory which can be cleaner and more efficient than the path Organization of Economic Cooperation and Development (OECD) countries have followed.

To enhance the sustainability of the development process, government actions can transform the conditions under which technology transfer takes place. The spread of proven technologies that would diffuse through commercial transactions may be limited because of the barriers listed above. Governments can play important roles in facilitating the private transfer of technologies by encouraging private sector trade and investment of environmentally-sound technologies. Capacity building programmes and enabling environments that reduce the risks and restrictions associated with transfer will increase the flow of technologies close to the commercial margin. The key issue is thus to make the markets work by "opening the channels". For technologies that will not yet diffuse commercially, it is important to go further than improving market performance by enacting policies that lower costs and stimulate demand in order to realise social and environmental benefits not adequately produced by private conduct. The international community could assist these extra efforts of individual countries by increasing available means for non-market transfers and creating new or improving existing mechanisms for technology transfer.

There are, therefore, no pre-set answers to enhancing technology transfer. It is important to tailor action to the specific barriers, interests and influences of different stakeholders in order

to develop effective policy tools. As has been stated clearly in Agenda 21, policy tools are most effective if they are considered in the context of sustainable development. Agenda 21 provided some of the earliest recommendations for public policies to promote technology transfer for environmental benefits. These recommendations reflect not only the need for hardware, but also for building associated local capacities and for providing market intermediation.

Strategies outlined in Agenda 21 include:

(a) Information networks and clearinghouses that disseminate information and provide advice and training;

(b) Government policies creating favourable conditions for both public sector and privatesector transfers;

(c) Institutional support and training for assessing, developing, and managing new technologies;

(d) Collaborative networks of technology research and demonstration centres;

(e) International programmes for cooperation and assistance in R&D 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.