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# SUSTAINABLE DEVELOPMENT AND TECHNOLOGY TRANSFER: PROBLEMS IN THE DIFFUSION OF ENVIRONMENTALLY SUSTAINABLE TECHNOLOGIES IN INDIA

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**Abstract**

*The growing consciousness on environmental degradation and its impact on human well-being have induced to embrace environmentally friendly technologies with an intention to conserve the environment for a long. The environmental improvement may be accomplished by the dissemination of sustainable technologies, which is either transferred from developed regions or existing sustainable technologies, in particular, in terms of greater energy efficiency and the associated reduction in the discharge of pollutants. The developed countries have the higher potential to afford technologies appropriate to environmental protection, whereas, poor countries have less ability to afford it. The economic structure of such developing countries itself constitute problems in adopting new technologies as the country suffering from poverty and poor economic development. India is not an exception, but diffusion of technology in the country is a slow process due to the interference of various obstructions. In the light of the global benefits to be gained by the implementation of Agenda-21 as a whole, the provision to developing countries of effective means, inter alia, financial resources and technology, without which it will be hard for them to fully carry out their commitments, will attend to the mutual interests of developed and developing rural areas and of humanity in general, including future generations. According to UNCED Report, environmentally sound technologies protect the environment, are less polluting, use all resources in a more sustainable way, recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they are stand-ins. Environmentally sound technologies in the context of pollution are 'process and product technologies' that generate low or no waste, for the prevention of pollution. They also cover 'end of the pipe' technologies for the treatment of pollution after it has been brought forth. The study intends to identify the issues associated with the technology transfer, diffusion of sustainable technologies and sustainable development issues due to poor technologies.*

**Keywords:** *technology transfer, sustainable development, sustainable technology, challenges.*

## Introduction

The tranfer and spreading of technology from the developed regions is vital in enabling countries to speed up progress towards sustainable development as contemplated in the outcome document of the 2012 United Nations Conference on Sustainable Development (Rio+20). The Rio+20 outcome document stresses the importance of cooperative action in technology innovation, research and development, and of exploring modalities for enhanced access to engineering sciences by developing countries. The importance of technology transfer for developing countries in Asia and the Pacific was also bet up in the Bangkok Declaration on the United Nations Development Agenda beyond 2015.

Agenda 21 is the comprehensive plan of action to come out of the first Earth Summit (1992) — was in many ways viewed as 'techno-centric' as it considered environmentally sound technology (ESTs) and information among the 'essential means' to achieve a sustainable world economy. In addition to Agenda 21, Principle 9 of the Rio Declaration went on to state that countries

*"Should cooperate to strengthen endogenous capacity-building for sustainable development by improving scientific understanding through exchanges of scientific and technological knowledge, and by enhancing the development, adaptation, diffusion and transfer of technologies, including new and innovative technologies".*

As a consequence of the momentum provided by the first Rio Summit, most of the Multilateral Environmental Agreements (MEAs) concluded thereafter incorporated provisions on technology transfer. In 2010, Parties to the United Nations Framework Convention on Climate Change (UNFCCC) agreed to the establishment of a Technology Mechanism to be operational by 2012, an important milestone in efforts to operationalise technology transfer provisions in MEAs.

Technology transfer can be a potent solution for simultaneously addressing the climate change and development challenges. This was recognized in Art. 4.5

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of the UNFCCC. There are increasing insights that meeting a growing global energy demand with improved energy access for the poor can only go hand in hand with low GHG emission pathways. The realization that these pathways involve rapid innovation of low-emission technologies has moved technology development and transfer to the nub of the climate negotiations and development debate. Although technology transfer was discussed at succeeding sessions of the UNFCCC Conference of the Parties (COP) within the context of the Convention's Art. 4.5, it was not until 2001 that significant change happened. At the seventh session of the COP (or COP 7), held in Marrakech (Morocco), a conclusion was made on a Development and Transfer of Technologies and the Expert Group on Technology Transfer (EGTT) was set up to facilitate transfers (UNFCCC, 2002).

The central ideas of the framework embraced by the EGTT were (UNFCCC, 2002):

- Assessment of technology needs;
- Technology information: technical and other information;
- Enabling environments: how to solve policy and legal barriers;
- Capacity building: identifying country needs; and
- Mechanisms: co-ordination of process and formulation of projects.

**New areas introduced were:**

- Innovative options for financing technology transfers; and
- Technologies for adaptation.

At 2009, the EGTT estimated the extra funding needs for low-emission technologies in developing countries at US$ 105–402 billion per year (which is 40–60% of global climate technology finance needs) (EGTT 2009). It was also concluded that: 2.2 Engagement of Developing Countries-

*"Not all countries have the technologies needed or the ability to innovate new technologies to mitigate and adapt to climate change. Those countries that are lacking in the technologies or capacity, mainly the developing countries, need to be helped not merely to adopt the existing environmentally friendly technologies but also to develop the capacity to innovate new technologies and practices in cooperation with others".*

It is important to underline that identification of engineering sciences and possibly implementing them in projects may not be enough to initiate a scheme change for widespread technology innovation in a nation. Although recognition of technologies is an important step in low-emission and climate-resilient development, overarching strategies will be needed to make certain that the technologies diffuse well within countries' systems or markets. The schemes may include actions such as organizational/institutional behavioral change, system-supporting services (e.g., Finance and legal support), network creation and support, skills training, international co-operation and intellectual property rights and corresponding policies and standards. This has been made clear by EGTT as follows:

*"Technology transfer includes not merely the transfer of hardware, but also best practices, information and improvement of human skills, especially those possessed by specialized professionals and engineers. The acquisition and absorption of foreign technologies, and their further development are complex processes that demand considerable knowledge and efforts on the part of those that acquire them. It is the capacity of the countries and the enabling environment in those countries that will enable them to change to a low-carbon economy".*

The need and significance of technology transfer have been identified to combat climate change issues. Thus, all the lands, respect of the intentensity of impact of climate change faced, holds their hands together to transfer environment friendly technologies. Environmentally sound technologies are not just individual technologies, but total systems, which include know-how, procedures, goods and services, and equipment every bit well as organizational and managerial processes. This involves that when talking about the transfer of applied sciences, the human resource development and local content-building aspects of technology choices, including gender-relevant aspects, should likewise be indicated. Environmentally sound technologies should be compatible with nationally determined socioeconomic, ethnic and environmental priorities. India has not much potential to adopt technologies at the dot of time due to financial restraints, lack of know-how, poor resource base and the cruel circle of poverty. Even though, the environment is still under the threat of pollution since the adoption of sustainable development policies. There is an urgent need for updating our technologies in the sectors of clean fuels, CFC free coolants/refrigerants, pollution control, growing chemicals, industrial/occupational safety, hazardous substances management, etc.

## Sustainable Development and Role of Technology

The concept of sustainable development first came forth in the 1960s when environmentalists started debating on the impact of economic development on the surroundings. Since then, different definitions of sustainability and sustainable development have been put forward and talked over, but the most widely adopted,

one was published in the report, "Our Common Future" (also recognized as the Brundtland Report) by the World Commission on Environment and Development in 1987, which defined sustainable development as:

*"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs".*

Sustainable development recognizes that development must be both inclusive and environmentally sound to cut poverty and build shared prosperity for today's population and to continue to satisfy the demands of future generations. It is efficient with resources and carefully planned to deliver both immediate and long-term benefits for people, planet, and prosperity.

The three pillars of sustainable growth – economic development, environmental stewardship, and social inclusion – carry across whole sectors of development, from cities facing rapid urbanization to agriculture, infrastructure, energy development and use, water availability, and shipping. Cities are embracing low-carbon growth and public transportation. Farmers are picking up the patterns of climate-smart agriculture. States are recognizing the value of their natural resources, and industries are realizing how much they can save through energy and supply chain efficiency.

Moreover, at that place is a great reliance on technology to solve environmental problems around the globe, because of an almost universal reluctance by governments and those who advise them to realize the social and political changes that would be necessary to cut growth in output and consumption (Beder, 1994). Until today the sorts of technological modifications that would be necessary to keep up with and counteract the growing environmental damage caused by increases in production and utilization of goods and services would have to be fairly dramatic. Sustainable development policies seek to change the nature of economic development rather than repair it. They are premised on the belief that continual growth in a finite creation is possible through the powers of technology, which will enable us to detect new sources or provide alternatives if a particular resource appears to be going out. Otherwise, technology will help us use and reuse what we have pulled up stakes in the most effective manner. The tools of sustainable growth, economic instruments, legislative bills and consumer pressures are directed at achieving technological changes such as recycling, waste minimization, substitution of materials, changed production processes, pollution control and more efficient use of resources (Beder, 1994).

The Organization for Economic Cooperation and Development (OECD), found that more investment in pollution control was being employed for end-of-pipe technologies, with only 20 per cent being used for cleaner production. Cleaner technologies are not always available and, even when they are, companies tend not to substitute their old technologies until they have run their useful lifetime. Similarly, companies prefer to keep to a minimum the organizational changes that necessitate to be repaired; they like to play it safe when it comes to investment in pollution management.

The problem with bars such as end-of-pipe technologies is that they are technological fixes that do not address the case of the problem. Such fixes can often cause other problems:

*"A target for improving the efficiency of the combustion of fossil fuels is to convert all available carbon in the fuel into carbon dioxide. On the other hand, carbon dioxide is a major greenhouse gas. Moreover, our means of achieving better thermal efficiencies is by increasing the temperature of the combustion process. As a result of increasing temperature, however, is that more oxides of nitrogen are formed from the air used in combustion. Oxides of nitrogen are an important element in the formation of photochemical smog. Thus, in the pursuit of more efficient energy usage, it is possible other potentially undesirable side-effects may arise".*

In an increasingly globalized world, the success of these technologies in their local communities suggests an opportunity for more extensive roll out to resolve similar issues about the world; however it's not that simple. Two common barriers faced by those developing sustainable technologies include the network of contacts necessary to communicate a design to market and the ability to scale up with resolutions to make them sustainable for the long-term and accessible more widely (Nathan, 2012).

It is a matter of fact that the technologies of the yesteryear, even dominating in transport, energy, industry and farming, are undermining our basic life supporting systems – clear water, clean air and fertile land. Yet, in each of these sectors there are new technologies available or emerging, which may, if widely used, essentially solve the environmental problems. Therefore, new technologies have the potential to lead to a decoupling of economic growth from pressure on natural resources. The fact is that we confront a choice between technological change at historically unprecedented rates or a change in atmospheric composition unlike any seen since the sunrise of mankind.

### Technology Transfer

Technology transfer must be realized as a broad and complex procedure if it is to avoid creating and keeping the dependency of the recipient, and if it is to contribute

to sustained and equitable growth. The end effect of the recipient must be the ability to use, replicate, improve and, possibly, re-sell the technology. Transfer of technology is more than merely the moving of high-tech equipment from the developed to the developing world, or within the developing world (United Nations Environment Program, 2003). If the transfer of inadequate, unsustainable, or unsafe technologies is to be avoided, technology recipients should be able to distinguish and select technologies that are appropriate to their actual needs, circumstances and capacities. Thus, a central component of this wider perspective of technology transfer is a option. There is no single strategy for successful transfer that is appropriate to all positions. Desirably a technology recipient will select a technology which at least fits the definition of being "environmentally sound". ESTs are technologies that possess the potential for significantly improved environmental performance, comparative to other technologies. ESTs protects the environment, are less polluting, use resources in a sustainable way, recycle more of their wastes and products, and handle all residual wastes in a more environmentally acceptable way than the technologies for which they are stand-ins. Preferably a technology recipient will go still further, and take a "sustainable technology" – i.e. A technology that is not just environmentally sound, but also economically viable and socially acceptable. Such technologies contribute to the three pillars of sustainable development.

Far-reaching developments in the global trading and environmental regimes since 1990 have accelerated the procedure of globalization and created both opportunities and challenges to developing nations. The Uruguay Round of trade negotiations culminating in the formation of the World Trade Organization (WTO) on 1 January 1995 developed rules for global trade in goods and services and also for cross-border flows of capital and engineering science. The United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro in 1992 stressed the need for internalization of environmental externalities in decision making at all levels and international cooperation among states for resolving transboundary/global environmental problems via multilateral environmental agreements (MEAs). Today, there are more than 200 MEAs dealing with global commons, common concerns of mankind and transboundary movements of goods causing pollution beyond national boundary lines.

**Modes of EST Transfer/Production**

There are four different modes of EST transfer depending on industry characteristics and policy goals. Theses four modes are summarized below.

1. **Large Firms**

   If ESTs is under the IPR regime and the transfer is a large firm, then the transfer is feasible through licensing, foreign direct investment (FDI) or joint venture (JV). Licensing is desirable if it is a standard technology. FDI or JV is appropriate if the transfer involves infoware, technoware, organware and humanware. The host country government's main responsibility is creation of a TRIPS-consistent environment for IPR protection, lowering of transaction cost of EST transfer and promotion of an open trading regime. Approach to the ESTs on fair and concessional terms or/and transfers take place under MEA obligations.

2. **Small and Medium Enterprises (SMEs)**

   If ESTs is under the IPR regime and the transfers are SMEs, then the interest of the host government, intergovernmental agencies such as UNCTAD and UNIDO, industry affiliations and industry-specific research institutions are needed in the configuration of a partnership. This is necessary to surmount the barriers to transfer of ESTs and their effective absorption in the host nation. The barriers and problems are:

   (i) Lack of information about ESTs appropriate to domestic environmental standards;

   (ii) Need for adaptation and diffusion of borrowed technologies;

   (iii) High costs of admission to and transfer of ESTs because of little size, information asymmetry and financing problems in host country, and IPR protection and restrictive practices of EST suppliers in home countries;

   (iv) non-incorporation of environmental costs in investment and pricing decisions because of under pricing of resources or/and poor enforcement of environmental regulations in host nations;

   (v) Presence of positive externalities in adoption of ESTs;

   (vi) Development goals such as decentralized development and employment generation; and

   (vii) Addressing the last mile problem in creating the access to scattered units and units in remote areas.

   Schedule 21 Chapter 34 suggests the following choices for transfer of ESTs coming under an IPR regime in favorable conditions:

   (a) Compulsory purchase of ESTs from IPR holders and their transfer to building up countries for specified functions on non-exclusive basis to fulfill their obligations under MEAs;

(b) Government purchase at market prices from IPR holders and remove them to developing countries on concessional terms to take on their CDR and other responsibilities

(c) Prevention of monopoly and restrictive practices of patent holders, e.g. High royalties, restrictions on exports/third-party sale, tie-in sales; and

(d) Financial assistance on concessional terms by governments directly on through UN agencies.

According to UNCTAD about 40 percent of R & D in OECD countries in 1998 were publicly funded. Some resulting technologies are immediately usable exclusively to firms in their countries. Equally percentage of international cooperation, OECD countries could afford access to these technologies to developing countries free of price.

Formal channels of technology transfer such as licensing, FDI and JV may not be appropriate under this mode because (i) there are many users, (ii) the technology must be made operational taking into account the ground realities, and (c) there will be spillovers.

3. **Development cooperation**

Some ESTs developed in the North may not be appropriate to developing nations because of differences in factor endowments, size, environmental measures and other position-specific genes. Hence, it is suitable to develop indigenous ESTs to meet local demands. For easier access and rapid dispersal of such ESTs, it is desirable to identify them in the public arena. A development cooperation model involving many stakeholders—firms, industry affiliations, research laboratories and governments of a host country, suppliers of different components of ESTs and the governments of host nations; and intergovernmental organizations is required. The corporation must be voluntary and mutually beneficial. This is possible when economies of scale and scope in the collective action result in cost complementarities and overall cost savings. We need incentive structures and monetary value-sharing arrangements to stimulate and maintain cooperation among the different stakeholders.

4. **South-South Cooperation**

Thither is a need for South-South Cooperation in the evolution and transfer of ESTs. The demands are obvious in agriculture where small firms dominate, operations are labor intensive, and climatic conditions are alike; in industries where SMEs dominate, techniques are labor-intensive and environmental criteria are similar; and health where most of the diseases are tropical and access to drugs at affordable costs is significant. Hence there is a case for public funding of R & D in these areas and maintaining the technologies in the public sphere. A regional cooperation agreement under FTA or economic partnership with support from UN agencies is an institutional alternative.

In India, the Department of Science and Technology with a network of research institutions under the Council of Scientific and Industrial Research, Indian Institute of Technology at cities are the principal authorities for research in industrial technologies. The International Technology Program of the Department of Scientific and Industrial Research aims at (a) documentation of technology export performance and capabilities, (b) showcasing and support of technology export capabilities, and (c) facilitation of applied science transfer and swap at the firm level.

NEP notes three barriers to the adoption of clean technologies. They are: (a) many of them are proprietary and protected by strong patent regimes held abroad; (b) lack of capability in development financial institutions for appraisal of proposals for switching existing production facilities to clean technologies; and (c) lack of coordination in R&D efforts aimed at producing a shelf of commercially viable clean technologies. The Action Plan aims at removing the barriers. It also encourages industry associations to embrace ISO 14000 giving purchase preference in government procurement, formulation of "safe practice guidelines" for ecolabels, and advancement of "good practice norms" to preserve natural resources and mitigate adverse environmental impacts. UNIDO's Country Service Framework: India aimed at leading to achieving sustainable development in India by fostering skills, capacities, and technologies for SMEs to save space with the fast developing Indian economy and the requirements of globalization. The five year program (2002-2007) envisaged strengthening the competitiveness of SMEs through technology-guided intervention; promoting FDI, JV and equity participation; promoting cleaner and environmentally friendly technologies and policies; and relieving poverty and industrial development programs in less developed countries.

**Sustainable Technology**

Sustainable technologies are appropriate technologies which are free from contamination of the surroundings. Thus, sustainable technologies are called environmentally sound technologies. Environmentally sound technologies protect the environment, are less polluting, use all resources in a more sustainable way,

recycle more of their wastes and products, and handle residual wastes in a more acceptable manner than the technologies for which they are stand-ins. Environmentally sound technologies in the context of pollution are 'process and product technologies' that generate low or no waste, for the prevention of pollution.

Why India wants to think about sustainable technologies? There are multiple factors motivated to adopt sustainable technologies in all the sectors. Major components are higher population growth, growing pollution due to the use of fuels and unscientific waste management. The major source of energy in the country is fossil fuels such as petroleum, diesel and coal. Thus the emission of GHGs causing severe environmental harm and further leads to climate change issues. Now, instead of utilizing electric energy for lightening the home and street, the regime has been encouraging the usage of solar panels and afforestation is being encouraged. Rather than applying chemical fertilizers and pesticides, organic agriculture has been promoted.

### Advances in Sustainable Technologies

Sustainable technologies have come a long way in the past few decades, driven by environmental awareness and the growing prices of fossil fuels.

**Nanotechnology**: This tiny technology has applications in clean energy, greenhouse gas management, green manufacturing and sustainable livelihood. In India, for instance, researchers are using composite nanoparticles to destroy contaminants such as bacteria and microbes in drinking water.

**Next-generation nuclear power:** encompasses low-carbon ideas such as advanced fission reactors, fusion-fission hybrids and pure hydrogen fusion. Nuclear scientists continue to attempt to improve the inefficiencies of fission (for example, pursuing less waste and better uranium conversion rates) and remain hopeful about fusion, leading research through projects such as the International Thermonuclear Reactor Experiment (ITER).

**Biofuels:** include ethanol and biodiesel made from oils and fats, as well as solid fuels made from non-food feedstocks, manure, waste materials and algae. The U.S. Energy Department has issued goals to grow cost-competitive, drop-in biofuels by 2017 and algae biofuels by 2022.

**Bioplastics:** Current forms of bioplastics include starch-based PLA and PHA plastics. As oil supplies dwindle, many industries, such as the auto and electronics industries, may look to ecoplastics as low-carbon options. According to Helmut Kaiser Consultancy, over 5,000 bioplastics processing companies are required to be in operation by 2020.

**Smart monitoring and predictive analytics:** monitoring and analytics can help increase efficiency in energy use, water usage and green manufacturing. Societies can use sensors to find errors (such as leaks in water supply networks) and predictive modeling to maximize resources (such as precision irrigation systems).

**Tidal energy:** Tidal energy may cause a secure future if investors are interested. Unlike wind or sun, tides are fabulously predictable. The urban center of Swansea in the United Kingdom is planning a 240-megawatt tidal power plant that would generate over 400 Giga Watt hours of electricity per year — enough to power about 121,000 households.

### Challenges in India

The challenges faced by the state in adopting and building up novel engineering sciences to conserve the environment are numerous. Foremost of all, the bulk of the population in the state is held away from the access to water, energy, food and livelihood creation, stopping up the health of natural resources on which the livelihoods of people depend, reducing vulnerabilities and ensuring equity is the primary challenges. In a sense, the prevalence of poverty is the major challenges in adopting technologies in many fields. The high price of engineering science and lack of funding from the government has escalated the issues further. Even though, the initiatives of the government in certain areas are extremely important.

There are number of obstacles in adopting sustainable technologies in India. These include-

- **Concealed Costs of Production:** The production of many novel technologies, such as biofuels and bioplastics, still requires sizable amounts of energy and imaginations. Critics as well contend that increased reliance on biometrics puts added pressure on arable land and edible crops, risking food shortages.
- **Lack of Investment:** Investment trends in renewable technologies are mostly convinced. Still, events like the Great Recession and the current boom in natural gas (which has caused electricity prices to come) can turn off nervous investors.
- **Lack of interest by the Government:** Substantial public funding is frequently needed to support up-and-coming technologies. In summation, some private sector companies may require considerable legislative pressure before they cause the shift to sustainable patterns.
- **Public Perception:** Renewable technologies have a residual 20th-century reputation for high cost and sketchy reliability. Although improvements in affordable technologies are being created daily, large-scale public acceptance remains a challenge.

### Combating Strategies

It is essential to discover out the major causes that preventing the adoption of environmentally sound technologies. The consciousness on climate change has risen along with threatening of normal life by day by day occurring new challenges. In this regards sustainable development goals are set to achieve in the course of time, but the developing countries still in a quandary. The investment on R&D in developing countries are inadequate. Through promoting appropriate technologies or environmentally sound technologies, the pace of economic growth has to be sped up. The major strategies to solve the issues related to sustainable technology adoption are-

- Development of local markets and local productions
- Promotion of typical products and traditional cultures
- Involvement of social parties in setting goals, commitments and sharing responsibilities.
- Eradication of poverty and encourage inclusive growth.
- Machanisation of agriculture, thereby sustainability in agriculture has achieved and problem food insecurity has to be eradicated.
- Provide awareness about environmental protection and environmetallt sound technologies.
- Environmental policies should strengthen with new policies of environmental management.
- Promote local technologies if it is pollution free.
- Provide incentives in accessing ESTs or provide it at affordable cost.

### Conclusion

In the absence of environmental friendly technologies at an affordable cost in India, the technology transfer is the only choice to mitigate growing issues of environment. Technology transfer must be informed by an apprehension of its implications in the social, economic and environmental contexts of the receiving societies. Technologies must be usable by and beneficial to locals. Where possible, existing local technologies must be advanced and adjusted to produce them more effective and utilitarian. Such local adaptations should also go to the upgradation of local technical skills. Local innovations and content building for training and managing locally relevant and appropriate technologies must be promoted and sustained. Integrating highly-advanced modern technology with traditional practices sometimes produces the most culturally-suited and acceptable solutions, which likewise establishes them more workable. Government should put an equal amount in R&D, thereby new technologies appropriate to the society can develop and is very soft to distribute among local communities.

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