5. Case Study Of The Textile Industry In Tirupur

5.1 Background

AS OUR CAR bounced along the narrow pot-holed road to Tirupur, a sign Welcome to Banian City greeted us. Banian is the local name for the white vests used mostly by men in India. This sign described what was in store for us in Tirupur. There does not seem to be any activity in the town that is not directly or indirectly connected with the manufacture and sale of banians and T-shirts.

The whole world appeared to have discovered Tirupur in the early nineties. The success story of Tirupur, the new boom town, had spread all over. Suddenly many international agencies began to take notice of this little town in the state of Tamil Nadu in the south of India.

We had decided to conduct an Industrial Ecology study in Tirupur. The purpose of the study was to see how to apply the concepts of Industrial Ecology in a developing country, where the pattern of industrialization was vastly different from that of a developed country.

As we first drove into the town, we wondered what made this place such a success story. The narrow streets were crowded and hardly well laid. There were open drains running along the sides of the roads, carrying filthy, colored water. An assortment of vehicles, trucks, hand carts and bullock carts with their assorted loads of cargo, clogged the streets. Smoldering garbage was dumped on both sides of the road and the stench was hardly bearable. Through one such narrow street we approached our first point of call, which was the Tirupur Exporters' Association (TEA). The moment we entered the building of TEA, we started to notice the efficiency which makes Tirupur successful. Professional, well-trained staff mans the plush office. The building itself has all the facilities that an exporter would require, including a well-equipped conference room.

A typical street in Tirupur

Roads in India

The roads in India leave much to be desired. Transport on the roads can be time consuming. All kinds of vehicles, including the ubiquitous bullock-cart, are used as transport vehicles on the roads (including on the highways).

When we met the secretary, he told us straight away that dozens of such studies had been conducted by various agencies and he did not see any point in further studies being carried out. Many national and international agencies had been conducting studies on waste minimization technologies. Other than this, Tirupur had been the subject of many technical and socio-economic studies in the past. However, since we were very keen on going ahead with the study, he offered all assistance. Through TEA, we were introduced to many of the leading industrialists in Tirupur, who had been witness to the phenomenal growth of the town.

5.2 The Study in Tirupur

The study was carried out in the year 1996. All the data and estimates pertain to the year 1995. Tirupur, chosen as a sample town, represented a typical industry pattern in developing countries with many small and micro enterprises involved in an industrial activity.

A lot of attention has been given to the industrial symbiosis model in Kalundborg (Denmark), where a few disparate large units have worked out an effective system to optimize the use of their material and energy resources (as described in Chapter 1). The industrial pattern in Tirupur is very unlike Kalundborg. Tirupur has a large number of small and medium units engaged in similar activities, a pattern much more representative of a developing country.

Small-scale sector policy

The declared policy of the Government was to encourage the small-scale sector as it was expected that the employment generation of the small sector was much greater than that of the large units. The sector has always been exempted from many of the licensing procedures. The small-scale units also enjoy many tax concessions.

5.2.1 Preparing a Framework

When Tirupur was chosen, no specific format was available for carrying out the study. The object was to explore how to apply the concepts of Industrial Ecology in a developing country. Our idea was that we needed to start looking at possibilities for building linkages between different industries as was done in Kalundborg or as was being experimented in some parts of North America. When the study began, we realized that this was much more difficult than we had imagined. Unlike the half-a-dozen industries in Kalundborg, Tirupur had nearly 4000! Even to start looking for partners who would be interested in forming linkages to share their wastes was a major task. Secondly, the scales of operation of most of the units were extremely small. Hence for any individual unit to make major investments in any recycling systems would not prove economical. Thirdly, the industries tend to be extremely secretive about their operations, as they do not wish that any information about their business should reach enforcement authorities of the Government. We faced a great deal of difficulty collecting any information other than from published sources. The only details available pertained to value of sales and were available with the Export Promotion Council. As a next step, we tried to meet the major industrial units and the heads of the different industries' associations in the town, to understand what they perceived as their problems.

The tax system in India

The taxation system in India is quite complex. Other than income tax, there is a variety of indirect taxation on manufactured goods. There is the Central Excise (or production tax), the state sales tax and an octroi in many towns (collected by the local municipality). The procedures for paying the taxes and the system of checking compliance are cumbersome.

The taxation in India has been marginally lowered over the years. Till a few years ago, the rates of taxation were extremely high. Coupled with so many restrictions on local and international trade, the parallel economy (the black market) thrived.

Note: In the last few years, the economy in India has been greatly liberalized, with the lowering of certain taxes.

Other than listing out hundreds of problems with the bureaucracy and making out a case for greater support from the Government, there did not appear to be any perceived problem. Oh, yes, there is also a lot of harassment from the Pollution

Control Board, which is needlessly making us spend millions, was the constant refrain. In any case this problem also appeared to have been solved, by the industries becoming members of the Common Effluent Treatment Plant Scheme.

At the end of the first month of the study, we were still struggling to collect useful data. The figures of water consumption and production, which were collected by us from different sources, also appeared to vary greatly.

We then decided that we should get a good idea of the activities of the town and we chose to make a rough assessment of the materials flowing through it, at least to understand what was happening in the area. As a first step, a fact file on the town was prepared.

5.3 Tirupur Fact File

5.3.1 History of Tirupur

The textile boom in Tirupur is recent. Tirupur used to be a center for cotton trading a few decades ago. Over the years a few small units were established to manufacture banians. It was said that the water in Tirupur was of such good quality that the banians made here were the whitest of them all. The fact that the town was located so close to Coimbatore, which was an established textile manufacturing and trading center, ensured that adequate skills were available. This business grew steadily. It was only in the early 1980s that some enterprising businessman got the idea that the same facilities could be used to manufacture colored T-shirts, which had become a rage all over the world.

5.3.2 Tirupur and its Industry

Tirupur is a relatively small town in the Coimbatore district of Tamil Nadu. It has a resident population of around 300,000. An additional 200,000 people come in from nearby towns to work in Tirupur's booming textile industry. The rainfall in the area is low and erratic. The groundwater in most parts of the town is now polluted through years of effluent discharge by the textile industry.

The entire town's economic activity is centered on the manufacture of cotton knitwear: for use as banians (mostly sold in the Indian market), and for use as T-shirts (mostly exported).

Table 5.1: Textile Industry Output of Tirupur for the Year 1994–1995

	Value (US $ million)	Weight (Tonnes)
Exports	685.71	71,600
Domestic	142.85	50,000
Total	**828.56**	**121,600**

In 1995, the annual value of production in Tirupur was estimated at US$ 828 million of which goods worth US$ 686 million were exported, mostly to the USA and Europe. This corresponds to an annual production of 121,600 tonnes of fabric (in the form of T-shirts for export and undershirts, which are mainly sold in the domestic market). The average price of a T-shirt at the factory gate is around US$ 2. The annual estimated output of the town is given in Table 5.1.

Table 5.2: Breakdown of Units in the Textile Industry of Tirupur

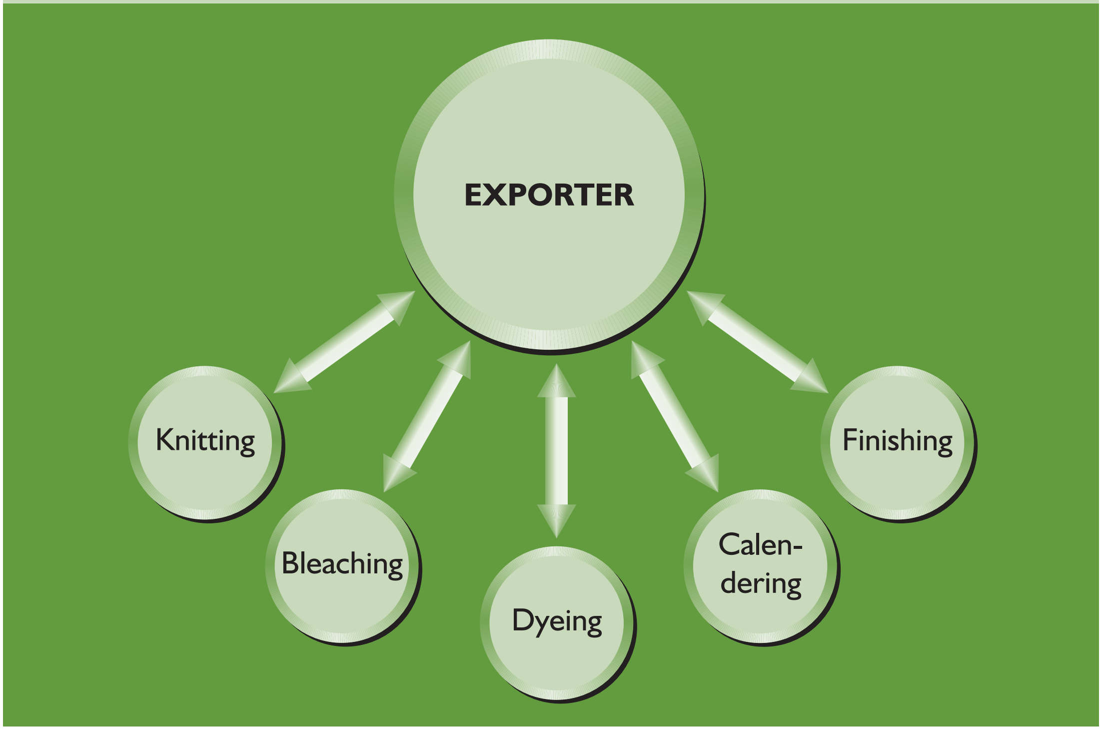
Activity	Number of Units
Knitting	650
Bleaching	400
Dyeing	300
Steam Calendering	150
Finishing	2,000
Printing	300
Miscellaneous	200
Total	**4,000**

Source: Tirupur Exporters' Association.

There are an estimated 4,000 small and medium units in the town which specialize in different aspects of the production process such as knitting, bleaching, dyeing, calendering, finishing and printing. Table 5.2 gives the estimated numbers of the

FIGURE 5.1

Transaction Pattern in Tirupur



units involved in these activities. Accurate figures are not available as many of these units are very small or in the cottage sector and are not registered with any statutory authorities. There are very few integrated manufacturing units in Tirupur, with all the activities under one roof. The absence of many large integrated units is partly due to the current government policy and the regulatory framework, which encourages the small-scale sector.

Tirupur is a job working center and not a brand exporter. This means that most of the exporters take up job work for brand marketers in developed countries and do not sell their own brands. This also means that the buyer in Europe or the USA can easily change his source of supply. Hence, the contact that the exporter has with the buyer is the most important business asset. This makes the exporter, who may have no manufacturing facility, the key player in the industry. Often, the exporter will buy the yarn and have the material processed by any of the jobbers in the town. The exporter may also have processing facilities. The pattern of transactions can be represented as in Figure 5.1.

5.3.3 Infrastructure

A view of the town does not give any indication of its prosperity. The power supply is erratic and the town is prone to frequent blackouts. A majority of the industrial units have diesel generators to provide stand-by power. The piped water supply is hardly adequate and the limited water is insufficient even for household requirements. There is no underground sewerage system. The industrial effluents are carried through open drains into a dry river called Noyel, which cuts through the town. The wastewater is carried to a reservoir built for irrigation purposes, about 15 km away. During its journey to the reservoir, a part of the wastewater permeates through the soil and contaminates the groundwater. Like in most parts of India, the piped water supply is very inexpensive, at around five US cents per cubic meter.

In an attempt to overcome the scarcity of water in the town, the New Tirupur Area Development Corporation Ltd (an organization set up in the mid-1990s to improve the infrastructure in Tirupur), is working on an ambitious plan to lay pipelines to bring water from the Cauvery river (nearly 70 km away). This would provide a cheap and plentiful supply of water to Tirupur for its domestic and industrial needs.

Water issues

Many urban centers in India do not have piped water supply. Much of the population has to collect water from streams or groundwater sources. In many parts of the country, especially for industrial use, the factories transport water in tankers from groundwater sources nearby.

The underground sewerage system covers only a small part of the population. Relatively few towns in the country have an underground sewerage system.

Women in Tirupur waiting for water

5.3.4 Government Policy and the Regulatory Framework

Till a few years ago, the large industry in India was governed by an elaborate licensing procedure. The government has always encouraged the small-scale sector, which has never needed more than a formal registration. Incentives like low interest loans and concessions in production and sales taxes are available to the small industry. The criterion for qualifying as a small-scale industry traditionally has been the total investment in plant and machinery and not the total production value.

India has a complex bureaucratic system and the industry is answerable to a number of Government agencies. This includes having to file periodic statements with different agencies. The small units fall outside the ambit of many government agencies. For instance, if a unit employs less than a specified number of persons, it falls outside the purview of the Factories Inspectorate, which specifies elaborate safety standards.

It is probably because of these considerations, that the small (but very prosperous) units stay small. Growth of a unit takes the form of a new firm being established. For example, if a garment manufacturer wants to increase production, he would establish a new firm and hire people accordingly. The value of equipment bought in the new firm would be small enough for qualification as a small-scale industry.

In the recent years, the Government of India has laid down elaborate standards for industrial effluents. In India, the responsibility for management of the environment is divided between the central and the state governments. The Central Pollution Control Board and the Ministry of Environment of the central government make policy, set standards and monitor their implementation at a national level.

The State Pollution Control Boards, which operate administratively under the state governments, are entrusted with the job of implementing the standards laid down. These boards carry out the regular monitoring of industries in India. These state agencies have wide powers to penalize offenders, including ordering the closure of manufacturing units.

The regulatory authorities have been active in implementing the standards, and in the recent past the law courts have been very active in giving priority to environment-related cases. Some of the High Courts in the states have a special Green Bench to deal exclusively with these matters.

The first awakening to environmental issues in India effectively came in the 1970s with the enactment of the Water Act and the Air Act, which laid down standards of emissions for release into water and air respectively. This legislation was not adequate to cover pollutants (mostly solid wastes and lagooned wastewater) dumped on the ground. Further much more comprehensive legislation was enacted in the late 1980s (which is yet to be effectively implemented).

A large-scale environmental consciousness is yet to take root in the country although a number of NGOs are doing a commendable job in taking up such causes. The law courts are also taking serious note of cases concerning environmental issues.

5.3.5 Industry and Production Processes

There are six production processes involved in the manufacture of knitted garments:

Knitting: Knitting is the first step, in which, the fabric is made from yarn. The output is in the form of a hose.

Scouring: The knitted fabrics are scoured in a bleaching or dyeing unit by boiling with caustic soda in open tanks. The fabric is then washed in freshwater.

Bleaching: Figure 5.2 gives the process chart of the bleaching operation. Bleaching is done manually, or mechanically in a winch.

Dyeing: Figure 5.2 gives the details of the dyeing process.

Calendering: After bleaching/dyeing, the fabric is passed through steam heated rollers in the steam calendering machines.

Finishing: After calendering, the fabric is ready to be made into garments in the finishing units. These units use electrically operated stitching machines and electric irons. Some of the processes like embroidery require sophisticated computer controlled machines.

FIGURE 5.2

The Bleaching and Dyeing Processes

5.4 Findings of the Resource Flow Analysis (RFA)

Once the fact file was prepared, an attempt was made to prepare an RFA for the town of Tirupur.

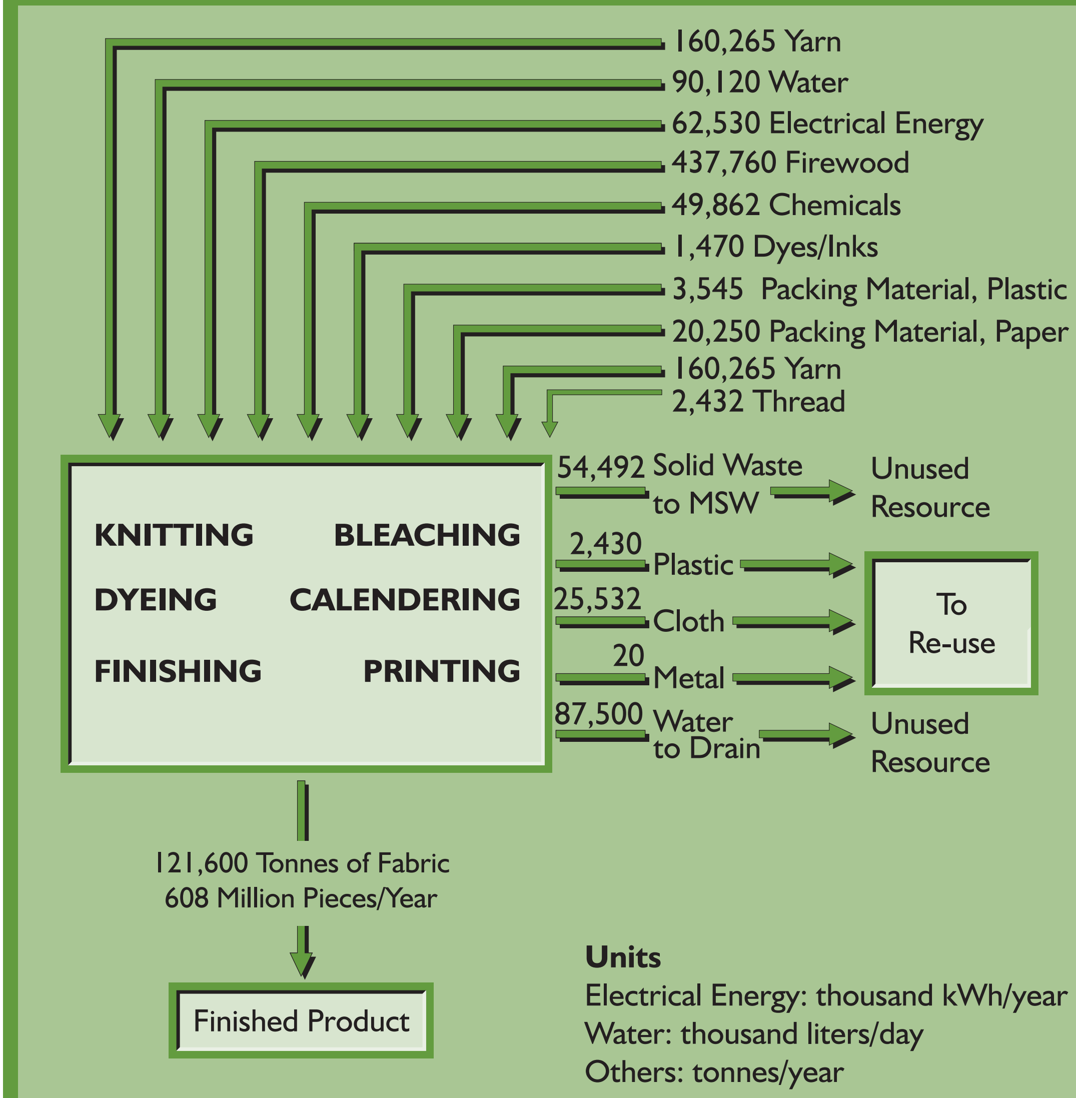
The material flow for each industry segment (knitting, bleaching, dyeing, calendering, finishing and printing) was estimated independently, using the method described in the section Methodology (Annex 5.1 at the end of this chapter). The results were integrated to arrive at the resource flows for the entire town. The results of the Resource Flow Analysis (RFA) for the town are presented in Figure 5.3 and the salient features are summarized in a box on the following page.

For ready reference, the resource flows through all major segments of the industry are provided in Annex 5.2 at the end of this chapter.

Based on the figures and the various pieces of information about the industry and the business environment that we had collected, an attempt was made to document and draw inferences from the Resource Flows. An outline of what, in our opinion, were the major issues in Tirupur, was also prepared.

FIGURE 5.3

Resource Flows for Tirupur Town



5.4.1 The Salient Features of the Resource Flow Analysis

- The industry in Tirupur consumes 90,120 cubic meters of water every day (i.e. 90.12 million liters/day) that equals the average water supply to an Indian town with a population of over 2 million people.
- The area is dry. Most of the groundwater is polluted and unusable.
- More than half this quantity of water is brought to the town by trucks from distances of over 50 km at a total estimated cost of US$ 6 million per year.
- The wastewater containing dyes and chemicals is discharged untreated into a dry river.
- The town consumes 62,530,000 kWh (i.e. 62.5 million kWh) of electrical energy per year, including the power generated by diesel generators. (Most units have diesel generators to overcome the erratic power supply.) No estimates are available of the diesel consumed.
- Nearly half a million tonnes (437,760 tonnes) of firewood, chopped from the nearby forests, are needed annually for the steam calendering, bleaching and dyeing operations.
- Almost fifty thousand tonnes (49,862 tonnes) of chemicals other than dyes are consumed annually. The majority of the reacted chemicals are discharged through the untreated wastewater.
- Around fifteen hundred tonnes (1,470 tonnes) of dyes are used annually, of which an estimated 292 tonnes find their way into the wastewater (i.e. almost 1 tonne of dyes per day).
- An estimated 3,171 tonnes of paper waste, 9,430 tonnes of textiles waste (rags and threads) and 59.25 tonnes of plastic wastes are contributed annually by the industry to the municipal solid waste (MSW). In addition to these combustible wastes, over 40,000 tonnes of ash is also disposed of. In total, the industry contributes 56,492 tonnes annually to the MSW.
- In addition, an estimated 91,250 tonnes of domestic solid waste are generated annually. Both the industrial and municipal wastes lie littered, untreated all over the town.
- An estimated 2,430 tonnes of plastics and 25,532 tonnes of waste rags, and 20 tonnes of metals are collected annually, and taken out of the town for reuse or recycling. No information is available on the fate of these resources.

5.5 Major issues in Tirupur

5.5.1 Water

As is apparent from Figure 5.3, water is a major requirement of the industry. As the area is dry and much of the groundwater is polluted, over half the water required by the industry is brought in by trucks from groundwater sources at distances of over 50 km. The industry pays around US$ 6 million annually to bring the water by trucks (which amounts to almost US$ 1 per cubic meter against a much lower price of just US$ 0.05 in many parts of India). In addition, the lure of quick money tempts small farmers who still have access to uncontaminated groundwater sources to sell water to the industry instead of using it for farming.

The other half of the water requirement is met from the few bore-wells where water is still of good quality. However, the groundwater table is going down rapidly and even these sources will soon not be available. The industrial effluents are drained out untreated into a dry river. The effluents accumulate at a reservoir, built originally for irrigation, around 15 km away. A substantial part of the effluent leaches into the ground through its passage to the reservoir. The water is saline, highly colored and contains toxic dyes. The entire agricultural operations in the neighborhood have been badly affected by the groundwater contamination.

Under pressure from the regulatory authorities, it is planned to set up nine traditional common effluent treatment plants (CETP) at an estimated cost of US$ 30 million including the cost of piping the effluents. The recurring costs of over US$ 7.5 million per annum for operation and maintenance would be extra. The design of the CETPs is primarily aimed at reducing the biological and chemical oxygen demand (BOD and COD) of the effluents. But the effluents after treatment may continue to contain toxic chemicals and will also be very saline. Due to this, the post-treatment effluents will not be usable for agriculture or for industry, and obviously not for domestic use also.

5.5.2 Firewood

The consumption of firewood by the industry is over 437,760 tonnes per year. The firewood is brought in by the felling of trees from the nearby Nilgiri Hills (part of the Western Ghats mountain range, about 100 km from Tirupur). The wood cover in the Nilgiri Hills is rapidly depleting. The steam calendering industry uses over half of this quantity, for steam generation. The bleaching and dyeing industry uses the rest. The firewood is used in inefficient boilers at 850 different production centers. It would be possible to substantially reduce the consumption by improving the design of the boilers. A central steam generating system could also be considered. Alternatively, a system of substitution of the fuel could be worked out—such as pre-heating with solar energy, substitution with treated municipal waste, etc.

5.5.3 Solid waste

Nearly 40 tonnes of combustible solid waste is generated every day by the textile industry. This comprises paper and textile scrap (rags and threads). This has a high fuel value. In addition, an estimated 250 tonnes per day of municipal waste is generated by the households.

The possibility of utilizing the fuel value of this waste could also be considered. These industrial and municipal wastes presently lie littered over the town, untreated and unused. Using the heat value of the waste would also help in reducing the consumption of firewood.

5.6 Direct Outcome of the Study

When the results were presented to the various industry associations, it came as quite a surprise to them. Till the numbers were aggregated, the magnitude of resources flowing through the system was not obvious to them. The total price paid for the different materials by the industry, as a whole, was also not obvious. Each small industrialist was paying a small amount for buying water every day and the costs had been internalized into the costing. Hence, the fact that such large quantities of water were being used in the town and given that such large amounts of money were being spent on water by the industry came as an eye-opener.

Based on the presentation of the results, it was obvious that water recycling could be both an economically viable option and a solution to the environmental problems, as a first step.

A private entrepreneur came forward to explore the business opportunity that this water recycling presented. Initially, the idea was to set up a water factory, which would take in the effluent from the industry and sell back the recycled purified water to the manufacturing units. After considerable work, this was not found to be economically feasible, because the cost of recycling the highly saline water would be high, as the process would be energy intensive.

As an alternative, the entrepreneur explored the possibility of using the waste heat from the boilers in the dyeing units to serve as the energy source, to recycle the wastewater. Development work was immediately started on this and a prototype was ready in six months. A commercial plant was readied for marketing and its use is now proliferating. By the last quarter of the year 2000, over 40 plants had been installed.

Entrepreneurs are also looking at the possibility of setting up central steam units with solar preheating as a commercial proposition. This facility may also use the high heat value of the municipal solid waste in the town.

Local entrepreneurs are looking at the possibility of using the municipal solid waste as a source of fuel to replace firewood as the waste has a high calorific value.

For the time being, pollution prevention and cleaner production approaches, such as cultivating colored cotton, natural dyes, and water minimisation, have not been considered as immediate solutions. Although promising, these approaches are very unlikely to be adopted on a large scale by the industry in the near future. In developing countries like India, where both agriculture and industry tend to be carried out by fragmented small players, there is a great reluctance to try new methods which often require substantial capital investment and may be risky, even more so in the context of increasing competition from neighboring countries.

5.6.1 Perspectives for Business and Planning

As it is today, the Tirupur industrial system is obviously not sustainable. It is characterized by heavy pollution, misuse and depletion of critical resources like land/soil, firewood and water. High flows of materials passing rapidly through the system and absence of materials loops makes this industrial cluster a good example of a typical unsustainable ecosystem. Unfortunately, as mentioned above, the proposed end-of-pipe (CETP) approach is not likely to improve the situation in the near future. On the other hand, the RFA study of Tirupur quickly pointed to new, simple and effective solutions.

In the perspective of Industrial Ecology, planners could play a crucial role in preventing potential disasters. RFA studies of different activity groups, aggregated to provide an overall picture of material flows in a region, would allow planners to consider promotion of industries in specific sectors that would optimize the use of critical resources, and guide the development of a region towards sustainability.

Annex 5.1

Methodology Adopted for the Assessment of Resource Flows

The study team collected the data between January and June 1996.

The exercise of data collection was quite a challenge as reliable data was not easily available.

Potential Sources of Data

The Industry

The industry in the town is made up of 4000 small and medium companies, most of which are owner managed. Although the owners have a high degree of specialized professional skill, they are mostly traditional, resisting new ideas. Competition is intense and secrecy is of paramount importance. The owners are often not keen on discussing details of their processes, material consumption, waste volumes or their sales and production figures. The recent crackdown by the Pollution Control authorities and the resultant spate of litigation, have made the industry more suspicious of any data collection being carried out.

Industry Associations

The industry is organized into twelve different industry associations, which represent specific activity segments. For example, there is a Bleachers' Association where all the bleaching units are members. There is substantial cross membership as many manufacturers are involved in more than one activity. The main role of the associations seems to be to represent the viewpoint of the members to different Government departments. Data availability with the associations is minimal.

Government Agencies

Consolidated data on the materials and energy consumption by the industries was not available with any of the various Government agencies, which monitor the industries. Some of the agencies like the Apparel Export Promotion Council and the Sales Tax Administration had data of total money value of sales but not the quantities.

The Assessment

None of these sources would be able to give the team the data that were required. A new approach was essential to collect the quantitative data so necessary to prepare an RFA. Very accurate data were not essential at this stage to get a broad understanding of resource flows, and reasonable estimations were adequate at least for the team to assess the order of magnitude of the different resources. Based on their relative importance, a more accurate assessment could be made for a few selected resources, if necessary.

The basis of the method chosen was to break down the entire industrial activity into six industry segments: knitting, bleaching, dyeing, calendering, finishing and printing. Within each segment, it was noted that the processes used by the different units were similar. Hence since each segment was homogeneous, it would be possible to select a few sample units in each segment, make assessments and extrapolate the results over the entire segment.

Each of the segments was taken up for specific analysis, so that an assessment of the material flows could be made for each individual segment.

At the first level, it was required to make an assessment of the total production quantities. This was achieved by taking the aggregate sales value and dividing it by the average price of a made-up garment sold. This gave the number of pieces sold. This estimation was done separately for exports and domestic sales, as there is a wide price variation. The number of pieces sold was multiplied by the average weight of a garment to arrive at the total tonnage produced. The figures were tallied with the total sales of yarn in the town. The figures concerning yarn, were assessed by taking a mean of trade reports and the sales value, as given by the tax administration. The assumptions on price and weight per garment were calculated on the basis of interviews with a number of industry experts. Details of the total production of the Tirupur Textile Industry are given in Table 5.3.

Table 5.3: Total Production of the Tirupur Textile Industry (1995)

Production	Number of Units
Total garments exported	358 million pieces (71,600 tonnes)
Domestic sales	250 million pieces (50,000 tonnes)
Total yarn/fabric processed	160,265 tonnes
Total tonnage of fabric manufactured	121,600 tonnes
Process losses	24.12%

Once the total tonnage was estimated, it was necessary to establish the process flow. That is, the processes the material has to go through from the stage of the yarn to the finished garment. The typical sequence is knitting, bleaching/dyeing, steam calendering, finishing, and printing. A finished garment must go through the complete sequence. That is, if the total quantity produced in Tirupur is known, it may be assumed that the entire quantity has passed through the entire sequence of operations except the dyeing/bleaching operations. It was assumed that only 50% of all the garments produced is dyed. The balance is sold as white and is just bleached.

The next stage was to make an assessment of the consumption and flow of materials and energy in each operation. The basis of the method was to establish material consumption norms for each operation, which could be extrapolated over the entire industry segment. For example, if the consumption of sodium chloride per kilogram of fabric dyed is known and the total fabric dyed in Tirupur is estimated, the total consumption of sodium chloride in Tirupur could be easily calculated. As mentioned earlier, this method was suitable for Tirupur, because, within each industry segment, the technology and methods adopted are largely uniform.

To arrive at the norms for extrapolation, the following steps were followed:

- Sample units were selected out of each industry group from the industry lists available from the associations.
- A good understanding of each process was gathered with the help of personnel in the industry association and in consultation with a few helpful entrepreneurs.
- Open-ended interviews were conducted with all the sample units.
- Data collected from the units in each segment were analyzed with the help of which tentative norms were established.
- The norms were re-checked with industry experts, in many cases the heads of the industry associations.

Typical Assumptions for Estimation of Energy

As an example of typical assumptions for the resource flow analysis in Tirupur, the details of the estimation of electrical energy are given below. Electrical energy concerns all the sectors of activity. The estimate is based on the total production figures indicated in Table 5.3, and assuming 300 working days per year and 12 working hours per day.

Electrical Energy

Knitting Industry

Average power consumption per tonne of fabric produced	:	138 kWh
Total annual production	:	145,920 tonnes
Total power consumption	:	20,140,000 kWh (20.14 million kWh)

Bleaching

Total fabric bleached per year	:	72,960 tonnes

Fabric bleached by machine	:	58,368 tonnes (assuming 80% of total fabric bleached by machine, and 20% hand bleached which does not need any power)
Power consumption per tonne of fabric bleached	:	26.78 kWh
Consumption per year	:	1,560,000 kWh (1.56 million kWh)
Dyeing	:	Exactly the same consumption as the bleaching industry

Note: *The original estimates were done for all the wet processes together as is usually estimated by the Pollution Control Board in Tirupur and the quantities divided between the bleaching and the dyeing sectors. Splitting this between bleaching and dyeing is difficult in Tirupur as many of the small units have facilities for dyeing and bleaching and change their activities depending on the needs of business. It is very difficult and time consuming to follow a more elaborate methodology for estimating the split between the dyeing and the bleaching unit. However, the overall aggregated industry figures have been cross-checked.*

Calendering

Average consumption per tonne	:	35.8 kWh
Total fabric calendered	:	145,920 tonnes
Total annual consumption	:	5,230,000 (5.23 million kWh)
Finishing	:	Cutting, Stitching + Ironing

Cutting & Stitching

Total production	:	608 million pieces
Average consumption per 1,000 pieces	:	12.78 kWh
Total annual consumption	:	7,780,000 kWh (7.78 million kWh)

Pressing/Ironing

Total production	:	608 million pieces
Consumption per 1,000 pieces	:	43.19 kWh
Total annual consumption	:	26,260,000 kWh (26.26 million kWh)
Total Finishing (stitching + ironing)	:	34,040,000 kWh (34.04 million kWh)

The summary of the total electrical energy consumption estimates is given in Table 5.4.

Table 5.4: Total Annual Electricity Consumption in Tirupur

Industry Segment	Industry Consumption (in thousand kWh/year)
Knitting	20,140
Bleaching	1,560
Dyeing	1,560
Calendering	5,230
Finishing	34,040
Total	**62,530**

Annex 5.2

RFA for each Segment of the Industry

The RFA for each segment of the industry in Tirupur are presented in Figures 5.4 to 5.8. The units for all the Figures are: electrical energy as million kWh per year, water as thousand litres per day, others as tonnes per year (MSW = Municipal Solid Waste).

No material flow details are provided for the printing industry as the total quantity of printing materials used in Tirupur is insignificant, as hardly any printing is done on the T-shirts. Although an estimate was prepared, a material flow diagram has not been provided.

FIGURE 5.4

Resource Flows in Knitting Industry, Tirupur

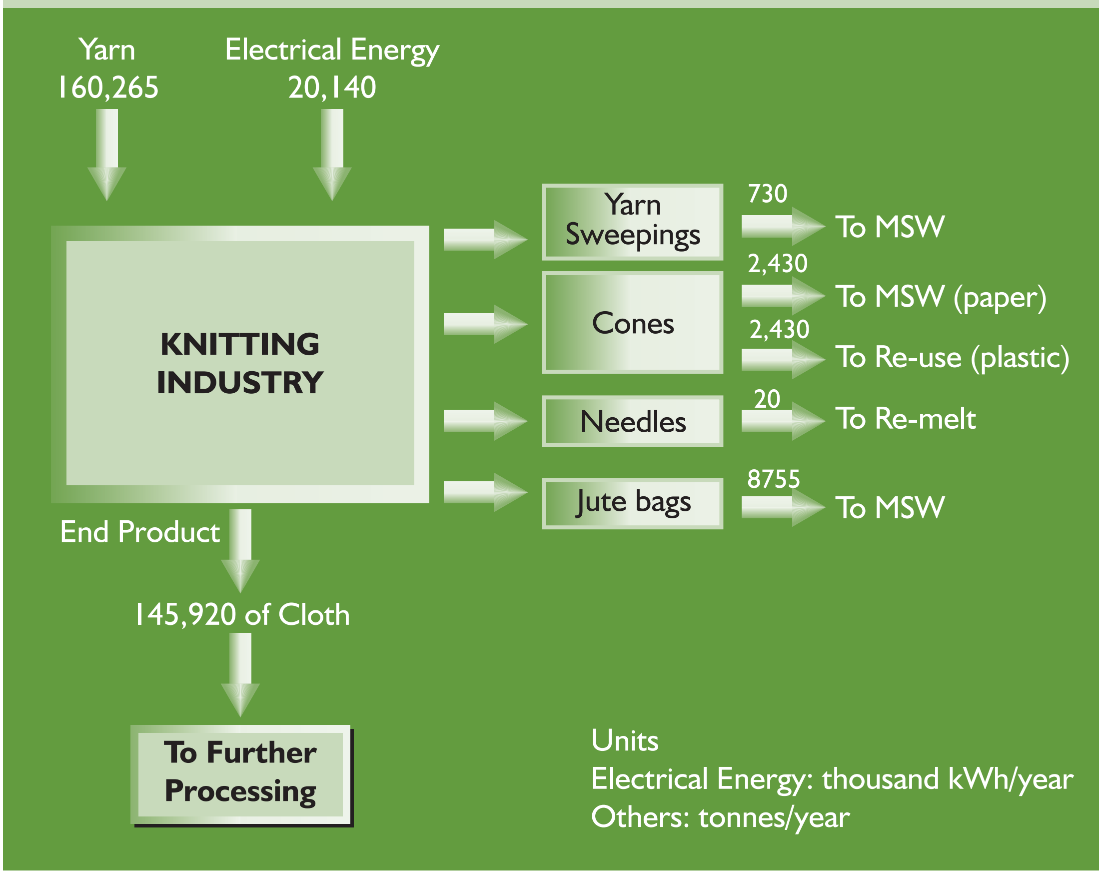


FIGURE 5.5

Transaction Flows in Bleaching Industry, Tirupur

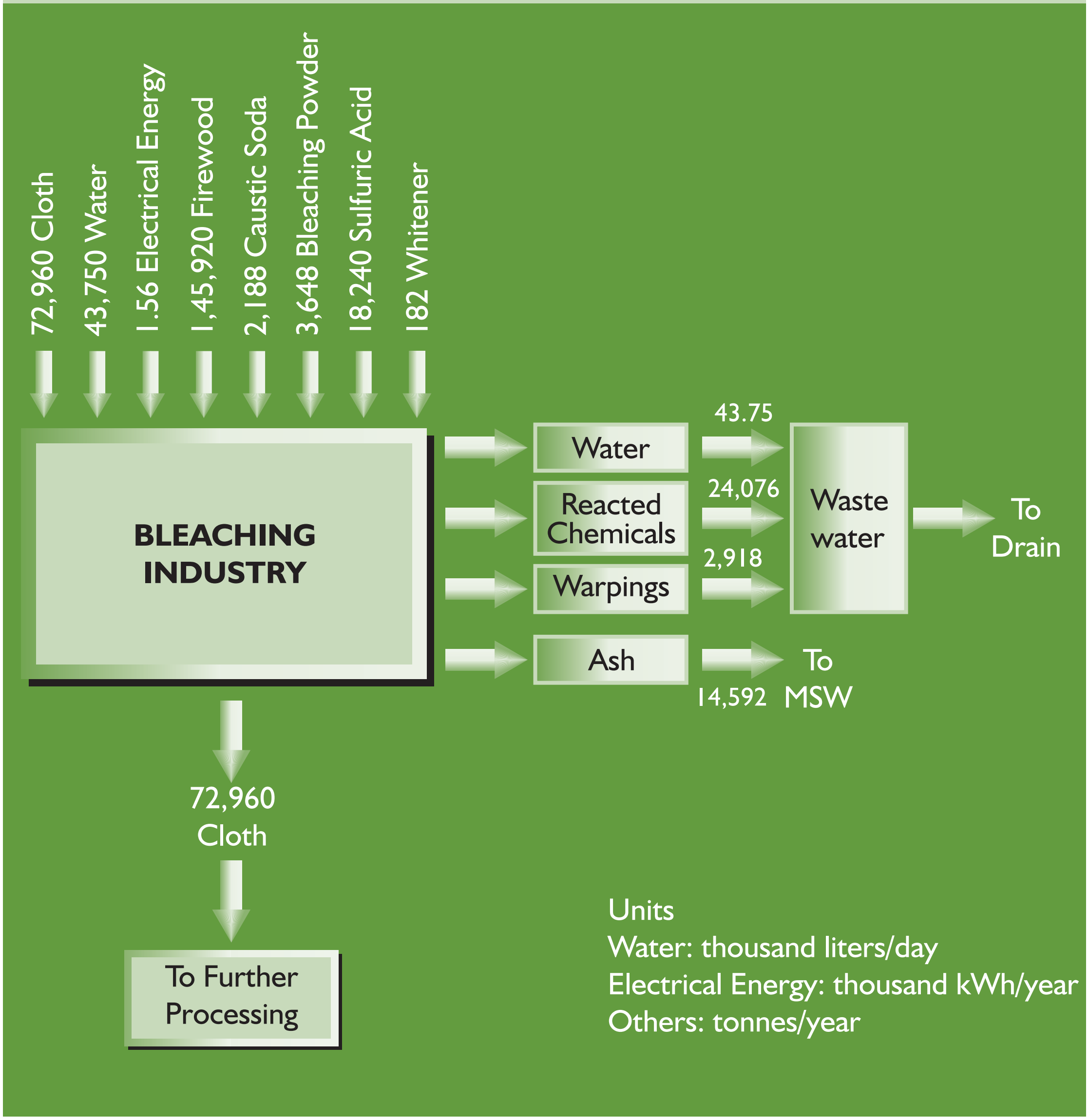
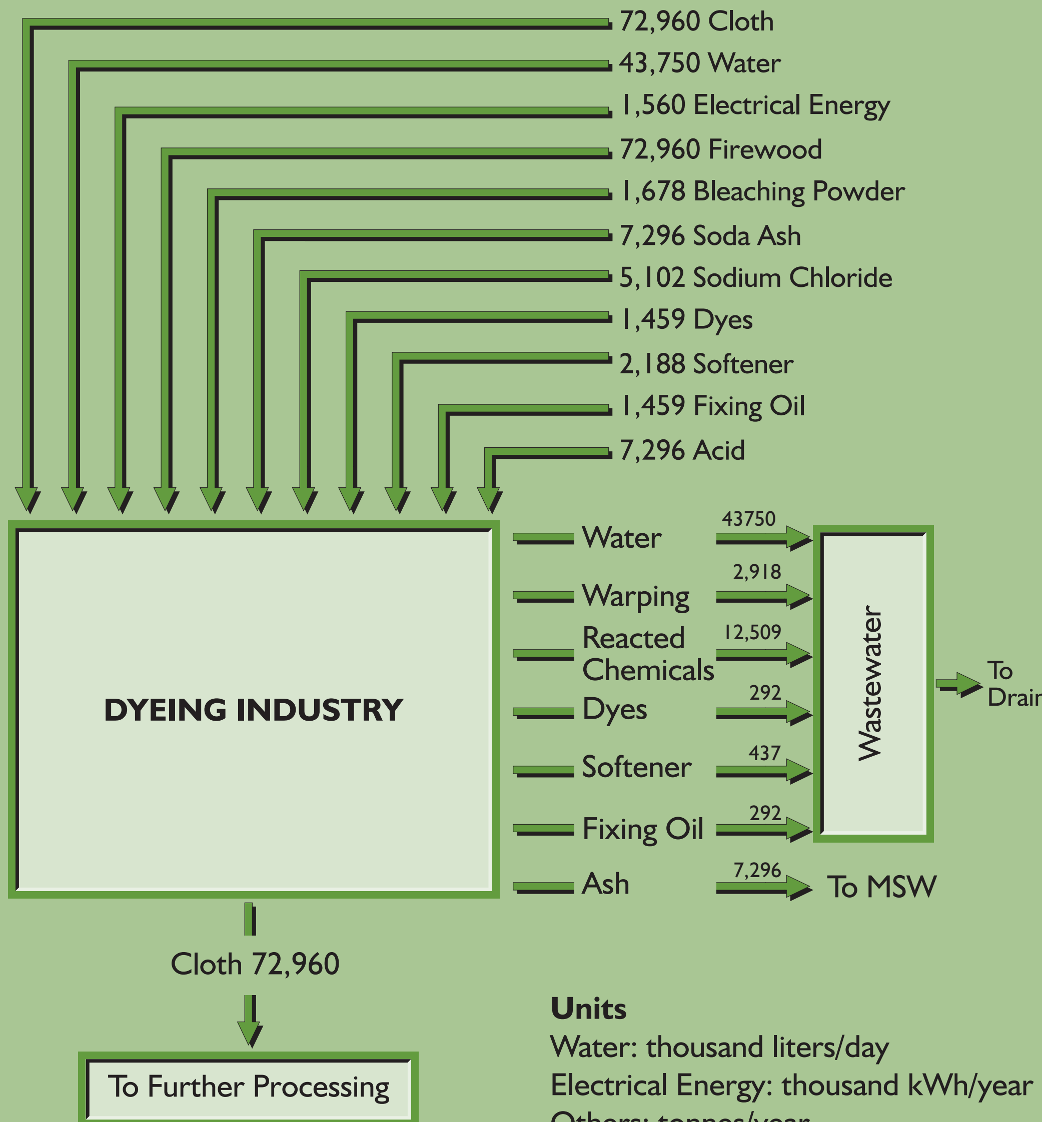


FIGURE 5.6

Resource Flows in Dyeing Industry, Tirupur



Units
Water: thousand liters/day
Electrical Energy: thousand kWh/year
Others: tonnes/year

FIGURE 5.7

Resource Flows in Calendering Industry, Tirupur

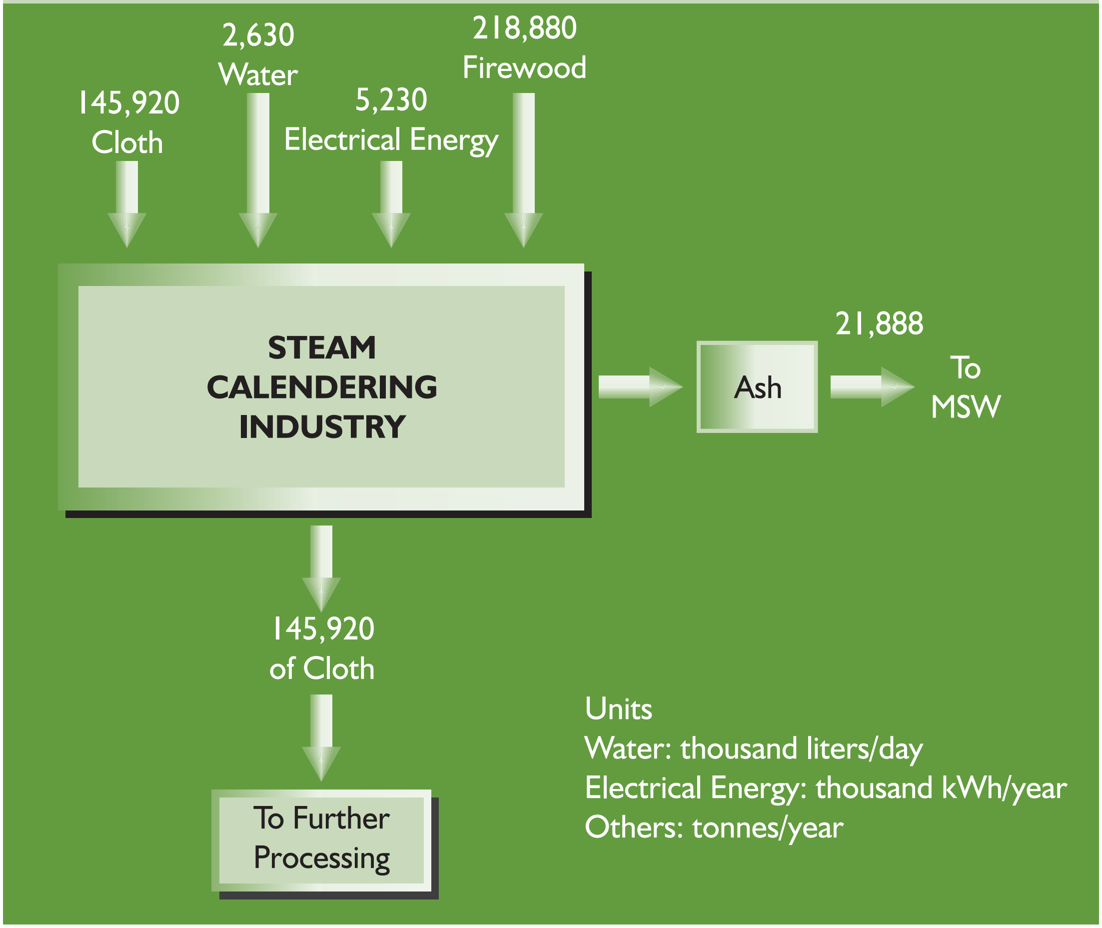


FIGURE 5.8

Resource Flows in Finishing Industry, Tirupur