Energy Utilisation in Karnataka: Part-III Small Scale Industries Sector

Dr. D.K. Subramanian **Dr. T.V. Ramachandra**

ENERGY RESEARCH GROUP
CENTRE FOR ECOLOGICAL SCIENCES
INDIAN INSTITUTE OF SCIENCE, BANGALORE 560 012, INDIA

Address for Correspondence

Dr. T.V.Ramachandra,
Energy and Wetlands Research Group,
Centre for Ecological Sciences,
Indian Institute of Science
Bangalore 560 012, India

E Mail : cestvr@ces.iisc.ernet.in
Cestvr@hamsadvani.serc.iisc.ernet.in
Energy@ces.iisc.ernet.in

Published in

Humanity Development Library
Versio - 2.0
Humanity Libraries Project
c/o Global Help Projects vzw
& HumanityCD Ltd.
Oosterveldlaan 196
B-2610 Antwerp BELGIUM
Email :humanity@globalprojects.org

Tel : 32-3-448.05.54
Fax : 32-3-449.75.74

Telephone : 91-080-3600985 / 309 2506
Fax : 91-080-3601428 / 3600085 / 3600683 [CES-TVR]

Next

INTRODUCTION

Energy utilization in a state is a complex activity closely intertwined with the limits on resources. At one end, there are energy resources which are used in various tasks. At the opposite are end uses in many sectors. In between we have many alternate paths of conversion of energy into many different forms and methods of transportation. The complexity of a total integrated energy scenario can be seen from the following aspects;

i) many energy sources can be used to perform a task (for example we can use electricity, firewood, coal, agricultural wastes, kerosene, charcoal and solar energy in the direst mode to heat water for bathing; we can run an irrigation pumping system with the help of electricity, diesel oil, biogas, or solar cells).

ii) energy from a resource can be converted via many stages to the form required by an end use. An example is the conversion of coal to heat (in a boiler), heat to mechanical energy (in a turbine), mechanical form to electrical form (in a generator), electricity to a mechanical form (in a motor) and mechanical to a potential form (in a pump) in order to pump water from a well. There may be several paths from a source to an end use device, (for example, we can use biogas for lighting either directly in a mantle or by its conversion into electricity, use it in an electric bulb).

iii) several devices may be available for a particular end use and one has to choose one of them (we have open chulas, mud stoves, steel stoves, improved stoves, smokeless chulas, three pan or two pan stoves for cooking purposes; all of them use firewood).

iv) Transporting methods are several (we can have a pithead thermal power station in a colliery and transmit electric energy via transmission lines or we can have a thermal power station close to a load centre and transport coal/oil by means of road, rail or sea routes).

The above features reveal the complexity of the energy situation. Add to this the fact that resources were available in abundance and the economists decreed that their costs/prices be negligible. All these made people consume large quanta of energy resources in the name of development with little or no concern for energy conservation. Energy efficiencies were very low. In several instances, only about 5 units of energy went into useful output out of an input of 100 units. This situation has nothing to do with many societal factors like - affluent stages of development, levels of technology, sectors of usage (like industrial or domestic) or resources (firewood or electricity).

Secondly, there was no emphasis on the use of renewable resources. Cost and convenience were the essential factors in the development of energy systems and this resulted in very low efficiencies of utilization on the oneside and on the other the rapid depletion of non renewable resources.

Both low efficiency use and rapid depletion of resources have their impact on our environment. These lead to the development of more mines, construction of giant hydroelectric projects,

planning, design and construction of nuclear plants and massive denudation of forests and village wood lots.

The previous two articles (Energy Utilisation in Karnataka part I and II) provided an exposure on the general energy situation in Karnataka and energy utilization in industries. The last study revealed that energy use is highly inefficient in the industrial sector. Since Small Scale Industries form an important component of our industrial set-up it was decided to concentrate on the small scale industrial sector in this study.

Certain important parameters of the small scale sector are

i) Industries are diffused all over the State. Hence it is possible to compare energy utilization in several districts.

ii) Industries in a group manufacture similar products. For example, bakeries in different places make products of great similarity. In the case of major industries we cannot get this degree of uniformity. If we consider two electrical industries, one may manufacture transformers and another motors. There are differences in technology, scales of production, materials used, production processes etc. Because of a greater degree of similarities that exist in a small scale industry group, conclusions on energy use can be meaningful.

iii) Economics of production is much more important in a small scale industry and energy plays a key role in the production efficiency in certain groups. It can even decide whether an industry can survive or not.

We start with a comparison of Karnataka with India with respect to Small Scale Industries (SSI). This is followed by a general picture of SSIs in Karnataka. Then a brief comparison with HT industries is given. The energy consumption comparisons for 47 groups are described later. Finally districtwise analysis of SSIs with reference to energy use is discussed.

The main indicator chosen in these studies has been the energy consumption/unit of production; the same as that used in the previous studies.

Before we look at the situation in Karnataka let us fix the position of Karnataka with reference to India in the Small Scale Industry sector. **Table 1** illustrates this.

We can see from this table that

(i) Karnataka has 5.57% of factories;
(ii) It's share of capital is only 4.43%;
(iii) It's share of manpower is 5.12%;
(iv) Wages constitute 4.90%;
(v) Fuels consumed account for 3.55% of all India total.
(vi) Value of the output is 4.24%.

Table 1: Selected Characteristics of SSIs 1980-81

(Value figures in Rs. lakhs Man days in Thousands and others in numbers)

		Karnataka	% of all India Total	All India
1	Number of factories	5381	5.57	96503
2	Fixed Capital	129642	4.43	2990038
3	Working Capital	50641	3.83	1320840
4	Invested Capital	206402	4.4	4688103
5	Outstanding loan	123469	4.27	2890820
6	Number of workers	302312	4.99	6046592
7	Man days workers	80261	4.76	1685303
8	Number of employees	396236	5.13	7714679
9	Man days Employees	113334	5.18	2188441
10	Total persons engaged	402026	5.12	7854274
11	Wages to workers	17888	4.53	394470
12	Total Emoluments	29931	4.9	609651
13	Old age benefits	2335	5.26	44385
14	Social Security benefits	595	4.6	12920
15	Other benefits	1274	6.61	19266
16	Fuels consumed	15052	3.55	423090
17	Material Consumed	140461	3.88	3615230
18	Total Inputs	187943	3.97	4723833
19	Products	226220	4.13	5466544
20	Value of output	259181	4.24	6108403
21	Depreciation	10936	5.7	191693
22	Net value added	60302	5.05	1192877
23	Rent paid	693	4.45	15774
24	Interest paid	12753	4.65	274067
25	Net income	46854	5.19	903036
26	Net fixed capital formation	12853	3.875	331610
27	Gross fixed capital formation	23788	4.54	523303
28	Addition in stock of			
	i) Materials, fuels etc.	8148		204191
	ii) Semi finished Goods	3776		32798
	iii) Finished Goods	6		31739
	iv) Total	11926	4.43	268725
29	Gross capital formation	35714	4.5	792031
30	Profits	12812	5.9	216814

This table shows that Karnataka is better placed relatively on the use of energy. Production/unit of energy is higher in the case of Karnataka compared to the all India figure.

Table 2 gives the detailed energy consumption figures in the 146 groups - identified by the three digit code. The table gives energy consumption in rupees per rupee of production for Karnataka and India. It also gives the number of industries sampled for Karnataka and India.

Table 2: Energy/Rupee of Production

Sl. No.	Karnataka 'No.of Industries	Code	Karnataka EC(Rs)/Pr(Rs)	India No.of Industries	India EC(Rs)/Pr(Rs)
1	3	200	0.01	22	0.049
2	10	201	0.02	258	0.037
3	13	202	0.03	1157	0.033
4	11	203	0.04	237	0.024
5	153	204	0.02	6923	0.015
6	39	205	0.05	499	0.044
7	2	206	0.07	2084	0.053
8	1	208	0.07	371	0.037
9	9	209	0.03	97	0.033
10	43	211	0.01	2680	0.152
11	3	212	0.02	1121	0.00615
12	13	213	0.10	61	0.043
13	5	214	0.00	517	0.007
14	16	215	0.36	261	0.276
15	3	216	0.00	137	0.015
16	2	217	0.08	293	0.1207
17	2	218	0.04	NA	NA
18	21	219	0.03	973	0.053
19	1	221	0.02	21	0.079
20	2	222	0.10	43	0.074
21	9	224	0.01	161	0.04
22	7	226	0.03	7884	0.007
23	1	227	0.01	85	0.0176
24	2	230	0.00	3384	0.046
25	2	231	0.03	1208	0.077
26	1	241	0.03	468	0.038
27	1	243	0.00	85	0.016
28	1	249	0.00	48	0.043
29	1	256	0.00	NA	NA
30	3	259	0.01	97	0.00068
31	15	260	0.01	901	0.00097
32	3	261	0.03	196	0.649
33	2	262	0.03	253	0.052
34	44	264	0.00	1141	0.0009
35	8	265	0.00	78	0.025
36	3	266	0.02	33	0.0009
37	4	267	0.01	80	0.037
38	7	269	0.01	43	0.03
39	6	270	0.01	299	0.047
40	91	271	0.03	2045	0.033
41	12	272	0.01	311	0.019
42	6	273	0.03	59	0.024
43	4	274	0.02	288	0.039
44	3	275	0.04	20	0.049
45	48	276	0.02	338	0.0176
46	9	277	0.01	3	NA
47	16	278	0.01	56	0.050
48	6	280	0.01	585	0.105
49	13	281	0.01	698	0.013
50	14	283	0.01	120	0.024
51	166	285	0.02	1262	0.029
52	3	287	0.03	107	0.0003
53	3	288	0.01	136	0.001
54	21	289	0.02	1733	0.029
55	3	290	0.01	598	0.014
56	24	291	0.01	201	0.019
57	5	292	0.00	34	0.023
58	4	293	0.01	31	0.023
59	1	295	0.03	NA	NA
60	1	298	0.12	24	0.016
61	26	300	0.04	298	0.049
62	4	301	0.13	337	0.044
63	17	302	0.08	878	0.044
64	70	303	0.03	1068	0.03
65	1	304	0.06	16	0.003
66	14	306	0.01	67	0.014709
67	10	310	0.12	417	0.17003
68	18	311	0.01	447	0.1253
69	10	312	0.04	668	0.07
70	13	313	0.02	1121	0.043
71	24	314	0.02	480	0.029
72	5	315	0.01	482	0.033
73	6	316	0.03	208	0.107
74	7	317	0.01	488	0.041
75	2	318	0.02	135	0.036
76	100	319	0.05	712	0.0004
77	14	320	0.23	2153	0.0006
78	8	321	0.05	590	0.229
79	2	322	0.20	12	0.3
80	3	323	0.12	425	0.164
81	7	324	0.09	251	0.2497
83	18	325	0.03	2298	0.013
84	36	328	0.01	1280	0.0089
85	19	329	0.04	98	0.03
86	2	330	0.03	1369	0.0715
87	64	331	0.07	1548	0.146
88	7	332	0.05	3293	0.077
89	6	333	0.03	53	0.03
90	4	334	0.02	141	0.116
91	2	335	0.03	243	0.048
93	3	339	0.05	388	0.2895
93	50	340	0.02	171	0.031
94	79	341	0.02	1736	0.025
95	37	342	0.01	9232	0.036
96	160	343	0.04	235	0.024
97	13	344	0.09	1694	0.048
98	37	345	0.04	414	0.1231
99	1	347	0.06	1418	0.024
100	17	348	0.02	NA	NA
1101	15	350	0.06	298	0.02276
1102	6	351	0.01	788	0.024
1103	3	352	0.03	219	0.0167
1104	20	353	0.02	1359	0.03
1105	20	354	0.03	737	0.026
1106	5	355	0.06	200	0.02
1107	11	356	0.01	583	0.029
1108	13	357	0.01	1088	0.04
1109	1	358	0.03	98	0.027
1110	162	359	0.04	1145	0.045
1111	14	360	0.02	1048	0.016
1112	25	361	0.01	347	0.017
1113	5	362	0.01	74	0.021
1114	24	363	0.01	950	0.037
1115	10	364	0.01	463	0.015
1116	14	366	0.00	120	0.00088
1117	99	367	0.02	178	0.032
1118	6	369	0.01	213	0.015
1119	1	370	0.01	158	0.027
1120	1	372	0.02	1145	0.1046
1121	33	374	0.05	1297	0.027
1122	3	376	0.04	238	0.029
1123	5	378	0.01	878	0.029
1124	20	379	0.04	10	0.02
1125	3	379	0.01	165	0.03
1126	2	390	0.01	446	0.643
1127	3	381	0.00	94	0.531
1128	7	382	0.02	213	0.017
1129	1	383	0.05	472	0.005
1130	2	385	0.03	52	0.45
1131	2	386	0.09	10	0.27
1132	9	387	0.02	313	0.013
1133	16	389	0.02	351	0.027
1134	1	395	0.13	NA	NA
1135	3	5324	0.05	NA	NA
1136	4	888	0.01	NA	NA
1137	1	926	0.05	NA	NA
1138	4	9853	0.02	NA	NA
1139	11	970	0.04	NA	NA
1140	11	972	0.02	64	0.1211
1141	54	973	0.06	2529	0.491
1142	4	9847	0.04	8	NA
1143	3	975	0.01	NA	NA
1144	18	976	0.08	NA	NA
1145	6	977	0.04	NA	NA
146	7	979	0.03	258	0.3483

We can see that Karnataka has higher costs of energy in the following sectors.

(i)	203:	Canning, preserving and processing of fish, crustacean and similar foods;
(ii)	204:	Grain mill products;
(iii)	205:	Manufacture of bakery products;
(iv)	207:	Products from indigenous Sugar, Boora, Khandasari, Gur, etc.;
(v)	213:	Coffee curing, roasting and grinding;
(vi)	215:	Manufacture of Ice;
(vii)	219:	Manufacture of food products not elsewhere classified;
(viii)	226:	Manufacture of bidis;
(ix)	259:	Manufacture of jute bags and other jute textiles;
(x)	260:	Knitting mills;
(xi)	262:	Embroidery and making of crepes; laces and fringes;
(xii)	266:	Manufacture of made up textile goods such as curtains, mosquito nets, etc.;
(xiii)	276:	Manufacture of wooden furniture and fixtures;
(xiv)	287:	Engraving, etching, blockmaking, etc.;
(xv)	288:	Book binding;
(xvi)	299:	Manufacture of leather and fur products not elsewhere classified;
(xvii)	301:	Manufacture of footwear made primarily of vulcanized or moulded rubber;
(xviii)	302:	Manufacture of rubber products not elsewhere classified;
(xix)	304:	Petroleum refineries;
(xx)	319:	Manufacture of chemical products not elsewhere classified;
(xxi)	320:	Manufacture of structural clay products;
(xxii)	325:	Manufacture of mica products;
(xxiii)	326:	Manufacture of structural stone products, stone dressing, stone-crushing;
(xxiv)	352:	Manufacture of prime movers, boilers and steam generating plant such as diesel engines;
(xxv)	354:	Industrial machinery for industries other than food and textile;
(xxvi)	355:	Manufacture of refrigerators, airconditioners and fire fighting equipment and other parts.
(xxvii)	358:	Manufacture of office computing and accounting machinery and accessories;
(xxviii)	360:	Manufacture of electrical industrial machinery and apparatus;
(xxix)	374:	Manufacture of motor vehicals and parts;
(xxx)	375:	Manufacture of motor cycles scooters and parts;
(xxxi)	378:	Bullockcarts, push carts, hand carts etc;
(xxxii)	382:	Manufacture of watches and clocks;

(xxxiii)	383:	Manufacture of jewellery and related articles;
(xxxiv)	387:	Manufacture of stationery articles like fountain pens, pencils, pens, tags etc.,

It shows that Karnataka has higher energy efficiency in 34 groups out of a total of 146 when compared with the all India figures.

Table 3 gives the same information but cumulated for a two digit code. This leaves us with only 25 groups. In this case, we find that two groups show a high energy efficiency figure for Karnataka compared to all India average and one group shows slightly higher value. The remaining 22 groups have lower figures for Karnataka than that for India. Both tables 2 and 3 show that in most of the groups, Karnataka has favourable energy use figures compared to the all India scene; but there are some groups that need a careful look - to find out ways and means of reducing energy consumption. Some groups show a very high difference and they need immediate attention.

Table 3: Energy Efficiency with two digit Industry Code

Sl. No.	No. of ind.	Karnataka		India	
		Ind. code	Ec(Rs)/ Pr(Rs)	No. of ind.	Ec (Rs)/ Pr(Rs)
1	240	20	0.02	17067	0.0315
2	106	21	0.02	8901	0.029
3	20	22	0.04	7189	0.076
4	4	23	0.01	3743	0.053
5	3	24	0.00	265	0.054
6	4	25	0.00	2889	0.015
7	84	26	0.01	4033	0.036
8	194	27	0.02	4798	0.103
9	221	28	0.01	868	0.015
10	37	29	0.01	3498	0.015
11	132	30	0.04	5479	0.088
12	190	31	0.04	6440	0.196
13	108	32	0.08	779	0.137
14	93	33	0.05	6457	0.036
15	394	34	0.03	7011	0.026
16	262	35	0.02	3406	0.019
17	84	36	0.01	2815	0.038
18	66	37	0.04	1956	0.018
19	50	38	0.01	NA	NA
20	1	39	0.18	NA	NA
21	2	52	0.05	NA	NA
22	4	88	0.01	NA	NA
23	1	92	0.05	NA	NA
24	4	96	0.02	NA	NA
25	103	97	0.05	2865	0.5206

Small Scale Industries In Karnataka :

Let us look at a general picture of the small scale industrial scene in Karnataka especially from the point of view of their spatial distribution, investment costs, growth rates and man power generation. Even though these aspects are not directly related to the energy consumption

patterns, they throw light on the developmental aspects and also indirectly influence energy and environment.

Table 4 gives the growth rate of SSI units in the State starting from 1969-70 onwards. Investment and number of persons employed are also given. We can see that the investment/job varies with years. Initially there was a downward trend. This was followed by an oscillatory behaviour; but the trend has become upward (increasing) from the year 1978-79 onwards. it has more than doubled in six years.

Table 4: Growth of Small Scale Industries in Karnataka

Sl.No.	Year	No.of registered SSI Units	Investment (Rs. in lakhs)	Persons employed	Persons employed Cumulative	Investment/job (cumulative) Rs/job
1	1969-70	3890	3456.70	47,960	47,960	7207
2	1970-71	1908	2279.43	44,295	92,255	5146
3	1971-72	2372	1309.39	21,343	113,598	6135
4	1972-73	2272	1350.10	22,490	136,088	6003
5	1973-74	3043	1638.23	21,814	157,902	7510
6	1974-75	1907	3991.27	56,043	213,945	7122
7	1975-76	1562	1641.36	12,783	226,728	12840
8	1976-77	1420	1482.51	15,406	242,134	9623
9	1977-78	1621	1517.11	24,750	266,824	6130
10	1978-79	1975	1451.46	16,957	283,841	8560
11	1979-80	2910	3255.01	34,376	318,217	9469
12	1980-81	2776	3041.83	26,164	344,381	11626
13	1981-82	3396	4955.16	41,375	385,756	11976
14	1982-83	6096	6255.29	46,420	432,176	13475
	Total	37161	37624.85	432,176		8705.90 (average)

The variations are more marked for the cumulative calculations. Percentage of units varies from 1.23 (for Kodagu) to 30.59 (for Bangalore). Bidar has 1.06% on investment while Bangalore takes a 38.22% share. Percentage of persons employed varies from 1.04 (Chikmagalur) to 36.25 (Bangalore).

Table 7 calculates investment/job in various districts, as well as the percent of population employed in each district. Investment/job is the lowest for Chikmagalur (Rs. 4,581.44) and highest for Bangalore (Rs. 26,898.67). In Bangalore rural, each job needs an investment on Rs. 33.291. This means that the industries are capital intensive. The Uttara Kannada district requires Rs. 21,904 per job.

Table 7: District-wise derived Indices for SSIs

Sl.No.	Districts	Investment/ job	% Population employed in SSI	Investment/ job	% Population employed in SSI
		During the year 1982-83		At the end of 1982-83 (Cumulative)	
1	Bangalore	26898.67	0.175	9178.43	3.16
	Bangalore (Urban)	16495.25	0.122	7802.87	2.95
	Bangalore (Rural)	33291.54	0.272	11108.07	3.54
2	Belgaum	11674.94	0.136	11546.63	0.539
3	Bellary	15931.71	0.074	9666.29	0.546
4	Bidar	5720.65	0.113	6922.10	0.58
5	Bijapur	5404.15	0.076	4654.82	0.54
6	Chitradurga	11715.02	0.076	8581.23	0.64
7	Chikmagalur	4581.44	0.101	8441.48	0.49
8	Dakshina Kannada	11833.48	0.141	6327.45	2.7
9	Dharwar	8045.01	0.125	8450.41	0.814
10	Gulbarga	8019.09	0.0679	8207.15	0.376
11	Hassan	9857.77	0.0663	8982.55	0.451
12	Kodagu	8741.66	0.1558	8774.18	2.367
13	Kolar	8704.54	0.1662	9630.31	0.612
14	Mandya	13236.33	0.039	9952.82	0.442
15	Mysore	10697.11	0.232	11312.40	0.891
16	Raichur	20485.71	0.058	8984.08	1.102
17	Shimoga	13800.72	0.166	14680.52	0.831
18	Tumkur	10551.58	0.155	7211.64	0.896
19	Uttara Kannada	21904.27	0.054	5830.58	0.859

Many times, we feel that SSIs generate employment. This aspect is also looked at in this table. The column percent of population employed calculates the ratio of the number of persons employed in SSI in a district to the total population of that district as a percentage. This fraction is quite low for all the districts. Mysore provides employment in SSI for only 0.23% of its population, U.K. district, on the lowest side, provides employment to only 0.054% of its population (for the year 1982-83). If we look at the cumulative picture, Bangalore gives employment to 3.16% of its population and Gulbarga to only 0.376% of its population. Only four districts cross the 1% mark, all others providing employment to less than 1% of their population in SSI sector.

Table 8 looks at another parameter - investment per capita. Again Bangalore leads with Rs. 47.16 in 1982-83 (Rs. 290.68 cumulative) and at the other end is Bijapur Rs. 4.11 in 1982-83 (25.15 cumulative). Only four districts have investment/population greater than this state average (cumulative).

The above comparisons show that there are a lot of disparities in investments in each district, investment/job, employment and investment/capita. Even SSIs have not dispersed very well in the whole of the State. These are pictorially displayed in figures. Fig. 1 gives the growth of the number of industries starting from 1970. Fig. 2 illustrates the manpower employed. Fig 3 shows the increase in investment. Fig. 4 graphs the distribution of SSIs in districts.

Table 8: Per-capita Indices for districts for SSIs

Sl. No.	District	Investment Rs. in lakhs	Population (Not)	Investment Capital Rs. %	Investment Rs. in lakhs	
		During the year 1982-83			Till end of 1982-83 (Cumulative)	
1	Bangalore	2333.36	4,947,610	47.16	7374.11	230.93
	Bangalore (Urban)	642.82	3,193,216	20.13	6907.67	393.73
	Bangalore (Rural)	1590.64	1,754,394	90.66	14381.78	290.68
2	Belgaum	472.82	2,980,440	15.86	1856.93	62.30
3	Bellary	177.32	1,489,556	11.90	786.16	52.77
4	Bidar	62.87	995,691	6.31	400.79	40.24
5	Bijapur	98.95	2,401,782	4.11	604.15	25.15
6	Chitradurga	158.27	1,777,499	8.92	979.72	55.11
7	Chikmagalur	42.47	941,769	4.50	380.12	40.36
8	Dakshina Kannada	398.97	2,376,724	16.77	4094.75	172.28
9	Dharwar	298.97	2,945,487	10.13	2027.17	68.28
10	Gulbarga	113.39	2,080,643	5.44	642.62	30.88
11	Hassan	88.72	1,357,014	6.53	550.90	40.59
12	Kodagu	62.94	461,888	13.62	959.61	207.77
13	Kolar	275.76	1,905,492	14.47	1124.05	58.99
14	Mandya	75.07	1,418,109	5.29	624.54	44.04
15	Mysore	645.25	2,595,900	24.85	2619.16	100.89
16	Raichur	215.1	1,783,822	12.05	1767.17	99.06
17	Shimoga	380.9	1,656,731	22.99	2022.83	122.09
18	Tumkur	325.2	1,977,854	16.44	1279.13	64.67
19	Uttara Kannada	128.14	1,072,034	11.95	537.23	50.11
	Total	6255.29	37,135,714	16.84	37624.85	101.31

Comparison of Small Scale Industries with Large and Medium Industries

Table 9 gives the gross fixed capital/employee and related figures for high tension consumers. The GFC/employee varies from Rs. 13,464 to 35,645. This shows that the variation between SSI and these industries is not very high especially if we look at the low end of the investment/employee. The table also shows that industries with a contract electricity demand of 100-250 KVA have a higher employment potential and lower energy consumption figures. These details are for the year 1978.

Table 9:Gross Fixed Capital Slab-wise

Sl. No.	G.F.C./EC (Rs.)	G.F.C./EC Rs.(KWH)	Empoleement per 100 KVA of Contract Demand (No.)	G.F.C per KVA of Contract Demand (Rs.)
1	35,645	1.617	19	6,876
2	27,232	8.710	70	19,166
3	20,975	10.300	79	16,549
4	13,464	8.448	73	9,783
	29,760		28	8,206

Energy Consumption in SSIs

The number of Small Scale Industries in the State is very large. Hence it is not possible to obtain data from all of them. So, data obtained from a sample were looked at. The SSIs have been coded into different groups. Even though about 140 groups were identified in the sample, many of them have a very few samples. Hence, we derived from the sample a secondary sample - we discarded all groups with a small sample. This resulted in a reduced sample of 47 groups.

Table 10 lists the SSI groups and their industrial codes. It has a variety of manufactures - bakery, food grains, furniture, garments, printing, leather chappals, polythene bags, plastics, soaps, oils, bricks, cement products, steel and structural products, agricultural tools, utensils, electroplating, machinery electrical appliances, automobile parts etc.

In order to compare the energy utilization, we calculated energy use/rupee of production for every group (this was also calculated district-wise as discussed in the next section).

Table 11 gives the specific energy consumption for the 47 groups. It gives the maximum value, minimum value, average and standard deviation for every group. The maximum value gives the maximum used by an industry in the group. Similarly the minimum is calculated. We can see that energy consumption in kilowatt hours/rupee of production has a considerable variation in each group; the variations being more than 100 times in some sectors. These wide variations show that there is a very good scope for improvement in energy use and conservation of energy. All groups exhibit strong variations.

Some sectors show a very high value of energy consumption and they deserve attention. Some examples are bricks and tiles, bakeries, tyre retread-plastic foam products, castings and agricultural implements.

In order to see the economic impact and survival of SSIs (with reference to energy use), **Table 12** is computed. This gives energy consumption in rupees per rupee of production. This again reveals the variations pictured in table 11. Industries in many groups use more than 30 paise for energy in a rupee of production. Two industries use more than 70 paise for energy per rupee of production. They belong to agarbathi and castings groups. Survival of many industries depends on energy conservation as revealed clearly especially in the case of those which use more than 25% of cost for energy.

Table 13 compares energy consumption with man power. In addition to the fact that there is a wide disparity in intrasector and intersector units, there is also a striking feature that the higher values of energy consumptions per person in some groups are greater than the similar figures for H.T. industries. This deserves further analysis and improvement are desirable. This also shows that all small scale units are not employment generating units.

Table 10 : Industrial Groups chosen for Analysis

Sl.No.	N.I.C.	Description
1	2018	Ice Candy, Cream, Baby Milkfood
2	2041	Milling of foodgrains
3	2042	Paddy Hulling, Rice
4	2043	Fried Gram
5	2051	Bread, Cake, Biscuits
6	2053	Biscuits
7	2110	Oil, Vanaspathy
8	2132	Coffee powder
9	2150	Cold storage
10	2641	Ready made Garments
11	2710	Wood sawing
12	2721	Wooden packing
13	2760	Wooden Furniture
14	2799	Wooden Photoframes, Articles
15	2850	Printing and Binding
16	2890	Commercial Printing
17	2913	Leather Chappals
18	3004	J.W. Tyre Retreading
19	3035	Polythene Bags
20	3039	Plastic Foam Products, Buttons
21	3053	Wax Candles
22	3101	Heavy Inorganic Chemicals
23	3142	Washing Soap and Powder
24	3199	Agarbathis, Misc. Chemicals
25	3209	Non ceramic Bricks, Tiles
26	3261	Marble Slabs, Stone Polished
27	3289	Asbestos Cement Products, Glazed Tiles
28	3291	Concrete Blocks, Hume Pipes
29	3311	Castings and Forgings
30	3402	Steel Trunk, Accessories
31	3403	Moulding - Drums, Tanks, Metal Containers
32	3410	Structural Metal Products
33	3420	Iron Furniture, Aluminium Furniture
34	3435	Agricultural Handtools, Implements
35	3440	Electro Plating, Polishing, Enamelling
36	3452	Utensils
37	3499	Misc. Metal Products including wire mesh, Safety pins
38	3549	Industrial Machinery
39	3578	Parts, Accessories of m/c tools
40	3598	Parts, Accessories
41	3599	Gen. Engg.
42	3699	Misc. Electrical m/c Apparatus and Appliances
43	3748	Automobile parts and Acc.
44	3781	Bullock carts and Parts
45	9730	Auto, Scooter, Cycle reparing
46	9731	Auto, Scooter Servicing
47	9760	M/c and servicing Pumpsets

Table 11: Energy Consumption (KWH)/P R. (Rs)

Sl.No.	Pr. code	No.of Ind.	Max	Min	Avg	S.D
1	2018	8	0.3264	0.0217	0.1545	0.1142
2	2041	13	0.8654	0.0064	0.0223	0.3055
3	2042	123	1.9375	0.0027	0.2595	0.3032
4	2043	14	0.4032	0.0002	0.0749	0.1292
5	2051	24	3.8409	0.0077	0.7479	1.0490
6	2053	12	0.4128	0.0268	0.2090	0.1897
7	2110	43	0.3214	0.0052	0.0770	0.0874
8	2132	13	1.9365	0.0140	0.2560	0.5140
9	2150	15	1.4043	0.0500	0.4748	0.4826
10	2641	44	0.5158	0.0007	0.0554	0.0980
11	2790	90	0.1375	0.0050	0.1890	0.1960
12	2721	12	0.3545	0.0015	0.0711	0.1031
13	2760	47	0.4000	0.0032	0.0745	0.0812
14	2799	15	0.2000	0.0042	0.0648	0.0617
15	2850	166	1.0667	0.0037	0.0591	0.0949
16	2890	21	0.2616	0.0080	0.0498	0.0676
17	2913	15	0.2400	0.0095	0.0612	0.0806
18	3004	23	3.8923	0.0063	0.7977	0.9518
19	3035	11	0.3600	0.0025	0.0676	0.0991
20	3039	35	4.3636	0.0009	0.1843	0.7298
21	3053	12	0.0511	0.0095	0.0320	0.0223
22	3101	10	1.9751	0.0024	0.2817	0.6043
23	3142	10	1.4608	0.0282	0.3463	0.5250
24	3199	95	2.2511	0.0007	0.0959	0.3179
25	3209	12	8.5372	0.1667	3.4434	2.9122
26	3261	14	0.3158	0.0076	0.0630	0.0816
27	3289	33	4.2067	0.0032	0.0325	0.0495
28	3291	11	0.1200	0.0023	0.0363	0.0384
29	3311	47	3.7017	0.0055	0.7749	0.8853
30	3402	12	0.6957	0.0068	0.1350	0.2127
31	3403	18	0.3870	0.0088	0.0747	0.0863
32	3410	79	0.5760	0.0052	0.1021	0.1056
33	3420	36	1.6354	0.0029	0.0834	0.2681
34	3435	134	5.1120	0.0086	0.7272	0.8173
35	3440	13	0.5255	0.0375	0.2362	0.1654
36	3452	35	2.0135	0.0035	0.2538	0.3767
37	3499	14	0.3742	0.0038	0.0701	0.0967
38	3549	10	0.1981	0.0095	0.0579	0.0556
39	3577	21	0.4248	0.0046	0.0806	0.1307
40	3598	14	0.1060	0.0080	0.0335	0.0274
41	3599	134	1.6867	0.0194	0.1565	0.2026
42	3669	11	0.0362	0.0023	0.0175	0.0102
43	3748	10	0.2203	0.0093	0.0745	0.0823
44	3781	20	1.2077	0.0067	0.2746	0.3087
45	9730	36	0.3330	0.0167	0.1120	0.0942
46	9731	18	0.6113	0.0500	0.1693	0.1378
47	9760	12	0.6483	0.0444	0.1659	0.1769

Table 12: Specific Energy Consumption (Rupees)

Sl.No.	Pr. Code	N.I.	Max	Min	Avg	S.D.
1	2018	8	0.1346	0.0161	0.0696	0.0408
2	2041	13	0.3462	0.0031	0.0111	0.1398
3	2042	123	0.3846	0.0011	0.1058	0.0993
4	2043	14	0.1629	0.0002	0.0373	0.0589
5	2051	24	0.3000	0.0038	0.0800	0.0804
6	2053	11	0.2700	0.0052	0.0810	0.0846
7	2110	43	0.1563	0.0022	0.0351	0.0416
8	2132	13	0.4862	0.0050	0.0802	0.1272
9	2150	15	0.4667	0.0250	0.02147	0.2232
10	2641	44	0.2075	0.0004	0.0248	0.0405
11	2710	90	0.3750	0.0024	0.0841	0.0784
12	2721	12	0.1022	0.0037	0.0251	0.0290
13	2760	47	0.2000	0.0013	0.0361	0.0400
14	2799	15	0.1131	0.0017	0.0354	0.0366
15	2850	166	0.5503	0.0019	0.0296	0.0489
16	2890	21	0.2158	0.0050	0.0257	0.0449
17	2913	15	0.1167	0.0019	0.0294	0.0378
18	3004	23	0.2545	0.0030	0.0873	0.0741
19	3035	11	0.1992	0.0010	0.0354	0.0555
20	3039	35	0.0968	0.0029	0.0584	0.0261
21	3053	12	0.0462	0.0020	0.0144	0.0114
22	3101	10	0.1728	0.0010	0.0649	0.0651
23	3142	10	0.0714	0.0042	0.0292	0.0230
24	3199	94	0.8657	0.0003	0.0428	0.1306
25	3209	12	0.3383	0.0667	0.2501	0.1028
26	3261	14	0.1276	0.0036	0.0286	0.0339
27	3289	33	0.0260	0.0006	0.0129	0.0143
28	3291	11	0.0480	0.0009	0.0174	0.0169
29	3311	47	0.7800	0.0022	0.1422	0.1523
30	3402	12	0.3478	0.0027	0.0485	0.0885
31	3403	18	0.1400	0.0038	0.0341	0.0343
32	3410	79	0.2000	0.0036	0.0427	0.0362
33	3420	36	0.2900	0.0014	0.0291	0.4820
34	3435	134	0.2500	0.0025	0.0839	0.0826
35	3440	13	0.2400	0.0225	0.0982	0.0807
36	3452	35	0.1837	0.0015	0.0560	0.0565
37	3499	14	0.0572	0.0019	0.0245	0.0199
38	3549	10	0.0760	0.0047	0.0307	0.0222
39	3578	21	0.3333	0.0049	0.0513	0.0766
40	3598	14	0.0733	0.0046	0.0233	0.0196
41	3599	134	0.3600	0.0100	0.1003	0.0946
42	3669	11	0.0234	0.0015	0.0102	0.0064
43	3748	10	0.0748	0.0055	0.0188	0.0209
44	3781	20	0.2500	0.0012	0.0552	0.0582
45	9730	36	0.2133	0.0083	0.0553	0.0438
46	9731	18	0.4438	0.0200	0.0963	0.0968
47	9760	12	0.2980	0.0178	0.0797	0.0790

Table 13: Energy per Manpower of Employment

Sl.No.	Pr. Code	N.I.	Max	Min	Avg	S.D.
1	2018	8	3879.00	300.00	1514.42	1406.80
2	2041	13	9875.00	360.00	3415.70	2564.76
3	2042	123	7535.71	214.29	1810.99	1439.02
4	2043	14	25250.00	120.00	3274.33	6632.26
5	2051	24	5550.00	31.25	1365.54	1348.17
6	2053	12	29451.00	120.00	5519.25	8093.79
7	2110	43	120000.00	250.00	4602.50	18112.90
8	2132	13	6235.29	83.33	1658.36	1655.55
9	2150	15	23233.33	166.67	3929.77	7034.55
10	2641	44	5455.58	7.36	372.22	822.29
11	2710	90	4900.00	58.22	852.48	607.42
12	2721	12	2044.60	107.14	671.99	575.29
13	2760	47	2666.67	30.00	360.92	417.18
14	2799	15	2450.00	80.00	570.35	603.84
15	2850	90	4127.00	25.00	373.52	490.44
16	2890	21	6636.13	72.00	743.11	1422.66
17	2913	15	14000.00	17.00	1108.44	3569.01
18	3004	23	13400.00	200.00	2908.28	3410.04
19	3035	11	2987.50	200.00	1529.98	852.25
20	3039	35	15000.00	58.75	1406.89	2660.83
21	3053	12	400.00	40.00	164.22	114.86
22	3101	10	6500.00	94.67	2324.56	2266.78
23	3142	10	8333.00	116.67	1545.68	2483.20
24	3199	95	126250.00	12.20	3181.50	15521.79
25	3209	12	58500.00	734.97	9678.93	15625.26
26	3261	14	2666.67	50.00	587.31	656.56
27	3289	33	6800.00	55.56	750.45	1266.90
28	3291	11	988.89	40.00	280.99	341.08
29	3311	47	17472.00	105.43	3783.06	3602.09
30	3402	12	1000.00	75.00	316.07	290.60
31	3403	18	1714.29	122.50	662.40	479.61
32	3410	79	3108.69	85.71	650.52	510.52
33	3420	36	1800.00	68.00	458.79	455.27
34	3435	134	12500.00	50.00	917.82	1335.05
35	3440	13	10909.00	450.00	2976.04	2999.32
36	3452	35	5988.36	125.00	1368.90	1946.40
37	3499	14	9920.00	143.75	1573.62	2495.59
38	3549	10	895.50	167.57	532.60	257.44
39	3578	21	4171.43	187.78	754.69	845.06
40	3598	14	1518.52	140.00	623.36	438.77
41	3599	134	3600.00	83.33	877.08	996.57
42	3669	11	800.00	61.54	341.48	237.98
43	3748	10	8898.54	298.68	1344.00	2662.34
44	3781	20	4166.67	50.00	902.66	986.88
45	9730	36	6200.00	62.50	753.85	1047.00
46	9731	18	3944.44	200.00	892.70	808.54
47	9760	12	3377.67	100.00	714.82	884.52

District-wise Variation of Specific Energy Consumption in SSIs

Since there are a lot of similarities in SSIs pertaining to the same industrial code, it was decided to calculate the energy consumption per rupee of production in various districts. These are calculated for the 47 sectors identified in the last section.

Table 14 displays the total energy consumption in all industries surveyed in the district. It lists out many parameters like specific energy consumption in kwhrs/rupee of production, specific energy consumption in rupees, energy consumption/manpower; we can see that specific energy consumption varies from a minimum of 0.02 for Bidar to a maximum 1.93 for Dakshina Kannada district (0.0105 rupees for Raichur to 0.38 rupees for South Kanara district). Similarly energy consumption/person employed also varies from 2,068 for Hassan to 28,940 for Tumkur. In order to look into variations in each group tables 15 and 16 are generated. They display specific energy consumption for the 47 groups and for all districts. They show remarkable differences in the values.

Table 14: District-wise SEC (total)

		No. IN	Ec/Pr (Rs)	Ec(Rs)/Pr(Rs)	Ec/MP (No)
Gulbarga	1	50	0.0717	0.0131	4776.78
Kodagu	2	33	0.1505	0.0372	4501.30
Bidar	3	42	0.0200	0.0086	2987.50
Chikmagalur	4	42	0.2724	0.0367	14221.54
Dharwar	5	152	0.0957	0.0284	9311.66
Mysore	6	153	0.1499	0.0275	11970.16
Shimoga	7	133	0.1295	0.0515	10606.81
Bijapur	8	91	0.1136	0.0258	5536.40
Kolar	9	84	0.6804	0.0453	26077.68
Hassan	10	68	0.0838	0.0365	2068.98
U.K.	11	40	0.3260	0.0704	7944.08
Mandya	12	51	0.0918	0.0169	5006.03
D.K.	13	188	1.9343	0.3828	14649.32
Belgaum	14	128	0.3967	0.0472	17333.64
Raichur	15	41	0.0314	0.0105	4328.86
Chitradurga	16	133	0.1854	0.0242	10057.48
Bellary	17	100	0.1943	0.0241	10924.35
Tumkur	18	86	0.6759	0.0570	28940.26
Bangalore	19	792	0.1321	0.0277	8219.29

Whenever an industry consumes more than 25% of its total costs for energy whereas another industry in the same group (producing similar or same items) has a much lower energy cost (say 7% or 10%) then energy becomes a critical factor in the survival of the first industry. Some example groups for this situation are listed below.

1) Foodgrain milling — Tumkur Dist - 0.33
Dharwar - 0.01

2) Biscuits — Mysore - 0.43
Chikmagalur - 0.0167

3) Coffee powder — Mysore - 0.4
Kodagu - 0.005

4) Cold storage	D.K. Dist - 0.48 Bidar - 0.03	
5) Bricks and tiles	Tumkur - 0.34 S.K. Dist - 0.33 Hassan - 0.07 U.K. Dist - 0.14	
6) Bullock Carts and parts	Dharwar - 0.25 Shimoga - 0.006	

The above list shows that price difference is also partly due to the difference in prices for traditional fuels like firewood. This does not mean that energy efficiency is the same; because table 15 shows that the difference in energy efficiency exists.

Conclusions

We can draw the following conclusions based on these studies;

(i) Even though Karnataka exhibits better energy efficiency compared to the Indian figures, it has higher energy consumption (lower energy efficiency) values for 34 groups out of a total of 146 groups considered. This means that a closer look at these 34 groups is needed.

(ii) Karnataka's map of Small Scale Industries reveals an uneven distribution of the industries amongst the various districts. Bangalore's share is very high. It has 30.59% of the SSI units in the State and has a share of 38.22% in the total investment.

Bangalore also needs the highest investment per job. Its investment/job is Rs. 26,896.67 compared to Rs. 4,581.44 for Chikmagalur. (Bangalore rural needs a still higher figure).

(iii) Percentage of population getting employment in Small Scale Industries is not high. It is very low. The maximum comes from Bangalore 3.16%; the lowest is for Gulbarga - only 0.376%. Only 4 districts cross the 1% mark; all others have employment for less than 1% of their population in the SSI sector.

(iv) Investment/capita also shows Bangalore leading (with Rs.290.68 cumulative) and Bijapur on the lower side (Rs. 25.15). Only four districts have investment/capita greater than the state average.

(v) Average investment per person employed for SSI is similar to that for the lower end of major industries - that is industries with a contract electricity demand of 100-250 KVA. A similar situation exists for energy consumption/person also.

(vi) One of the indices to compare energy efficiencies in a group of industries is the specific energy consumption factor - energy consumption per unit (rupee) of production. This was

calculated for 47 groups of SSIs. Many groups exhibit very great differences for this index. Ratios of 1:100 are found in several sectors. Some of the groups with wide variations are bricks and tiles, bakeries, tyre retreading, castings and agricultural implements. They need immediate attention. There is a need for a central monitoring agency to prepare norms for various groups and inform the SSIs whenever they exceed the norms. Several associations exist for small scale sector in the Country and the State. They can also take a lead in establishing a monitoring agency.

(vii) Economic impact of energy on an industry can be indicated by the fractional cost of energy in the overall cost of production. Many industries spend more than 30 paise for energy in a rupee of production. Viability of an industry is closely related to the energy usage in many cases.

(viii) District-wise variations in specific energy consumptions show that Dakshina Kannada district has a high value and Bidar a low value. In order to separate energy intensity nature, groupwise analysis was conducted.

(ix) Group-wise and district-wise analysis of specific energy consumptions show wide variations in every group. About 33 groups reveal ratios of maximum to minimum specific energy consumptions greater than 10. This means that there is a remarkable potential for energy conservation in these groups.

(x) Group-wise and district-wise analysis of percentage of expenditure on energy reveal very high differences in some cases. Some of the groups, where some industries have an energy expenditure of 25% or more and many others with lower values, are foodgrain milling, biscuits, coffee powder, cold storage, bricks and tiles, and bullock carts and parts. In all these cases, marked differences exist suggesting again the need for energy conservation measures.

Since many of these groups are traditional in nature and consume fuels like firewood, their impact on environment is obvious and clear.

Acknowledgments

Thanks are due to the Director, Small Scale Industries and Mr. Ramanathan, Assistant Director (Ele.) for their help in our data collection work and energy analysis.

References

Aburas, R., 'Energy conservation policies in Jordan', Energy Policy, pp 591-598, Butterworth and Co (Publishers) Ltd, Dec. 1989.

Anandalingam, G., 'Policy incentives for industrial energy conservation', Discussion Paper No. 02.83, TERI, New Delhi.

Anandalingam, G., 'Energy conservation in the industrial sector of developing countries', Energy Policy, pp 335-339, Butterworth and Co (Publishers) Ltd, Aug. 1985.

Anderson, W.P., 'Energy and the environment: The new case for conservation', Energy Studies Review, Vol. 6, No. 1, pp 16-32, Canada, 1994.

Ang, B.W., 'Decomposition of industrial energy consumption: The energy intensity approach', Energy Economics, Vol. 16, No. 3, pp 163-174, Butterworth-Heinemann Ltd, 1994.

Ang, B.W. and Lee, S.Y., 'Decomposition of industrial energy consumption: Some methodological and application issues', Energy Economics, Vol. 16, No. 2, pp 83-92, Butterworth-Heinemann Ltd, 1994.

Ang, B.W., 'A statistical analysis of energy coefficients', Energy Economics, pp 93-110, Butterworth-Heinemann Ltd, April 1991.

Anxo, D. and Sterner, T., Using electricity data to measure capital utilization', Energy Economics, Vol. 16, No. 1, pp 63-74, Butterworth-Heinemann Ltd, 1994.

Arya, G., 'Energy saving in motor control systems', 3rd Annual Conference, Environmental and Energy Efficiency Management, July 1990.

Beck, R. and Solow, J.L., 'Forecasting nuclear power supply with Bayesian autoregression', Energy Economics, Vol. 16, No. 3, pp 185-192, Butterworth-Heinemann Ltd, 1994.

Communication, 'State of industrial sickness in India', Productivity, Vol. 30, No. 4, pp 462-465, January-March 1990.

DPIE, 'Future Energy Management', Australian Government Publishing Service, Canberra, Nov. 1991.

Fawkes, S.D. and Jacques, J.K., 'Approaches to energy conservation management in beverage - related industries and their effectiveness', Energy Policy, pp 559-566, Butterworth-Heinemann Ltd, Dec. 1987.

Hansen, U., 'Delinking of energy consumption and economic growth: The German experience', Energy Policy, pp 631-640, Butterworth-Heinemann Ltd, Sep. 1990.

Howarth, R.B., Schipper, L., Duerr, P.A. and Strom, S., 'Manufacturing energy use in eight OECD countries: Decomposting the impacts of changes in output, industry structure and energy intensity', Energy Economics, pp 135-141, Butterworth-Heinemann Ltd, April 1991.

Huang, J.P., 'Industry energy use and structural change: A case study of The People's Republic of China', Energy Economics, pp 131-136, Butterworth-Heinemann Ltd, April 1993.

Hunter, R., 'Energy options', SPA, pp 35-40, Autumn 1992.

Industrial Economist, Annual Number, Vol. XVIII, No. 12.

Jelinski, L.W. et al. 'Industrial ecology: Concepts and approaches', Colloquium Paper, Vol. 89, pp 793-797, Proceedings of National Academic Sciences, USA, 1992.

Jutsen, J., 'Energy management in industry: issues and challenges', The National Energy Management Forum, June 1991.

Kothari, V.S., 'Industrial energy policies of India', TERI, Oct. 1987.

Levine, M.D., et al. 'Energy efficiency, developing Nations, and Eastern Europe', A Report to the U.S. Working Group on Global Energy Efficiency, June 1991.

Lohani, B.N. and Azimi, A.M., 'Barriers to energy end-use efficiency', Energy Policy, pp 533-545, Butterworth-Heinemann Ltd, June 1992.

Mander, S. and Wilson, B., 'An analysis of data from the enterprise energy audit program', Project 41.013, ABARE.

McInnes, G. and Unterwurzacher, E., 'Electricity end-use efficiency: an assessment of the scope for efficiency gains and policy options', Energy Policy, pp 208-216, Butterworth-Heinemann Ltd, April 1991.

Munasinghe, M., 'Efficient management of the power sector in developing countries', Energy Policy, pp 94-103, Butterworth-Heinemann Ltd, 1992.

Natarajan, T.V. and Bhattacharya, A., 'Reliability considerations in generation, transmission and distribution of electric power system - with special reference to India', Discussion Paper No. 07.84, TERI, New Delhi.

Nilsson, K., 'Industrial production planning with optimal electricity cost', Energy Conservation Management, Vol. 34, No. 3, pp 153-158, Pergamon Press Ltd, Great Britain, 1993.

NPC Energy Management Division, 'Energy indicators for Indian refinery sector', Productivity, Vol. 30, No. 4, pp 495, January-March 1990.

NPC Research Section, 'Productivity in Indian food processing industries', Productivity, Vol. 30, No. 4, pp 466-482, January-March 1990.

Oelschlager, R., 'Cutting costs: Energy savings with industrial dryers', Drying Technology, Vol. 9, No. 4, pp 883-890, Marcel Dekkar, Inc, 1991.

Pachauri, R.K., 'Energy efficiency in developing countries: Policy options and the poverty dilemma', Natural Resources Forum, pp 319-325, Butterworth-Heinemann Ltd, Nov. 1990.

Pachauri, R.K., 'Energy efficiency and conservation in India', UNEP Industry and Environment, pp 19-24, 1990.

Parikh, J., et al. 'Consumption patterns: The driving force of environmental stress', United Nations Conference on Environment and Development, Oct. 1991.

Pasha, H.A., Ghaus, A. and Malik, S., 'The economic cost of power outages in the industrial sector of Pakistan', Energy Economics, pp 301-322, Butterworth and Co (Publishers) Ltd, Oct. 1989.

Rapp, B. and Selmer, J., 'Impact of organizational factors on energy conservation measures', Energy Policy, pp 437-444, Butterworth and Co (Publishers) Ltd, Oct 1985.

Reddy, A.K.N. and Goldemberg, J., 'Energy for the developing world', Scientific American, pp 63-72, Sep. 1990.

Reddy, A.K.N., 'An alternative pattern of Indian industrialization', In: Change and Choice in Indian Industries, Eds. Bagchee, A.K. and Bannerji, N., Calcutta, 1982.

Rudig, W., 'Energy conservation and electricity utilities: a comparative analysis of organizational obstacles to CHP/DH', Energy Policy, pp 104-148, Butterworth and Co (Publishers) Ltd, April 1986.

Samuelson, P.A., 'Conserved energy without work or heat', Applied Mathematics, Vol. 89, pp 1090-1094, Proceedings of National Academic Sciences, USA, Feb. 1992.

Schurr, S.H., 'Energy conservation and productivity growth: Can we have both?', Energy Policy, pp 126-142, Butterworth and Co (Publishers) Ltd, April 1985.

Silverstrini, G.V., ' Energy planning and flexibility of the energy system', Energy Systems and Policy, Vol. 14, pp 113-125, Taylor and Francis, UK, 1990.

'Small scale industries in India', Hand Book of Statistics 1989, Ministry of Industry, New Delhi.

Somasekhara, N., Selvaraju, V. and Rao, D.M., 'Economies of scale in Indian manufacturing industries', Productivity, Vol. 30, No. 4, pp 445-448, January-March 1990.

Soussan, J., 'Energy crisis in the third world', Primary Resources and Energy in the Third World, Rout Ledge, London and New York, 1988.

Steer, A., 'Energy and industry', World Development Report, pp 114-133, World Bank, Oxford University Press, Inc, 1992.

Tamimi, A. and Kodah, Z., 'Modeling of energy consumption and projection in Jordan', Energy Conversation Management, Vol. 34, No. 5, pp 427-432, Pergamon Press Ltd, Great Britain, 1993.

Tripathy, S.C., Roy, M.C. and Balasubramanian, R., 'Energy auditing kit for cement industries', Energy Conversation Management, Vol. 33, No. 12, pp 1073-1078, Pergamon Press Ltd, Great Britain, 1992.