TECHNOLOGY TRANSFER IN THE ASIA PACIFIC REGION
Country Paper – India

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"Our future depends on our ability to resist the imposition of technology which is obsolete or unrelated to our specific requirements and of policies which tie us to systems which serve the purposes of others rather than our own, and our success in dealing with vested interests in our organisation; governmental, economic, social and even intellectual, which bind us to outmoded systems and institutions."

Technology Policy Statement of Government of India,, 1983

1. Introduction:

Emerging from their colonial past countries in the Asia-Pacific region have opted for democratic regimes to ensure welfare of the maximum number of their citizens. Nature has been bountiful and endowed these countries with natural resources in plenty, and yet, they are often characterised by extreme poverty which is further compounded by over population and lack of amenities and infrastructure. Agriculture has been the traditional mainstay of economy supplemented by raw material exports. Biotic pressures have put tremendous strain on the natural resources creating environmental imbalance in some areas of the region.

The first industrial revolution led to a worldwide emphasis on adoption of industrialisation as the quickest route for rapid economic development accompanied by large-scale import of technologies – obsolete and not-so-obsolete – by the developing countries.

All industrial production processes depend upon natural resources for inputs (source), and for disposal of waste (sink). Environmental problems are created either when inputs are demanded beyond the regenerative capacity at the source and/or when wastes overwhelm the recycling and/or absorptive capacity at the sink. The pressure on the source or sink is determined by the efficiency of the process, which depends among other things, on the kind of technology applied. Efficiency improvements in technology can lead to reduced pressure on the resource base, both on the source and sink sides, and result in increased production of goods and services.

In the Indian sub-continent, like elsewhere, selection of technologies based on the criteria of "lowest initial capital investment" has resulted in a basketful of technologies which are obsolete and which create increasing pressure on the natural resource base.

The need to encourage adoption of Cleaner Technology is, therefore, self evident.

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CLEAN TECHNOLOGY (CT) OR ENVIRONMENTALLY SOUND TECHNOLOGY (EST)

The term "Cleaner Technology" may be defined as "no waste technology" or, more practically, "low waste technology", Cleaner technologies are also referred to as Environmentally Sound Technologies (ESTs).

A cleaner technology is thus a more efficient technology to achieve the following:

- Waste prevention and minimization by reduced consumption of raw materials.
- Modification and upgradation of the process so that the optimal utilization of natural resources is achieved.
- Adoption of a preventive, rather than a corrective approach to pollution abatement.

A number of cleaner production measures ranging from process modification, raw material recycling, equipment redesign, product formulation and waste recycling are possible in a variety of industries.

Prioritisation of ESTs can be done on the basis of:

- Pollution potential and environmental impact of the resultant products and services during and after use; and
- Energy and raw materials usage per unit output.

Cleaner Technology or EST, however, is much more than hardware – it is a complex arrangement with social and cultural attitude shifts. The promotion of cleaner technologies would be facilitated by the following measures:

- Inventory of available CTs and an inventory of needs of developing countries such as India for CTs;
- Performance evaluation rating (PER) of technologies on a uniform scale, to be used as yardstick for firms choosing technologies, either domestically, or through technology transfer from overseas
- Ranking of CTs based on PER.

2. TECHNOLOGY SCENARIO SINCE 1950s:

Soon after independence India realised that "technology" holds the key to accelerated economic development and, therefore, a big boost was given to both scientific education and creation of institutional infrastructure. A network of national laboratories, accompanied by establishment of institutes of higher learning like IITs, IIMs and Universities supplemented by in-house R&D efforts of the industrial houses was put in place. These efforts soon got eclipsed and negated, however, by such Policy interventions as Licensing and a regime of subsidies & administered prices. Institutions created for promotion of appropriate technologies and development of indigenous technology had to be dismantled as their net practical contribution amounted to no more than perpetuation of obsolete technologies which

resulted in low productivity, poor quality and unusually high consumption of raw materials and energy. Subsidised provision of raw materials and energy was justified as a policy to promote indigenous entrepreneurs and the heavy price of this inefficiency was paid by the consumers in the form of both shoddy products sold at exorbitant prices in a protected seller's market. Licensing system channelised all the energies of entrepreneurs towards somehow obtaining a LICENCE which became the gateway to assured profits. Power lobbies and vested interests developed to perpetuate the inefficient system. Therefore, adoption of Environmentally Sound Technologies (ESTs), often equated with advanced and costly technologies, has been hampered in the past because of the following factors:

Attitudinal stance of the Management and the Unions:

- Managements have equated ESTs with high investment at procurement and operational stages.
- Managements have perceived ESTs to be requiring highly skilled workers with higher wage tags without commensurate benefits.
- A captive market with administered prices not being conducive to competitive edge provided by the ESTs in quality and price of the product.
- Unions apprehend large scale retrenchment and, therefore, increased unemployment due to automation linked to introduction of ESTs.
- Indifferent public attitude to environmental degradation caused by dependence on inefficient old technologies.

Technological Issues:

- Licensing system encouraged procurement of "Proven", euphimism for old and inefficient technologies usually ready to be discarded by the industrialised countries.
- Reluctance to supply state-of-art technologies by the industrialised countries.
- Lack of conviction that ESTs can help improve benefit stream.
- Assured profits in a protected market encouraged continuation of resource wasting inefficient technologies.

3. CATALYSTS FOR CHANGE:

Starting with Stockholm Conference, emphasis began to be given gradually to integration of environmental concerns with the development process. In the initial stages, environment remained an add-on component with emphasis on "end of pipe" treatment. Rapid industrialisation coupled with reliance on inefficient and obsolete technologies, has built up a backlog of environmental problems – land degradation, air, water and noise pollution – especially in the areas with concentration of industrial units. The linkage between industrial pollution and human health has been brought home over the years thereby compelling authorities to initiate pollution prevention, or at least control, programmes.

Global realisation for the long term implications of pollution in the form of micro and macro climate change, ozone depletion etc. gave further impetus in the 80's, to such programmes. The UNCED conference in 1992 further underlined the need for switching over to cleaner

and efficient technologies as a strategy for Sustainable Development through natural resource optimisation. Access to CTs is promised under Agenda 21 along with additional financial resources for Transfer of Technology because of the realisation that:

- The dwindling natural resources can no longer be wasted through use of inefficient technologies.
- Better environmental management is essential for survival of mankind.
- Compliance with stricter environmental standards is economically possible only by adoption of ESTs.
- International Conventions and Treaties underline switch over to ESTs.

Competition in the market place has also contributed to the need for adoption of CTs so that products from developing countries could compete both on quality and price criteira.

The net result is that emphasis on "End of Pipe" treatment is slowly giving way to "Preventive" measures where adoption of CTs is the front runner.

There is need to catch up with the rest of the world through leap frogging by adopting a strategy combining:

- Indigenous development of technology; and
- Judicious Technology Transfer.

Liberalisation trends have made the industry realise that the competition posed by MNCs can be effectively met only through technological innovation. With this objective there is increased interaction between the industry and the national laboratories & R&D Houses and also a desire to access technology globally.

4. Policy Initiative:

Promotion of "Preventive" rather than "curative" strategy requires policy direction and commitment. Shift to adoption of cleaner technologies in India got a boost with the Resolution of Government of India in February, 1992 on "Policy Statement for Abatement of Pollution" which recognised that mere notification of laws is not enough and instead the focus has to be on integration of environmental concerns in the development planning, pollution prevention at source by encouraging development and application of best available technical solution etc.

The policy initiative provides for:

- Assistance to small scale industrial units to control pollution through adoption of cleaner technologies;
- Switching over to mass-based standards which shall not only encourage minimisation of waste but also be an instrument for technological upgradation/change;
- Phasing out the regime of subsidies and "administered prices" and
- Introduction of "environmental audit", LCA and Resource Accounting as improvement tools.

The Regulatory Agencies are following up the initiative through such action as:

- Prepare compliance status for all "polluting units" followed by phased implementation scheduled in a time-bound manner failing which the units could be closed;
- Setting up of Common Effluent Treatment Plants for a cluster of small industrial units; and
- Modernisation and upgradation of old industrial units in a phased manner.

In addition, environmental impact assessment, which was hitherto carried out only for public sector projects, has been made mandatory to ensure coverage of projects both in the public and private sectors. Evaluation of technology in the proposed projects is a major component of the EIA exercise. The energy sector provides a good illustration.

Per capita consumption of energy is an accepted indicator of the level of development of a country. Coal based thermal plants already contribute 70% of the total electricity generated and indications are that coal will continue to be a primary source of energy in the coming decades. The environmental consequences of coal extraction, transport and the use for power generation are well recognised and there is a growing realisation that coal related environmental problems must be seriously addressed and controlled, specially because the consumption of high ash Indian coal will continue to steadily rise with the increased demand of energy. A perusal of the Coal Cycle clearly indicates the need for conservation of resources and electricity to cut down drastically the wastage and pollution load.

The solution is provided by cleaner technologies. It is worthwhile to compare efficiency and cost of electricity from the conventional boilers using pulverised coal vis-à-vis cleaner technologies both in terms of cost as well as contribution of gaseous emissions. These are indicated in ***Table-1 and 2.***

Upgradation of existing plants and adoption of cleaner Production in the new ones is, therefore, a must.

Table-1
Comparison of Efficiencies and Costs of Generation for Various Technologies

Technology	Efficiency (%)		Pithead Cost of Generation (Rs. KWh)	
	Expected Efficiency	Standard Deviation	Expected Cost	Standard Deviation
PFBCC	38.09	0.66	0.431	0.00871
IGCC	36.8	0.91	0.504	0.00892
IG-MFC	46.30	1.72	0.458	0.0263
PC Boiler / Steam turbine	31.50	0	0.672	0

Table-2

CO_2 and NO_2 Emissions from Advanced Technologies

	CO_2 Emission		NO_2 Emissions Gms/kWh	SO_2 Emissions Gms/kWh	Particulate Gms/kWh
	Expected	Standard			
PFBCC	0.911	0.016	1.42	0.029	126
IGCC	0.921	0.034	0.43	4.0	9.5
IG-MCFC	0.778	0.029	0.096	0.096	6.2
PC Boiler / Steam Turbine	0.930	0	9.6	3	20.5

5. Accessing Environmentally Sound Technologies and Technology Transfer:

Identification, acquisition, development and promotion of cleaner technologies in diferent development sectors is, therefore, imperative. Resource Conservation and Pollution Prevention through cleaner production are the main themes of the Second Industrial Revolution presently sweeping the industrialised world. Most of the third world countries missed out on the 1st Industrial Revolution but they can ill afford to ignore the 2nd one.

While the large industrial enterprises do have in-house capability for scanning, screening, evaluation and transfer of ESTs, the need for arming the small and medium scale entrepreneurs with adequate know-how and realistic performance data on the available technologies has to be met effectively. This need can be met by creating Data Bases provided the Data Base is able to ensure that:

- Storage of data and information is done after due quality control;
- Data base is continually updated; and
- Information is user-friendly.

Cleaner Production Network:

To be able to effectively deal with environmental problems including Climate Change & Ozone depletion and to facilitate devising of strategies for Sustainable Development, the Cleaner Production Network has a varied role covering the following:

A. Master Data Base:

- Creation of a Master Data Base on Cleaner or ESTs for various development sectors like energy, transportation, industry, mining, construction, tourism, agriculture, etc.
- Identify globally the source(s) from where cleaner technology and data/details thereon can be obtained.

- ⊙ Access the technologies available indigenously, or to be imported, and rank them on Performance Evaluation Ratings (PERs).
- ⊙ Information dissemination duly safeguarding secrecy clauses relating to Patents/IPRs.

B. Demonstration & Training:

- ⊙ Procurement of state-of-art technologies and their DEMONSTRATION to the users.
- ⊙ Scaling up/down the technologies already available, or under development for their tailoring and adaptation to the local situation.
- ⊙ Preparation of Manuals to impart training.
- ⊙ Arrange "Green Credit" from national and international financial institutions for DEMONSTRATIONS.

C. Know-how on Patents and IPRs:

- ⊙ Facilitate introduction of policies and legislation to promote adoption of ESTs.
- ⊙ Facilitate transfer of "know-how" to the users on issues related to Patents, IPRs and ISO certification etc. to achieve Total Quality Management (TQM).
- ⊙ Impart know-how to the users on negotiations and management of International agreements/contracts, arbitration and resolution of conflicts.

D. Capacity Building:

- ⊙ Build up indigenous capability for Technology scanning, forecasting and assessment.
- ⊙ Development of indigenous design engineering capability for absorption, adaptation and improvement of imported technology through joint ventures.
- ⊙ Develop know-how on process modification, product reformulation, and equipment redesign.
- ⊙ Development of tools and methodologies like Life Cycle Analysis (LCA), Natural Resource Accounting (NRA) and Environment Audit for resource conservation and to improve the capability of indigenous consultancy firms for using these tools for promoting ESTs.

Data Bases Established by International Agencies:

As a follow-up to the Agenda 21, the United Nations Environment Programme (UNEP) established the first Centre at Paris which has taken up case studies for efficiency improvement through a combination of Operation & Management (O&M), as well as technological, upgradation in some countries .

The United Nations Industrial Development Organisation (UNIDO) has also launched a programme to establish National Cleaner Production Centres (NCPCs) in the developing countries dedicated primarily to deal with problems of Small and Medium Enterprises (SMEs). One such Centre has been set up in India also in 1995 which has taken up study of such sectors as Hosiery to identify efficiency improvement options.

Draw Backs of International Data Bases:

It has been experienced that the International Data Bases invariably suffer from the following:

- Data is stored and furnished by the commercial supplier often with exaggerated claims that confuse the prospective buyers of technology.
- Data provides neither Performance Evaluation nor Ranking of Technologies resulting in many suppliers claiming to be "The Best" in the market which obviously is not possible.
- Many of the technologies listed and marketed as "Proven Technologies" are in fact old and outmoded ones giving very little, if any advantage to the user.

6. Financial Support for Transfer of ESTs:

The transfer and implementation of ESTs is plagued by two obstacles:

- Lack of financial resources despite the assurances to provide new and additional financial resources, and
- Absence of a reliable inventory of available ESTs to meet the needs of developing countries.

Lack of finance is specially acute for Demonstration programmes which are considered essential for promoting extensive replication of the ESTs. Entrepreneurs have been suggesting that, in the initial phase, the interest component of soft loans from international funding agencies may be underwritten by the Government concerned. It is generally suggested that adoption of ESTs may be encouraged through:

- Reorientation of lending policies of national and international financial institutions towards Greener Credit and by opening of 'Special Window' for financing ESTs, and
- Long term soft loans for effective Demonstration of "know-how" through "show-how".
- Creation of separate R&D fund to support R&D initiatives for indigenous development of ESTs.

7. Change Management:

It has been observed that among other factors, a switch over from "Proven" to "Cleaner Technologies" requires attitudinal shifts in the stake holders – policy makers, users, banking institutions and employees at the local, national and global level. Long entrenched beliefs and attitudes take time to be remoulded and that poses a big challenge in the switch over to cleaner production.

Attitudinal shifts are a pre-requisite for ensuring the following actions:

A. Motivation among entrepreneurs:

- ⊙ Involve the management and the workers in actual Case Studies in identifying cleaner production options in existing units leading to improved economic returns;
- ⊙ Demonstrate the improved economic benefits achieved in selected units so that large scale replication becomes possible.
- ⊙ Transfer of "Know-how" through "Show-How".
- ⊙ Short and long term "hands-on" training to the workers, operators and the Supervisory staff to upgrade their skills and gear them to adoption of ESTs.
- ⊙ Make objective oriented "Training Manuals" available for reorientation and training of the shop floor personnel.
- ⊙ Motivate workers and management to move towards Total Quality Management (TQM) through Certification under ISO-9000 & 14000.
- ⊙ The Management must believe in and operationalise the motto, "Pollution Prevention Pays".

B. **Policy Reorientation**:

The Government has to demonstrate its commitment to cleaner production through:

- ⊙ Providing incentives, subsidies and other concessions for promotion of cleaner technologies rather than installation of the end-of-pipe systems presently in vogue.
- ⊙ Provision of soft loans for switching over from polluting and outmoded technologies to ESTs.
- ⊙ Abolition of subsidies for raw materials and energy in units dependent upon out-moded technologies.

8. CONCLUSIONS:

To facilitate Selection, Adoption and Transfer of Cleaner Technologies, it is necessary that following actions are given priority:

- ⊙ Preparation of a list of the available CTs along with the inventory of the needs of the developing countries.
- ⊙ Ranking of CTs on the basis of their Performance Evaluation Rating (EPR) for use by the buyers.
- ⊙ Strengthening the capacity in the developing countries so that they can catch up with the developed countries by "leap frogging".
- ⊙ Transfer of technology to be governed at least by the principle of "best practice" if not always the state-of-the-art technology not only from North-South but also among South-South or even South-North countries where possible.
- ⊙ Create an Asian Clearing House for CTs.