JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

PLAN & BUDGET ORGANIZATION (PBO)
THE ISLAMIC REPUBLIC OF IRAN

THE COLLABORATIVE STUDY
ON
THE COMPREHENSIVE ENERGY DEVELOPMENT PLAN
IN
THE ISLAMIC REPUBLIC OF IRAN

FINAL REPORT

Vol. 3 Appendix

MARCH 1994

INSTITUTE FOR RESEARCH IN PLANNING AND DEVELOPMENT
(IRPD)
THE INSTITUTE OF ENERGY ECONOMICS, JAPAN
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(The year of the Islamic Republic of Iran begins on March 21 of the Gregorian calendar and ends on the following March 20. To arrive at the corresponding Gregorian years, 621 years should be added to the Iranian years.)

Table 2.1 -2.8

[Mrd. Rs/a]

Year	VAG	MINR+IN	VOI	VWP	VCO	VTRC	VSE	GD	IMPTO	IMPC
1353	1,394	782	4,826	84	564	674	2,697	11,610	1,335	1,331
1354	1,530	852	4,250	88	763	819	3,283	12,316	1,991	3,489
1355	1,706	1,106	4,781	91	1,150	866	3,774	14,250	2,151	3,803
1356	1,640	1,161	4,408	99	1,070	874	3,943	13,972	2,484	4,019
1357	1,747	1,042	3,144	99	964	813	4,028	12,551	1,679	2,908
1358	1,851	911	2,535	105	758	891	4,074	11,911	1,204	1,835
1359	1,915	1,019	866	92	763	903	3,952	10,321	1,175	1,738
1360	1,953	1,098	883	106	671	736	3,771	9,847	1,290	2,149
1361	2,091	1,062	1,948	127	696	770	3,774	11,110	1,251	2,308
1362	2,193	1,186	2,006	132	937	890	4,246	12,348	1,883	4,352
1363	2,354	1,327	1,626	148	890	906	4,354	12,363	1,638	3,867
1364	2,538	1,298	1,644	162	773	907	4,466	12,533	1,305	2,421
1365	2,651	1,210	1,403	174	649	785	3,869	11,353	946	2,199
1366	2,716	1,341	1,599	193	550	643	3,698	11,189	1,006	2,209
1367	2,648	1,358	1,754	186	433	600	3,431	10,824	791	1,869
1368	2,746	1,477	1,890	207	426	655	3,446	11,294	946	2,915
1369	2,968	1,707	2,265	247	438	796	3,703	12,673	1,274	

Year	IMPI	IMPC	CC	CR	CR	KTO	XTO	IMTO	IBTO	ITO
1353	4,266	1,017	408	1,535	1,756	3,658	5,159	500	1,134	1,634
1354	6,212	1,995	501	1,760	2,146	4,696	4,850	866	1,587	2,453
1355	6,713	2,250	511	1,621	2,379	6,385	5,404	904	2,425	3,329
1356	7,910	2,697	694	1,813	2,307	8,679	4,707	987	2,244	3,231
1357	5,350	2,114	811	1,910	2,347	11,377	3,457	592	2,031	2,623
1358	5,301	2,559	1,042	2,041	2,177	14,976	2,659	378	1,438	1,816
1359	6,207	2,899	1,338	2,190	1,968	17,080	869	358	1,490	1,848
1360	8,225	3,141	1,653	1,986	1,948	19,026	843	426	1,298	1,724
1361	6,861	2,676	1,936	1,936	1,910	19,564	1,726	473	1,368	1,842
1362	10,840	2,911	2,411	2,130	1,930	19,576	1,899	720	1,831	2,551
1363	8,310	2,317	2,641	2,192	1,811	20,915	1,546	828	1,734	2,562
1364	7,411	1,576	2,806	2,252	1,898	25,011	1,400	617	1,537	2,153
1365	5,461	1,695	3,132	2,143	1,508	38,286	1,221	320	1,326	1,646
1366	5,498	1,662	3,727	2,027	1,403	51,260	1,557	245	1,116	1,361
1367	4,829	1,479	4,330	1,893	1,396	56,817	1,730	278	894	1,173
1368	7,548	2,344	5,402	2,052	1,189	74,318	1,866	393	864	1,257
1369			6,864	2,395	1,337		2,253	518	918	1,436

Table 2.9 Total & Urban population

(Unit:Million)

Year	Total	Urban	Year	Total	Urban
1338	21.204	7.072	1370	57.263	32.585
1340	22.444	7.743	1372	60.162	34.57
1342	23.739	8.489	1374	62.962	36.549
1344	25.091	9.316	1376	65.891	38.64
1346	26.501	10.233	1378	68.822	40.752
1348	27.97	11.247	1380	71.884	42.959
1350	29.499	12.369	1382	75.081	45.265
1352	31.089	13.607	1384	78.268	47.574
1354	32.818	15.139	1386	81.59	49.975
1356	34.736	16.648	1388	84.886	52.367
1358	37.991	18.45	1390	88.315	54.849
1360	41.221	20.604	1392	91.883	57.427
1362	44.438	23.093	1394	95.408	59.982
1364	47.807	25.802	1396	99.068	62.63
1366	50.995	28.067	1398	102.666	65.241
1368	54.504	30.778	1400	106.396	67.94

Table 2.10 Crude Oil Price in the World Market & Domestic cons. of Oil

Year	Pxoil[$/bl]	Doil[bl/a]	Year	Pxoil[$/bl]	Doil[Mio. bl/a]
1348	n.a.	188.70	1376	20.51	524.85
1350	n.a.	217.18	1378	21.15	572.48
1352	n.a.	229.73	1380	21.70	623.19
1354	10.52	262.87	1382	22.17	677.08
1356	12.67	294.33	1384	22.57	734.21
1358	22.17	305.30	1386	22.92	794.68
1360	34.48	248.87	1388	23.21	858.57
1362	27.46	246.14	1390	23.47	925.94
1364	24.32	362.69	1392	23.69	996.85
1366	17.00	278.32	1394	23.87	1,071.38
1368	16.70	363.10	1396	24.03	1,149.55
1370	17.88	399.42	1398	24.17	1,231.43
1372	18.89	438.42	1400	24.29	1,317.04
1374	19.76	480.19			

Table 2.11 Consumption of Electricity and Natural Gas

Year	Elec.[GWh/a]	Gas[Mrd.m^3/a]	Year	Elec.[GWh/a]	Gas[Mrd.m^3/a]
1368	48.7	47.2	1386	225.9	517.6
1370	58.7	63.1	1388	262.9	656.4
1372	70.4	83.8	1390	304.9	828.1
1374	84.2	110.7	1392	352.5	1,039.2
1376	100.2	145.2	1394	406.1	1,297.7
1378	118.7	189.4	1396	466.5	1,612.4
1380	140.2	245.6	1398	534.0	1,993.9
1382	165.0	316.6	1400	609.5	2,453.8
1384	193.4	405.9			

Table 2.12 Rate of Increase of Electricuty & Gas Consumption

Year	Elec.[%]	Gas[%]	Year	Elec.[%]	Gas[%]
1368-1370	9.77	15.62	1384-1386	8.07	12.92
1370-1372	9.54	15.26	1386-1388	7.88	12.61
1372-1374	9.31	14.90	1388-1390	7.70	12.32
1374-1376	9.09	14.55	1390-1392	7.52	12.03
1376-1378	8.88	14.21	1392-1394	7.34	11.75
1378-1380	8.67	13.87	1394-1396	7.17	11.47
1380-1382	8.47	13.55	1396-1398	7.00	11.20
1382-1384	8.27	13.23	1398-1400	6.84	10.94

Table 2.13 Development of GDP and GDP per Capita

Year	GDP[Mrd Rs/a]	GDP/pop[Th Rs/a]	Year	GDP[Mrd Rs/a]	GDP/pop[Th Rs/a]
1338	2,485.7	117.2	1370	10,044.2	175.4
1339	2,707.0	124.1	1371	10,310.1	175.6
1340	2,936.6	130.8	1372	10,576.0	175.8
1341	3,116.6	135.0	1373	10,822.1	175.8
1342	3,286.2	138.4	1374	11,068.1	175.8
1343	3,517.6	144.1	1375	11,325.6	175.8
1344	4,029.3	160.6	1376	11,583.1	175.8
1345	4,411.5	171.1	1377	11,840.7	175.8
1346	4,927.5	185.9	1378	12,098.4	175.8
1347	5,493.7	201.8	1379	12,367.5	175.8
1348	6,179.9	220.9	1380	12,636.6	175.8
1349	6,836.7	238.0	1381	12,917.6	175.8
1350	7,685.0	260.5	1382	13,198.7	175.8
1351	9,033.7	298.3	1383	13,478.8	175.8
1352	9,833.9	316.3	1384	13,758.8	175.8
1353	10,544.0	330.0	1385	14,050.8	175.8
1354	11,043.9	336.5	1386	14,342.8	175.8
1355	12,921.8	383.3	1387	14,632.5	175.8
1356	12,625.5	363.5	1388	14,922.2	175.8
1357	11,310.8	313.5	1389	15,223.7	175.8
1358	10,545.0	277.6	1390	15,525.1	175.8
1359	9,032.3	227.8	1391	15,838.7	175.8
1360	8,894.1	215.8	1392	16,152.3	175.8
1361	10,135.0	236.8	1393	16,462.1	175.8
1362	11,049.6	248.7	1394	16,771.9	175.8
1363	11,187.2	242.1	1395	17,093.6	175.8
1364	11,379.7	238.0	1396	17,415.3	175.8
1365	10,318.5	209.0	1397	17,731.6	175.8
1366	10,196.4	199.9	1398	18,047.9	175.8
1367	10,410.3	197.6	1399	18,375.7	175.8
1368	9,560.2	175.4	1400	18,703.5	175.8
1369	9,802.2	175.4			

Table 2.14 Consumption of Urban, Rural & Government Expenditure

(Unit:Mrd Rs/a)

Year	Rural	Urban	Government	Year	Rural	Urban	Government
1338	972.1	677.2	173.5	1362	2,130.4	4,562.5	1,930.1
1339	910.2	713.9	184.3	1363	2,192.2	4,879.8	1,810.8
1340	878.8	749.3	179.9	1364	2,252.4	4,953.5	1,898.1
1341	873.0	787.0	183.4	1365	2,143.1	4,316.5	1,507.6
1342	849.6	827.1	197.7	1366	2,026.5	4,048.1	1,402.8
1343	746.1	867.8	238.9	1367	1,893.1	4,226.6	1,396.1
1344	782.6	906.2	317.9	1368	2,052.1	4,246.0	1,189.4
1345	881.4	949.3	362.3	1370	2,126.1	4,657.8	1,229.2
1346	963.0	1,049.7	418.2	1372	2,463.9	4,941.7	1,151.3
1347	882.1	1,143.3	494.3	1374	2,543.1	5,302.3	1,089.2
1348	812.3	1,365.6	588.6	1376	2,624.1	5,653.4	1,039.8
1349	846.7	1,573.7	682.2	1378	2,799.1	5,962.5	1,000.5
1350	955.7	1,814.1	898.9	1380	3,065.1	6,285.4	969.1
1351	903.6	2,046.5	1,127.3	1382	3,361.0	6,622.8	944.2
1352	999.1	2,352.6	1,236.5	1384	3,631.5	6,960.5	924.3
1353	1,535.0	2,164.2	1,756.4	1386	3,861.9	7,405.3	908.4
1354	1,760.4	3,158.8	2,145.9	1388	4,164.7	7,759.6	895.8
1355	1,621.2	3,297.3	2,379.4	1390	4,506.0	8,127.4	885.8
1356	1,813.1	3,449.5	2,307.1	1392	4,881.6	8,509.3	877.7
1357	1,909.5	3,492.5	2,346.9	1394	5,249.3	8,888.0	871.3
1358	2,041.0	3,548.7	2,177.3	1396	5,402.4	9,528.5	866.3
1359	2,190.4	3,125.7	1,968.4	1398	5,741.7	9,992.7	862.3
1360	1,986.1	3,484.8	1,947.9	1400	5,997.7	10,572.2	858.5
1361	1,935.5	3,922.6	1,910.1				

Table 2.15 Development of Capital Stock & Investment

(Unit:Mrd Rs/a)

Year	Capital	Investment	Year	Capital	Investment
1344	n.a.	103.7	1374	23,038.3	1,747.9
1346	n.a.	164.7	1376	24,301.9	1,799.9
1348	n.a.	195.5	1378	25,594.1	1,877.8
1350	n.a.	252.5	1380	26,947.7	1,973.9
1352	n.a.	370.1	1382	28,340.8	2,061.8
1354	n.a.	2,453.0	1384	29,846.9	2,189.4
1356	n.a.	3,231.0	1386	31,388.2	2,282.7
1358	n.a.	1,815.8	1388	33,016.9	2,404.6
1360	n.a.	1,724.2	1390	34,690.7	2,509.2
1362	n.a.	2,551.1	1392	36,382.7	2,602.2
1364	n.a.	2,153.3	1394	38,126.3	2,713.3
1366	n.a.	1,360.6	1396	39,895.9	2,813.8
1368	18,613.1	1,216.8	1398	41,669.1	2,904.1
1370	20,401.9	1,851.1	1400	43,461.8	3,002.8
1372	21,750.7	1,711.8			

Table 2.16 Import of Consumer, Intermediate & Capital Goods

(Unit:Mrd $/a)

Year	CON	INT	CAP	Year	CON	INT	CAP
1338	0.16	0.27	0.11	1370	2.20	6.36	4.93
1340	0.16	0.33	0.13	1372	2.21	7.31	4.84
1342	0.12	0.29	0.10	1374	2.23	8.16	5.09
1344	0.16	0.52	0.22	1376	2.26	9.06	5.38
1346	0.15	0.71	0.33	1378	2.30	9.89	5.73
1348	0.17	0.99	0.39	1380	2.35	10.68	6.12
1350	0.24	1.34	0.48	1382	2.41	11.51	6.50
1352	0.56	2.27	0.91	1384	2.46	12.35	6.97
1354	2.00	6.21	3.49	1386	2.52	13.25	7.38
1356	2.70	7.91	4.02	1388	2.58	14.15	7.85
1358	2.56	5.30	1.84	1390	2.63	15.10	8.30
1360	3.14	8.23	2.15	1392	2.69	16.11	8.74
1362	2.91	10.84	4.35	1394	2.75	17.14	9.23
1364	1.58	7.41	2.42	1396	2.81	18.22	9.70
1366	1.66	5.50	2.21	1398	2.87	19.33	10.17
1368	2.34	7.55	2.92	1400	2.93	20.51	10.66

Table 2.17 Export of Non-oil goods

(Unit:Mrd Rs/a)

Year	Non-oil goods	Year	Non-oil goods
1338	80.4	1370	132.1
1340	77.5	1372	134.0
1342	75.9	1374	136.0
1344	93.3	1376	137.9
1346	89.1	1378	140.7
1348	112.1	1380	144.5
1350	160.5	1382	148.4
1352	151.5	1384	152.4
1354	129.5	1386	156.6
1356	101.6	1388	160.8
1358	102.0	1390	165.2
1360	31.6	1392	169.8
1362	28.5	1394	174.4
1364	31.5	1396	179.1
1366	24.4	1398	183.9
1368	113.0	1400	188.8

Table 2.18 Shadow Price of Foreign Exchange Reserves and Oil

Year	SFX[Rs/$]	Poil[$/bl]	Year	SFX[Rs/$]	Poil[$/bl]
1370	259.5	39.2	1386	404.0	35.0
1372	274.3	26.6	1388	426.9	34.9
1374	289.9	28.2	1390	451.2	33.8
1376	306.4	29.6	1392	476.9	37.0
1378	323.8	30.8	1394	504.0	35.3
1380	342.2	32.0	1396	532.6	32.8
1382	361.7	31.1	1398	562.9	33.0
1384	382.2	31.8	1400	1,041.4	20.7

Table 2.19 Crude Oil Price in the World Market

(Unit:$/bl)

Year	Reference	POIL_1	POIL_2	POIL_3	POLI_4
1353	10.28	10.28	10.28	10.28	10.28
1354	10.52	10.52	10.52	10.52	10.52
1355	11.29	11.29	11.29	11.29	11.29
1356	12.67	12.67	12.67	12.67	12.67
1357	12.65	12.65	12.65	12.65	12.65
1358	22.17	22.17	22.17	22.17	22.17
1359	35.46	35.46	35.46	35.46	35.46
1360	34.48	34.48	34.48	34.48	34.48
1361	28.75	28.75	28.75	28.75	28.75
1362	27.46	27.46	27.46	27.46	27.46
1363	26.73	26.73	26.73	26.73	26.73
1364	24.32	24.32	24.32	24.32	24.32
1365	12.88	12.88	12.88	12.88	12.88
1366	17.00	17.00	17.00	17.00	17.00
1367	14.09	14.09	14.09	14.09	14.09
1368	16.70	16.70	16.70	16.70	16.70
1370	19.30	18.69	20.46	23.45	17.88
1372	21.54	20.46	23.45	27.72	18.89
1374	23.45	22.05	25.83	30.40	19.76
1376	25.10	23.45	27.72	32.10	20.51
1378	26.51	24.71	29.21	33.17	21.15
1380	27.72	25.83	30.40	33.85	21.70
1382	28.75	26.83	31.35	34.27	22.17
1384	29.64	27.72	32.10	34.54	22.57
1386	30.40	28.51	32.70	34.71	22.92
1388	31.06	29.21	33.17	34.82	23.21
1390	31.62	29.84	33.55	34.89	23.47
1392	32.10	30.40	33.85	34.93	23.69
1394	32.51	30.90	34.08	34.95	23.87
1396	32.87	31.35	34.27	34.97	24.03
1398	33.17	31.75	34.42	34.98	24.17
1400	33.43	32.10	34.54	34.99	24.29

Table 2.20 Development of GDP for Diff. Scenarios of Oil Prices

(Unit:Mrd Rs/a)

Year	Reference	POIL_1	POIL_2	POIL_3	POIL_4
1338	2,485.7	2,485.7	2,485.7	2,485.7	2,485.7
1339	2,707.0	2,707.0	2,707.0	2,707.0	2,707.0
1340	2,936.6	2,936.6	2,936.6	2,936.6	2,936.6
1341	3,116.6	3,116.6	3,116.6	3,116.6	3,116.6
1342	3,286.2	3,286.2	3,286.2	3,286.2	3,286.2
1343	3,517.6	3,517.6	3,517.6	3,517.6	3,517.6
1344	4,029.3	4,029.3	4,029.3	4,029.3	4,029.3
1345	4,411.5	4,411.5	4,411.5	4,411.5	4,411.5
1346	4,927.5	4,927.5	4,927.5	4,927.5	4,927.5
1347	5,493.7	5,493.7	5,493.7	5,493.7	5,493.7
1348	6,179.9	6,179.9	6,179.9	6,179.9	6,179.9
1349	6,836.7	6,836.7	6,836.7	6,836.7	6,836.7
1350	7,685.0	7,685.0	7,685.0	7,685.0	7,685.0
1351	9,033.7	9,033.7	9,033.7	9,033.7	9,033.7
1352	9,833.9	9,833.9	9,833.9	9,833.9	9,833.9
1353	10,544.0	10,544.0	10,544.0	10,544.0	10,544.0
1354	11,043.9	11,043.9	11,043.9	11,043.9	11,043.9
1355	12,921.8	12,921.8	12,921.8	12,921.8	12,921.8
1356	12,625.5	12,625.5	12,625.5	12,625.5	12,625.5
1357	11,310.8	11,310.8	11,310.8	11,310.8	11,310.8
1358	10,545.0	10,545.0	10,545.0	10,545.0	10,545.0
1359	9,032.3	9,032.3	9,032.3	9,032.3	9,032.3
1360	8,894.1	8,894.1	8,894.1	8,894.1	8,894.1
1361	10,135.0	10,135.0	10,135.0	10,135.0	10,135.0
1362	11,049.6	11,049.6	11,049.6	11,049.6	11,049.6
1363	11,187.2	11,187.2	11,187.2	11,187.2	11,187.2
1364	11,379.7	11,379.7	11,379.7	11,379.7	11,379.7
1365	10,318.5	10,318.5	10,318.5	10,318.5	10,318.5
1366	10,196.4	10,196.4	10,196.4	10,196.4	10,196.4
1367	10,410.3	10,410.3	10,410.3	10,410.3	10,410.3
1368	10,845.5	10,845.5	10,845.5	10,845.5	10,845.5
1370	11,137.3	10,348.3	11,129.3	11,108.7	9,562.2
1372	12,915.5	12,271.4	13,097.6	13,303.7	10,927.3
1374	15,292.3	14,582.2	15,962.8	16,485.4	12,682.4
1376	16,420.9	15,459.4	17,961.2	19,499.0	13,227.6
1378	17,177.5	16,150.8	18,884.6	21,568.2	13,734.4
1380	17,894.8	16,778.7	19,920.1	23,148.3	14,192.1
1382	18,887.0	17,574.6	21,059.1	24,795.3	14,721.2
1384	19,782.6	18,443.7	22,790.1	25,881.4	15,265.1
1386	21,119.7	19,315.8	23,930.9	26,710.7	15,814.1
1388	22,377.2	20,683.1	24,677.7	27,438.6	16,361.6
1390	23,213.6	21,731.3	25,334.4	28,227.0	17,073.5
1392	23,825.0	22,434.5	25,982.7	29,144.4	17,744.3
1394	22,638.0	21,350.8	24,816.6	28,398.0	16,987.1
1396	22,802.7	21,438.5	25,463.7	30,226.8	17,447.7
1398	23,075.8	21,687.6	26,413.6	34,317.4	17,969.0
1400	23,471.9	22,036.3	28,531.1	44,118.4	18,399.7

Table 2.21 Scenarios of Domestic Oil Consumption

(Unit:Mio.bl/a)

Year	Reference	DOIL_1	DOIL_2
1368	363.1	363.1	363.1
1370	398.6	397.0	391.1
1372	435.8	430.6	413.9
1374	474.5	463.9	432.1
1376	514.8	496.5	446.5
1378	556.5	528.3	457.7
1380	599.4	559.1	466.5
1382	643.6	588.7	473.2
1384	688.8	617.2	478.3
1386	735.0	644.3	482.3
1388	782.1	670.1	485.3
1390	829.8	694.6	487.6
1392	878.2	717.7	489.4
1394	927.0	739.4	490.7
1396	976.2	759.9	491.7
1398	1,025.6	779.0	492.5
1400	1,075.1	796.8	493.1

Table 2.22 Shadow Prices of Crude Oil for Diff. Scenario of Domestic Oil Consumption

(Unit:$/bl)

Year	Reference	DOIL_1	DOIL_2
1370	5.3	4.2	1.1
1372	6.1	4.8	1.3
1374	6.9	5.4	1.4
1376	7.9	6.2	1.6
1378	9.1	7.1	1.9
1380	10.4	8.2	2.2
1382	11.9	9.4	2.5
1384	13.6	10.7	2.8
1386	15.6	12.3	3.2
1388	17.9	14.0	3.7
1390	20.5	16.1	4.2
1392	23.4	18.4	4.8
1394	26.8	21.1	5.5
1396	30.7	24.1	6.4
1398	35.2	27.6	7.3
1400	40.6	31.9	8.4

Table 2.23 Shadow Prices of Foreign Exch. Res. for Diff. Scen. of Domes. Oil Consumption

(Unit:RS/$)

Year	Reference	DOIL_1	DOIL_2
1370	238.8	225.7	215.7
1372	252.4	238.6	228.0
1374	266.8	252.1	240.9
1376	281.9	266.5	254.6
1378	298.0	281.6	269.1
1380	314.9	297.6	284.4
1382	332.8	314.5	300.6
1384	351.7	332.4	317.7
1386	371.7	351.3	335.7
1388	392.9	371.3	354.8
1390	415.2	392.4	375.0
1392	438.8	414.7	396.3
1394	463.8	438.3	418.8
1396	490.1	463.2	442.6
1398	518.0	489.6	467.8
1400	543.1	513.3	490.5

Table 3.1 Final energy uses per unit real exp. in rural and urban hous.

(Unit:BOE/Mio.Rs)

Year	Urban	Rural
1361	9.43	17.26
1362	9.13	16.14
1363	9.83	16.14
1364	10.11	16.39
1365	11.75	17.12
1366	13.01	17.27
1367	14.34	18.43
1368	14.82	17.22
1369	14.63	15.95

Table 3.2 Share of final energy consumption in rural and urban areas

(%)

Year	Urban	Rural
1361	52.11	47.89
1362	54.68	45.32
1363	57.42	42.58
1364	57.59	42.41
1365	58.47	41.53
1366	60.92	39.08
1367	63.18	36.82
1368	64.50	35.50
1369	63.14	36.86

Table 3.3 Development of final energy consumption in household

(Unit:MBOE/a)

Year	Elec	N. Gas	Pet. Prod	Trad Fuel
1361	4.94	4.74	40.46	21.94
1362	5.56	5.85	44.56	21.77
1363	6.27	7.69	49.72	22.53
1364	6.94	8.27	54.74	21.40
1365	7.59	9.23	53.21	21.11
1366	8.29	10.40	53.49	20.04
1367	8.64	13.68	56.43	21.29
1368	9.58	14.46	62.17	19.58
1369	10.73	16.19	60.36	20.79

Table 3.4 Development of final energy consumption in urban household

(Unit:MBOE/a)

Year	Elec	N. Gas	Pet. Prod	Trad Fuel
1361	4.02	4.71	24.47	4.36
1362	4.51	5.81	27.91	4.28
1363	4.93	7.61	32.25	4.71
1364	5.32	8.06	34.69	4.53
1365	5.97	8.93	34.50	3.89
1366	6.05	10.18	36.00	3.95
1367	6.46	13.29	38.74	4.72
1368	7.08	14.04	43.03	4.09
1369	7.72	15.65	40.61	4.26

Table 3.5 Development of final energy consump. per Cap. in urban hous.

(Unit:BOE/a)

Year	Elec	N. Gas	Pet. Prod	Trad Fuel
1361	0.18	0.22	1.12	0.20
1362	0.20	0.25	1.21	0.19
1363	0.20	0.31	1.32	0.19
1364	0.21	0.31	1.34	0.18
1365	0.22	0.33	1.29	0.15
1366	0.22	0.36	1.28	0.14
1367	0.22	0.45	1.32	0.16
1368	0.23	0.46	1.40	0.13
1369	0.24	0.49	1.27	0.13

Table 3.6 Development of energy consumption of a family in urban areas(1361)

YEAR	ELEC (MJ)	N.GAS (MJ)	LPG (MJ)	KEROSENE (MJ)	GAS OIL (MJ)	F.WOOD (MJ)	CHARCOAL (MJ)	Total (MJ)	Elec [BOE/a]	N. Gas [BOE/a]	Pet. Prod [BOE/a]
G_1	1380.35	68.58	1576.26	13668.84	332.85	620.89	891.53	18539.3	0.225	0.012	2.636
G_2	2114.87	166.18	2847.51	17100.35	440.43	2208.79	586.73	25464.9	0.345	0.028	3.451
G_3	2790.32	987.39	3615.46	18831.24	939.71	2446.11	853.43	30463.7	0.456	0.167	3.959
G_4	3886.36	2133.92	5041.93	20001.99	3032.97	2082.87	1005.83	37185.9	0.635	0.361	4.753
G_5	4338.52	2021.37	5341.90	21880.91	2228.51	2180.93	1280.15	39272.3	0.709	0.342	4.986
G_6	5494.34	4812.08	6053.58	23381.36	2722.52	1523.20	1522.17	45509.2	0.897	0.814	5.444
G_7	6729.75	7297.69	6860.72	26156.84	2456.41	4307.90	2419.14	56228.5	1.099	1.235	6.006
G_8	8338.34	12661.06	7171.16	27233.39	3908.13	7841.14	2995.72	70148.9	1.362	2.142	6.486
G_9	10703.83	22508.54	9313.20	29268.75	23887.91	5261.28	2177.12	103120.6	1.748	3.808	10.574
G_10	14600.28	31652.64	8575.91	36838.25	8914.05	35915.03	6785.36	143281.5	2.385	5.355	9.197

Table 3.7 Development of energy consumption of a family in urban areas(1363)

YEAR	ELEC (MJ)	N.GAS (MJ)	LPG (MJ)	KEROSENE (MJ)	GAS OIL (MJ)	F.WOOD (MJ)	CHARCOAL (MJ)	Total (MJ)	Elec [BOE/a]	N. Gas [BOE/a]	Pet. Prod [BOE/a]
G_1	1374.23	133.32	1749.26	15169.05	369.38	552.74	793.68	20141.7	0.224	0.023	2.926
G_2	2095.39	301.33	3160.04	18977.18	488.77	1966.36	522.34	27511.4	0.342	0.051	3.830
G_3	2766.21	922.19	4012.27	20898.05	1042.85	2177.64	759.76	32579.0	0.452	0.156	4.393
G_4	3869.18	1921.20	5595.31	22197.29	3365.86	1854.26	895.44	39698.5	0.632	0.325	n.a.
G_5	4347.64	2412.54	5928.19	24282.43	2473.10	1941.57	1139.65	42525.1	0.710	0.408	n.a.
G_6	5534.77	6372.88	6717.98	25947.55	3021.33	1356.02	1355.11	50305.6	0.904	1.078	n.a.
G_7	6771.59	9614.57	7613.72	29027.66	2726.02	3835.09	2153.63	61742.3	1.106	1.627	n.a.
G_8	8388.44	14033.32	7958.23	30222.37	4337.07	6980.55	2666.93	74586.9	1.370	2.374	n.a.
G_9	10768.56	27449.92	10335.36	32481.11	26509.70	4683.83	1938.17	114166.7	1.759	4.644	n.a.
G_10	14687.70	40923.29	9517.15	40881.40	9892.41	31973.21	6040.64	153915.8	2.399	6.924	n.a.

Table 3.8 Development of energy consumption of a family in urban areas(1366)

YEAR	ELEC (MJ)	N.GAS (MJ)	LPG (MJ)	KEROSENE (MJ)	GAS OIL (MJ)	F.WOOD (MJ)	CHARCOAL (MJ)	Total (MJ)	Elec [BOE/a]	N. Gas [BOE/a]	Pet. Prod [BOE/a]
G_1	1681.68	211.83	1885.55	16350.94	398.16	499.06	716.59	21743.8	0.275	0.036	n.a.
G_2	2653.28	537.53	3406.25	20455.78	526.86	1775.38	471.61	29826.7	0.433	0.091	n.a.
G_3	3542.15	1786.05	4324.89	22526.30	1124.10	1966.14	685.97	35955.6	0.579	0.302	n.a.
G_4	4907.03	3571.55	6031.26	23926.78	3628.10	1674.17	808.47	44547.4	0.801	0.604	n.a.
G_5	5475.88	4585.93	6390.08	26174.38	2665.79	1752.99	1028.96	48074.0	0.894	0.776	n.a.
G_6	6957.75	13109.42	7241.41	27969.24	3256.73	1224.32	1223.49	60982.4	1.136	2.218	n.a.
G_7	8508.57	17340.00	8206.93	31289.33	2938.41	3462.61	1944.46	73690.3	1.390	2.934	n.a.
G_8	10565.62	23900.14	8578.29	32577.12	4674.98	6302.56	2407.90	89006.6	1.726	4.043	n.a.
G_9	13571.11	33976.63	11140.63	35011.85	28575.19	4228.91	1749.93	128254.2	2.217	5.748	n.a.
G_10	18511.30	46300.26	10258.67	44066.64	10663.17	28867.79	5453.94	164121.8	3.024	7.833	n.a.

Table 3.9 Development of energy consumption of a family in urban areas(1369)

YEAR	ELEC (MJ)	N.GAS (MJ)	LPG (MJ)	KEROSENE (MJ)	GAS OIL (MJ)	F.WOOD (MJ)	CHARCOAL (MJ)	Total (MJ)	Elec [BOE/a]	N. Gas [BOE/a]	Pet. Prod [BOE/a]
G_1	2030.78	428.93	1944.04	16858.09	410.51	476.02	683.52	22831.9	0.332	0.073	n.a.
G_2	3158.58	861.57	3511.90	21090.25	543.20	1693.43	449.84	31308.8	0.516	0.146	n.a.
G_3	4170.36	3470.13	4459.03	23225.00	1158.96	1875.38	654.31	39013.2	0.681	0.587	n.a.
G_4	5802.05	6425.44	6218.33	24668.91	3740.64	1596.89	771.15	49223.4	0.948	1.087	n.a.
G_5	6507.28	6500.58	6588.28	26986.22	2748.48	1672.07	981.46	51984.4	1.063	1.100	n.a.
G_6	8272.07	17091.15	7466.02	28836.75	3357.74	1167.80	1167.01	67358.6	1.351	2.892	n.a.
G_7	10121.81	22800.62	8461.49	32259.82	3029.55	3302.77	1854.70	81830.8	1.653	3.857	n.a.
G_8	12598.09	33252.36	8844.36	33587.56	4819.99	6011.63	2296.75	101410.7	2.058	5.626	n.a.
G_9	16173.62	54871.87	11486.18	36097.81	29461.50	4033.70	1669.15	153793.8	2.642	9.283	n.a.
G_10	22061.19	74774.4	10576.86	45433.45	10993.90	27535.24	5202.18	196577.2	3.603	12.651	n.a.

Table 3.10 Development of energy consumption of a family in rural areas(1361)

YEAR	ELEC (MJ)	N.GAS (MJ)	LPG (MJ)	KEROSENE (MJ)	GAS OIL (MJ)
G_1	349.20	6.79	545.99	10864.76	82.11
G_2	579.25	13.58	1333.73	15557.85	116.37
G_3	949.29	20.37	2147.47	19443.53	240.20
G_4	1344.51	33.95	2658.14	20896.88	407.50
G_5	1639.13	47.53	3222.76	20488.12	292.01
G_6	2125.81	67.91	4055.12	25288.87	936.20
G_7	2833.18	108.65	5187.45	28242.66	1991.83
G_8	3215.19	156.18	6025.64	30471.46	2024.32
G_9	4553.40	190.14	6691.92	27638.78	6876.12
G_10	5326.93	448.18	7755.57	33874.37	7447.85

Table 3.11 Development of energy consumption of a family in rural areas(1363)

YEAR	ELEC (MJ)	N.GAS (MJ)	LPG (MJ)	KEROSENE (MJ)	GAS OIL (MJ)
G_1	436.87	15.40	561.72	11164.57	84.48
G_2	698.71	30.79	1372.16	15987.17	119.72
G_3	1216.08	46.19	2209.34	19980.07	247.12
G_4	1759.48	76.98	2734.73	21473.52	419.24
G_5	2045.32	107.77	3315.61	21053.49	300.43
G_6	2884.48	153.95	4171.96	25986.72	963.17
G_7	4003.57	246.33	5336.92	29022.01	2049.22
G_8	4396.70	354.10	6199.25	31312.32	2082.65
G_9	6607.66	431.07	6884.73	28401.47	7074.24
G_10	7321.61	1016.10	7979.02	34809.13	7662.44

Table 3.12 Development of energy consumption of a family in rural areas(1366)

YEAR	ELEC (MJ)	N.GAS (MJ)	LPG (MJ)	KEROSENE (MJ)	GAS OIL (MJ)
G_1	636.99	49.00	579.48	11465.53	n.a.
G_2	1138.55	98.00	1415.55	16418.12	n.a.
G_3	2021.87	147.00	2279.21	20518.66	n.a.
G_4	3218.27	245.00	2821.21	22052.37	n.a.
G_5	3806.53	343.01	3420.46	21621.01	n.a.
G_6	5234.70	490.01	4303.89	26687.22	n.a.
G_7	7413.12	784.01	5505.68	29804.33	n.a.
G_8	8235.80	1127.02	6395.29	32156.37	n.a.
G_9	12871.33	1372.02	7102.45	29167.06	n.a.
G_10	14523.55	3234.05	8231.34	35747.45	n.a.

Table 3.13 Development of energy consumption of a family in rural areas(1369)

YEAR	ELEC (MJ)	N.GAS (MJ)	LPG (MJ)	KEROSENE (MJ)	GAS OIL (MJ)
G_1	739.53	95.44	599.56	11792.50	n.a.
G_2	1256.82	190.88	1464.60	16886.33	n.a.
G_3	2255.68	286.32	2358.20	21103.81	n.a.
G_4	3353.05	477.20	2918.98	22681.25	n.a.
G_5	4164.05	668.08	3539.00	22237.60	n.a.
G_6	6155.33	954.40	4453.05	27448.28	n.a.
G_7	8918.66	1527.04	5696.49	30654.29	n.a.
G_8	10120.21	2195.12	6616.93	33073.41	n.a.
G_9	15723.03	2672.32	7348.59	29998.85	n.a.
G_10	17741.30	6299.0	8516.61	36766.89	n.a.

Table 3.14 Development of useful energy consumption of a family in urban areas(1361)

YEAR	Elect.(GJ)	Heating(GJ)	Cooking(GJ)
G_1	1.38	5.59	1.69
G_2	2.11	7.23	2.43
G_3	2.79	8.75	2.92
G_4	3.89	11.25	3.63
G_5	4.34	11.37	3.90
G_6	5.49	13.76	4.49
G_7	6.73	16.55	5.29
G_8	8.34	21.59	5.98
G_9	10.70	41.36	7.55
G_10	14.60	44.20	9.33

Table 3.15 Development of useful energy consumption of a family in urban areas(1363)

YEAR	Elect.(GJ)	Heating(GJ)	Cooking(GJ)
G_1	1.37	6.19	1.86
G_2	2.10	7.99	2.68
G_3	2.77	9.51	3.21
G_4	3.87	12.14	3.97
G_5	4.35	12.61	4.31
G_6	5.53	15.77	5.03
G_7	6.77	19.01	5.92
G_8	8.39	23.61	6.55
G_9	10.77	47.05	8.51
G_10	14.69	50.89	10.55

Table 3.16 Development of useful energy consumption of a family in urban areas(1366)

YEAR	Elect.(GJ)	Heating(GJ)	Cooking(GJ)
G_1	1.68	6.68	2.00
G_2	2.65	8.67	2.90
G_3	3.54	10.62	3.50
G_4	4.91	13.86	4.38
G_5	5.48	14.63	4.77
G_6	6.96	20.43	5.86
G_7	8.51	24.25	6.86
G_8	10.57	30.12	7.66
G_9	13.57	53.01	9.46
G_10	18.51	55.08	11.37

Table 3.17 Development of useful energy consumption of a family in urban areas(1369)

YEAR	Elect.(GJ)	Heating(GJ)	Cooking(GJ)
G_1	2.03	6.99	2.07
G_2	3.16	9.09	3.00
G_3	4.17	11.83	3.73
G_4	5.80	15.80	4.71
G_5	6.51	16.05	5.04
G_6	8.27	23.04	6.29
G_7	10.12	27.70	7.43
G_8	12.60	35.78	8.51
G_9	16.17	65.70	11.20
G_10	22.06	71.53	13.66

Table 3.18 Development of useful energy consumption of a family in rural areas(1361)

YEAR	Elect.(GJ)	Heating(GJ)	Cooking(GJ)
G_1	0.35	6.52	0.93
G_2	0.58	10.26	1.65
G_3	0.95	13.01	2.23
G_4	1.34	13.83	2.47
G_5	1.64	14.24	2.78
G_6	2.13	18.08	3.49
G_7	2.83	20.41	4.06
G_8	3.22	22.27	4.57
G_9	4.55	24.71	4.99
G_10	5.33	28.44	5.59

Table 3.19 Development of useful energy consumption of a famil in rural areas(1363)

YEAR	Elect.(GJ)	Heating(GJ)	Cooking(GJ)
G_1	0.44	6.60	0.94
G_2	0.70	10.32	1.65
G_3	1.22	13.09	2.24
G_4	1.76	13.94	2.49
G_5	2.05	14.31	2.80
G_6	2.88	18.18	3.51
G_7	4.00	20.57	4.09
G_8	4.40	22.45	4.61
G_9	6.61	25.08	5.03
G_10	7.32	28.72	5.63

Table 3.20 Development of useful energy consumption of a family in rural areas(1366)

YEAR	Elect.(GJ)	Heating(GJ)	Cooking(GJ)
G_1	0.64	6.70	0.95
G_2	1.14	10.42	1.67
G_3	2.02	13.21	2.26
G_4	3.22	14.11	2.52
G_5	3.81	14.47	2.83
G_6	5.23	18.40	3.55
G_7	7.41	20.94	4.16
G_8	8.24	22.91	4.69
G_9	12.87	26.25	5.18
G_10	14.52	29.34	5.72

Table 3.21 Development of useful energy consumption of a famil in rural areas(1369)

YEAR	Elect.(GJ)	Heating(GJ)	Cooking(GJ)
G_1	0.74	6.80	0.96
G_2	1.26	10.52	1.68
G_3	2.26	13.35	2.29
G_4	3.35	14.32	2.56
G_5	4.16	14.67	2.87
G_6	6.16	18.68	3.60
G_7	8.92	21.41	4.24
G_8	10.12	23.53	4.79
G_9	15.72	27.85	5.38
G_10	17.74	30.16	5.85

Table 3.22 Value-added of industry and GDP in constant prices of 1361

(Unit:Mrd.Rs/a)

Year	Industry	GDP	Year	Industry	GDP
1338	97.3	2,177.6	1354	806.8	9,227.8
1339	107.9	2,384.4	1355	1,049.1	11,254.3
1340	116.8	2,598.6	1356	1,101.3	11,183.8
1341	135.7	2,778.6	1357	986.2	10,070.8
1342	149.0	2,936.9	1358	859.1	10,543.1
1343	157.9	3,158.7	1359	964.8	9,323.1
1344	178.0	3,621.6	1360	1,042.3	9,175.2
1345	206.4	3,992.8	1361	996.7	10,335.4
1346	237.4	4,440.3	1362	1,115.3	11,536.7
1347	273.5	5,001.7	1363	1,252.3	11,587.1
1348	309.6	5,653.3	1364	1,225.9	11,607.4
1349	338.5	6,252.3	1365	1,148.0	9,861.7
1350	397.7	7,045.5	1366	1,275.6	10,019.8
1351	470.4	8,201.9	1367	1,301.8	9,234.3
1352	561.8	8,956.3	1368	1,417.9	9,514.6
1353	745.7	9,342.7	1369	1,643.8	10,664.9

Table 3.23 Share of ind. value-added in GDP and GRP at constant prices(1361)

(Unit: %)

Year	IND/GDP	IND/GRP	Year	IND/GDP	IND/GRP
1338	4.468	7.528	1354	8.743	16.207
1339	4.525	7.692	1355	9.322	16.207
1340	4.495	8.046	1356	9.847	16.254
1341	4.884	9.038	1357	9.793	14.237
1342	5.074	9.470	1358	8.148	10.728
1343	4.999	9.492	1359	10.348	11.408
1344	4.915	9.424	1360	11.360	12.569
1345	5.169	10.168	1361	9.644	11.883
1346	5.346	10.561	1362	9.667	11.703
1347	5.468	11.109	1363	10.808	12.571
1348	5.476	11.793	1364	10.561	12.305
1349	5.414	11.857	1365	11.641	13.572
1350	5.645	12.532	1366	12.731	15.148
1351	5.735	12.346	1367	14.097	17.403
1352	6.273	13.508	1368	14.902	18.595
1353	7.982	16.510	1369	15.413	19.569

Table 3.24 Energy consumption in total of Large industry

Year	Elec.(Mio. kWh/a)	Energy(Mio. BOE)	Year	Elec.(Mio. kWh/a)	Energy(Mio. BOE)
1350	1452.66	14.06	1360	2398.10	n.a.
1351	1647.56	14.84	1361	2679.38	34.60
1352	2367.64	16.03	1362	2962.61	40.71
1353	4815.28	20.29	1363	3334.69	43.80
1354	4996.07	22.65	1364	2987.55	41.96
1355	5318.53	25.10	1365	3110.03	45.86
1356	n.a.	n.a.	1366	3970.14	46.44
1357	n.a.	n.a.	1367	5467.09	58.10
1358	2180.49	n.a.	1368	6385.02	70.59
1359	2448.95	n.a.	1369	8330.72	67.73

Table 3.25 Share of industry in energy consumption

Year	Energy(%)	Electricity(%)	Year	Energy(%)	Electricity(%)
1350	22.7	45.0	1361	22.7	29.8
1351	24.2	48.0	1362	20.8	31.0
1352	24.2	51.9	1363	19.9	30.6
1353	24.7	54.6	1364	18.3	28.7
1354	24.7	50.6	1365	17.8	26.7
1355	31.6	47.5	1366	17.9	20.8
1356	23.3	45.1	1367	17.9	21.7
1357	20.5	41.2	1368	19.5	21.2
1358	22.3	38.4	1369	19.2	22.7
1359	22.5	35.9	1370	19.6	21.6
1360	22.7	34.7			

Table 3.26 Share of energy carriers in energy consumption of industry

Year	Elec	N. Gas	Others	Pet. Prod
1350	6.06	0.00	0.00	93.94
1351	6.52	0.00	0.00	93.48
1352	8.67	0.00	0.00	91.33
1353	13.93	0.00	2.11	83.96
1354	12.94	0.00	2.29	84.76
1355	12.43	0.00	2.51	85.05
1356	n.a.	n.a.	n.a.	n.a.
1357	n.a.	n.a.	n.a.	n.a.
1358	n.a.	n.a.	n.a.	n.a.
1359	n.a.	n.a.	n.a.	n.a.
1360	n.a.	n.a.	n.a.	n.a.
1361	4.54	20.49	0.57	74.40
1362	4.27	27.96	0.47	67.30
1363	4.47	29.24	0.24	66.05
1364	4.18	31.18	0.47	64.18
1365	3.98	30.04	0.44	65.54
1366	5.02	30.36	0.00	64.63
1367	5.52	25.63	0.00	68.84
1368	5.31	29.25	0.00	65.44
1369	7.22	32.69	0.00	60.09

Table 3.29 Value added of transport sectors fixed prices of 1361

Year	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369
consum price index 1361=100	18.33	18.61	19.26	19.54	20.64	21.93	24.38	28.15	30.94	36.06	45.1	49.61	55.26	68.27	83.87	100	114.8	126.7	135.4	167.5	213.9	275.7	323.8	352.8
consum price index 1353=100	65.1	66.1	68.4	69.4	73.3	77.9	86.6	100	109.9	128.1	160.2	176.2	196.3	242.5	297.9	355.2	418.1	462.1	480.9	580.9	747.2	963.08	1131.1	1232.41
whole price index 1361=100	19.55	19.71	20.47	21	22.54	23.67	26.88	31.44	33.1	37.57	43.04	47.12	56.46	73.66	87.93	100	107.8	116	124.5	155.8	202.1	246.5	291.9	361.7
whole price index 1353=100	62.2	62.7	65.1	66.8	71.7	75.3	85.5	100	105.3	119.5	136.9	149.9	179.6	234.3	279.7	318.1	358	385.2	406.2	501.6	650.6	793.5	939.7	1164.4
Price Index of whole sale Goods group of mashins & transport means	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369
1361=100					32.6	34.99	38.36	40.63	46.04	51.16	57.13	62.29	69.04	81.96	89.56	100	103.8	104.1	107.4	124.5	189.2	258.2	295.5	
1353=100					80.4	86.1	94.4	100	113.3	125.9	140.6	153.3	169.9	201.7	220.4	246.1	252.3	253.7	261.8	303.5	461.2	629.4	720.3	
growth rate																	3.8	0.3	3.2	15.9	52	36.5	14.4	
Price Index of consuming goods & services in urban region group of transportation & comunication	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369
1361=100					20.9	21.7	22.5	23.7	25.6	29.1	38.4	41.8	45.8	59	77.8	100	118.6	137.1	144.4	168.4	241.7	331.6	368	449
1353=100					88.57	91.8	95.1	100	108.3	123	162.2	176.6	193.4	249.4	328.7	422.7	508.6	594.8	627.3	731.6	1050	1440	1598.7	1952.3
growth rate																	18.6	15.6	5.3	16.6	43.5	37.2	11	22.1
population in thousand	26501	27223	27970	28727	29499	30286	31089	31908	32742	33709	35016	36381	37807	39296	40853	42480	44181	45960	47820	49765	51304	53161	55011	56882
GDP (nominal) miliard rials	516.1	578.6	642.6	713.5	902.7	1130.2	1678.8	2986.5	3302.5	4440.8	5177	5095.5	6158.2	6471.1	7884.3	10335.4	12930	14242.4	15167.8	15614	20605.4	23048.2	27567.5	35284.7
GDP (fixed 1353)	1357.4	1529	1728.2	1911.3	2153.8	2507.3	2737.9	2986.5	2977.2	3558.8	3594.9	3030.8	3143.9	2676.3	2753.8	3159.5	3587.9	3536.5	3541.2	2961.2	3146.1	2967.57	3074.47	3396.09
GDP (fixed 1361)	4096.03	4781.82	5400	5975.71	6731.54	7832.29	8556.57	9342.7	9227.8	11254.3	11183.8	10070.8	10543.1	9323.1	9175.2	10335.4	11536.7	11587.1	11607.4	9861.7	11370.1	10726	11111.4	12273.8
value added of transportation & communication=VT																								
VT (nominal)	29.7	31.1	32.6	38.8	45.3	64.3	91.2	134.5	178.3	227.5	331.5	355.8	441.6	560.1	628.9	769.7	1030.9	1169.4	1182.1	1132.7	1315.9	1482.1	1767.6	2638.6
VT (fixed 1361)	243.4	204.83	221.86	267.44	306.5	446.23	535.88	673.6	819.4	866.5	874.4	813.4	890.9	903.4	735.9	769.7	889.6	906.3	906.9	785.5	642.9	597.7	650.6	784
VT (fixed 1353)	48.6	40.9	44.3	53.4	61.2	89.1	107	134.5	163.3	174.9	183.9	165.7	195	178.9	162.9	177.2	207.5	214.4	234	201.1	173.1	160.93	175.17	211.09
value added of transportation (nominal & milion rials)																								
overland	22201	23959	24622	28972	32926	42399	60998	96326	123520	160456	231115	274063	346047	485315	526323	617176	827725	961003	974350	919466	1075920			
air-line	1221	1279	1711	2365	2794	3575	4709	6219	10667	12738	16631	15715	13071	5921	10504	15272	33201	40285	35133	42618	48700			
marine	143	295	922	1867	2183	7409	6964	10208	12403	21393	26789	11489	10291	8700	20235	36569	47438	42191	34518	37127	34592			
total	23565	25533	27255	33207	37903	53383	72671	112753	146590	194587	274535	301267	369409	499936	557062	669017	908364	1043479	1044001	999211	1159212			
value added of transportation (fixed 1361 & milion rials)																								
overland	211990	171678	184040	220340	246848	331254	398120	546770	657328	693738	660337	655948	721790	793944	614169	617176	708421	733673	744296	644947	512080			
air-line	3730	3905	5160	6994	7611	9629	11933	13293	19306	22207	28240	24501	19918	8569	12000	15272	33051	39774	34621	58181	41057			
marine	837	1723	5390	10918	12769	38804	33322	36198	40139	59261	59399	23164	18610	12738	24118	36569	41358	33353	25607	22272	16233			
total	216557	177306	194590	238252	267228	379687	4433375	596261	716773	775206	747976	703613	760318	815251	650287	669017	782830	806800	804524	705400	569370			
value added of transportation (fixed 1353 & milion rials)	1346	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364	1365	1366	1367	1368	1369
overland	37347	30245	32423	38818	43488	58358	70138	96326	114035	122031	118120	116561	143541	146591	126395	131285	150786	158748	181464	153258	127273			
air-line	1745	1827	2414	3272	3561	4505	5583	6219	9134	10518	13592	11670	9390	3855	5617	7232	16050	19184	16694	18474	20230			
marine	236	486	1520	3079	3601	10943	9397	10208	11286	16700	16723	6520	5242	3587	6793	10296	11346	9131	7177	6392	4629			
total	39328	32558	36357	45169	50650	73806	85118	112753	134455	149249	148435	134751	158173	154033	138805	148813	178182	187063	205335	178124	152132			

Table 3.30 Activity level of passenger transport modes

(Unit:Mio. p-km)

Year	Mini-Bus	Bus	M. Cycle	Train_Diesel	Air (Dom)
1349<	9,078	10,936	865	1,782	n.a.
1350	10,136	12,210	995	1,772	n.a.
1351	11,506	13,862	1,080	2,034	n.a.
1352	12,900	15,541	1,165	2,167	n.a.
1353	14,315	17,245	1,239	2,244	n.a.
1354	15,838	19,080	1,220	2,805	1,272
1355	18,151	21,867	1,278	3,476	1,490
1356	20,989	25,286	1,149	3,636	1,763
1357	22,549	27,165	1,139	2,951	1,630
1358	23,714	28,569	942	3,168	1,581
1359	24,978	30,091	1,430	2,677	1,170
1360	26,786	32,269	2,098	2,501	1,867
1361	27,966	33,690	2,167	4,687	2,085
1362	30,953	37,289	2,155	5,726	3,334
1363	34,932	42,083	2,190	6,069	4,107
1364	39,023	47,011	2,160	5,529	4,035
1365	40,737	49,076	2,083	4,592	4,695
1366	41,452	49,938	1,944	3,637	4,792
1367	41,315	49,772	1,684	4,614	4,194
1368	41,690	50,225	1,467	4,705	4,713
1369	41,911	50,490	1,227	4,528	5,700
1370	44,814	53,988	1,111	n.a.	5,369

Table 3.31 Activity of modes in Freight transportation

(Unit:Mio. t-km)

Year	S.Truck	L.Truck	Train_Diesel	Air(Dom)
1349	1,114	12,623	2,330	n.a.
1350	1,253	14,196	3,006	n.a.
1351	1,401	15,876	3,692	n.a.
1352	1,560	17,677	4,388	n.a.
1353	1,784	20,221	4,917	n.a.
1354	2,445	27,715	4,943	134
1355	3,138	35,563	4,877	163
1356	4,109	46,569	5,017	199
1357	4,800	54,396	4,083	178
1358	5,117	57,995	3,124	174
1359	5,429	61,529	3,428	123
1360	5,624	63,735	3,861	217
1361	5,840	66,189	5,567	245
1362	6,730	76,275	6,762	398
1363	7,706	87,338	7,566	475
1364	8,695	98,539	6,888	410
1365	8,887	100,717	7,316	485
1366	8,915	101,037	8,625	582
1367	8,674	98,306	8,047	502
1368	8,384	95,020	7,963	533
1369	8,202	92,951	9,041	639
1370	8,506	96,401	n.a.	526

Table 3.32 Fuel Consumption in Road Transport Sector

Otto Engine (Unit:MBOE/a)

Year	Car Tr.	MC.Tr	Mini-Bus Tr.	Bus Tr.	S.Truck Tr.	L.Truck Tr.
1349<	4.65	0.24	0.84	0.79	1.15	4.96
1350	5.42	0.27	0.94	0.88	1.29	5.58
1351	6.49	0.30	1.07	1.00	1.45	6.24
1352	7.71	0.32	1.19	1.12	1.61	6.95
1353	9.65	0.34	1.32	1.24	1.84	7.95
1354	12.61	0.34	1.46	1.37	2.53	10.90
1355	15.66	0.35	1.67	1.57	3.24	13.98
1356	19.32	0.31	1.93	1.82	4.20	18.27
1357	20.41	0.31	2.07	1.95	4.88	21.32
1358	21.57	0.25	2.17	2.05	5.19	22.71
1359	22.69	0.37	2.28	2.16	5.49	24.07
1360	22.95	0.54	2.44	2.32	5.67	24.91
1361	23.20	0.55	2.55	2.42	5.88	25.84
1362	23.89	0.54	2.81	2.67	6.74	29.67
1363	24.65	0.55	3.16	3.01	7.69	33.84
1364	25.07	0.53	3.51	3.35	8.61	38.05
1365	24.25	0.51	3.64	3.49	8.76	38.79
1366	23.26	0.47	3.70	3.55	8.75	38.83
1367	22.11	0.40	3.68	3.54	8.50	37.72
1368	20.92	0.35	3.70	3.56	8.20	36.42
1369	19.10	0.29	3.71	3.58	8.00	35.56
1370	18.04	0.25	3.94	3.81	8.26	36.76

Table 3.33 Final energy intensity in passenger transportation modes

(Unit:kJ/p-km)

Year	Car (Otto)	Car(Diesel)	Taxi	Mini-Bus	Bus	Train_Elec	Train_Diesel
1349<	1,681	1,716	2,052	548	426	290	446
1350	1,680	1,715	2,050	548	426	290	413
1351	1,678	1,713	2,048	548	426	290	354
1352	1,676	1,711	2,046	547	426	290	350
1353	1,675	1,710	2,044	547	426	290	334
1354	1,673	1,708	2,042	546	426	290	352
1355	1,672	1,707	2,041	545	426	290	380
1356	1,671	1,706	2,040	543	425	290	337
1357	1,623	1,657	1,981	542	425	290	375
1358	1,619	1,653	1,976	541	425	290	407
1359	1,610	1,643	1,965	540	425	290	364
1360	1,578	1,611	1,926	539	425	290	382
1361	1,570	1,603	1,916	538	425	290	331
1362	1,570	1,603	1,916	537	424	290	268
1363	1,558	1,591	1,902	535	423	290	264
1364	1,564	1,597	1,909	531	422	290	318
1365	1,562	1,595	1,907	529	421	290	271
1366	1,559	1,591	1,903	527	420	290	293
1367	1,558	1,590	1,901	527	420	290	290
1368	1,559	1,591	1,903	525	419	290	290
1369	1,515	1,547	1,849	524	419	290	347
1370	1,491	1,522	1,820	520	417	n.a.	n.a.

Table 3.34 Final energy intensity in transportation sector

(Unit:kJ/t-km)

Year	S.Truck	L.Truck	Train_Diesel	Total
1349<	6,109	2,325	883	2,378
1350	6,109	2,325	818	2,659
1351	6,109	2,325	700	2,485
1352	6,109	2,325	692	2,605
1353	6,109	2,325	662	2,647
1354	6,109	2,325	697	2,782
1355	6,097	2,324	753	2,793
1356	6,041	2,320	666	2,882
1357	6,009	2,317	743	2,824
1358	5,993	2,315	805	2,773
1359	5,978	2,313	720	2,646
1360	5,964	2,311	757	2,639
1361	5,949	2,308	655	2,595
1362	5,921	2,300	531	2,427
1363	5,897	2,291	523	2,420
1364	5,856	2,283	629	2,446
1365	5,830	2,277	536	2,428
1366	5,806	2,272	580	2,403
1367	5,794	2,269	575	2,406
1368	5,782	2,266	574	2,398
1369	5,768	2,262	688	2,380
1370	5,743	2,254	n.a.	2,525

Table 3.36 Development of share of expenditure groups in urban population (Unit:%)

Year	1368	1373	1378	1383	1388	1393	1398	1400
UPOP_1&2	7.46	7.46	7.46	7.46	7.46	7.46	7.46	7.46
UPOP_3&4	23.31	23.31	23.31	23.31	23.31	23.31	23.31	23.31
UPOP_5&6	37.07	37.07	37.07	37.07	37.07	37.07	37.07	37.07
UPOP_7&8	23.99	23.99	23.99	23.99	23.99	23.99	23.99	23.99
UPOP_9&10	8.17	8.17	8.17	8.17	8.17	8.17	8.17	8.17

Table 3.37 Development of share of expenditure groups in rural population (Unit:%)

Year	1368	1373	1378	1383	1388	1393	1398	1400
RPOP_1+2	16.36	16.36	16.36	16.36	16.36	16.36	16.36	16.36
RPOP_3+4	36.15	36.15	36.15	36.15	36.15	36.15	36.15	36.15
RPOP_5+6	32.58	32.58	32.58	32.58	32.58	32.58	32.58	32.58
RPOP_7+8	12.59	12.59	12.59	12.59	12.59	12.59	12.59	12.59
RPOP_9+2	2.31	2.31	2.31	2.31	2.31	2.31	2.31	2.31

Table 3.38 Development of Real expenditure of Urban & Rural Households

(Unit:1,000 Rs/Capita/a)

Year	1368	1373	1378	1383	1388	1393	1398	1400
Urban	164.8	164.8	164.8	164.8	164.8	164.8	164.8	164.8
Rural	96.5	96.5	96.5	96.5	96.5	96.5	96.5	96.5

Table 3.39 Development of Demand for Useful Energy in Rural Household

(Unit:PJ/a)

Year	1368	1373	1378	1383	1388	1393	1398	1400
Heating	25.56	28.87	32.28	35.96	39.81	43.92	48.15	49.90
Air Cond.	3.25	3.67	4.10	4.57	5.06	5.58	6.12	6.34
Refrig.	2.86	3.24	3.62	4.03	4.46	4.92	5.40	5.59
Elec+TV	4.16	4.70	5.26	5.86	6.48	7.15	7.84	8.13
Lighting	1.15	1.29	1.45	1.61	1.78	1.97	2.16	2.24

Table 3.40 Development of Demand for Useful Energy in Urban Household

(Unit:PJ/a)

Year	1368	1373	1378	1383	1388	1393	1398	1400
Heating	65.72	74.23	82.99	92.46	102.36	112.92	123.80	128.30
Air Cond.	18.61	21.02	23.50	26.18	28.98	31.97	35.05	36.33
Refrig.	7.56	8.54	9.55	10.64	11.78	12.99	14.24	14.76
Elec+TV	8.57	9.68	10.83	12.06	13.35	14.73	16.15	16.74
Lighting	3.05	3.45	3.86	4.30	4.76	5.25	5.75	5.96

Table 3.41 Development of Demand for Useful Energy in Industry

(Unit:PJ/a)

Year	1368	1373	1378	1383	1388	1393	1398	1400
Heating	220.77	245.56	287.45	343.94	404.65	472.67	545.64	576.52
M. Power	28.90	32.15	37.63	45.03	52.97	61.88	71.43	75.47
Feed Stk	44.28	49.25	57.65	68.99	81.16	94.80	109.44	115.63
Elec	35.18	39.13	45.81	54.81	64.48	75.32	86.95	91.87

Table 3.42 Development of Demand for Useful Energy of UP Transport

(Unit:PJ/a)

Year	1368	1373	1378	1383	1388	1393	1398	1400
UP_Car	45.35	54.33	64.96	76.71	89.08	102.46	116.23	122.27
UP_Taxi	7.52	9.00	10.76	12.71	14.76	16.98	19.26	20.26
UP_MC	0.88	1.06	1.26	1.49	1.73	1.99	2.26	2.37
UP_M-Bus	6.86	8.21	9.82	11.59	13.46	15.49	17.57	18.48
UP_Bus	1.98	2.37	2.84	3.35	3.89	4.47	5.07	5.34
UP_Train	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UP_TOT	62.58	74.97	89.64	105.85	122.93	141.39	160.38	168.72

Table 3.43 Development of Demand for Useful Energy of IP Transport

(Unit:PJ/a)

Year	1368	1373	1378	1383	1388	1393	1398	1400
IP_Car	1.44	1.76	2.10	2.47	2.86	3.27	3.69	3.87
IP_M-Bus	4.14	5.04	6.03	7.09	8.20	9.39	10.61	11.11
IP_Bus	6.77	8.25	9.86	11.60	13.42	15.36	17.35	18.17
IP_D-Train	1.32	1.62	1.93	2.27	2.63	3.01	3.40	3.56
IP_E-Train	0.01	0.02	0.02	0.02	0.03	0.03	0.03	0.03
IP_Air	4.48	5.47	6.53	7.68	8.89	10.17	11.50	12.04
IP_TOT	18.17	22.15	26.47	31.13	36.01	41.22	46.58	48.78

Table 3.44 Development of Demand for Useful Energy of Freight Transport

(Unit:PJ/a)

Year	1368	1373	1378	1383	1388	1393	1398	1400
Fr_L-Truck	80.00	87.42	103.14	129.46	156.81	185.52	215.46	227.28
Fr_S-Truck	13.46	14.71	17.36	21.79	26.39	31.22	36.26	38.25
Fr_D-Train	1.70	1.85	2.19	2.74	3.32	3.93	4.57	4.82
Fr_E-Train	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Fr_Air	0.83	0.91	1.07	1.34	1.63	1.93	2.24	2.36
Fr_TOT	95.99	104.89	123.75	155.34	188.15	222.60	258.52	272.71

Fig. 4.6 Production of Petroleum Products

(Unit:Mio. BOE/a)

Year	1347	1348	1349	1350	1351	1352	1353	1354	1355	1356	1357	1358	1359	1360	1361	1362	1363	1364
LPG	0.4	0.6	2.9	5.0	5.5	6.8	6.6	6.8	6.7	7.6	5.0	5.4	4.1	3.4	4.3	5.0	5.5	5.6
Gasoline	16.9	16.6	17.5	19.5	19.2	20.7	21.3	23.9	26.2	27.4	29.1	31.7	26.7	22.6	25.1	28.7	32.7	33.9
J_Fuel	16.9	17.6	17.3	15.6	17.3	16.2	15.4	15.6	11.3	13.3	12.0	6.7	4.8	3.0	3.3	0.8	0.8	0.8
Kerosine	16.2	18.1	16.9	18.6	19.2	19.5	20.1	20.1	30.9	32.0	28.8	38.5	32.9	26.2	30.7	25.7	26.5	23.8
G_Oil	28.7	29.7	32.3	35.6	35.5	38.7	40.5	45.9	48.8	53.8	56.5	57.5	57.1	47.0	49.2	67.1	75.9	80.4
F_Oil	73.9	78.7	83.8	85.3	84.4	90.2	99.6	103.5	97.9	111.1	103.4	120.8	102.1	62.5	67.1	68.1	73.7	75.4
Year	1365	1366	1367	1368	1369	1370	1371	1372	1373	1374	1375	1376	1377	1378	1379	1380	1381	1382
LPG	5.2	5.3	5.9	7.2	10.4	10.8	13.6	17.1	21.5	21.2	21.0	20.8	20.6	20.3	21.7	23.2	24.8	26.5
Gasoline	29.3	30.7	30.6	38.7	41.8	47.6	53.5	60.1	67.6	70.0	72.5	75.1	77.8	80.6	83.5	86.5	89.7	92.9
J_Fuel	0.6	0.5	2.7	2.6	3.5	4.1	4.6	5.1	5.6	8.0	11.3	16.0	22.6	32.0	30.7	29.3	28.0	26.8
Kerosine	21.8	25.7	27.6	40.4	35.9	41.9	43.3	44.8	46.2	46.5	46.7	46.9	47.1	47.4	48.3	49.3	50.3	51.3
G_Oil	71.3	65.9	66.5	78.9	89.1	98.2	98.3	98.4	98.6	104.4	110.6	117.2	124.1	131.5	136.4	141.4	146.7	152.1
F_Oil	72.9	70.7	76.2	98.9	102.7	119.2	114.1	109.2	104.5	109.8	115.4	121.2	127.4	133.8	136.3	138.9	141.6	144.3
Year	1383	1384	1385	1386	1387	1388	1389	1390	1391	1392	1393	1394	1395	1396	1397	1398	1399	1400
LPG	28.4	29.4	30.6	31.7	32.9	34.2	35.3	36.3	37.4	38.6	39.7	41.0	42.2	43.5	44.8	46.2	47.6	49.0
Gasoline	96.3	99.4	102.6	105.8	109.2	112.7	116.1	119.5	123.0	126.7	130.4	133.9	137.4	141.0	144.7	148.5	152.4	156.5
J_Fuel	25.7	26.5	27.3	28.1	29.0	29.9	32.4	35.0	37.9	40.9	44.3	46.8	49.4	52.1	55.0	58.1	61.4	64.8
Kerosine	52.4	52.9	53.3	53.8	54.4	54.9	55.4	55.9	56.5	57.0	57.6	57.7	57.7	57.8	57.9	58.0	58.1	58.2
G_Oil	157.7	163.4	169.2	175.3	181.5	188.0	197.0	206.4	216.3	226.6	237.5	245.4	253.6	262.1	270.8	279.9	289.3	298.9
F_Oil	147.0	150.2	153.5	156.8	160.2	163.7	171.0	178.7	186.6	195.0	203.7	210.1	216.7	223.5	230.6	237.8	245.3	253.0

Fig. 4.7 Fuel consumption of thermal power plants (Unit:Mio. BOE)

	1347	1350	1355	1360	1365	1370	1373	1378	1383	1388	1393	1400
N-Gas	0.1	0.1	6.7	14.1	24.7	51.5	76.0	105.9	49.1	50.1	18.3	19.9
G-oil	0.8	1.0	2.5	6.1	13.6	7.1	7.3	8.1	8.7	11.7	31.5	49.4
F-oil	2.0	4.4	8.3	9.6	23.2	31.3	59.0	52.1	95.4	96.6	117.4	135.5

Fig. 4.8 Share of sectors in final energy consumption (Unit:Mio.BOE/a)

	1350	1360	1370	1373	1378	1383	1388	1393	1400
HLD & SEI	24.8	73.7	179.7	178.5	196.7	219.3	243.1	269.4	308.3
IND	38.2	70	126.4	169.1	169.6	189.1	214.2	242.2	284.9
TRC	22.3	53.8	105.5	128.1	152.3	184.7	218.5	254.6	307.3
AGR	3.3	13.7	33.8	30.9	34	40.3	46.7	52.9	60.7
TOTAL	88.6	211.2	445.4	506.6	552.6	633.4	722.5	819.1	961.2
[%]									
HLD & SEI	28.0	34.9	40.3	35.2	35.6	34.6	33.6	32.9	32.1
IND	43.1	33.1	28.4	33.4	30.7	29.9	29.6	29.6	29.6
TRC	25.2	25.5	23.7	25.3	27.6	29.2	30.2	31.1	32.0
AGR	3.7	6.5	7.6	6.1	6.2	6.4	6.5	6.5	6.3

Fig. 4.9 Emission of Pollutants in I. R. Iran (kt/a)

	1350	1360	1370	1373	1378	1383	1388	1393	1400
CO2	12.3	38.8	87.0	139.8	148.4	162.1	177.1	203.1	246.2
CO	179.9	426.7	867.4	793.2	935.7	1110.8	1294.0	1490.7	1776.9
NOX	189.9	466.9	1345.1	1354.3	1549.2	1829.9	2128.6	2461.7	2946.5
SO2	108.7	287.5	536.6	541.2	516.5	747.0	846.0	1058.7	1318.0

Fig. 4.10 Consumption of Energy Carriers in Household of I.R. Iran (Unit:kBOE/a)

Year	73	78	1400	73	78	1400	73	78	1400	73	78	1400
	(REF01)			(BASE01)			(LOW01)			(HIGH01)		
N-Gas	58.4	81.1	160.7	63.6	94.3	232.5	58.4	81.1	160.7	63.6	94.3	235.1
Pet Prod	47.9	36.9	17.2	47.9	36.9	17.2	47.9	36.9	17.2	47.9	36.9	14.0
Elec	11.8	13.4	21.0	12.4	15.1	31.3	11.8	13.4	21.0	12.4	15.1	31.3
	(REF09)			(BASE09)			(LOW09)			(HIGH09)		
N-Gas	87.3	96.2	108.1	95.9	106.1	159.0	80.3	89.8	111.5	95.3	99.5	144.1
Pet Prod	16.8	11.4	10.5	15.9	11.4	10.5	19.5	11.4	10.5	16.6	11.4	10.5
Elec	12.9	12.0	14.3	11.8	13.6	22.9	15.5	11.9	14.1	11.7	13.7	23.0

Fig. 4.11 Consumption of Energy Carriers in Industry of I. R. Iran (Unit:Mio.BOE/a)

Year	73	78	83	88	1400	73	78	83	88	1400	73	78	83	88	1400
	(REF01)					(BASE01)					(HIGH01)				
Coal	5.2	6.1	7.3	8.6	12.3	5.9	7.6	9.1	10.7	14.3	5.8	8.9	11.9	16.2	54.4
N-Gas	82.1	82.7	100.0	121.7	131.8	82.5	98.2	105.4	110.4	115.2	82.5	116.0	141.2	142.6	143.9
Pet.Prod	16.9	13.1	10.1	7.9	52.8	16.9	13.1	10.1	7.9	5.7	16.9	13.1	10.1	37.1	20.1
Elec	17.2	20.2	24.1	28.4	40.4	19.4	24.6	25.8	26.7	28.1	19.2	28.5	33.8	40.6	45.3
	(REF10)					(BASE10)					(HIGH10)				
Coal	5.2	6.1	7.3	8.6	12.3	5.9	7.6	9.1	10.7	14.3	5.8	8.9	11.9	16.2	23.1
N-Gas	82.1	87.6	100.0	112.2	142.7	88.4	106.0	104.9	102.5	93.6	87.5	123.0	137.4	150.1	151.2
Pet.Prod	0.1	0.1	0.1	0.1	0.1	11.7	1.5	1.4	1.4	1.3	11.3	11.0	10.7	16.1	9.9
Elec	17.2	19.4	22.6	25.5	32.9	13.6	23.0	23.2	23.1	22.2	13.6	22.2	26.0	31.0	32.0

II. Record of Visits to Factories and Plants

1. Cement
2. Sheet Glass
3. Sugar
4. Iron and Steel
5. Power Generation
6. Oil Refining
7. Others

1. Cement

1.1 Tehran Cement Factories (No. 1 and No. 2)

1.1.1 Outline

Tehran Cement Company, one of state-owed cement companies in this country, has 2 factories near to Tehran, one (No. 1) of which installed No. 1-6 lines and another (No. 2) No. 7 line. These plants are producing cement in their full operation, coping with rapid increase in demand for cement in recent years. More specifically, they are operating for 335 days per annum, andmaintenance period is curtailed as short as possible although 30 days are usually allocated for it. Some of indicators of these plants are shown in Table 1.1.

1.1.2 Countermeasures (Devices) on Heat Consumption

(i) Outline of Heat Consumption

Indicators for considering countermeasures for promoting energy in No. 1 and No. 2 factories including capacity, production, energy consumption, and others are shown in Table 1.2 and 1.3 respectively.

Fig. 1.1 shows production flow in No. 2 factory (No. 7 line), which installed SP kiln with satellite coolers, and energy consumption per unit of production (970 kcal/kg-cl) is reported to be among the lowest of factories which have the similar scale of production capacity to this.

Temperatures of exhaust gas and clinker at No. 7 kiln are as follows

exhaust gas (at the outlet of kiln	1,200℃
exhaust gas (at the outlet of pre-heater)	450-500℃
exhaust gas (at the outlet of EP)	90-120℃
clinker (at the outlet of pre-heater)	800℃
clinker (at the outlet of cooler)	130℃

Table 1.1 Some Indicators of Tehran Cement Factories (NO.1 and NO.2)

Line	Capacity(t-cl/h)	Kiln type	Fuel	Established year
No1	300	Wet	FO, NG	1952
No2	300	Wet	〃	1957
No3	600	Wet	〃	1967
No4	2,000	Dry	〃	1973
No5	300	Wet	〃	1961
No6	4,000	Lepol	FO/NG	1978
No7	2,000	S P	FO/NG	1985

NOTE: " FO, NG " means that heavy fuel oil or natural gas is fired and " FO/NG " means that they are fired mixedly.

Table 1.2 Indicators on Energy Consumption in NO.1 Factory

1 Factory					
Major product	Portland cement				
Production	1988	1989	1990	1991	
	1.9	1.92	1.64	1.9	Mt-cl/Y
Operating hour	365×24				h/Y
No of employee	1,800				persons
2 Energy consumption	1991	1992			
Heavy Fuel oil	48,738	82,566			kl/Y
Natural gas	174,158	132,998			m_n^3/Y
3 Specific energy consumption					
Heavy Fuel oil	25.7	~			l/t-cl
Natural gas	91.7	~			m_n^3/t-cl
4 Energy cost					
Heavy Fuel oil	~				IR/kl
Natural gas	~				〃

NOTE : ~ (See Table 1.1)

Table 1.3 Indicators on Energy Consumption in NO. 2 Factory

1 Factory					
Total capacity	2, 000				t-cl／D
Production	1988	1989	1990	1991	
	409	414	502	472	k t -cl／Y
Emproyee	4 2 0				persons
Mech' engineer,	2				〃
Chem' 〃	4				〃
Elec' 〃	4				〃
2 Energy consumption					
Fuel oil	8. 5				k l／h
N-gas	8, 0 0 0				m_n^3／h
3 Specific fuel consumption					
Fuel oil	9 4～9 5				k g／t-pro
N-gas	1 0 0				m_n^3／t-pro
(Calory base)	9 7 0				k c a l／kg-cl
4 Energy cost					
Fuel oil	2.5(at refinery), 5(at factory)				I R／I
N-gas	5				I R／m_n^3
5 Lower calorific value					
Fuel oil	9, 6 0 0				k c a l／k g
N-gas	9, 4 0 0～9, 6 0 0				k c a l／ m_n^3

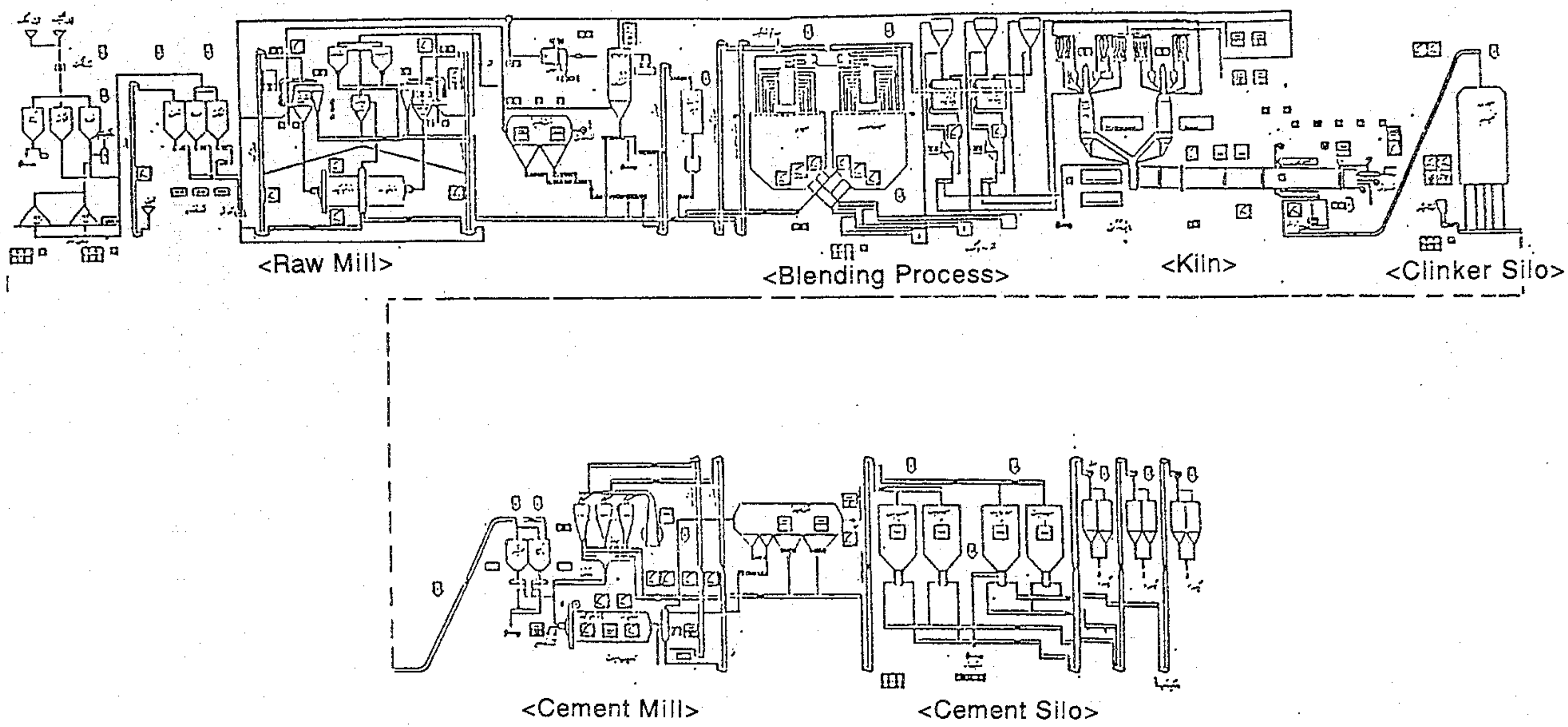


Fig. 1.1 Outline of NO.7 Line on Tehran Cement Co.

(ii) Countermeasures to be Considered

Energy consumption per kg of clinker in No. 2 factory is reported to be 970 kcal, which can be compared with 706 kcal in 1990 in Japan. Following countermeasures or devices can be recommended for the factory and No. 1 factory, which is less efficient in energy uses, to fill such a difference.

a) Countermeasures at the 1st step

* Rehabilitation of bricks in kilns.
* Rehabilitation of ducts for insulation of high-temperature combustion gas, combustion air, and clinker.
* Preventing high-temperature combustion gas, combustion air, and clinker from leakage.
* Preventing cool air from entering kiln.
* Quality control in preparing raw materials (reducing moisture and making the grains uniform, in particular).
* Managing fuel and combustion in kiln.

Additionally, special mention should be made of the necessity of preserving working environment in the factory. Preventing clinker as well as cement from dispersing within the factory might mean "money conservation" rather than energy conservation.

b) Countermeasures at the 2nd step

Wet type kilns (= 130-140 kg/t-cal) are installed in No. 1 factory except for No. 4 kiln (= 85 kg/t-cal) and No. 6 kiln (Lepole type; = 80 kg/t-cal) and are less efficient in energy usages. Following recommendations can be made mainly for these kilns.

* Installation of SP (suspension pre-heater)
* Installation of pre-calciner (new suspension pre-heater...... NSP)
* Recovery of exhaust heat from air cooler.

In addition, the installation of exhaust gas heat recovery power plants should be considered. Heat losses due to exhaust gas and radiation account for a major part of heat loss in kilns. In Japan, there has been a growing number of exhaust gas heat recovery power plant installed in cement factories where the temperature of exhaust gas at the outlet of pre-heater at SP kiln is 32 0 - 350℃. The temperature of exhaust gas of No. 7 kiln is reported to be 450-500℃, much higher than that in Japan, and heat can be utilized for power generation through modifying pre-heater. The same suggestion is supposed to be able to be made for other kilns although any specific data could be obtained by Japanese experts.

c) Countermeasures at the 3rd step

As countermeasures at the 2nd step mentioned above and conversion from wet type kiln to dry type will require a large amount of investment, a comprehensive examination and decision including considering replacement of the wet type kilns with larger scale ones should be conducted. If the replacement is implemented, decrease in energy consumption per unit production caused by higher efficiency as well as by larger scale can be enjoyed in addition to decrease in production cost.

1.1.3 Countermeasures (Devices) on Electricity Consumption

(i) Outline of Electricity Consumption

Electric power used in this factory are supplied from outside.
The loads of main electricity users in No. 1 factory are as follows.

Raw mill	12.5 MW
Kiln	11.8 MW
Cement mill	15.4 MW

And the loads of main electricity user in No. 2 factory are as follows.

Raw mail	3.75 MW
Kiln	1.4 MW
Cement mill	3.8 MW

Electricity consumption per ton of clinker is reported to be 130-150 KWh in wet kilns and 95 - 110 KWh in dry kilns in No. 1 factory. Average consumption of electricity per ton of clinker in this factory is as follows.

1991	132 kWh/t
1990	123 kWh/t
1989	130 kWh/t

1988 125 kWh/t

And 90-92% of electricity is consumed for driving motors and 8-10% for heating and lighting in No. 1 factory. Consumption of electricity per ton of cement products is reported to be 117 KWh in No. 2 factory, which can be compared with 102 kWh in Japan in 1990. This comparison implies that even No. 2 factory, one of the most efficient factories in this country, still has much soon for saving electricity.

(ii) Countermeasures to be Considered

a) Countermeasures at the 1st step

* Measuring and monitoring of electricity consumption to operate main facilities effectively
* Reducing operation hour of main facilities and lowering peak load

b) Countermeasures at the 2nd step

* Controlling the volume of air flow and water flow by introducing inventer system

c) Countermeasures at the 3rd step

* Introducing more efficient crushers

  Crushers in raw and cement mills use about two-thirds of total electricity consumption in a cement factory. The effect of installing more efficient crusher, vertical one, is substantial in decreasing electricity consumption. In addition, introducing preliminary crushing system also brings effective utilization of electricity in the cement factories.
* Conversion from wet type kiln to dry type kiln

  This device mentioned already can also contribute to reducing electricity consumption in No. 1 factory where four wet type kilns (No. 1, 2, 3, 5) are installed.

2. Sheet Glass

2.1 Ghazvin Glass Co.

2.1.1 Outline of the factory

The factory is located in Ghazvin at about 200 km in the west of Teheran, being a national factory belonging to the Ministry of Industry. In 1968, the present No. 1 line was constructed, and 4 years later, No. 2 line and in succession No. 3 line were constructed. At present, with No. 4 line completed, the production capacity has been expanded to 550 t/d from the initial capacity of 70 t/d. It is the largest sheet glass factory in Iran (the share in 1992 is about 70%). Presently, with the cooperation of Nippon Sheet Glass Co., Ltd., a new line of float system is being planned.

The factory uses silica rocks, soda ash, dolomite, etc. sent from mines, and produces sheet glass (also patterned glass) by a process consisting of a crushing plant, mixing step, glass melting & clearing step, and molding & annealing & processing step.

It is said that a wet crushing factory is being constructed in Drekuhi (mine) at 50 km away from Ghazvin as a joint invested factory of four glass factories under the guidance of the government for rationalization of production and to avoid the problem of dust pollution. The crushing factory is scheduled to start deliveries two weeks later.

Most of the glass products are sold in the domestic market, and very recently export to the Middle and Near East has just started.

2.1.2 Present situation of the factory and energy saving indicators

The present situation of the factory and energy saving indicators are shown in Table 2.1.

Table 2.1 Present situation of the factory and indicators concerned

1 Factory	
Total Capacity	120,000 product-t/Y
Crushing Plant	35 (3 plant total) t/h
Diesel-Generater (emergency)	860 kVA × 8 set, 530 kVA × 3 set
Production (1992 actual)	146,000 product-t/Y
Name of Product	Sheet Glass
Operating Hour	365 × 24 = 8,760 h/Y
No of Employee	1,400 persons
No of Engineer	20 persons
2 Energy Consumption (1991)	
Heavy Fuel Oil	≒ 200,000 l/d
Gas oil	≒ 7,500 l/d
Natural Gas	≒ 12,000 Nm^3/d
Electricity	~ kWH/Y
3 Specific Energy Consumption	
Heavy Fuel Oil	5,257 Mcal/t
Electricity	~ kWH/t

Note: The value of mark (~) are filed by the report after given by the factory.

2.1.3 Energy saving measures

A glass melting furnace is a major apparatus in the glass manufacturing industry. The melting temperature of glass is generally as high as 1400 to 1600°C, and glass melting accounts for about 9 0% of the heat energy consumption of the entire factory.

The specific energy consumption rates in the sheet glass industry of Japan are as follows:

- Specific heat energy consumption: 2,934 Mcal/t (in terms of fuel oil)
- Specific electric energy consumption: 229 kWH/t

The specific heat energy consumption of this factory is as very large as 5,257 Mcal/t as shown in Table 2.1.

(i) Energy saving measures in the 1st step

The energy saving measures in the first stage are taken by intensifying equipment maintenance and improving operation. The older the equipment, the more effective these measures. Major matters found as a result of the field survey are as follows:

a) Repair of furnace walls and prevention of ingress of cold air into furnaces
b) Repair of ducts of hot gas, hot air, etc. to ensure more perfect heat insulation, and prevention of leak
c) More intensive fuel and combustion control of respective furnaces
d) Repair of meters and more intensive numerical control
e) Prevention of scattering of raw materials and intermediate products
f) Enhancement of yield by decreasing the quantity of broken glass, etc.
g) Improvement of operation in the clearing step

(ii) Energy saving measures in the 2nd step

a) Glass melting furnaces

- Especially in the glass manufacturing industry, the furnace walls are not often thermally insulated to keep the life of furnace materials as long as possible since the repair cost of furnace materials is very high. It is recommended to adopt high performance electrocast refractories for raising the refractoriness of the furnace materials and extending the continuous operation time, and also to thermally insulate them more perfectly.
- The loss due to the exhaust gas of melting furnaces is considered to be on the level of 60 to 70% though not measured. If high performance recuperators are installed for recovery of waste heat, to heat the secondary air to the level of 1000°C by the hot exhaust gas, the loss due to exhaust gas can be decreased to lower than 25%. In addition, this raises combustion performance, and greatly contributes to the improvement of glass quality.
- High performance burners should be adopted to lower the excess air ratio to lower than 1.15. The excess air ratio of the presently used burners is surmised to be more than 2.0

judging from the white smoke emitted from the stack, though not measured. A higher excess air ratio increases the loss due to exhaust gas, and exerts adverse effects such as the increase of hot flames blown out of the opening.

The fuel is planned to be changed to natural gas 2 years later. So, the above must of course be sufficiently examined.

b) Generators

The factory has eight 860 kVA diesel generators and three 530 kVA diesel generators for emergency in preparation for unstable electric power supply. In addition, in preparation for a new line to be installed, emergency diesel generators of 4 MW in total are being newly installed. Even if recuperators are installed for the melting furnaces, the exhaust gas temperature is still on the level of 300°C. So, it is recommended to install exhaust gas boilers and to constantly operate steam turbine driven generators for power generation, for reducing the purchased electricity. This is surmised to be effective for energy saving and economical.

c) Electric equipment

The factory uses large-capacity blowers. It is recommended to control their rotational speeds, for reducing the electric energy consumption.

(iii) Energy saving measures in the 3rd step

The energy saving measures in the second stage described above are concerned with the improvement of existing apparatuses. Adopting larger melting furnaces is also very effective for energy saving. This is recommended to be examined in connection with the modernization of equipment. This should of course be judged comprehensively, considering the market trends, economic effect, operation efficiency, etc.

2.2 Abguineh Glass Mfg. Co.

2.2.1 Outline of the factory

The factory is located in Alborz Industry City at about 150 km in the west of Teheran, being a national factory belonging to the Ministry of Industry. The factory contains glass production lines and glass processing lines. The outline is as follows:

- No. 1 line: Started operation in 1972. The present production capacity is 42,000 tons/year.
- No. 2 line: A new plant which was decided to be constructed in 1987 and started operation in July, 1992 with the cooperation of Nippon Sheet Glass Co., Ltd. (including a cullet regeneration plant). The production capacity is 54,300 tons/year.
- No. 3 line: Started operation as color glass line in 1982. The present production capacity is 18 tons/year.
- Automobile front glass processing line: Raw glass is imported from Turkey.
- Tempered glass processing line: Production capacity, 100,000 m2/year
- Glass laminate processing line

The factory is the second largest sheet glass factory next to the above mentioned Ghazvin Glass Co. in Iran.

Such raw materials as silica rocks, soda ash and dolomite sand sent from crushing plants at mines are mixed in an automated batch plant and the mixture is sent to the Nos. 1 and 2 lines.

A wet crushing factory is being constructed at Drekuhi (mine) at 50 km away from Alborz as a joint invested factory of four glass factories under the guidance of the government for rationalization of production and to avoid the problem of dust pollution, as described before.

Most of the products are sold in the domestic market, but 10,000 m2 of products per year are exported to Afghanistan, Turkmenistan, Bangladesh, etc.
Furthermore, a business strategy is being developed based on an estimate that 410,000 tons of total domestic glass consumption will be covered by domestically produced 310,000 tons and imported 10 0,000 tons.

2.2.2 Present situation of the factory and energy saving indicators

The present situation of the factory and energy saving indicators are shown in Table 2.2.

Table 2.2 Present situation of the factory and indicators concerned

1 Factory	
Total Capacity	100,000 product/t-Y
No. 1 Line	42,000 product/t-Y
No. 2 Line	54,300 product/t-Y
No. 3 Line	18 product/t-Y
Production	~ product/t-Y
Name of Product	Sheet Glass & Others
Operating Hour	365 × 24 = 8,760 h/Y
No of Employee	1,100 persons
No of Engineer	22 persons
2 Energy Consumption	
Natural Gas (*)	~ Nm^3/Y
Electricity	~ kWH/Y
3 Specific Energy Consumption	
Natural Gas	Mcal/t
Electricity	kWH/t

Note: The value of mark (~) are filed by the report after given by the factory.

2.2.3 Energy saving measures

As stated before, the specific energy consumption rates of the sheet glass industry in Japan are as follows:

- Specific heat energy consumption: 2,934 Mcal/t (in terms of fuel oil)
- Specific electric energy consumption: 229 kWH/t

The energy consumption rates and production quantities in this factory are unknown, not allowing accurate comparison. The consumption estimated from the natural gas consumption in April, 1993 (3,387,805 Nm^3) and the nominal production capacity (100,000 tons/year) is 3,862 Mcal/t (in terms of fuel oil).

Judging from this value, the specific heat energy consumption can be said to be large.

(i) Energy saving measures in the 1st step

In this factory, Nos. 2 line and the batch plant started their operation only recently, and so are well maintained and adjusted. For the other plants, it is recommended to intensify equipment maintenance and to improve operation as energy saving measures.

a) Repair of furnace walls and prevention of ingress of cold air into furnaces

b) Repair of ducts for hot gas, hot air, etc., to ensure more perfect heat insulation, and prevention of leak

c) More intensive fuel and combustion control of respective furnaces

d) Repair of meters and more intensive numerical control

e) Prevention of scattering of raw materials and intermediate products

f) Raising yield by decreasing the quantity of broken glass, etc.

g) Improvement of operation in clearing step

(ii) Energy saving measures in the 2nd step

a) Glass melting furnaces

- * Especially in the glass manufacturing industry, the furnace walls are not often thermally insulated to keep the life of furnace materials as long as possible since the repair cost of furnace materials is very large. High performance electrocast refractories are adopted only partially in No. 2 melting furnace. It is recommended to adopt the high performance electrocast refractories fully, for more perfect heat insulation.
- * The temperature of the exhaust gas is said to be on the 750°C level in No. 1 melting furnace and on the 400°C level in No. 2 melting furnace, and the heat efficiencies are said to be 28% and 32% respectively. It is recommended to install exhaust gas boilers and to constantly operate the steam turbine driven generators for power generation, to reduce the electricity purchased. The available heat for glass and the recovered heat of the exhaust gas boilers together are expected to give a heat efficiency of more than 70% as shown in Table 2.3. The economic effect is also large, as well as the energy saving effect.

Table 2.3 Heat balance of glass melting furnace
(with exhaust gas boiler installed)

Item	%
Combustion heat of fuel	100.0
Available heat for glass	35.0
Recovered heat of boilers	37.5
Radiation loss of furnace walls	14.0
Loss due to exhaust gas	13.5

* At present, the excess air ratios of burners are said to be on the 1.2 level. No. 2 furnace has an automatic air ratio controller, and in addition, is designed to allow flow control of individual burners. So, the excess air ratios of burners can be easily adjusted. However, Nos. 1 and 3 furnaces are manually controlled, and the excess air ratios are surmised to be somewhat higher. The excess air ratio directly affects the loss due to exhaust gas.

b) Electric equipment

This factory also uses large-capacity blowers. It is recommended to control their rotational speeds and also those of pumps, etc., for reducing the electric energy consumption.

(iii) Energy saving measures in the 3rd step

Nos. 2 line, batch plant, etc. are modernized in efforts to have efficient equipment. The difference between the new equipment and the old equipment is large. It is recommended to scrap the old equipment for substitution by new equipment, comprehensively considering the market trends, economic effect, operation efficiency, etc.

3. Sugar

3.1 Varamin Sugar Refining Factory

3.1.1 Introduction

There are 36 sugar factories including cane sugar, beet sugar, and refining in this country. Varamin Sugar Factory which Japanese experts visited is one of state-owned factories, and was built in 1933 by using the technologies and equipments of Scoda Company of former Czechoslovakia. Crude sugar refined in this factory is imported from the Philippines, Thailand, Cuba, Brazil and others.

The flow of heat energy in the factory is shown in Fig.3.1. The main sources of heat utilized in its production line are low-pressure steam from turbine and steam generated in a boiler which was installed for supplying steam exclusively to distillation process.

3.1.2 Countermeasures (Devices) on Heat Consumption

(i) Outline of Heat Consumption

Indicators for considering countermeasures for promoting energy conservation in this factory including capacity, production, energy consumption and others are shown in Table 3.1. And the outline of boilers and generators is shown in Table 3.2.

(ii) Countermeasures to be considered

This factory is 60 years old and almost all parts of it have not been renovated.

a) Boilers and generators

1) Countermeasures at the 1st step

- Rehabilitation for appropriate combustion in boilers
- Rehabilitation for insulation of steam pipes, high-temperature part of ducts, and others
- Rehabilitation for preventing steam, high-temperature condensate, and others from leakage
- Leveling off of boiler load

In addition, sudden and repeated stoppages and starts of the operation of a diesel generator (23 5 kW) for emergency use, which are caused by blackouts for around 2 hours every 2-3 days, are not desirable in terms of energy conservation.

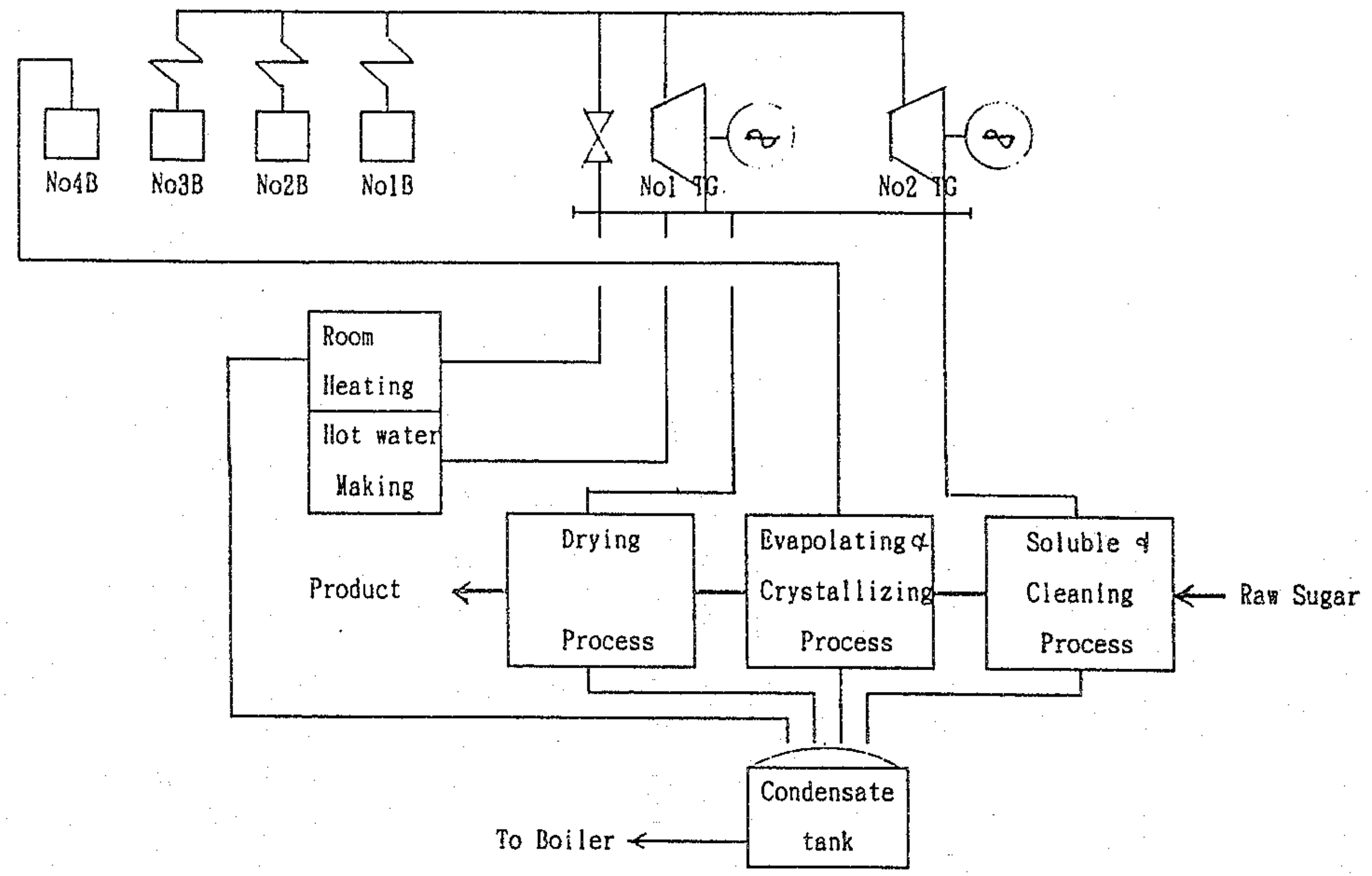


Fig. 3.1 Flow of Heat Energy in Varamin Sugar Factory

Table 3.1 Indicators on Energy Consumption in Varamin Sugar Factory

1 Factory					
Major product	White sugar				
Production (based on product sugar)	1988 55	1989 53	1990 50	1991 42	kt/Y
Total capacity (based on raw sugar)	150				t/d
Raw sugar					
Crude sugar	70				t/d
Granulated sugar	130				t/d
Product price					
Official	30				IR/kg-prod.
Free market price	700				IR/kg-prod.
Subsidy	500				IR/kg-prod.
Operating hour	365 x 24				
Yield factor	200 / 150				
Number of employee	700				persons
Mech', Chem', Elec', Food Engineer	1 each				person
2 Energy Consumption					
Heavy fuel Oil	16,060 (1991)				kl/Y
Diesel fuel oil	14 (1991)				kl/Y
Electricity (Commercial elec')	9,196				Mwh/Y
(Auto' generation)	3,456				Mwh/Y
3 Specific energy consumption					
Heavy fuel oil	382				kl/t-prod.
Diesel fuel oil	0.3				kl/t-prod.
Electricity	301				kwh/t-prod.
4 Energy cost					
Heavy fuel oil	8.4				IR/l
Diesel fuel oil	13				IR/l
Electricity	~				IR/kwh

Table 3.2 Outline of Boilers and Generators in Varamin Sugar Factory

No.1 ~ No.3 Boiler			
Type		Water tube boiler	
Pressure		18	kg/cm2G
Temperature		350	Deg C
Evaporation	(Rating)	6	t/h
	(Actual)	8	t/h
Fuel		Heavy fuel oil	
Control		Manual	
No.4 Boiler			
Type		Fire tube boiler	
Pressure		150	lb/in2G
Temperature		sat'	
Evaporation	(Rating)	22,500	lb/h
Fuel		Heavy oil	
Control		Automatic	
No.1, No.2 Turbine			
Type		Back pressure turbine	
Steam Pressure	(Inlet)	18	kg/cm2G
	(Outlet)	1.8 ~ 2	kg/cm2G
Steam Temperature	(Inlet)	350	Deg C
Revolution		3,000	rpm
No1, No.2 Generator			
Voltage		380	V
Cycle		50	Hz
Output		800	KVA

2) Countermeasures at the 2nd step

* Installation of economizers and air-heaters for heat recovery from exhaust gas of boilers
* Complete recovery of condensate from steam using facilities

  (Present ratio of condensate recovery is estimated to be about 60%)
* Installation of measuring instruments

Investments in these equipments and instruments should be finally determined after taking into account the cost of investments in countermeasures at the 3rd step mentioned below.

3) Countermeasures at the 3rd step

Replacement of water tube boilers can be recommended as one of devices for modernizing facilities and equipments. The efficiency of the boilers is estimated to be less than 60%, considering over-load operation, type and date of manufacturing of them. The over-load operation should be avoided particularly in terms of safety.

b) Production line

Soluble tank, evaporator, and crystallizer are main users of steam in sugar factories. Consumption of heat energy per ton of crude sugar is estimated to be 382 1 of heavy fuel oil equivalent in this factory, which can be compared with 130-140 1 depending upon refining methods in Japan.

1) Countermeasures at the 1st step

* Preventing molasses and others from leakage
* Leveling off of crystallizer load

  Steam utilization in the crystallizer varies substantially to influence heavily boiler load mentioned above. Improving the operation of the crystallizer can bring good results.
* Reducing exhaust vapor from crystallizer

  Heat energy of exhaust vapor from crystallizer is equivalent to about half of total heat energy consumption in sugar factories. Generation of the exhaust vapor can be reduced by improved operation of reducing feed water to crystallizer.

2) Countermeasures at the 2nd step

As a large volume of hot water is used in sugar factories, the installation of heat exchanger for heat recovery from the exhaust vapor of crystallizer is effective for supplying hot water to be used.

3.1.3 Countermeasures (Devices) on Electricity Consumption

(i) Outline of Electricity Consumption

Main users of electricity in this factory are centrifugal separators, mixing machines, and vacuum pumps. Power loads of these facilities are as follows.

centrifugal separator:	720 kW (90 kW *8)
mixing machine:	100 kW (5 kW *20)
vacuum pump:	56 kW+47 kW

1,100 - 1,500 kW of electric power is supplied from the national grid, and 800 kW from auto generation plants. Annual electricity consumption is reported to be 9,196 MWh.

If the figure of 42,000 tons is used as annual production of sugar, electricity consumption per ton of sugar is calculated to be 301 kWh, which can be compared with 100 kWh in Japan.

(ii) Countermeasures to be Considered

a) Countermeasures at the 1st step

* Strengthening the management of maintenance and operation (the same as those in iron and steel)

b) Countermeasures at the 2nd step

* Managing peak load (the same as those in iron and steel)
* Controlling the volume of air flow and water flow by introducing invertor system
* Revising the capacity of motors to correspond to load in order to improve power factor

3.2 Haft Tappeh Cane Sugar Co.

3.2.1 Outline of the factory

The factory is located at 80 km in the north-northwest of Ahwaz and has an about 10,000 -hectare plantation of sugar canes. It is a crude sugar production-sugar refining factory and adjacent to it is a paper mill using bagasse as a raw material, to constitute a consistent complex as a whole. (The factory survey was conducted only for the crude sugar production-sugar refining factory.)

The factory is operated in a period from November 1 to March 15 only in relation with the harvest season of sugar canes.

3.2.2 Present situation of the factory and energy saving indicators

The present situation of the factory and energy saving indicators are shown in Table 3.3

Table 3.3 Present situation of the factory and indicators concerned

1 Factory	
Total Capacity	1,000 × 10^3 Suger Cane-t/Y
Raw Suger Plant	120 × 10^3 product-t/Y
Refined Suger Plant	100 × 10^3 product-t/Y
Crushing Capacity	1,000 t/d
Mill Capacity (total)	5,000 (Terbine Driven × 6 unit) t/d
Boiler	68 t/h × 2 unit, 200 t/h × 1 unit
Terbine-Generater	3.15 MW × 2 unit
Giesel-Generater (emergency)	1 MW × 1 unit
Production (1991 actual)	30,753.9 product-t/Y
Name of Product	Raw & Rifine Suger
Operating Hour	100 × 8 = 800 h/Y
No of Employee	5,000 persons
No of Engineer	~ persons
2 Energy Consumption (1992)	
Heavy Fuel Oil	6,541.285 l/Y
Electricity	~ kWH/Y
3 Specific Energy Consumption	
Heavy Fuel Oil	212.7 l/p-t
Electricity	~ kWH/p-t

Note: The value of mark (~) are filed by the report after given by the factory.

3.2.3 Energy saving measures

The sugar factory is a crude sugar production-sugar refining factory with a plantation of sugar canes as described above. We have no such factory in Japan.

The sugar refining industry in Japan is high in the degree of refining and must produce various kinds in respectively small quantities to meet the market structure peculiar to Japan. So, the specific energy consumption is said to be relatively high. For reference, the national average specific energy consumption rates of the sugar refining industry in FY 1990 in Japan are shown below.

- Specific fuel consumption (in terms of crude oil) 102.3 l/RS-t
- Specific electric power consumption 102.8 kWH/RS-t

Especially the steam consumption in the crude sugar process heavily depends on the sugar content of sugar canes. According to our survey, the annual mean rainfall in the plantation is 250 to 3 00 mm, and the sugar canes are 32 to 33% in the mean sugar content and 52 to 54% in water content.

(i) Energy saving measures in the 1st step

The energy saving measures in the 1st step are recommended to be taken by intensifying equipment maintenance and improving operation, and are desired to be sufficiently taken since little investment is required.

a) Boilers, generators, etc.

A sugar factory uses much low pressure steam for both crude sugar production and refining. So, it is often practiced to install turbine driven mills and turbine generators, for using the waste steam as a heat source for concentrators, crystallizers, etc.

The energy flow of this factory is also the same. The major particulars of the boilers and turbines are shown in Table 3.3. Steam is discharged from the boilers by 31 kg/cm^2 at 385°C, and from the turbines by 1.7 kg/cm^2.

The fuel of the boilers is being converted from fuel oil to natural gas based on the request of the government due to unstable supply of fuel oil.

Major energy saving measures in the first stage for the boilers and turbines are enumerated below.

1) Low oxygen operation of boilers (decrease of loss due to exhaust gas by lowering excess air ratio)
2) More perfect heat insulation of steam pipes, hot ducts, etc.
3) Prevention of leak of steam and hot condensate
4) Leveling of boiler loads (reduction of crystallizer loads, cycle adjustment)
5) Maintenance of meters, and more intensive numerical control

b) Production equipment

1) Prevention of scattering and leak of raw materials and intermediate products

2) Leveling of crystallizer loads (reduction of crystallizer loads, cycle adjustment)

3) Decrease of feed water to crystallizers (decrease of evaporated water)

(ii) Energy saving measures in the 2nd step

a) Boilers, generators, etc.

The following energy saving measures require the improvement of equipment for recovery of waste heat of boilers, etc.

1) Heat recovery from exhaust gas of boilers, for preheating combustion air, and installation of process hot water making equipment

2) More perfect recovery of condensate from steam-using apparatuses such as evaporators and crystallizers

3) Installation of energy control and measuring instruments

b) Production equipment

1) Hot water and heat recovery from crystallizers

The crystallizers discharge a large quantity of about 65°C steam due to the evaporation of water from molasses. On the other hand, a large quantity of hot water is used for washing containers, floor, etc. So, the recovery of hot water and heat from the steam evaporated from the crystallizers is effective, and also contributes to the load reduction of vacuum pumps.

2) Utilization of CO2 gas in the exhaust gas of boilers

At present, a lime kiln is installed in the crude sugar cleaning process, and the coke used as the fuel for it is supplied from Isfahan Iron & Steel Complex. If the CO2 gas in the exhaust gas from the boilers in the crude sugar cleaning process is utilized, the kiln is not required. In Japan, no lime kiln is used.

c) Electric equipment

It is recommended to control the rotational speeds of the blowers of boilers, etc. and water supply and drainage pumps, for reducing the electric energy consumption.

(iii) Energy saving measures in the 3rd and 4th steps

This factory is one of agricultural product processing factories and is inevitably operated for a seasonally limited period, as described before. So, the factory operation rate is low and the energy saving effect and factory profitability are poor. Apart from the field production in a crude sugar factory, refining factories can be integrated to raise the operation rate of the refining process. This problem is recommended to be examined comprehensively together with the modernization of Varamin Sugar Refining Factory reported in 3.1.

In Iran, there exist the following factories concerned with sugar.

- 39 beet factories
- 2 cane factories
- 2 refining factories

It is planned to construct seven 100,000-ton factories (including plantations) by the end of 199 6. (At present, 50% of domestic consumption is covered by domestic production, while the balance of 50% is covered by import.)

For rationalization of the crude sugar factory, it is recommended to consider the construction of a food processing factory as an annex, and many other measures.

4. Iron & Steel

4.1 Isfahan Iron & Steel Complex

4.1.1 Introduction

The iron and steel complex of Isfahan Steel Company is located at Dashte - Tabas, 45 km south of Isfahan city. The construction of the complex was started after a contract between Iran and former USSR was signed on January 13,1966, and No. 1 blast furnace, which has the production capacity of 600,000 tons of crude steel, was constructed by 1969. Additional construction works were made from 1974 to 1992 to reach the production capacity of crude steel of 1.9 million tons. The modernization and expansion of the complex has been planned, in which the production capacity of crude steel will be increased to 2.5 million tons, 3.7 million tons, and 5.0 million tons as the first, second, and third step respectively.

As can be seen in Fig. 4.1, facilities including sintering plant, coke oven, blast furnace, basic oxygen furnace, continuous casting unit, hot rolling mill are installed in the complex, which is only one iron & steel complex installed with blast furnace in this country.

4.1.2 Countermeasures (Devices) on Heat Consumption

(i) Outline of Heat Consumption

Indicators for considering countermeasures for promoting energy conservation in this complex including capacity, production, energy consumption and others are shown in Table 4.1. The outline of facilities visited by Japanese experts are as follows.

a) Coke oven

No. 1 coke oven, which has the capacity of 500,000 ton per annum (58 cells), and No. 2, which has the capacity of 600,000 ton per annum (72 cells), are operated at the cell cycle 20 m/∞ Both of them are heated directly by coke oven gas (COG) and wet quenching method is adopted. 1.3 million tons of coking coal, around half of which is imported from foreign countries including Australia, are used in the coke ovens. Expansion of capacity through replacing the existing equipments is being considered. The temperature air and exhaust gas is as follows.

Heated air	800 - 900℃
Exhaust gas (at the outlet of coke oven)	850℃
Exhaust gas (at the outlet of cooler)	75℃

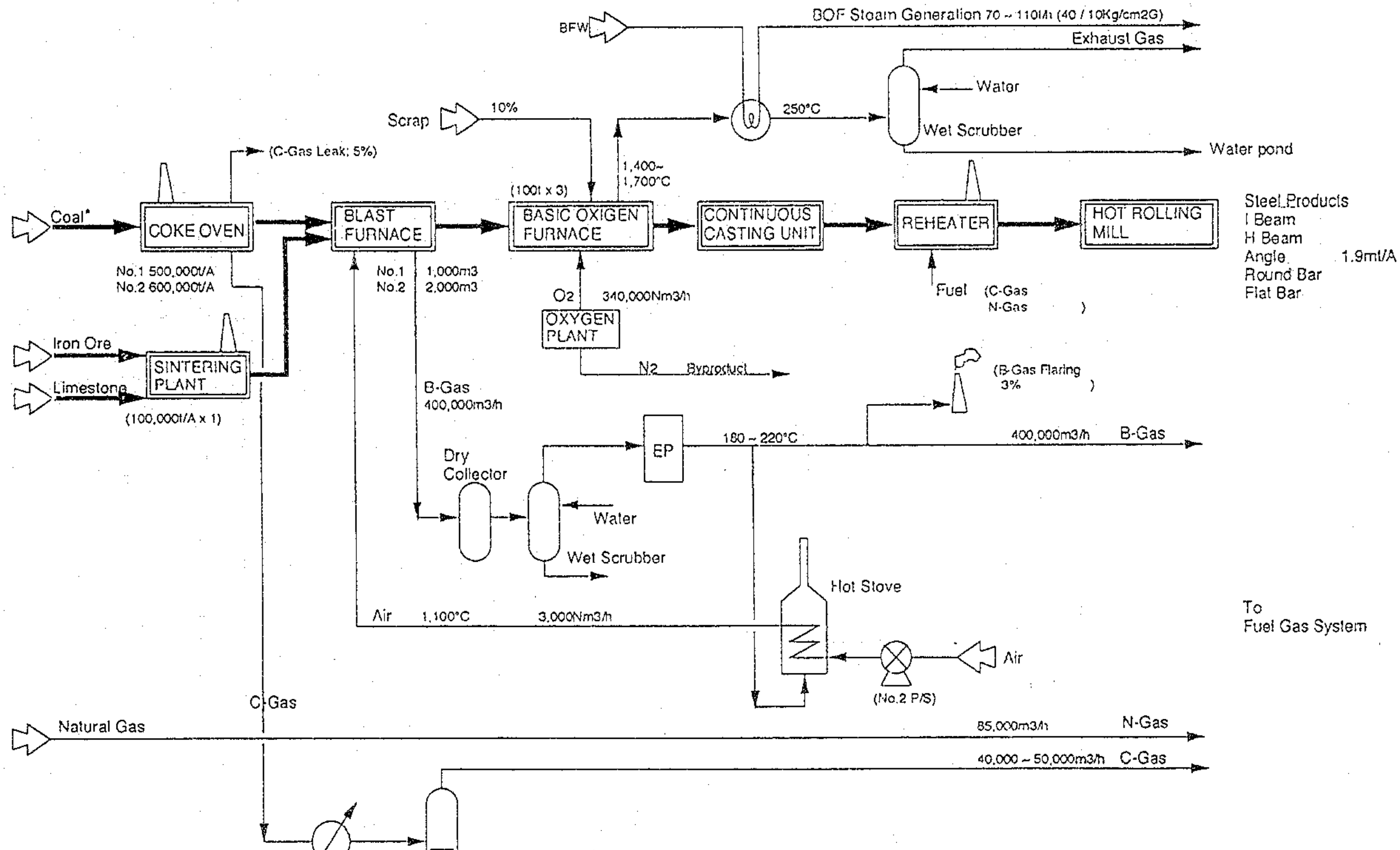
b) Blast furnace

No. 1 blast furnace, which has the capacity of 1,033 m^3, and No. 2, which has the capacity of 2,000 m^3, are installed in this complex with the total production of pig iron being 2,050,000 tons per annum. Fig. 4.2 shows the energy flow and other indicators of operation at No. 2 blast furnace which Japanese experts visited.

c) Basic oxygen furnace

Three units of basic oxygen furnace, which has the capacity of 100 tons for each, are installed.

Fig. 4.1 Energy Flow in Isfahan Steel Mill



Power Consumption 130 ~ 135MW

Power Station No.1 24MW(Generation)
No.2 110MW(Generation)

Steam Generation No.1 140t/h(40Kg/cm2G)
15t/h to Factory at 10BAR and
10t/h Recovery by Condensate
No.2 440t/h(100Kg/cm2G)

Fuel Consumption(m3/h)	
N-Gas	16,000
C-Gas	6,000
B-Gas	190,000

Solvent	330t/A
B.T.X.	7,865
Benzole	9,093
Phenole	390
H2SO4	4,700
(NH4)2SO4	16,200
Tar	57,870

* Energy Balance
Coal 85%
N-Gas 15%

Table 4.1 Outline of Operation and Energy Consumption in Isfahan Steel Mill

1 Factory		
Total capacity(based on hot metal)	1,900	kt / Y
Production(based on hot metal)	2,100	kt / Y
Operating hour	365 x 24	h / Y
Operating ratio	110.5	%
Pig iron	2,050	kt / Y
Crude steel	2,200	kt / Y
Steel products	~	kt / Y
Annual sales amount	~	IR / Y
2 Index for energy consumption		
Energy consumption rate (based on steel product ton)	9	Gcal / t
Coal consumption rate (based on hot metal ton)	~	Gcal / t
N-gas consumption rate (based on hot metal ton)	~	Gcal / t
3 Energy consumption		
(1) Coal consumption	1,300~1,500	kt / Y
(2) N-gas consumption	100,000	Nm3 / Y
4 Energy cost		
(1) Coal	~	IR / t
(2) N-gas	~	IR / Nm3
5 Cost of commercial electricity		
(1) for sale (mean)	7.5	IR / kwh
(2) for buying (mean)	"	IR / kwh
6 Generated gas consumption		
(1) COG	40~50,000	Nm3 / h
(2) BFG	400,000	Nm3 / h
7 Lower calorific value		
(1) Coal		
(2) N-gas	9,500	kcal / Nm3
(3) COG	4,000	kcal / Nm3
(4) BFG	900~1,000	kcal / Nm3
8 Energy consumption by each process (equivalent value / crude steel ton)		
(1) Coal	~	~ / t
(2) N-gas	~	~ / t
(3) COG	~	~ / t
(4) BFG	~	~ / t
9 Treatment for slag		
(1) Sand wool	5	%
(2) Slag aggregate	80	%
(3) Others	15	%

NOTE : ~ indicates that figures will be filled later.

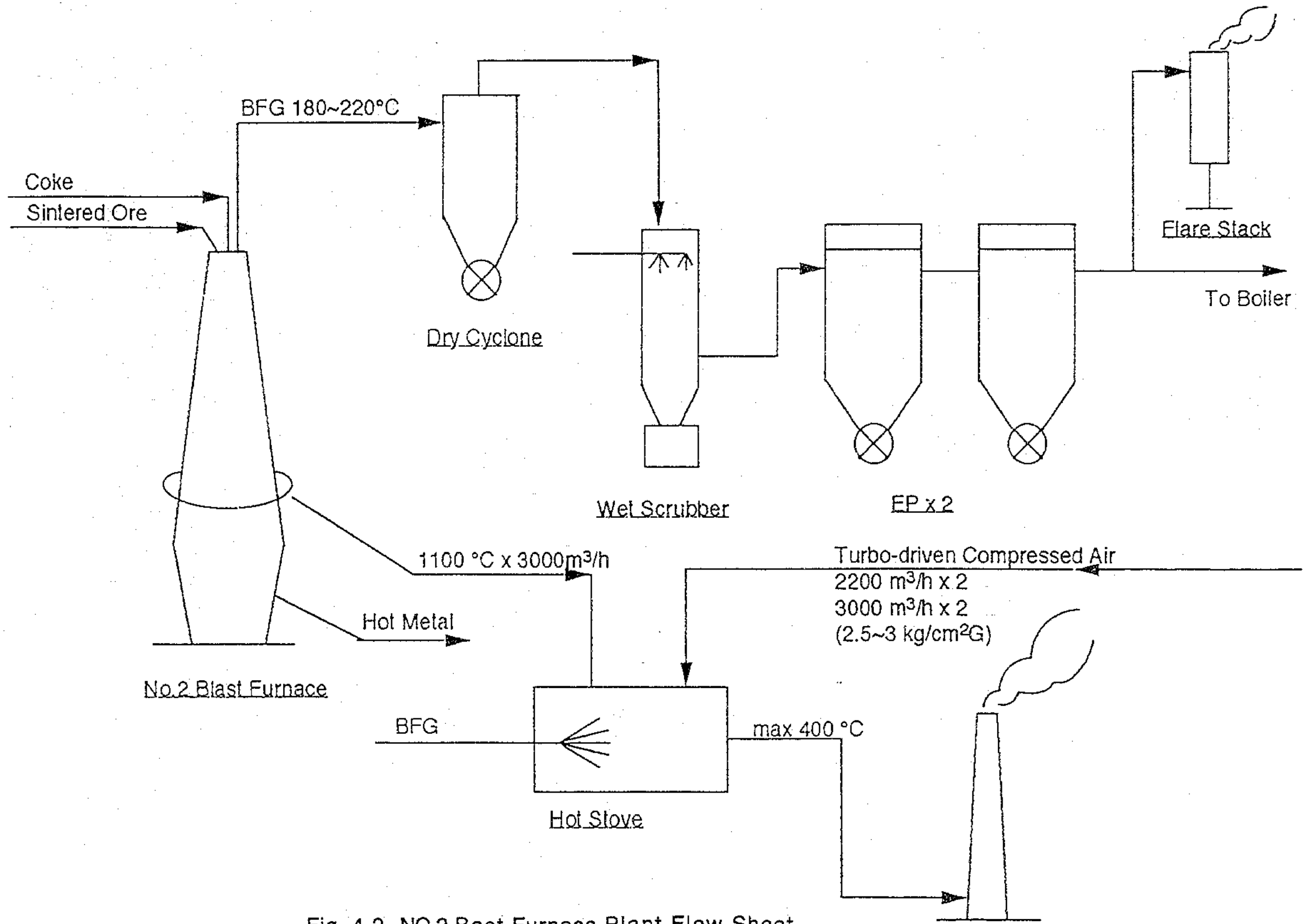


Fig. 4.2 NO.2 Bast Furnace Plant Flow Sheet

The flow of exhaust gases and other indicators at the furnaces are shown in Fig. 4.3. The capacity expansion to 130 tons for each unit is being planned.

d) Power plant for own use

Demand for electricity in this complex is usually fully supplied by two power plants constructed for own use, one (No. 1) of which has the capacity of 24 MW and another (No. 2) 115 MW. There are two units of turbines in No. 2 power plant which was visited by Japanese experts (Fig. 4.4), and the extract steam of one unit (No. 3....4 stage extract steam condensate turbine) is confirmed to be used for heating water and as the heat source of heat exchanger for heating the complexes' building (8 kg/cm^2 G x 110℃). Another unit (No. 4....3 stage extract steam condensate turbine) is not supplying its extract steam for utilization for un-identified reasons.

Three boilers are installed in No. 2 plant, mixed - firing natural gas (NG), blast furnace gas (BFG), and COG.

(ii) Countermeasures to be Considered

As mentioned above, this complex has been planning to modernize and rationalize its facilities as well as to expand its production capacity. As details on its planning could not be confirmed during Japanese experts' visit there, recommendations on countermeasures or devices for promoting energy conservation are made in this report without taking into account the planned modernization and rationalization. Some of our recommendations might have been already adopted or implemented by the management.

The present energy consumption per ton of steel products in this complex, however, is reported to be around 9 Gcal, which can be compared with 5.7 Gcal in Japan, showing that there is much room for this complex to save energy in future.

a) Countermeasures at the 1st step

Strengthening the management of maintenance and operation of individual facilities is the countermeasure at the 1st step as mentioned earlier. Individual effects of such countermeasures are not so great, but a large amount of effect can be accumulated in total. In other words, such a kind of devices leads to "the elimination of wastes." Following devices can be recommended as those at the 1st step.

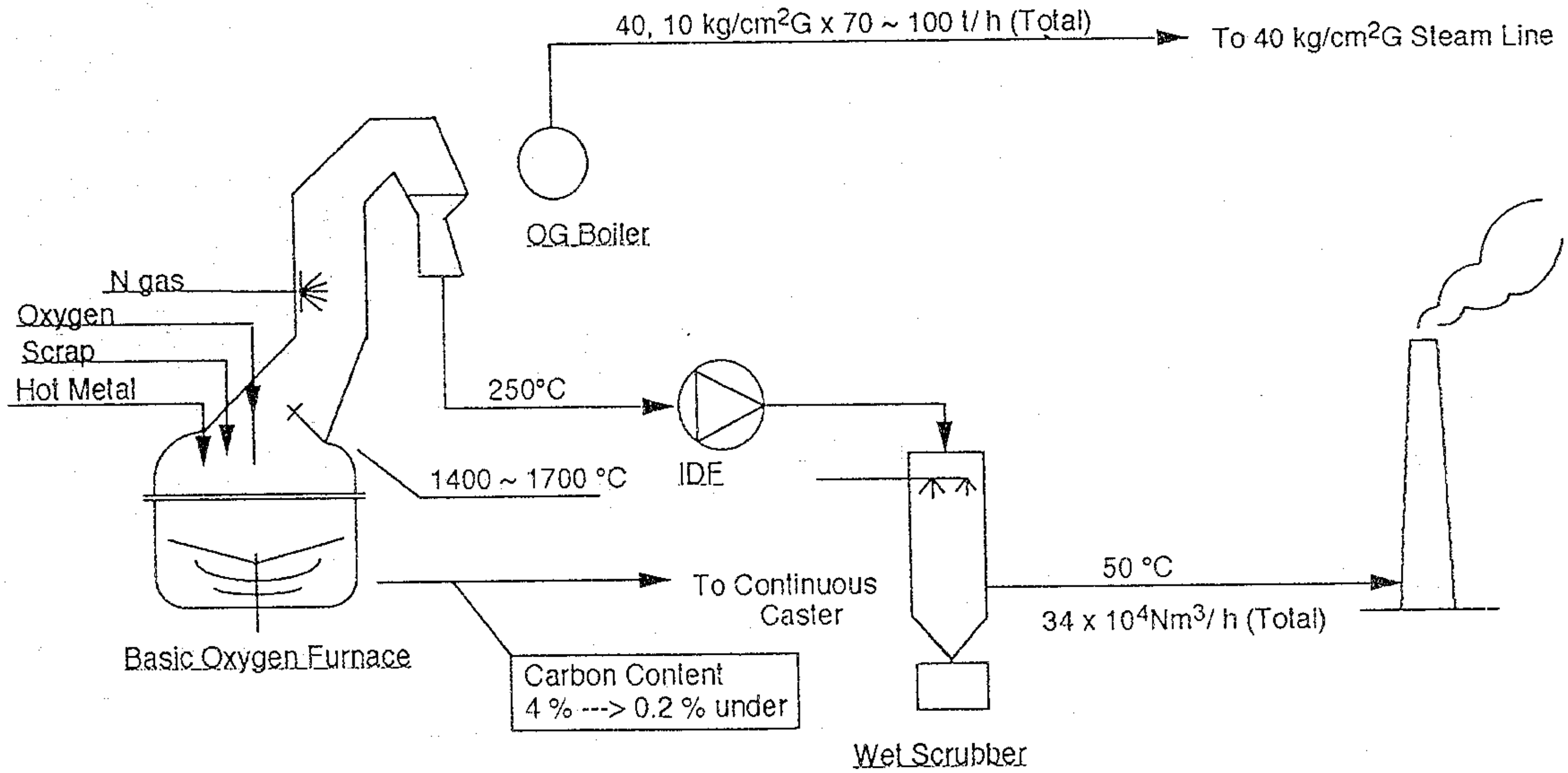


Fig. 4.3 Basic Oxygen Plant Flow-Sheet

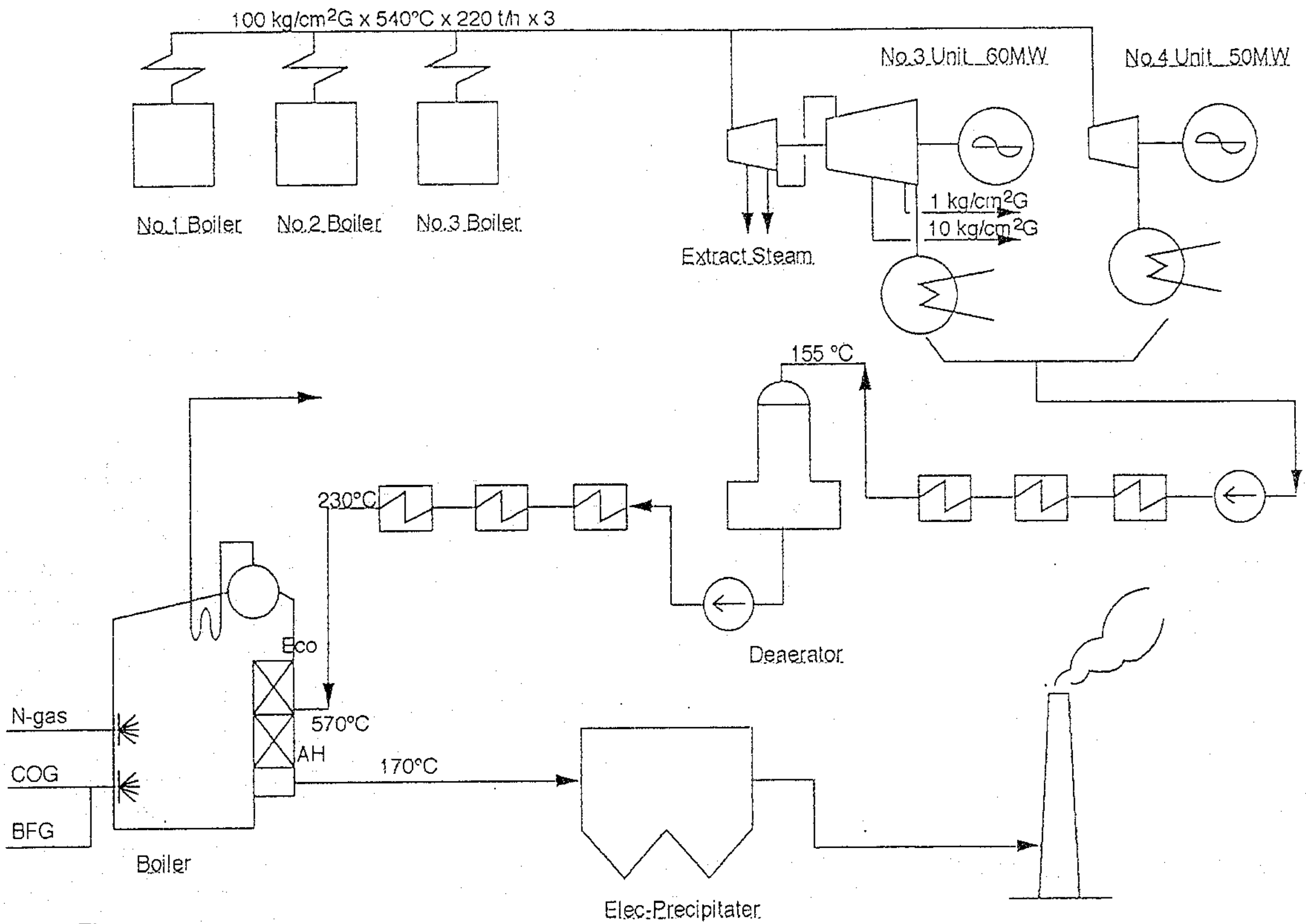


Fig. 4.4 NO.2 Boiler Plant Flow-Sheet

* Rehabilitation of furnaces and boilers for insulation and the prevention of cool air from entering.
* Rehabilitation of pipes and dusts for insulation and for the prevention of steam, high - temperature gas and air from leakage.
* Management of fuel and combustion in furnaces and boilers.

In order to accelerate these devices, the executives and employees are requested to have the consciousness of participating in the campaign for such acceleration.

b) Countermeasures at the 2nd step

Total amount of energy emitted from iron and steel works as the forms of exhaust gas, exhaust hot water and the sensible heat of intermediate products and others are estimated to account for around 40% of energy consumed in the works. The effective utilization of the exhaust energy is very important not only for reducing costs but also for accelerating environmental protection measures including those in the global point of view.

1) For iron-making process

Since energy consumption in iron-making process accounts for around 60% of total energy consumption in iron and steel works, countermeasures for the process is especially important for promoting energy saving. Adopting following devices in order can be recommended if references are made to the experience of rationalization in Japan.

* Strengthening the making of the grains of iron ore and coke uniform.
* Hi-pressure operation of blast furnace(Pressure at the top of blast furnace is 1 kg/cm^2 G).
* Expansion of the scale of blast furnace
* Operation of blast furnace in de-humidity of air injected.
* Installation of TPT (top - pressure recovery turbine) at blast furnace.
* Installation of CDQ (coke dry quenching) at coke oven.

2) For steel - making process

The energy of exhaust gas from basic oxygen furnace is the biggest of energies exhausted from this process. This works has already adopted OG (oxygen gas) method to recover the heat of the exhaust gas, but the amount recovered could not be confirmed by Japanese experts. In Japan the enhanced recovery of OG has been intended through improving the skirt of basic oxygen furnace.

3) Improving measuring systems to increase measured items

Investments in facilities and equipments mentioned in 1. and 2. above should be effective in terms of getting return mainly because of high costs. And in order to assess the investments being effective, it is indispensable to grasp detailed and accurate data and to analyze them to evaluate the effect of the investments. In this regard, it seems to Japanese experts that this works should be much better equipped with measuring systems to collect a great number of detailed and precise data.

c) Countermeasures at the 3rd step

Adopting continuous caster and hot direct rolling contributes substantially to increasing yield and rationalizing production facilities. Lossess in the sensible heat of intermediate products and solids is the largest of losses in exhaust heat in the integrated iron and steel works, and it is reported that the lossess accounts for around 18% of total energy consumption in the works in Japan. To introduce continuous casting and other devices is very effective for energy conservation in the steel works as one of measures reducing the lossess in the sensible heat. It is supposed that the yields of steel products in this works, which has already installed continuous casters, is higher than other works which still installs ingot making process,although specific figures on yields were not obtained during our visit.

d) Power plants for own use

Since two power plants are supplying all power load in this works, the stable supply of power from these plants should be considered seriously. The power plants are reported to have continued their operation at the load factor of more than 100%. Supposing such situations, following suggestions can be made for No. 2 power plant which was visited by Japanese experts.

1) Countermeasures at the 1st step

* Usual operation of gas turbine generators

Operating power plants at the maximum efficiency at the endof generation results in the largest effect of energy conservation in the plants. Some measures should be adopted for reducing high load at present, and the usual operation of generators (2 units of 27 MW gas turbine generator) installed as emergency use are supposed to be one of realistic solutions in which power plants in the iron and steel works will operate at the maximum efficiency.

* Utilization of extract steam of turbine

As mentioned earlier, the extract steam of No. 4 turbine is not utilized at present for un-identified reasons. The utilization of the extract steam can be recommended to increase the efficiency of Rankin cycle.

* Enhancing the degree of vacuum of condenser

The degree of vacuum of condenser has been reduced for unidentified reasons. Operating value was 0.76 kg/cm^2 abs. at No. 3 turbine, which could be compared with designed value (0.04 kg/cm^2 abs. at No. 3 turbine; 0.035 kg/cm^2 abs. at No. 4 turbine). To investigate the reasons why the degree of vacuum has decreased can be recommended for enhancing the efficiency at the end of generation.

2) Countermeasures at the 2nd step

It is supposed that the reduced capability of air cooling tower has caused the reduced degree of vacuum of condenser. If it is the case, increasing the capacity of air cooling tower and improving method of cooling water of condenser will need to be considered and implemented.

4.1.3 Countermeasures (Devices) on Electricity Consumption

(i) Outline of Electricity Consumption

a) Power generation

This steel works installs two power plants, which are supplying almost all electricity used inside it in recent years. BFG, COG and NG are used as fuels for power generation. The outline of the plants is shown below.

Frequency:	50 Hz
Voltage:	63 kv (No. 1)
	230 kv (No. 2)
Capacity:	24 MW (No. 1)
	115 MW (No. 2)

Surplus of generated electricity can be sold to the national grid although the sold volume has been negligible since 1991. The price of selling and buying electricity is 7.5 IR/KWh, and the contracted volume of electricity bought from the national grid is 70 MW.

b) Power utilization

Annual consumption of electric power is reported about 1,161,000 MWh, the largest part of which is used in oxygen plants (45MW). Six oxygen plants generate 340, 000 m^3 of oxygen per hour. The load factor of the works is very high (about 97%) and its power factor more than 80%. If we use the figure of 2.2 million tons as an annual crude steel production, we can get the figure of 527 KWh per ton as a unit consumption of electricity, which can be compared with 450-480 KWh in Japan.

(ii) Countermeasures to be Considered

a) Countermeasures at the 1st step

1) Strengthening the management of maintenance and operation

- * Electrical equipments and machines should be operated at a proper load because of lower efficiency of conversion from electric power to motive power at lower load.
- * The voltage of power sources should be maintained at an appropriate level.
- * Lack of lubricant in machines, looseness in belts, etc, should be avoided.

2) Installing more efficient lamps in hot rolling mills

Converting mercury lamps to sodium lamps in hot rolling mills are estimated to total to 40% saving of electricity.

b) Countermeasures at the 2nd step

1) Managing peak load to improve power factor to more than 90% in each shop by introducing measuring systems.

2) Controlling the volume of air flow and water flow by introducing inventer system.

3) Effective utilization of nitrogen generated at oxygen plant

As mentioned above, electricity consumption of oxygen plant is the largest in this works. In this plant, electricity is also consumed for generating nitrogen, the volume of which is four-fold of oxygen generated there and is not utilized at all. Nitrogen can be utilized for cooling, preventing oxidization and others.

4.2 Ahwaz Steel Co.

4.2.1 Outline of the complex

Ahwaz Steel Co. adopts a direct reduction steel making process, like Mobarakeh Steel Co. which started operation in 1992, and is one of three major steel complexes belonging to NISCO (National Iranian Steel Company) under the control of the Ministry of Metals and Mines, and Isfahan Iron & Steel Complex reported in PR1 is another of the three complexes.

This complex began to be constructed before the 1979 revolution with Swindell Dressler, USA as a consultant, and the construction was suspended by the Iran-Iraq war. In February, 1989, the construction was completed independently by the complex alone, to start production. The outline of the present facilities is shown in Fig. 4.5.

Iron ores and coal for coke making are imported from Brazil, India, Australia, etc. and transported by freight car from Bandar Imam Khomeini port.

The production of blooms and slabs (no mill line) planned to be achieved in FY 1992 (Iranian fiscal year from March 21 to March 20; hereinafter this applies) is 800,000 tons, and that in 1993, 1,0 00,000 tons.

At present, the products are supplied to nearby Kaavian Steel Co., Nasr Steel Co., etc., and because of deficiency in the mill capacity of INSIG (Iran National Steel Industry Group), semi-finished products are exported to China and Germany.

4.2.2 Present situation of the factory and energy saving indicators

The present situation of the factory and energy saving indicators are shown in Table 4.2.

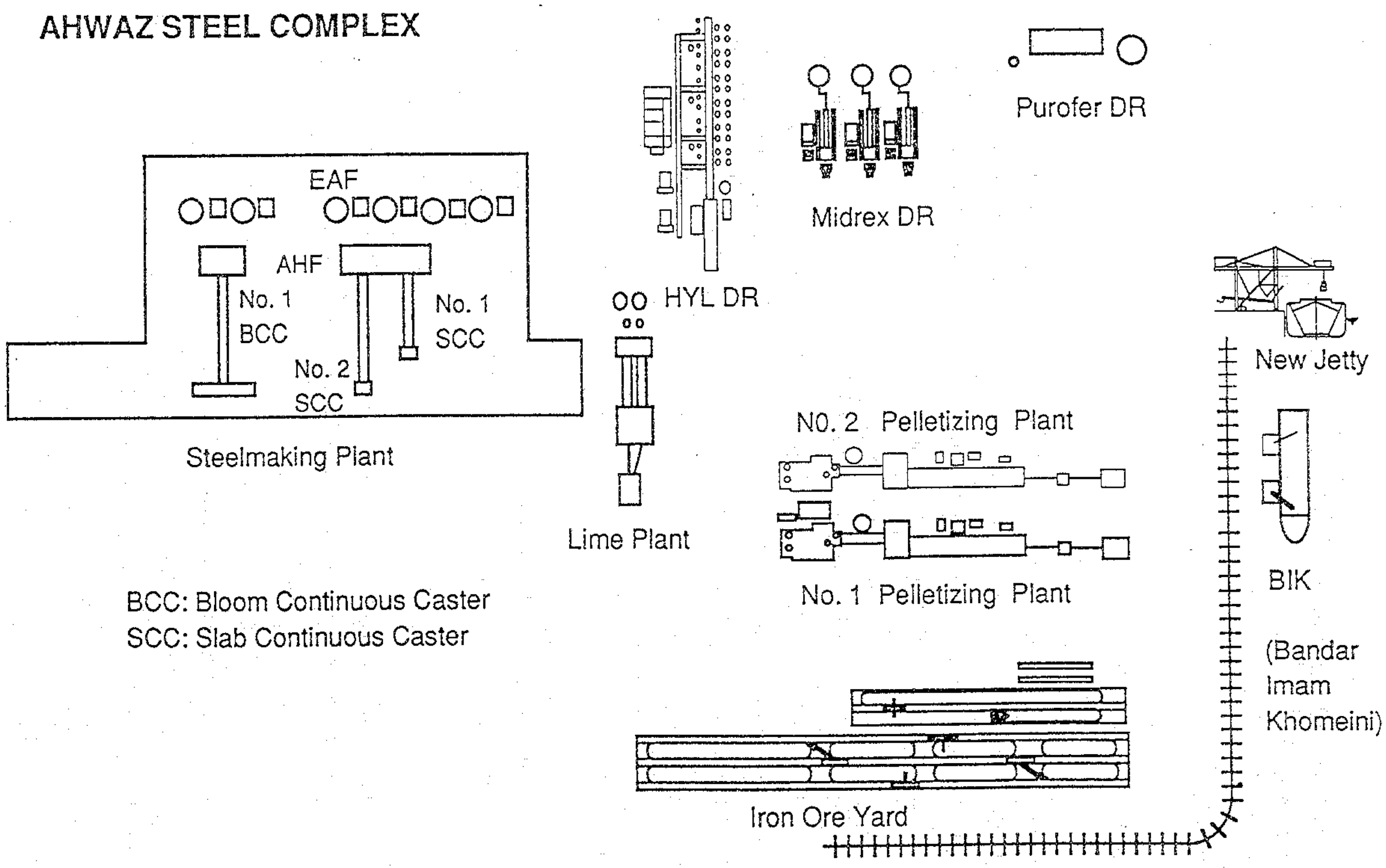


Fig. 4.5 Plant outline of Ahwarz Steel Complex (1)

Table 4.2 Present situation of the factory and energy saving indicators

1 Factory	
Total Capacity	1,500 × 10^3 t/Y
Pellet Plant	2,500 × 10^3 pellet-t/Y × 2 plant
DR Plant (PUROFER)	330 × 10^3 pellet-t/Y × 1 plant
(MIDREX)	400 × 10^3 pellet-t/Y × 3 plant
(HYL)	1,000 × 10^3 (3 plant total (U/C))
Continuous Casting	1,500 × 10^3 product-t/Y (3 plant total)
Electric Ark Furnace	1,600 × 10^3 product-t/Y (6 plant total)
Production	804,752 t/Y (1992)
Name of Product	Bloom, Slab
Operating Hour	24 × 11 × 30 ≒ 8,000 h/Y
No of Employee	5,000 P
No of Engineer	≒ 300 P
2 Energy Consumption (1992)	
Natural Gas	286,164,728 Nm^3/Y
Electricity	872,600 MWH/Y
3 Specific Energy Consumption	
Natural Gas	3.34 Gcal/t
Electricity	1,084 kWH/t

4.2.3 Energy saving measures

The steel making plant of the complex adopts a direct reducing furnace-electric furnace process as described above, and since the process is not adopted for commercial operation in Japan, it is difficult to compare the specific energy consumption. Compared to the specific energy consumption of a typical direct reducing furnace-electric furnace process shown in Table 4.3, the specific energy consumption of natural gas is somewhat lower, and that of electricity is higher.

Table 4.3 Specific energy consumption of typical DR steel making plant

	DR Plant	Electric Ark Furnace	Continuous Caster	Total
Yield (%)		90	95	
DRI Mixing Ratio (%)		85		
Specific Energy Consumption				
Natural Gas (Gcal/t)	2.85	0.47	0.47	3.79
Electricity (kWH/t)	130	700	20	850

(i) Energy saving measures in the 1st step

The energy saving measures by way of intensified equipment maintenance and improved operation are small in the effect of each measure, but their cumulative effect is large as a feature of these measures. Typical measures are enumerated below.

a) Repair of furnace walls to ensure more perfect heat insulation, and prevention of ingress of cold air into furnaces
b) Repair of pipes of hot gas, hot air, steam, etc. to ensure more perfect heat insulation, and prevention of leak
c) More intensive fuel and combustion control of respective furnaces
d) Prevention of scattering of raw materials and intermediate products
e) Repair of meters and more intensive numerical control

(ii) Energy saving measures in the 2nd step

a) DR plant

A typical energy balance of the field-surveyed Midrex plant is shown in Fig. 4.6. As can be seen from the drawing, large heat loss includes the sensible heat loss of DRI (70.8%), loss due to exhaust gas of top gas (9.6%) and loss due to exhaust gas of combustion gas (9.2%). These waste heat losses amount to 89.6%.

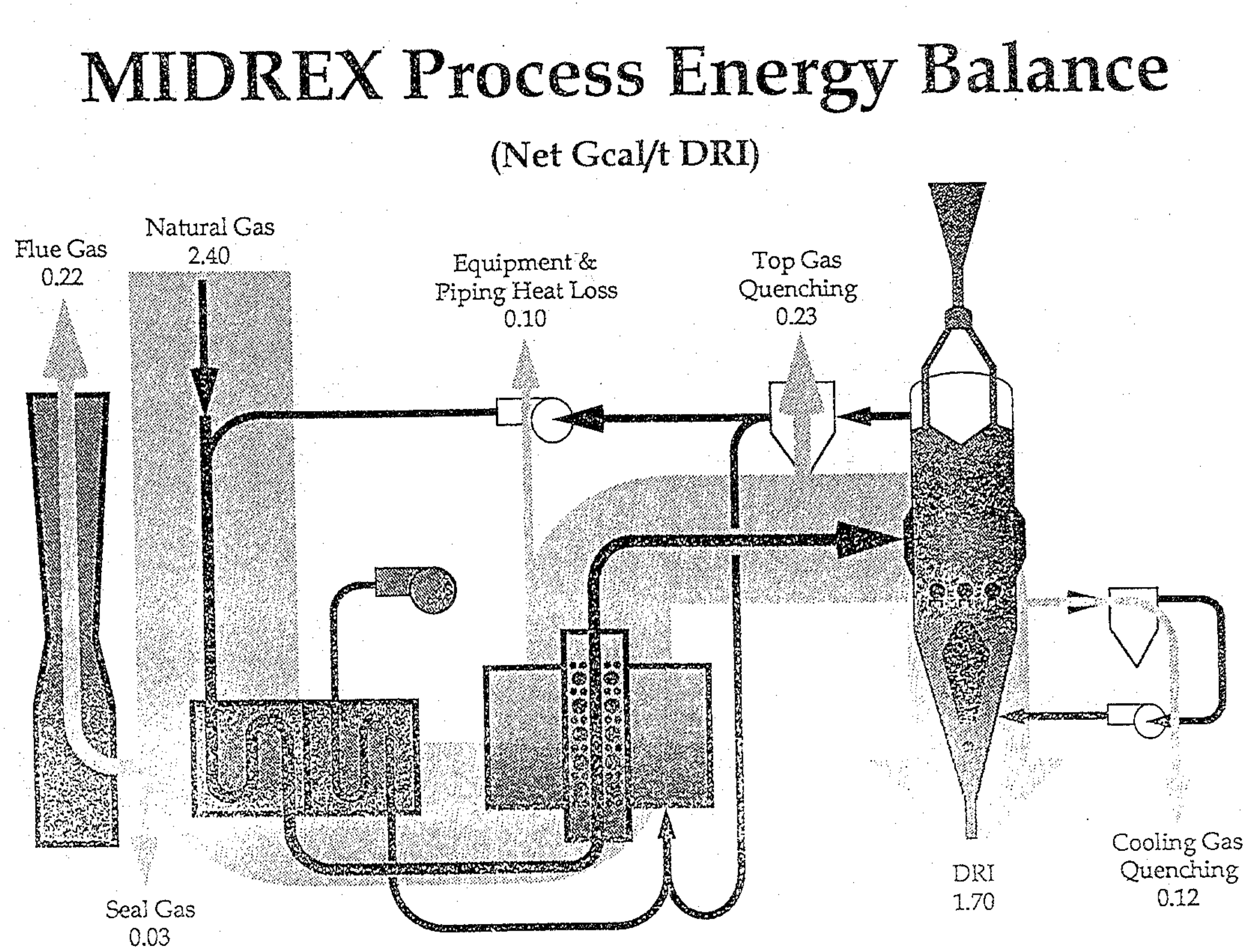


Fig. 4.6 Energy ballance of Midrex Plant (2)

It can be understood that the waste heat must be recovered more perfectly.

b) Electric furnaces

The electric furnaces of this complex are relatively large in capacity, and are relatively modernized, being provided with continuous casters, Flicker compensator system and preheating equipment by natural gas. The consumption in FY 1992 was 710.8 kWH per ton of molten steel.

Simple comparison with the consumption by electric furnaces in Japan cannot be made, since scraps are used as the raw material in Japan. Anyway, the specific electric energy consumption in the Japanese electric furnace steel making industry in 1990 was 515 kWH per ton of products as a mean of the whole country, and the lowest consumption reported was 340 kWH per ton of products.

Among the improvement measures taken for lessening the energy consumption in Japan, typical energy saving measures surmised to be effective for equipment improvement and waste heat recovery in the electric furnaces of the complex are enumerated below.

1) Oxygen enriching equipment
2) Preheating of scraps by the exhaust gas of electric furnaces
3) Adoption of water-cooled furnace walls (adoption rate in Japan: more than 75%)
4) More perfect sealing at the openings of preheating furnaces and electric furnaces

Most of these measures greatly contribute to not only energy saving, but also to dissolution speedup, quality improvement and productivity enhancement.

c) Electric equipment

The iron industry uses large-capacity blowers and pumps. If their rotational speeds are controlled, the consumption of electric energy can be very effectively decreased.

(iii) Energy saving measures in the 3rd and 4th steps

a) DR plants

The sensible heat loss of DRI at DSR plants is very large, as described above. It is recommended to examine the direct supply of DRI into the electric furnaces since it is one of very effective measures.

b) Mills

The complex does not have any mill as described above. The installation of mills can make substantially a consistent steel making factory. This should be studied preferentially from a comprehensive viewpoint of increasing the production capacity of rolled steels, reducing the transport cost, etc. This will of course greatly contribute to production enhancement and quality improvement, with a resultant large contribution to energy saving.

c) Electric power supply

The electric power supply to the complex is being improved recently, but the shortage of power supply in the summer peak season compels them to curtail their operation. In addition to existing two 2.5 kVA diesel generators, they are installing additional two 2.5 MW gas turbine generators in preparation for service interruption. Electric power plants are being constructed one after another for ensuring stable power supply which is a problem to be solved before talking about energy saving measures.

d) Utilization of scraps

The utilization of scraps as a raw material for the electric furnaces is very low. The establishment of a scrap recovery system for using more scraps will greatly lower the specific electric energy consumption of the electric furnaces. The raw material for steel making by electric furnaces in Japan is scraps, and their specific energy consumption is as described before. The utilization of scraps is needless to say preferable also in view of the re-utilization of resources. In Japan, the scrap utilization accounts for about 35% in the raw materials of steel making, and the recycling rate of steel cans reaches 50%.

5. Power Station

5.1 Montazer Ghaem Power Station

5.1.1 Introduction

This power station is located in Shahriyar region to the south-west of Tehran. An agreement on installing steam units was concluded in 1967 between Iranian Ministry of Energy and General Electric Company of the U.S.A. No. 1 and No. 2 units of generator were commissioned in 1972 and No. 3

and No. 4 in 1974 (156 MW for each). A gas turbine unit (24 MW) was also constructed. The construction works of 6 gas turbines (116 MW for each) as parts of combined cycle power plants are under way with two of them having already been commissioned. The construction of 6 steam turbines as parts of the plants are planned although no contracts on the construction have been made yet.

This station owned by Tavanir, state-owned electric power generation and transmission company under the Ministry of Energy, is supplying electricity to Tehran area together with four other power stations located in the area. In addition to these power stations, electricity is supplied to Tehran area by other stations including hydro and thermal ones in Esfahan, Tabriz and other places.

Table 5.1 shows the outline of operation in this power station.

5.1.2 Countermeasures (Devices) on Heat Consumption

(i) Outline of Heat Consumption

Indicators for considering countermeasures for promoting energy conservation in this power station are shown in Table 5.2.

(ii) Countermeasures to be Considered

a) Countermeasures at the 1st step

1) To enhance total heat efficiency

Heat efficiency at the end of generation was reported to be 35 - 36% when Japanese experts visited the station. The efficiency at the end of transmission was not identified, but it was reported that own use of electricity is about 6% for each generator and about 7% for the power station. All of steam pressure at the outlet of boiler heater (1,750 p s i), steam temperature at the same outlet (990℃), and vacuum degree of condenser (23 inch-Hg..... 11.7 inch. Hg-a b s) were observed to be lower than planned ones while figures on heat efficiency at planning stage were not given. And it was explained that the operation of boilers had been conducted at lower pressure and temperature than planned ones because of the water tube of the boilers being corroded, but the cause of decreased degree of vacuum could not be confirmed.

Table 5.1 Outline of Boilers and Generators in Montazer Ghaem Power Station

1 Boiler	
Type	Natural circulating one drum water tube boiler
Maker	CE (USA)
Normal working steam pressure(SH outlet)	1,875 psi
Normal working steam temp'(SH outlet)	1,005 °F
Continious maximum evapolation	1,100,000 lb/h
Reheater steam temperature(RH in/outlet)	688/1,005 °F
Reheater steam flow rate	988,000 lb/h
Air heater air temperature(AH in/outlet)	635/311 °F
Heavy fuel oil	77,800 lb/h
Thermal efficiency (planning)	90.57 %
Feed water treatment	Demineralizer
2 Turbo-generater	
Type	Tandem-compound type 6 stage extract condencing unit
Maker	GE (USA)
Turbine revolution	3,000 rpm
Voltage	15 kv
Output	176.471 mvA
Cycle	50 Hz
Condenser cooling type	Air cooling tower type
Condenser vacume	2.5 inch Hg-abs
Generater cooling type	H_2 gas cooling type

Talle 5.2 Indicators on Energy Consumption in Montazer Gheam Power Station

Total generated power(1991)	3, 643, 966	mwh/Y
Peak lord	≒ 700~750	mw
Mean lord	≒ 500~600	〃
Power consumption for plant	6~7	%
Operating hour	365×24	h/Y
Operating ratio(mean in 1991)	70. 29	%
Total fuel consumption(1991)	857, 000	kl/Y
Heavy fuel oil		
Specific gravity	0. 9641	
Lower calorific value	9, 695	kcal/kg
Fuel cost		

The decreased pressure, temperature, and vacuum degree are considered to have a negative effect on the heat efficiency at the end of generation. To increase them to at least planned levels can be recommended for enhancing the heat efficiency.

Corresponding figures in power stations in Japan, which install around the same scale of generation units and operate in around the same condition of steam, are as follows.

*	Heat efficiency (at the end of generation)	38.15%
*	Heat efficiency (at the end of transmission)	35.74%
*	Own use of electricity	5.70%

2) To control boilers' heat efficiency

Heat efficiency of boilers was reported to be 90%, around the same as that of planning stage. Following devices, however, can be suggested for strengthening the management of maintenance and operation of boilers.

* Control of fuel usage (fuel's temperature in particular)
* Low oxygen combustion for reducing exhaust gas
* Controlling water quality
* Preventing steam, combustion gas and air from leakage
* Controlling the blow of boiler water
* Preventing heat transfer surface from being soiled and corroded

3) Relating to turbine

Soiling of cooling pipe at condenser, decreased capability of ejector and cooling tower, and air leakage are considered to be main causes for the decreased vacuum degree of condenser. Countermeasures for coping with these items should be taken for increasing heat efficiency in this power station.

4) Measuring and monitoring data

It was observed that automatic control and measuring instruments in a monitoring center in the power station were well equipped. Detailed measurements, however, seemed not to be conducted there. In Japan, data including heat efficiency are measured and managed at least to one place of decimals every hour. If heat efficiency drop by 0.1%, increase in fuel consumption will be 309 tons of heavy fuel oil per annum for each unit of boiler and generator in this station. This figure implies that control in power stations should be conducted through utilizing detailed and reliable figures.

b) Countermeasures at the 2nd step

1) Conversion of boiler fuel from heavy fuel oil to natural gas

This power station is planning to convert its fuel from heavy fuel oil to natural gas. Such conversion is important for preventing heating surface from being soiled and corroded as well as for environmental protection.

2) Establishing auxiliary heat surface in boilers

Establishing auxiliary heat surface in boilers will increase boilers' heat efficiency because the dew point of exhaust gas from natural gas is lower than that from heavy fuel oil.

5.1.3 Countermeasures (Devices) on Electricity Consumption

(i) Outline of Electricity Consumption

As mentioned above, own use of electricity is about 6% for each generator and about 7% for the station as a whole. When Japanese experts visited the station, it was observed that 8 MW was used for own use at No. 3 generator the output of which was 80-90 MW. These figures can be compared with 5.7% in Japan.

(ii) Countermeasures to be Considered

Rehabilitation or more efficient operation for reducing own use of electricity (at the 1st step)

6. Oil Refinery

6.1 Tehran Oil Refinery

6.1.1 Introduction

Tehran Oil Refinery, which composes of No. 1 (South) and No. 2 (North) refineries, is located south of Tehran city. The former was constructed in 1967 and the latter in 1974. Total refining capacity is 220,000 b/d at present.

6.1.2 Countermeasures (Devices) on Heat Consumption

(i) Outline of Energy Consumption

Gas and oil are used as fuel for heating furnaces and boilers in this refinery. Fuel gas used here is a mixture of stabilizer off-gas, isomax off-gas, hydrogen off-gas, platformer off-gas, and natural gas which is supplied through national pipeline network when needed.

Fuel oil is a mixture of furfural extract, vacuum residue, visbreaker bottom, waste oil, etc...

It was observed that furnaces in process units and boilers were not installed with any devices such as economizer and air pre-heater for recovering heat from high-temperature exhaust gases.

Accordingly, heat efficiency of many furnaces is estimated to be 60-70%, which can be compared with the appropriate level of more than 80%. In addition, some of furnaces;have not installed any instruments for controlling excess air and the instruments in others are not in services.

Typical examples of exhaust gas temperature are as follows:

No. 1/No. 2 Crude furnace	900 °F
Vacuum furnace	900 °F
Platformer furnace	1,400 °F
Boiler plant	500-700 °F

Demand for electric power is satisfied with supply from auto-generation in this refinery. Exceptionally, a part of generated power there is being supplied to neighboring NIOPDC's deposit for heating tank. No. 1 and No. 2 refineries have a power plant respectively, the generation capacity of which is 21.6 MW (7.2 MW * 3), although an integrated operation of two plants are conducted.

Four units of boilers (320,000 Lb/h for each) are installed in No. 1 refinery and three units (the same as in No. 1) in No. 2.

According to the refineries' record, internal use and loss of energy is 7.2% in terms of crude oil input in January, 1993, in which 5.8% is accounted for by fuel uses and 1.4% by losses. The standard ratio of internal use and loss is estimated 4.5% for the similar type of refinery.

(ii) Countermeasures to be Considered

A committee for energy conservation has already been established for a few years in this refinery, according to the instruction of Refinery Expansion & Development Center of NIOC. 3-4 projects for implementing energy saving are reported to have been at their construction steps and some on application for construction. All of countermeasures mentioned below including setting air pre-heater system might have been seriously considered in the refinery.

a) Countermeasures at the 1st step
   * Rehabilitation of pipes and other parts for insulation
   * Proper management of excess air control for combustion

b) Countermeasures at the 2nd step
   * Installation of economizers and air pre-heaters in furnaces and boilers

7. Others

7.1 Kaavian Steel Co.

7.1.1 Outline of the complex

Kaavian Steel Co. is located in Ahwaz, being a national factory belonging to the above Ahwaz Steel Complex. The construction started in 1976, and the operation started in 1980 but suspended by the Iran-Iraq war. Six years ago, re-construction started, and was completed four years ago. Operation was resumed one and a half years ago.

The factory is engaged in the hot rolling of the slabs (250 * 1200 * 4000 mm) and blooms (85 to 130 mm t) mainly supplied from Ahwaz Steel Complex, and produces slabs, blooms and plates of 8 to 40 mm in thickness.

They produced 109,000 tons in 1992, and plan to produce 400,000 tons in 1993 and 800,000 tons/year two years later. However, since their products are not officially qualified, the sales are rather poor, to lower the operation rate.

7.1.2 Present situation of the factory and energy saving indicators

The present situation of the factory and energy saving indicators are shown in Table 7.1.

Table 7.1 Present situations of the factory and indicators concerned

1 Factory	
Total Capacity	800,000 product-t/Y
Slab	400,000 product-t/Y
Bloom	300,000 product-t/Y
Plate	100,000 product-t/Y
Furnace Capacity	120 t × 1 plant, 150 × 1 plant
Production (1992 actual)	109,000 product-t/Y
Name of Product	Slab, Bloom, Plate
Operating Hour (1992 actual)	5,300 h/Y
No of Employee	960 persons
No of Engineer	60 persons
Yield	≒ 90%
2 Energy Consumption (1992)	
Natural Gas	21,462,851 Nm^3/Y
Gas oil	95,903 kg/2 months
Electricity	10,469,732 kWH/Y
3 Specific Energy Consumption	
Fuel	1.92 Gcal/t
Electricity	96.05 kWH/t

7.1.3 Energy saving measures

There is no appropriate factory comparable to this factory in Japan. For reference, a specific heat energy consumption of about 0.32 Gcal/t was achieved in Japan for heating cold billets only in a converter steel making-hot rolling process. Compared to the value, the above consumption is very high.

(i) Energy saving measures in the 1st step

As described also for Ahwaz Steel Complex, essential energy saving measures by intensified equipment maintenance and improved operation are as enumerated below.

a) Repair of furnace walls to ensure more perfect heat insulation, and prevention of ingress of cold air into furnaces
b) Repair of ducts of hot gas, hot air, etc. to ensure more perfect heat insulation, and prevention of leak
c) More intensive fuel and combustion control of respective furnaces
d) Repair of meters and more intensive numerical control

A further other cause for the high specific heat energy consumption of the factory is surmised to be a low operation rate. The fuel consumption required for the start-up of the heating furnaces and the fuel consumption required for keeping the internal temperature of the furnaces remaining out of operation are large.

(ii) Energy saving measures in the 2nd step

a) Heating furnaces
The heating furnaces have recuperators installed for recovery of waste heat, and the outlet temperature of the exhaust gas is 800°C at the highest and on the level of 300°C normally. It is recommended to use the exhaust gas for preheating the steel, and this will also contribute to the improvement of product quality.
b) Electric equipment
This factory uses various blowers and pumps including the large-capacity blowers for the heating furnaces. If their rotational speeds are controlled, the consumption of electric energy will be very effectively reduced.

(iii) Energy saving measures in the third stage

This factory is an intermediate product factory relying on other factories working upstream and downstream, unpreferably in view of factory management. This situation of course greatly affects the operation rate. A fundamental study in this regard is required.

7.2 Khuzistan Pipe Manufacturing Co., Ltd.

7.2.1 Outline of the factory

The factory is located in Ahwaz, being a private factor which produces 45,000 tons/year (target of 1993) of cast steel pipes of ductile cast iron and gray cast iron for city water and drainage, and also various joints (in conformity with DIN and ISO), using 50% of scraps and 50% of pellets (imported from Brazil) as raw materials.

7.2.2 Present situation of the factory and energy saving indicators

The present situation of the factory and energy saving indicators are shown in Table 7.2.

Table 7.2 Present situation of the factory and indicators concerned

1 Factory	
Total Capacity	~ product-t/Y
Electrical Induction Furnace	2.5 MW × 3 line
Holding Furnace	750 kW × 1 set, 350 kW × 1 set
Annealing Furnace	~ × 1 line
Casting Plant	3 line
Production (1993 target)	45,000 product-t/Y
Name of Product	Cast Iron Tube & Fitting
Operating Ratio	74%
Yield	83%
No of Employee	1,200 persons
No of Engineer	15 persons
Electric Capacity	16 MW
2 Energy Consumption (1992)	
Natural Gas	~ Nm^3/Y
Gas oil	~ kl/Y
Electricity	~ kWH/Y
3 Specific Energy Consumption	
Fuel	~ Gcal/t
Electricity	~ kWH/t

Note: The value of mark (~) are filed by the report after given by the factory.

7.2.3 Energy saving measures

The factory is a casting factory using electric induction furnaces only as stated above, and we have no factory of this type in Japan. The casting of this scale is effected by a cupola.

(i) Energy saving measures in the 1st step

The energy saving measures in the first stage are taken by intensifying equipment maintenance and improving operation. Typical measures are enumerated below.

a) Repair of furnace walls of electric induction furnaces and annealing furnace to ensure more perfect heat insulation, and prevention of ingress of cold air into furnaces

b) More intensive fuel and combustion control of annealing furnace

c) Shortening of waiting time in process

d) Repair of meters and more intensive numerical control

(ii) Energy saving measures in the 2nd step

The first step of energy saving measures is to identify the present conditions. This is the reason why measuring instruments for energy control must be installed. This is a problem common to equipment in general.

a) Annealing furnace

1) The waste heat temperature of the annealing furnace is estimated to be on the level of 300 to 500°C, though not confirmed because of no measurement made. The preheating of cast iron pipes by the exhaust gas is effective not only for energy saving but also for product quality improvement. The identification of the present conditions, numerical analysis and examination of economic values are surmised to be necessary. The heat recovery for preheating combustion air is one of relatively easy waste heat recovery methods.

2) Improving the sealing structure at the portion where cast iron pipes are inserted is also effective for energy saving as well as for product quality improvement. The examination of this item is surmised to be as valuable as that of the above item.

b) Electric equipment

This factory uses various blowers and pumps. If their rotational speeds are controlled, the consumption of electric energy will be very effectively decreased.

(iii) Energy saving measures in the 3rd step

a) Electric power supply

At present, electric power supply is unstable (service interruption occurred for 1,360 hours in 1992). So, in addition to two existing 2 MW emergency diesel generators, two 2.5 MW gas turbine generators were ordered and are scheduled to be installed six months later in preparation for service interruption. It is recommended to examine the additional installation and constant operation of gas turbine generators, based on the economic effect analysis in reference to power loads, power cost reduction effect, drop of factory operation rate due to decreased production, etc. This will also enhance energy saving.

b) Utilization of scraps

Scraps account for 50% of the raw materials at present, and the supply from a scrap collection company under the control of the Ministry of Heavy Industry is said to be stable. It is recommended to examine measures for stabilizing the quality of scraps and to increase the utilization of scraps. This contributes to not only energy saving but also the recycling of resources.

7.3 Bafkar Textile Co.

7.3.1 Outline of the factory

The factory is located in Teheran and is one of four largest national factories belonging to the Ministry of Industry. It began to be constructed as a joint concern of an American company and the Iranian government in 1937, and started operation in 1958, being managed under the American company till 1969.

The raw cotton and chemical fibers used are 100% domestic products, and the dyes are imported from Germany, France, China and India. It is a consistent factory consisting of the steps of spinning, weaving, bleaching, dyeing and textile finishing, and produces various printed fabrics. (The share of the products is about 2%.)

At present, they produce 3,520 tons/year (22,000,000 m^2/year). They are modernizing the spinning step and changing the exhaust gas treatment in the spinning step from open type to closed type (the rate of recovering raw cotton from the exhaust gas will be 80%), and after completion of the improvement, they will increase the production to 4,300 tons/year.

They have filed an application for the permission to move the dyeing line to Zanjan at about 400 km in the west-northwest of Teheran within 5 years. This decision is said to have been triggered by the request from the municipal government, which requires additional investment for the treatment of their waste water. (They can receive a subsidy of seven million US dollars and will be exempted from tax for 10 years if they take any environmental protection measure in conformity with the regulations of the Ministry of Industry.)

7.3.2 Present situation of the factory and energy saving indicators

The present situation of the factory and energy saving indicators are shown in Table 7.3.

Table 7.3 Present situation of the factory and indicators concerned

1 Factory	
Production	22,000 × 10^3 product-m^2/Y
	3,520 product-t/Y
Name of Product	Textile (print)
Operating Hour	275 × 24 = 6,600 h/Y
No of Employee	2,000 persons
No of Engineer	45 persons
2 Energy Consumption (1991)	
Natural Gas	35,640,000 Nm^3/Y
Gas oil	150,000 l/Y
Electricity	31,680,000 kWH/Y
3 Specific Energy Consumption	
Fuel (oil equivalent)	10,441 l/t
Electricity	9.0 kWH/kg

7.3.3 Energy saving measures

Among textile products, especially clothing is highly fashion-oriented and seasonal. So a textile factory high in the production ratio of clothing like this factory is forced to produce many items in respectively small amounts, and as a result, is poor in efficiency in view of energy consumption. In addition, a factory with steps of bleaching, dyeing and textile finishing is higher in the fuel cost proportion in the production cost than factories of other categories.

Also in Japan, the textile industry engaged in the weaving of short-fibers of cotton and chemical fibers and dyeing & textile finishing recorded the following average specific energy consumption rates in three years till 1990.

- Specific heat energy consumption: 1280.1 l/t (in terms of fuel oil)
- Specific electric energy consumption: 6.13 kWH/kg

The factory is very large in specific heat energy consumption, since it has a history of about 35 years as stated before. The specific electric energy consumption is also large, though not so large as the specific heat energy consumption.

(i) Energy saving measures in the 1st step

The energy saving measures in the first stage are taken by intensifying equipment maintenance and improving operation. Main measures are enumerated below.

a) Prevention of leak of steam, condensate, hot water, compressed air, etc.
b) Repair of hot pipes and hot ducts to ensure more perfect heat insulation
c) More intensive fuel and combustion control of boilers, direct fire type dryers, etc.
d) Repair of walls and prevention of ingress of air of boilers, direct fire type dryers, etc.
e) More thorough decrease of hot waste water
f) Repair of meters and more intensive numerical control
g) Decrease of re-processing and failure of cloth
h) Decrease of waiting time in process

Many cylinder dryers are operated in this factory, and the heat balance of such a cylinder dryer is shown in Table 8. Water evaporation of cloth and radiation loss account for a large percentage. The recovery and re-utilization of the heat is being developed in Japan, but is substantially difficult. The next large heat loss item is the leak of steam at the joint of cylinder rotary portion and at the steam trap. This steam consumption can be positively decreased by intensifying the maintenance.

(ii) Energy saving measures in the 2nd step

The energy saving measures in the second stage accompany equipment investment for recovery of waste heat, etc.

For proper judgment of investment, as shown in Table 8, it is first of all necessary to accurately numerically identify and analyze the supplied energy, effective heat energy, discharged energy and present temperature level for each step of the process. This is the reason why measuring instruments are required.

Table 7.4 Heat balance of cylinder dryer

Item	%
Water evaporation of cloth	38.2
Radiation loss	23.7
Leak of steam at joint and trap	17.6
Loss due to pause	11.5
Others	9.0
Total	100.0

Also for this factory, it is recommended to install energy control instruments and to intensify the numerical control based on the instruments.

a) Spinning

More than 90% of the energy consumed in this step is electricity, and in the electric energy consumption, cotton and dust collectors account for more than 60%. In the factory, the equipment are being modernized as described before, and it is recommended to introduce rotational speed control for suction fans.

b) Dyeing and processing

1) Recovery and effective utilization of steam drain

All the steps of bleaching, dyeing and textile finishing use heat energy consuming apparatuses, with much waste energy discharged from them. The waste energy includes the exhaust gas from dryers, hot waste water from washing machines and dyeing machines, the heat due to radiation and steam drain generated from the liquid surfaces of washing tanks and hot water storage tanks, etc.

Especially cylinder dryers, washing machines, dyeing machines, heat setters and steam pipes discharge condensates of various pressures and temperatures. They should be positively used for boiler feed, flush steam, etc.

2) Heat recovery from hot waste water

As important as the recovery and effective utilization of steam drain as an energy saving measure in the dyeing and processing step is the heat recovery from the hot waste water generated in large quantities by washing and dyeing. It is recommended to use plate type heat exchangers, etc. for cascade utilization of heat, and to use heat pumps for utilizing hot waste water at a higher temperature.

c) Boilers and generators

The factory has two 3,000 kVA condensate turbine generators and one 1,250 kVA diesel generator for emergency in preparation for unstable electric power supply, but the condensate turbine generators are little used since they are superannuated.

The dyeing and processing step uses a large amount of steam for various heat sources and hot water production as described before. This factory has the following boilers.

- Water tube boiler for power generation: 41 kg/cm^2 * 360°C * 16 t/h * 2 units
- Fire tube boiler: 6 kg/cm^2 saturated * 4 units
- Flue and smoke tube boiler: 135 lb/in^2 saturated * 4 units

Normally, low pressure boilers are operated (56 t/h in the rated quantity of evaporation by 7 units), using natural gas as the fuel.

For the fire tube boilers and flue and smoke tube boilers now in operation, it is recommended to more thoroughly recover the drain for utilization for feed, and also to more thoroughly recover heat from the exhaust gas as described before.

(iii) Energy saving measures in the 3rd step

a) Dyeing and processing

In Japan, jet streaming type dyeing apparatuses and economical dye liquor applicators are introduced already as novel energy saving type dyeing equipment. As of 1991, 225 units of the former (adoption rate 16%) and 41 units of the latter (adoption rate 9%) are introduced for contribution to rationalization of production. However, since they are very expensive for investment, production scale, marketability of products and funding plan must be examined as well as technical aspect. For example, available for this approach are the wince type dyeing machines different in performance such as liquor ratio as shown in Fig.7. 3.

Furthermore, making the flow in the dyeing and processing step continuous, allowing production of many kinds in respectively small lots, speed-up, enhancement of product yield, etc. are rationalization measures which also remarkably affect energy saving.

In the current construction of a new factory for dyeing and processing, it is expected that these matters are sufficiently taken into account in addition to simply renewing the existing superannuated apparatuses.

b) Boilers and generators

The heat efficiency of the existing fire tube boilers is considered to be as very low as less than 60%. This problem is surmised to be solved by the new boilers installed in the new factory, as in the above case.

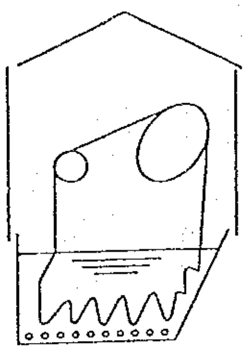
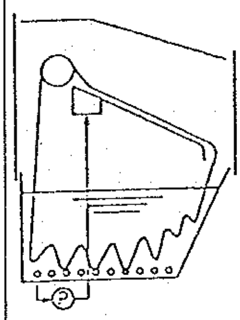
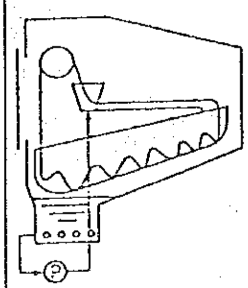
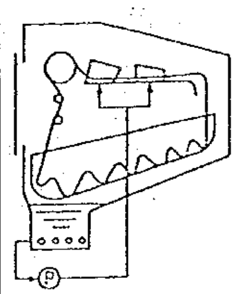
Type	Wince	Liquor flow type wince (winpact)	Liquor flow type wince (dash line)	Liquor flow type wince (super flow)
				
Textile velocity	60 m/min	80 m/min	80 m/min	210 m/min
Liquor circulating cycle	—	60 sec	30 sec	20 sec
Liquor ratio	1:20	1:15	1:10	1:5
Productivity	1 revolution/D	2 revolutions/D	2 revolutions/D	4-5 revolutions/D

Fig. 7.3 Characteristic value of Wince Type Dyeing Machines (3)

III. Materials on "Energy and Environment"

1. Unit Conversion Factors and Emission Factors
2. Parameters for Emission Estimation(1～4)
3. Estimation of Energy Balance Table with Forecast to 2021(1～6)
4. Estimation of Emission Volumes by Use of Energy Balance Table(1～8)
5. Selected Ambient Quality Indicators for Various Cites in the World(1～3)
6. Comparison of Pollutant Emission Level in the World(1～7)

   (Source: OECD, 1993, and others)
7. Effectiveness of Countermeasures for Environmental Improvement
8. Environmental Administration in Japan

   (Source: Environmental Agency, Japan, 1989)
9. Institutional Mechanism for Financing Environmental Administration in Japan

   (Source: Michio Hashimoto, "Development of Environmental Policy and Its Institutional Mechanism of Administration and Finance, 1985)

1. Unit Conversion Factors and Emission Factors

Unit Conversion Factors

	Unit	TOE	BOE	GJ	1000 Kcal	TOE/ton
Crude Oil	Kl	0.890	6.289	37.179	8,882	1.000
Gasoline	Kl	0.780	5.525	32.657	7,801	1.070
Jet Fuel	Kl	0.860	6.063	35.839	8,562	1.065
Gas Oil	Kl	0.870	6.190	36.593	8,742	1.035
Fuel Oil	Kl	0.920	6.502	38.435	9,182	0.960
Gas	1000 m3	0.880	6.198	36.635	8,752	
Coal	Ton	0.625	4.356	27.214	6,501	
Fuel Wood	Ton					

After JICA's Energy Balance of IRAN

SOx Emission Factor

	SOx Emission (SO2 equivalent)			S Content %wt. @IRAN	Avg. SO2 Emission	
Crude Oil	20 x S%	*0.46 x S%	kg/ton	3	20	0.46 kg/ton
Gasoline	20 x S%		kg/ton	008 - 0.10	1.8	kg/ton
Jet Fuel	3.2		kg/ton	0.005 - 0.01	3.2	kg/ton
Gas Oil	20 x S%		kg/ton	0.8 - 1.0	18	kg/ton
Fuel Oil	20 x S%		kg/ton	3.0 - 3.5	65	kg/ton
Gas	0.0092		kg/1e10cal		0.0092	kg/1e10cal
Coal	15.5 x S%		kg/ton	2	31	kg/ton
Fuel Wood	0.86		kg/toe		0.86	kg/toe

* : @Refinery @Refinery

After The Science and Technology Agency, Government of Japan

NOx Emission Factor Unit: kg/ton

	Refinery	Power Gen.	Industry	Air Trans.	Road Trans.	Other Trans.	Residential	Agric. & Commercial
Crude Oil	0.24	7.24	5.09			5.09	1.70	3.05
Gasoline		16.71	16.71	16.71	31.7	16.71	16.71	16.71
Jet Fuel				10.50				
Gas Oil		27.37	9.62	54.13	27.4	54.13	3.21	5.77
Fuel Oil		10.00	5.84	54.13	27.4	54.13	1.95	3.50
Gas *		4.40	2.24			2.24	1.57	1.57
Coal		9.95	7.50			7.50	1.88	3.75
Fuel Wood **			6.00				6.00	

* ; kg / 1e10 cal.

** ; kg/ toe

After The Science and Technology Agency, Government of Japan

CO2 Emission Factor

Crude Oil	3.165	ton/ton
Gasoline	3.132	ton/ton
Jet Fuel	3.157	ton/ton
Gas Oil	3.187	ton/ton
Fuel Oil	3.219	ton/ton
Gas	2.31E-04	g-CO2/cal.
Coal	3.905	ton/toe
Fuel Wood	4.366	ton/toe

After The Science and Technology Agency, Government of Japan

Emission Factor for "Other Fuel" Unit: kg/TOE

	Refinery	Power Gen.	Industry	Air Trans.	Road Trans.	Other Trans.	Residential	Agric. & Commercial
SOx kg/toe	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
NOx kg/toe	6	6.00	6.00	6.00	6.0	6.00	6.00	6.00
CO2 Ton/toe	4.366	4.366	4.37	4.366	4.366	4.366	4.37	4.366

2. Parameters for Emission Estimation (1)

[Pop. and GDP ; World Table '92 IRAN]	1970	1971	1972	1973	1974	1975
Population	28,429,008	29,300,000	30,213,008	31,167,008	32,164,000	33,206,000
GNP per capita (US$, curr. pr.)	380	430	510	690	950	1,320
Gross National Product (local,curr. pr.)	798,199,971,840	968,199,962,624	1,235,000,229,888	1,836,399,460,352	3,079,400,325,120	3,497,399,418,880
Gross Domestic Product (local,curr. pr.)	884,100,104,192	1,014,300,016,640	1,264,400,203,776	1,860,899,438,592	3,089,900,765,184	3,512,100,451,400
GDP Deflator (1987=100,Index)	6	7	8	10	16	17
GDP Deflator (1985=100,Index)	9	10	11	14	22	24
Gross Domestic Product (local,1985. pr.)	10,184,761,784,899	10,405,126,363,723	11,749,175,813,510	13,508,725,146,583	14,026,984,637,807	14,364,168,140,415

[Pop. and GDP ; Prepared by IRANIAN Counterpart]	1970	1971	1972	1973	1974	1975
Population	N/A	29,499,000	30,286,000	31,089,000	31,951,000	32,818,000
Gross Domestic Product (local, 1982 pr.)	N/A	7,045,500,000,000	8,201,900,390,625	8,956,299,804,688	9,342,700,195,313	9,227,799,804,688
Gross Domestic Product (local, current pr.)	N/A	902,700,012,207	1,130,199,951,172	1,678,800,048,828	2,986,500,000,000	3,302,500,000,000

[Primary Energy Requirement] ;Energy Balance Table, H. KIBUNE '93	1970	1971	1972	1973	1974	1975
Solid Fuel (MM bbl Oil Eq.)	1.40	1.60	2.50	4.20	4.60	8.40
Petroleum (MM bbl Oil Eq.)	84.36	89.99	93.16	117.02	133.65	155.52
Natural Gas (MM bbl Oil Eq.)	10.34	13.01	15.24	19.88	20.05	21.68
Hydro (MM bbl Oil Eq.)	2.60	4.20	5.50	4.40	5.30	5.40
Others (MM bbl Oil Eq.)	21.50	20.49	19.37	18.97	17.85	17.24
Non-Comm. (MM bbl Oil Eq.)	4.00	3.80	3.70	3.50	3.40	3.40
Primary Energy Requirement Total (MM bbl Oil Eq.)	124.20	133.09	139.47	167.97	184.85	211.64

[Flare Gas; OPEC, (Value 1970-1976 ; Estimated)]	1970	1971	1972	1973	1974	1975
Flared Natural Gas (M3)	18,574,000,000	22,021,000,000	24,367,000,000	28,431,000,000	29,210,000,000	25,953,000,000
Flared Natural Gas (MM bbl Oil Eq. ; 6.198 BOE/1,000M3)	115.12	136.49	151.03	176.22	181.04	160.86

[CO2 Emission Est. ; JICA Team '93]	1970	1971	1972	1973	1974	1975
CO2 Emission Estimation (CO2 million ton)	44.66	46.57	49.75	58.10	62.98	71.83
Total CO2 Emission Estimation (Carbon million ton)	12.18	12.70	13.57	15.84	17.18	19.59

[CO2 Emission from FLARE GAS ; JICA Team '93]	1970	1971	1972	1973	1974	1975
Cal. Value Flare Gas (cal.) @8752 Kcal/M3	1.63E+17	1.93E+17	2.13E+17	2.49E+17	2.56E+17	2.27E+17
CO2 from Flare Gas (CO2 million ton) @0.0002312 g-CO2/cal	37.58	44.56	49.31	57.53	59.11	52.51
CO2 from Flare Gas (Carbon million ton)	10.25	12.15	13.45	15.69	16.12	14.32

[SOx Emission Est. by Fuel; JICA Team '93]	1970	1971	1972	1973	1974	1975
Solid Fuel	0.0100	0.0114	0.0178	0.0299	0.0327	0.0342
Petroleum	0.252	0.264	0.277	0.346	0.380	0.460
Gas	0.000000827	0.000002092	0.000004994	0.000010758	0.000013577	0.000015817
Others	0.00266	0.00253	0.00240	0.00235	0.00221	0.00213
Non-Commercial	0.000495	0.000470	0.000458	0.000433	0.000420	0.000420
Total SOx Emission Estimation (SO2 million ton)	0.265	0.279	0.298	0.379	0.416	0.496

[SOx Emission from FLARE GAS ; JICA TEAM '93]	1970	1971	1972	1973	1974	1975
Flared H2S (litters) @H2S 4 mol%	742,960,000,000	880,840,000,000	974,680,000,000	1,137,240,000,000	1,168,400,000,000	1,038,120,000,000
H2S (g-mols)	33,167,857,143	39,323,214,286	43,512,500,000	50,769,642,857	52,160,714,286	46,344,642,857
H2S (grms)	1,127,707,142,857	1,336,989,285,714	1,479,425,000,000	1,726,167,857,143	1,773,464,285,714	1,575,717,857,143
H2S (ton)	1,127,707	1,336,989	1,479,425	1,726,168	1,773,464	1,575,718
SOx from Flare Gas (SO2 million ton)	2.123	2.517	2.785	3.249	3.338	2.966

[NOx Emission Est. by Fuel; JICA Team '93]	1970	1971	1972	1973	1974	1975
Solid Fuel	0.0024	0.0028	0.0043	0.0072	0.0079	0.0083
Petroleum	0.1149	0.1253	0.1346	0.1612	0.1808	0.2182
Gas	0.0002	0.0008	0.0019	0.0040	0.0051	0.0059
Others	0.0185	0.0177	0.0167	0.0164	0.0154	0.0149
Non-Commercial	0.0035	0.0033	0.0032	0.0030	0.0029	0.0029
Total NOx Emission as NO2 (million ton)	0.1395	0.1498	0.1606	0.1917	0.2121	0.2502

[NOx Emission from FLARE GAS ; JICA Team '93]	1970	1971	1972	1973	1974	1975
Cal. Value Flare Gas (cal.) @8752 Kcal/M3	1.63E+17	1.93E+17	2.13E+17	2.49E+17	2.56E+17	2.27E+17
NOx from Flare Gas (NO2 million ton) @2.24 NO2 kg / 1e10 cal.	0.036	0.043	0.048	0.056	0.057	0.051

[Crude Oil Production ; Arab Oil & Gas Directory]	1970	1971	1972	1973	1974	1975
Annual Crude Oil Production (MM bbl)	1397.59	1656.92	1838.46	2139.23	2197.88	1952.79

Year	1970	1971	1972	1973	1974	1975
Cement Production [million ton]						

CO2 from Cement Production (0.12 Carbon ton / Cement ton)	1970	1971	1972	1973	1974	1975
CO2 from Cement Production [Carbon million ton]						

2. Parameters for Emission Estimation (2)

[Pop. and GDP ; World Table '92 IRAN]	1976	1977	1978	1979	1980	1981
Population	34,294,000	35,431,008	36,617,008	37,848,000	39,124,000	40,450,000
GNP per capita (US$, curr. pr.)	1,890	2,170	1,970	2,080	1,990	2,540
Gross National Product (local,curr. pr.)	4,691,699,171,328	5,849,500,090,368	5,343,801,245,696	6,390,801,235,968	6,628,101,324,800	8,379,801,010,176
Gross Domestic Product (local,curr. pr.)	4,696,898,011,136	5,947,500,003,328	5,529,597,378,560	6,335,401,820,160	6,621,698,719,744	8,349,199,368,192
GDP Deflator (1987=100,Index)	20	23	26	33	43	50
GDP Deflator (1985=100,Index)	28	33	37	47	61	71
Gross Domestic Product (local,1985. pr.)	16,877,803,625,802	18,005,466,594,486	14,930,492,538,390	13,557,106,474,238	10,936,703,386,382	11,829,066,270,621

[Pop. and GDP ; Prepared by IRANIAN Counterpart]	1976	1977	1978	1979	1980	1981
Population	33,709,000	34,736,000	36,077,000	37,991,000	39,646,000	41,221,000
Gross Domestic Product (local, 1982 pr.)	11,254,299,804,688	11,183,799,804,688	10,070,799,804,688	10,543,099,609,375	9,323,099,609,375	9,175,200,195,313
Gross Domestic Product (local, current pr.)	4,440,799,804,688	5,177,000,000,000	5,095,500,000,000	6,158,200,195,313	6,471,100,097,656	7,884,299,804,688

[Primary Energy Requirement] ;Energy Balance Table, H. KIBUNE '93	1976	1977	1978	1979	1980	1981
Solid Fuel (MM bbl Oil Eq.)	8.40	8.50	4.80	7.50	7.90	6.60
Petroleum (MM bbl Oil Eq.)	179.08	202.60	197.25	212.33	189.58	198.97
Natural Gas (MM bbl Oil Eq.)	23.62	26.60	24.75	37.97	33.72	35.83
Hydro (MM bbl Oil Eq.)	6.20	6.60	9.80	8.50	8.80	9.70
Othres (MM bbl Oil Eq.)	17.24	17.14	17.85	17.14	17.85	17.04
Non-Comm. (MM bbl Oil Eq.)	3.40	3.50	3.40	3.50	3.40	3.60
Primary Energy Requirement Total (MM bbl Oil Eq.)	237.94	264.94	257.85	286.94	261.25	271.74

[Flare Gas; OPEC, (Value 1970-1976 ; Estimated)]	1976	1977	1978	1979	1980	1981
Flared Natural Gas (M3)	28,538,000,000	26,384,000,000	25,728,000,000	15,793,000,000	9,470,000,000	8,200,000,000
Flared Natural Gas (MM bbl Oil Eq. ; 6.198 BOE/1,000M3)	176.88	163.53	159.46	97.89	58.70	50.82

[CO2 Emission Est. ; JICA Team '93]	1976	1977	1978	1979	1980	1981
CO2 Emission Estimation (CO2 million ton)	81.70	95.45	95.61	104.28	98.45	103.09
Total CO2 Emission Estimation (Carbon million ton)	22.28	26.03	26.07	28.44	26.85	28.12

[CO2 Emission from FLARE GAS ; JICA Team '93]	1976	1977	1978	1979	1980	1981
Cal. Value Flare Gas (cal.) @8752 Kcal/M3	2.50E+17	2.31E+17	2.25E+17	1.38E+17	8.29E+16	7.18E+16
CO2 from Flare Gas (CO2 million ton) @0.0002312 g-CO2/cal	57.75	53.39	52.06	31.96	19.16	16.59
CO2 from Flare Gas (Carbon million ton)	15.75	14.56	14.20	8.72	5.23	4.53

[SOx Emission Est. by Fuel; JICA Team '93]	1976	1977	1978	1979	1980	1981
Solid Fuel	0.0363	0.0605	0.0370	0.0534	0.0562	0.0470
Petroleum	0.532	0.609	0.641	0.669	0.647	0.703
Gas	0.000018599	0.000021957	0.000020335	0.000035560	0.000038349	0.000046281
Others	0.00213	0.00212	0.00221	0.00212	0.00221	0.00211
Non-Commercial	0.000420	0.000433	0.000420	0.000433	0.000420	0.000445
Total SOx Emission Estimation (SO2 million ton)	0.571	0.672	0.681	0.725	0.706	0.753

[SOx Emission from FLARE GAS ; JICA TEAM '93]	1976	1977	1978	1979	1980	1981
Flared H2S (litters) @H2S 4 mol%	1,141,520,000,000	1,055,360,000,000	1,029,120,000,000	631,720,000,000	378,800,000,000	328,000,000,000
H3S (g-mols)	50,960,714,286	47,114,285,714	45,942,857,143	28,201,785,714	16,910,714,286	14,642,857,143
H2S (grms)	1,732,664,285,714	1,601,885,714,286	1,562,057,142,857	958,860,714,286	574,964,285,714	497,857,142,857
H2S (ton)	1,732,664	1,601,886	1,562,057	958,861	574,964	497,857
SOx from Flare Gas (SO2 million ton)	3.261	3.015	2.940	1.805	1.082	0.937

[NOx Emission Est. by Fuel; JICA Team '93]	1976	1977	1978	1979	1980	1981
Solid Fuel	0.0088	0.0146	0.0090	0.0129	0.0136	0.0114
Petroleum	0.2580	0.3110	0.3215	0.3366	0.2918	0.3134
Gas	0.0066	0.0080	0.0074	0.0125	0.0128	0.0141
Others	0.0149	0.0148	0.0154	0.0148	0.0154	0.0147
Non-Commercial	0.0029	0.0030	0.0029	0.0030	0.0029	0.0031
Total NOx Emission as NO2 (million ton)	0.2911	0.3515	0.3562	0.3799	0.3365	0.3568

[NOx Emission from FLARE GAS ; JICA Team '93]	1976	1977	1978	1979	1980	1981
Cal. Value Flare Gas (cal.) @8752 Kcal/M3	2.50E+17	2.31E+17	2.25E+17	1.38E+17	8.29E+16	7.18E+16
NOx from Flare Gas (NO2 million ton) @2.24 NO2 kg / 1e10 cal.	0.056	0.052	0.050	0.031	0.019	0.016

[Crude Oil Production ; Arab Oil & Gas Directory]	1976	1977	1978	1979	1980	1981
Annual Crude Oil Production [MM bbl]	2153.15	2066.93	1913.22	1156.28	537.05	480.30

Year	1976	1977	1978	1979	1980	1981
Cement Production [million ton]	7.375	7.706	7.150	7.620	7.895	9.231

CO2 from Cement Production [0.12 Carbon ton / Cement ton]	1976	1977	1978	1979	1980	1981
CO2 from Cement Production [Carbon million ton]	0.885	0.925	0.858	0.914	0.947	1.108

2. Parameters for Emission Estimation (3)

[Pop. and GDP ; World Table '92 IRAN]	1982	1983	1984	1985	1986	1987
Population	41,832,000	43,276,000	44,787,008	46,374,000	48,051,008	49,824,000
GNP per capita (US$, curr. pr.)	3,140	3,530	3,750	3,990	3,960	3,650
Gross National Product (local,curr. pr.)	11,152,000,024,576	14,021,000,429,568	15,151,000,453,120	16,521,999,941,632	18,106,994,917,376	21,280,203,997,184
Gross Domestic Product (local,curr. pr.)	11,152,101,736,448	14,027,800,444,928	15,162,000,015,360	16,555,902,500,864	18,124,996,870,144	21,269,986,672,640
GDP Deflator (1987=100,Index)	58	66	68	71	84	100
GDP Deflator (1985=100,Index)	82	94	96	100	119	142
Gross Domestic Product (local,1985. pr.)	13,605,095,770,735	14,981,405,324,795	15,736,842,681,720	16,555,902,500,864	15,253,877,217,312	15,015,146,246,038

[Pop. and GDP ; Prepared by IRANIAN Counterpart]	1982	1983	1984	1985	1986	1987
Population	42,800,000	44,438,000	46,201,000	47,807,000	49,363,000	50,995,000
Gross Domestic Product (local, 1982 pr.)	10,335,400,390,625	11,536,700,195,313	11,587,099,609,375	11,607,400,390,625	9,861,700,195,313	10,019,799,804,688
Gross Domestic Product (local, current pr.)	10,335,400,390,625	12,930,000,000,000	14,242,400,390,625	15,167,799,804,688	15,614,000,000,000	19,284,000,000,000

[Primary Energy Requirement] ;Energy Balance Table, H. KIBUNE '93	1982	1983	1984	1985	1986	1987
Solid Fuel (MM bbl Oil Eq.)	8.90	8.40	6.50	6.40	6.30	6.20
Petroleum (MM bbl Oil Eq.)	222.01	271.26	300.62	318.35	292.90	312.81
Natural Gas (MM bbl Oil Eq.)	41.69	47.64	55.28	55.05	52.60	66.69
Hydro (MM bbl Oil Eq.)	10.10	9.70	9.00	8.70	11.70	13.10
Othres (MM bbl Oil Eq.)	18.36	24.84	22.37	20.28	23.57	26.16
Non-Comm. (MM bbl Oil Eq.)	3.50	3.50	3.50	3.50	3.50	3.30
Primary Energy Requirement Total (MM bbl Oil Eq.)	304.56	365.34	397.27	412.28	390.57	428.26

[Flare Gas; OPEC, (Value 1970-1976 ; Estimated)]	1982	1983	1984	1985	1986	1987
Flared Natural Gas (M3)	14,250,000,000	9,700,000,000	6,500,000,000	5,400,000,000	5,300,000,000	4,800,000,000
Flared Natural Gas (MM bbl Oil Eq. ; 6.198 BOE/1,000M3)	88.32	60.12	40.29	33.47	32.85	29.75

[CO2 Emission Est. ; JICA Team '93]	1982	1983	1984	1985	1986	1987
CO2 Emission Estimation (CO2 million ton)	114.72	139.80	148.61	160.35	152.94	162.96
Total CO2 Emission Estimation (Carbon million ton)	31.29	38.13	40.53	43.73	41.71	44.44

[CO2 Emission from FLARE GAS ; JICA Team '93]	1982	1983	1984	1985	1986	1987
Cal. Value Flare Gas (cal.) @8752 Kcal/M3	1.25E+17	8.49E+16	5.69E+16	4.73E+16	4.64E+16	4.20E+16
CO2 from Flare Gas (CO2 million ton) @0.0002312 g-CO2/cal	28.83	19.63	13.15	10.93	10.72	9.71
CO2 from Flare Gas (Carbon million ton)	7.86	5.35	3.59	2.98	2.92	2.65

[SOx Emission Est. by Fuel; JICA Team '93]	1982	1983	1984	1985	1986	1987
Solid Fuel	0.0633	0.0598	0.0463	0.0455	0.0448	0.0441
Petroleum	0.752	0.928	1.041	1.168	1.120	1.102
Gas	0.000053902	0.000061634	0.000071554	0.000071255	0.000068073	0.000085723
Others	0.00227	0.00307	0.00277	0.00251	0.00291	0.00323
Non-Commercial	0.000433	0.000433	0.000433	0.000433	0.000433	0.000408
Total SOx Emission Estimation (SO2 million ton)	0.818	0.991	1.090	1.216	1.169	1.150

[SOx Emission from FLARE GAS ; JICA TEAM '93]	1982	1983	1984	1985	1986	1987
Flared H2S (litters) @H2S 4 mol%	570,000,000,000	388,000,000,000	260,000,000,000	216,000,000,000	212,000,000,000	192,000,000,000
H2S (g-mols)	25,446,428,571	17,321,428,571	11,607,142,857	9,642,857,143	9,464,285,714	8,571,428,571
H2S (grms)	865,178,571,429	588,928,571,429	394,642,857,143	327,857,142,857	321,785,714,286	291,428,571,429
H2S (ton)	865,179	588,929	394,643	327,857	321,786	291,429
SOx from Flare Gas (SO2 million ton)	1.629	1.109	0.743	0.617	0.606	0.549

[NOx Emission Est. by Fuel; JICA Team '93]	1982	1983	1984	1985	1986	1987
Solid Fuel	0.0153	0.0145	0.0112	0.0110	0.0108	0.0107
Petroleum	0.3401	0.4201	0.4611	0.5173	0.4896	0.5041
Gas	0.0172	0.0194	0.0221	0.0218	0.0202	0.0281
Others	0.0158	0.0214	0.0193	0.0175	0.0203	0.0226
Non-Commercial	0.0030	0.0030	0.0030	0.0030	0.0030	0.0028
Total NOx Emission as NO2 (million ton)	0.3915	0.4785	0.5167	0.5706	0.5440	0.5683

[NOx Emission from FLARE GAS ; JICA Team '93]	1982	1983	1984	1985	1986	1987
Cal. Value Flare Gas (cal.) @8752 Kcal/M3	1.25E+17	8.49E+16	5.69E+16	4.73E+16	4.64E+16	4.20E+16
NOx from Flare Gas (NO2 million ton) @2.24 NO2 kg / 1e10 cal.	0.028	0.019	0.013	0.011	0.010	0.009

[Crude Oil Production ; Arab Oil & Gas Directory]	1982	1983	1984	1985	1986	1987
Annual Crude Oil Production [MM bbl]	872.82	891.22	743.86	800.20	743.55	838.63

Year	1982	1983	1984	1985	1986	1987
Cement Production [million ton]	10.001	10.912	11.803	12.10	11.27	12.62

CO2 from Cement Production [0.12 Carbon ton / Cement ton]	1982	1983	1984	1985	1986	1987
CO2 from Cement Production [Carbon million ton]	1.200	1.309	1.416	1.45	1.35	1.51

2. Parameters for Emission Estimation (4)

[Pop. and GDP ; World Table '92 IRAN]	*1988*	*1989*	*1990*
Population	51,698,000	53,681,008	55,779,008
GNP per capita (US$, curr. pr.)	3,070	2,580	2,490
Gross National Product (local,curr. pr.)	23,597,808,615,424	28,138,897,670,144	36,463,097,937,920
Gross Domestic Product (local,curr. pr.)	23,587,859,726,336	28,123,512,963,072	36,441,992,200,192
GDP Deflator (1987=100,Index)	119	137	162
GDP Deflator (1985=100,Index)	168	195	229
Gross Domestic Product (local,1985. pr.)	14,043,636,413,372	14,453,812,552,201	15,910,289,668,741

[Pop. and GDP ; Prepared by IRANIAN Counterpart]	*1988*	*1989*	*1990*
Population	52,672,000	54,504,000	56,401,000
Gross Domestic Product (local, 1982 pr.)	9,234,299,804,688	9,514,599,609,375	10,664,900,390,625
Gross Domestic Product (local, current pr.)	21,753,599,609,375	27,028,800,781,250	35,755,000,000,000

[Primary Energy Requirement] ;Energy Balance Table , H. KIBUNE '93	*1988*	*1989*	*1990*
Solid Fuel (MM bbl Oil Eq.)	6.40	4.70	4.70
Petroleum (MM bbl Oil Eq.)	314.49	330.26	348.66
Natural Gas (MM bbl Oil Eq.)	69.51	91.34	119.44
Hydro (MM bbl Oil Eq.)	11.40	11.70	9.50
Othres (MM bbl Oil Eq.)	33.00	31.68	24.90
Non-Comm. (MM bbl Oil Eq.)	3.40	3.20	3.20
Primary Energy Requirement Total (MM bbl Oil Eq.)	438.20	472.88	510.40

[Flare Gas; OPEC, (Value 1970-1976 ; Estimated)]	*1988*	*1989*	*1990*
Flared Natural Gas (M3)	4,000,000,000	1,500,000,000	11,350,000,000
Flared Natural Gas (MM bbl Oil Eq. ; 6.198 BOE/1,000M3)	24.79	9.30	70.35

[CO2 Emission Est. ; JICA Team '93]	*1988*	*1989*	*1990*
CO2 Emission Estimation (CO2 million ton)	167.98	180.13	185.08
Total CO2 Emission Estimation (Carbon million ton)	45.81	49.13	50.48

[CO2 Emission from FLARE GAS ; JICA Team '93]	*1988*	*1989*	*1990*
Cal. Value Flare Gas (cal.) @8752 Kcal/M3	3.50E+16	1.31E+16	9.93E+16
CO2 from Flare Gas (CO2 million ton) @0.0003312 g-CO2/cal	8.09	3.04	22.97
CO2 from Flare Gas (Carbon million ton)	2.21	0.83	6.26

[SOx Emission Est. by Fuel; JICA Team '93]	*1988*	*1989*	*1990*
Solid Fuel	0.0455	0.0334	0.0334
Petroleum	1.124	1.175	1.225
Gas	0.000087969	0.000113201	0.000139061
Others	0.00408	0.00392	0.00308
Non-Commercial	0.000420	0.000396	0.000396
Total SOx Emission Estimation (SO2 million ton)	1.174	1.213	1.262

[SOx Emission from FLARE GAS ; JICA TEAM '93]	*1988*	*1989*	*1990*
Flared H2S (litters) @H2S 4 mol%	160,000,000,000	60,000,000,000	454,000,000,000
H2S (g-mols)	7,142,857,143	2,678,571,429	20,267,857,143
H2S (grms)	242,857,142,857	91,071,428,571	689,107,142,857
H2S (ton)	242,857	91,071	689,107
SOx from Flare Gas (SO2 million ton)	0.457	0.171	1.297

[NOx Emission Est. by Fuel; JICA Team '93]	*1988*	*1989*	*1990*
Solid Fuel	0.0110	0.0081	0.0081
Petroleum	0.5015	0.5392	0.5642
Gas	0.0285	0.0354	0.0428
Others	0.0285	0.0273	0.0215
Non-Commercial	0.0029	0.0028	0.0028
Total NOx Emission as NO2 (million ton)	0.5724	0.6127	0.6394

[NOx Emission from FLARE GAS ; JICA Team '93]	*1988*	*1989*	*1990*
Cal. Value Flare Gas (cal.) @8752 Kcal/M3	3.50E+16	1.31E+16	9.93E+16
NOx from Flare Gas (NO2 million ton) @3.24 NO2 kg / 1e10 cal.	0.008	0.003	0.022

[Crude Oil Production ; Arab Oil & Gas Directory]	*1988*	*1989*	*1990*
Annual Crude Oil Production [MM bbl]	843.79	1027.14	1116.66

Year	*1988*	*1989*	*1990*
Cement Production [million ton]	12.12	12.83	15.15

CO2 from Cement Production [0.12 Carbon ton / Cement ton]	*1988*	*1989*	*1990*
CO2 from Cement Productioe [Carbon million ton]	1.45	1.54	1.82

3. Estimation of Energy Balance Table with Forecast to 2021 (1)

	Year	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Production(生産)																	
Solid Fuel	SOPD	1.1	1.3	1.4	1.6	2.5	4.2	4.6	8.4	8.4	8.5	4.8	7.5	7.9	6.6	8.9	8.4
Crude Oil	CRPD	1,088.7	1,257.8	1,421.5	1,688.9	1,832.9	2,141.9	2,195.3	1,950.1	2,185.5	2,078.2	1,833.1	1,202.7	531.0	540.5	979.7	986.6
Natural Gas	GAPR	149.5	168.9	192.7	257.9	257.8	298.1	386.7	281.9	312.9	418.0	273.7	259.2	101.5	97.6	185.4	173.3
Hydro	HYPD	1.3	2.1	2.6	4.2	5.5	4.4	5.3	5.4	6.2	6.6	9.8	8.5	8.8	9.7	10.1	9.7
Others	OTPD	23.0	21.9	21.5	20.5	19.4	19.0	17.9	17.2	17.2	17.1	17.9	17.1	17.9	17.0	18.4	24.8
Non-Comm.	NOPR	4.3	4.2	4.0	3.8	3.7	3.5	3.4	3.4	3.4	3.5	3.4	3.5	3.4	3.6	3.5	3.5
Prod. Total	TLPD	1,267.9	1,456.2	1,643.7	1,976.9	2,121.8	2,470.8	2,612.7	2,262.3	2,529.7	2,527.9	2,141.1	1,494.9	666.6	672.4	1,201.6	1,202.4
Import(輸入)																	
Solid Fuel	SOIM	0.0	0.0	0.0	0.0	0.0	0.2	0.4	4.3	4.0	4.1	1.9	3.7	3.8	2.6	4.4	3.9
Petroleum Products	PTIM	0.0	0.0	0.0	0.0	0.0	0.2	0.4	4.3	4.0	4.1	1.9	3.7	3.8	21.2	34.5	58.7
Impo. Total	TLIM	0.0	0.0	0.0	0.0	0.0	0.4	0.8	8.6	8.0	8.2	3.8	7.4	7.6	23.8	38.9	62.6
Export(輸出)																	
Solid Fuel	SOEX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crude Oil	CREX	-936.5	-1,070.6	-1,218.6	-1,475.0	-1,624.5	-1,917.8	-1,956.6	-1,687.3	-1,920.5	-1,790.6	-1,565.9	-902.7	-271.0	-346.0	-772.5	-763.4
Petroleum Products+Bunker	PTEX	-43.0	-89.1	-113.6	-96.2	-135.7	-117.3	-112.8	-124.6	-61.3	-76.6	-230.2	-142.3	-57.0	-4.4	-15.4	-1.2
Natural Gas	GAEX	0.0	0.0	-6.1	-35.6	-51.7	-54.7	-57.5	-60.3	-58.4	-59.1	-32.4	-22.0	0.0	0.0	0.0	0.0
Impo. Total	TLEX	-979.5	-1,159.7	-1,338.3	-1,606.8	-1,811.9	-2,089.8	-2,126.9	-1,872.3	-2,040.2	-1,926.3	-1,368.5	-1,067.0	-328.0	-341.6	-787.9	-764.6
Stock Change & Some loss(在庫変動ほか)																	
Solid Fuel	SOSC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crude Oil	CRSC	32.1	1.5	-7.7	3.3	6.0	5.6	4.1	0.1	0.3	6.7	5.4	5.3	1.9	2.6	-1.8	5.4
Petroleum Products	PTSC	-67.2	-25.5	2.7	-31.0	14.5	4.4	3.3	13.0	-29.0	-19.2	152.9	45.6	-19.1	-14.9	-2.5	-14.9
Natural Gas	GASC	-148.5	-167.8	-176.3	-209.3	-190.9	-223.5	-309.1	-199.9	-230.9	-332.3	-216.5	-199.2	-67.8	-61.8	-143.7	-125.7
(Nat. Gas Fleair +Inj.)		-123.9	-139.5	-116.3	-131.9	-147.4	-169.6	-172.5	-146.3	-178.8	-249.3	-203.2	-172.3	-59.8	-54.0	-120.7	-101.9
Statis. Diff. Total	TLSC	-183.6	-191.8	-181.2	-237.0	-170.4	-213.5	-301.8	-186.9	-259.5	-344.8	-58.2	-148.3	-85.0	-74.1	-148.0	-135.1
Primary Energy Requirement(一次供給)																	
Solid Fuel	SOPR	1.1	1.3	1.4	1.6	2.5	4.2	4.6	8.4	8.4	8.5	4.8	7.5	7.9	6.6	8.9	8.4
Crude Oil	CRPR	184.3	188.7	195.2	217.2	214.4	229.7	242.8	262.9	265.3	294.3	272.6	305.3	261.9	197.1	205.4	228.6
Petroleum Prod.	PTPR	-110.2	-114.6	-110.9	-127.2	-121.2	-112.7	-109.1	-107.3	-86.3	-91.7	-75.4	-93.0	-72.3	1.9	16.6	42.6
Natural Gas	GAPR	1.0	1.1	10.3	13.0	15.2	19.9	20.1	21.7	23.6	26.6	24.8	38.0	33.7	35.8	41.7	47.6
Hydro	HYPR	1.3	2.1	2.6	4.2	5.5	4.4	5.3	5.4	6.2	6.6	9.8	8.5	8.8	9.7	10.1	9.7
Othres	OTPR	23.0	21.9	21.5	20.5	19.4	19.0	17.9	17.2	17.2	17.1	17.9	17.1	17.9	17.0	18.4	24.8
Non-Comm.	NOPR	4.3	4.2	4.0	3.8	3.7	3.5	3.4	3.4	3.4	3.5	3.4	3.5	3.4	3.6	3.5	3.5
Primary. Total	TLPR	104.8	104.7	124.2	133.1	139.5	168.0	184.9	211.6	237.9	264.9	257.9	286.9	261.3	271.7	304.6	365.3
(Sum of energy exclude pet.pro.)		215.0	219.3	235.1	260.3	260.7	280.7	294.0	319.0	324.2	356.7	333.2	379.9	333.5	269.8	288.0	322.7

Remark: Any Erroneous of the estimation is ascribed to the JICA team.
In order to produce the Tabel, following data sources are turned to accoount.
1) for the Primary enrgy, NIOC data book " ? "
2) same as, 'Energy balance Table in IRAN,' by Ministry of Energy
3) for the industrial sector, Iranian authority named ?
4) for 'Other' energy in the household sector, Mr. Darabi's estimation
5) 'Non-OECD Energy Balance' by OECD/IEA is not so useful.

Conversion Sector(転換部門)

Refinary		1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Crude Oil input	CRPT	-184.3	-188.7	-195.2	-217.2	-214.4	-229.7	-242.8	-262.9	-265.3	-294.3	-272.6	-305.3	-261.9	-197.1	-205.4	-228.6
Pet.Prod. Output	PTPT	168.6	178.3	189.0	202.5	200.8	215.0	228.5	251.1	250.1	275.9	261.6	287.7	254.2	182.6	197.6	213.9
Conversion Loss	TLPT	-15.7	-10.4	-6.2	-14.7	-13.6	-14.8	-14.2	-11.8	-15.3	-18.5	-11.0	-17.6	-7.7	-14.5	-7.8	-14.7

3. Estimation of Energy Balance Table with Forecast to 2021 (2)

	Year	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Electric Utility																	
Solid Fuel for Power	SOEL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pet. Pro. for Power	PTEL	-3.5	-4.0	-5.4	-4.9	-4.5	-7.8	-8.0	-10.8	-12.5	-13.6	-15.7	-15.6	-15.7	-18.2	-18.9	-24.9
Gas for Power	GAEL	-0.2	-0.1	-0.1	-1.0	-2.1	-4.5	-5.9	-6.7	-6.9	-9.5	-8.6	-14.5	-14.1	-14.6	-19.7	-22.4
Generation	ELEL	2.0	1.9	2.5	3.2	4.0	5.5	6.6	7.5	8.4	9.3	10.2	11.4	11.7	13.2	15.5	17.9
Hydro for Power	HYEL	-1.3	-2.1	-2.6	-4.2	-5.5	-4.4	-5.3	-5.4	-6.2	-6.6	-9.8	-8.5	-8.8	-9.7	-10.1	-9.7
Nuclear for Power	NUEL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Convrsn Loss of Pow.	TLEL	-2.9	-4.4	-5.6	-6.9	-8.1	-11.2	-12.6	-15.4	-17.3	-20.4	-23.8	-27.1	-26.9	-29.4	-33.2	-39.1
Effic. of Gene.(%)		40.6	30.1	30.8	31.9	33.2	32.9	34.3	32.8	32.6	31.2	30.0	29.7	30.3	31.0	31.8	31.4
Auto Generation																	
Petro. input	PTAU	-1.9	-4.9	-5.1	-5.2	-5.2	-5.2	-5.3	-5.7	-5.8	-6.8	-5.6	-5.5	1.3	-5.4	-5.4	-5.8
Auto Output	ELAU	0.8	1.5	1.6	1.6	1.7	1.7	1.8	1.9	1.9	2.1	1.7	1.6	-0.4	1.7	1.7	1.8
Loss of auto.	TLAU	-1.1	-3.4	-3.5	-3.5	-3.5	-3.5	-3.5	-3.8	-3.9	-4.7	-3.9	-3.9	0.9	-3.7	-3.7	-4.0
Own Use																	
Refinary	PTOW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Power Plant	ELOW	-0.3	-0.4	-0.5	-0.6	-0.7	-0.9	-1.2	-1.4	-1.5	-1.6	-1.9	-2.1	0.0	-2.5	-2.7	-3.1
Own Use Total	TLOW	-0.3	-0.4	-0.5	-0.6	-0.7	-0.9	-1.2	-1.4	-1.5	-1.6	-1.9	-2.1	0.0	-2.5	-2.7	-3.1
Statistical Difference																	
Solid	SOSD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-3.6	-3.3	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Petroleum	PTSD	-9.7	-6.0	-14.4	-5.7	-3.6	-11.2	-16.7	-20.6	-18.1	-11.7	-9.6	-9.5	-14.3	-4.7	-18.0	-12.8
Gas	GASD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Electricity	ELSD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total SD	TLSD	-9.7	-6.0	-14.4	-5.7	-3.6	-11.2	-16.7	-24.2	-21.4	-11.7	-9.2	-9.5	-14.3	-4.7	-18.0	-12.8

Final Energy Demand Total(最終エネルギー需要)

		1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Total	TLFN	75.09	80.19	94.01	101.71	109.96	126.37	136.69	155.11	178.52	208.09	208.05	226.82	213.34	216.97	239.13	291.58
Solid Fuel	SOFN	1.10	1.30	1.40	1.60	2.50	4.20	4.60	4.80	5.10	8.50	5.20	7.50	7.90	6.60	8.90	8.40
Petroleum	PTFN	43.36	48.78	53.30	59.52	66.19	78.01	89.43	106.66	127.27	152.05	155.40	164.18	153.28	156.13	171.87	213.04
Gas	GAFN	0.80	1.00	10.20	12.00	13.10	15.40	14.20	15.00	16.70	17.10	16.20	23.50	19.60	21.20	22.00	25.20
Electricity	ELFN	2.50	3.00	3.60	4.30	5.10	6.30	7.20	8.00	8.80	9.80	10.00	11.00	11.30	12.40	14.50	16.60
Others	OTFN	23.02	21.91	21.50	20.49	19.37	18.97	17.85	17.24	17.24	17.14	17.85	17.14	17.85	17.04	18.36	24.84
Non-Commercial	NOFN	4.30	4.20	4.00	3.80	3.70	3.50	3.40	3.40	3.40	3.50	3.40	3.50	3.40	3.60	3.50	3.50
Industrial Sector																	
Total	TLIN	12.42	13.76	15.61	17.26	20.15	27.42	30.89	35.16	40.27	46.74	43.70	49.82	53.24	56.55	59.78	66.74
Solid Fuel	SOIN	1.10	1.30	1.40	1.60	2.50	4.20	4.60	4.80	5.10	8.50	5.20	7.50	7.90	6.60	8.90	8.40
Petroleum Total	PTIN	9.42	10.26	11.51	12.36	12.85	15.52	17.19	20.26	23.17	26.74	27.80	27.62	30.34	33.65	35.98	42.24
Gas oil		2.95	3.17	3.61	4.02	4.36	5.41	6.06	7.35	8.65	10.82	11.29	11.25	11.06	12.00	13.80	16.56
Fuel Oil		6.47	7.08	7.90	8.34	8.49	10.11	11.13	12.91	14.51	15.92	16.50	16.37	19.28	21.65	22.18	25.68
Gas	GAIN	0.30	0.40	0.50	0.60	1.60	3.70	4.50	5.30	6.90	6.10	5.80	9.60	10.00	11.10	9.60	10.00
Elec.	ELIN	1.60	1.80	2.20	2.70	3.20	4.00	4.60	4.80	5.10	5.40	4.90	5.10	5.00	5.20	5.30	6.10
Food	TLFO	2.51	2.78	3.15	3.49	4.07	5.54	6.24	7.10	7.67	8.91	8.55	8.71	9.12	8.65	9.54	10.91
Textile	TLTX	1.20	1.33	1.51	1.67	1.95	2.66	2.99	4.08	3.39	3.72	3.44	4.81	5.22	4.63	5.36	4.76
Wood & Pro.	TLWO	0.10	0.11	0.13	0.14	0.17	0.23	0.26	0.26	0.27	0.26	0.30	0.50	0.53	0.47	0.78	0.94
Paper & Pulp	TLPA	0.16	0.18	0.20	0.23	0.26	0.36	0.40	0.43	0.50	0.60	0.59	0.56	0.84	1.33	1.07	1.03
Chemical	TLCH	0.85	0.94	1.07	1.18	1.37	1.87	2.11	2.25	4.55	5.93	6.22	7.61	5.02	5.80	4.50	4.96
Ceramics & Non-metal	TLNM	5.27	5.83	6.62	7.32	8.54	11.62	13.10	15.02	17.96	21.25	20.88	23.57	27.89	31.74	33.06	33.59
Primary Metal	TLPM	1.33	1.47	1.67	1.84	2.15	2.93	3.30	3.65	3.39	3.44	1.52	1.19	1.17	1.43	1.81	6.09
Machinary	TLMN	1.00	1.10	1.25	1.39	1.62	2.20	2.48	2.36	2.52	2.62	2.20	2.86	3.45	2.49	3.63	4.43
Other Manufacturings	TLOT	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02

3. Estimation of Energy Balance Table with Forecast to 2021 (3)

	Year	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Transportation Sector		1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983
Total	TLTR	12.31	13.71	15.90	18.14	20.15	24.84	28.80	35.55	43.48	54.06	55.77	56.42	51.14	49.23	55.06	68.62
Petoroleum Total	PTTR	12.31	13.71	15.90	18.14	20.15	24.84	28.80	35.55	43.48	54.06	55.77	56.42	51.14	49.23	55.06	68.62
for Road & Train	PTTRR	10.93	12.05	13.77	15.60	17.26	21.12	24.52	30.33	37.28	46.32	49.46	53.03	47.74	47.66	51.85	64.98
Gasoline		5.03	5.71	6.56	7.55	8.54	10.30	12.40	15.63	19.97	24.69	26.87	30.53	25.62	23.67	24.24	31.85
Gas oil		5.90	6.35	7.21	8.05	8.72	10.82	12.12	14.70	17.30	21.64	22.59	22.50	22.12	23.99	27.61	33.13
for Air	PTTRA	1.38	1.66	2.13	2.55	2.89	3.72	4.29	5.22	6.20	7.74	6.32	3.40	3.40	1.57	3.21	3.64
Jet fuel		1.38	1.66	2.13	2.55	2.89	3.72	4.29	5.22	6.20	7.74	6.32	3.40	3.40	1.57	3.21	3.64
Agricultural Sector																	
Total	TLAG	3.10	3.43	3.89	4.32	4.68	5.78	6.56	7.92	9.28	11.66	12.16	12.11	12.01	13.10	15.19	18.29
Gas Oil	PTAG	3.10	3.33	3.79	4.22	4.58	5.68	6.36	7.72	9.08	11.36	11.86	11.81	11.61	12.60	14.49	17.39
Electricity	ELAG	0.00	0.10	0.10	0.10	0.10	0.10	0.20	0.20	0.20	0.30	0.30	0.30	0.40	0.50	0.70	0.90
Residential/Commercial Sector																	
Total	TLRE	44.46	45.99	46.11	46.98	49.98	52.14	55.34	60.27	67.69	75.84	77.62	88.46	83.14	86.20	98.40	123.53
Solid Fuel	SORE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Petroleum	PTRE	16.23	18.78	19.31	21.19	25.01	27.38	31.58	36.42	43.04	49.79	50.27	58.92	50.59	48.95	55.84	70.59
Gas	GARE	0.00	0.00	0.00	0.00	0.10	0.10	0.10	0.20	0.50	1.30	1.30	3.30	5.40	9.90	12.20	15.00
Electricity	ELRE	0.90	1.10	1.30	1.50	1.80	2.20	2.40	3.00	3.50	4.10	4.80	5.60	5.90	6.70	8.50	9.60
Other Fuel	OTRE	23.02	21.91	21.50	20.49	19.37	18.97	17.85	17.24	17.24	17.14	17.85	17.14	17.85	17.04	18.36	24.84
Non-Commercial	NORE	4.30	4.20	4.00	3.80	3.70	3.50	3.40	3.40	3.40	3.50	3.40	3.50	3.40	3.60	3.50	3.50
Household Sector																	
Total	TLHO	40.69	41.75	41.34	41.89	44.59	45.65	48.25	51.87	58.12	64.77	65.89	75.12	66.80	65.12	74.54	95.81
Solid Fuel	SOHO																
Petroleum	PTHO	12.99	15.24	15.36	17.02	20.77	22.32	26.02	29.97	35.78	41.83	42.02	50.73	40.95	38.13	44.75	57.75
Gas	GAHO	0.00	0.00	0.00	0.00	0.03	0.03	0.03	0.06	0.15	0.38	0.38	0.98	1.60	2.93	3.61	4.52
Electricity	ELHO	0.38	0.41	0.48	0.58	0.72	0.84	0.95	1.20	1.54	1.90	2.23	2.76	3.01	3.42	4.32	5.21
Other Fuel	OTHO	23.02	21.91	21.50	20.49	19.37	18.97	17.85	17.24	17.24	17.14	17.85	17.14	17.85	17.04	18.36	24.84
Non-Commercial	NOHO	4.30	4.20	4.00	3.80	3.70	3.50	3.40	3.40	3.40	3.50	3.40	3.50	3.40	3.60	3.50	3.50
Commercial Sector																	
Total	TLCM	3.76	4.24	4.78	5.09	5.40	6.49	7.08	8.40	9.57	11.07	11.73	13.34	16.33	21.08	23.86	27.72
Solid Fuel	SOCM																
Petroleum	PTCM	3.24	3.54	3.95	4.17	4.24	5.05	5.56	6.46	7.26	7.96	8.25	8.19	9.64	10.82	11.09	12.84
Gas	GACM	0.00	0.00	0.00	0.00	0.07	0.07	0.07	0.14	0.35	0.92	0.92	2.32	3.80	6.97	8.59	10.48
Electricity	ELCM	0.52	0.69	0.82	0.92	1.08	1.36	1.45	1.80	1.96	2.20	2.57	2.84	2.89	3.28	4.18	4.39
Other Fuel	OTCM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-Energy Use																	
Total Non-Energy	TLNE	2.80	3.30	12.50	15.00	15.00	16.20	15.10	16.20	17.80	19.80	18.80	20.00	13.80	11.90	10.70	14.40
petro	PTNE	2.30	2.70	2.80	3.60	3.60	4.60	5.50	6.70	8.50	10.10	9.70	9.40	9.60	11.70	10.50	14.20
gas	GANE	0.50	0.60	9.70	11.40	11.40	11.60	9.60	9.50	9.30	9.70	9.10	10.60	4.20	0.20	0.20	0.20

3. Estimation of Energy Balance Table with Forecast to 2021 (4)

	Year	1984	1985	1986	1987	1988	1989	1990	1994	2001	2011	2021
Production(生産)												
Solid Fuel	SOPD	6.5	6.4	6.3	6.2	6.4	4.7	4.7	5.087	5.844	6.455	7.131
Crude Oil	CRPD	867.6	907.5	796.6	891.7	933.3	1,075.1	1192	1423	1681	1681	1681
Natural Gas	GAPR	193.1	217.0	161.4	194.5	219.5	333.0	402	517	803	1308	2130
Hydro	HYPD	9.0	8.7	11.7	13.1	11.4	11.7	9.5	13.44	21.75	31.13	40.9
Others	OTPD	22.4	20.3	23.6	26.2	33.0	31.7	24.9	27.97	29.37	37.98	43.13
Non-Comm.	NOPR	3.5	3.5	3.5	3.3	3.4	3.2	3.2	3.507	3.682	0	0
Prod. Total	TLPD	1,100.2	1,161.9	1,001.5	1,133.5	1,205.7	1,458.5	1,636.3	1,990.0	2,544.6	3,064.6	3,902.2

Import(輸入)												
Solid Fuel	SOIM	1.9	1.5	1.6	1.4	1.3	0.9	1	0.04	0.127	0.824	1.742
Petroleum Products	PTIM	37.9	61.6	58.0	72.4	68.9	49.6	45.3	46.6	1567.4	1024.6	1208.5
Impo. Total	TLIM	39.8	63.1	59.6	73.8	70.2	50.5	46.3	46.6	1,567.5	1,025.4	1,210.2

Export(輸出)												
Solid Fuel	SOEX	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crude Oil	CREX	-620.0	-652.2	-557.0	-635.0	-699.3	-726.6	-828	-1019	-1164	-1060	-975
Petroleum Products+Bunker	PTEX	-9.0	-0.3	-10.4	-1.4	-15.3	-32.5	-107.3	-50.6	-1408.6	-715.4	-777.1
Natural Gas	GAEX	0.0	0.0	0.0	0.0	0.0	-6.7	-13.6	-84	-283.6	-703.4	-1446.5
Impo. Total	TLEX	-611.0	-652.5	-567.4	-636.4	-684.0	-765.8	-948.9	-1,153.6	-2,856.2	-2,478.8	-3,198.6

Stock Change & Some loss(在庫変動ほか)												
Solid Fuel	SOSC	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Crude Oil	CRSC	3.4	6.7	-5.9	-26.1	13.2	-43.1	-46.4	-46.4	-46.4	-46.4	-46.4
Petroleum Products	PTSC	20.7	-5.0	11.6	11.3	13.7	7.8	93	93	93	93	93
Natural Gas	GASC	-137.9	-162.0	-108.8	-127.8	-150.0	-235.0	-268.5	-268.5	-268.5	-268.5	-268.5
(Nat. Gas Fleair +Inj.)		-102.3	-124.9	-86.0	-104.2	-122.3	-141.8	-163.5	0.0	0.0	0.0	0.0
Statis. Diff. Total	TLSC	-113.8	-160.3	-103.1	-142.6	-123.1	-270.3	-221.9	-221.9	-221.9	-221.9	-221.9

Primary Energy Requirement(一次供給)									660.8			
Solid Fuel	SOPR	6.5	6.4	6.3	6.2	6.4	4.7	4.7	5.127	5.971	7.279	8.873
Crude Oil	CRPR	251.0	262.0	233.7	230.6	247.2	305.4	317.7	357.9	470.7	575	659.8
Petroleum Prod.	PTPR	49.6	56.4	59.2	82.2	67.3	24.9	30.9	88.9	251.7	402	524.4
Natural Gas	GAPR	55.3	55.0	52.6	66.7	69.5	91.3	119.4	164	250.7	335.8	415.1
Hydro	HYPR	9.0	8.7	11.7	13.1	11.4	11.7	9.5	13.44	21.75	31.13	40.9
Othres	OTPR	22.4	20.3	23.6	26.2	33.0	31.7	24.9	27.97	29.37	37.98	43.13
Non-Comm.	NOPR	3.5	3.5	3.5	3.3	3.4	3.2	3.2	3.507	3.682	0	0
Primary. Total	TLPR	397.3	412.3	390.6	428.3	438.2	472.9	510.3	660.8	1,033.9	1,389.2	1,692.2
(Sum of energy exclude pet.pro.)		347.7	355.9	331.3	346.0	370.9	448.0	479.4	571.9	782.2	987.2	1,167.8

Remark: Any Erroneous of the estimation is a:
In order to produce the Tabel, following data :
1) for the Primary enrgy, NIOC data book "
2) same as, 'Energy balance Table in IRAN,'
3) for the industrial sector, Iranian authorit
4) for 'Other' energy in the household secto
5) 'Non-OECD Energy Balance' by OECD/IE

Conversion Sector(転換部門)

Refinary		1984	1985	1986	1987	1988	1989	1990	1994	2001	2011	2021
Crude Oil input	CRPT	-251.0	-262.0	-233.7	-230.6	-247.2	-305.4	-317.7	-357.9	-470.7	-575	-659.8
Pet.Prod. Output	PTPT	234.1	240.1	218.0	217.8	233.3	292.8	303.6	341.9	449.8	549.4	630.4
Conversion Loss	TLPT	-16.9	-21.9	-15.6	-12.7	-13.9	-12.6	-14.13	-15.92	-20.94	-25.57	-29.34

3. Estimation of Energy Balance Table with Forecast to 2021 (5)

	Year	1984	1985	1986	1987	1988	1989	1990	1994	2001	2011	2021
Electric Utility												
Solid Fuel for Power	SOEL	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0
Pet. Pro. for Power	PTEL	-30.7	-36.8	-37.1	-32.3	-34.4	-34.5	-38.35	-54.24	-87.79	-125.66	-165.12
Gas for Power	GAEL	-24.1	-24.7	-23.9	-33.8	-35.5	-42.5	-51.5	-72.9	-118	-168.9	-221.9
Generation	ELEL	20.0	21.6	23.0	25.0	25.7	28.7	32.3	46.6	78.11	123.5	179.26
Hydro for Power	HYEL	-9.0	-8.7	-11.7	-13.1	-11.4	-11.7	-9.5	-13.44	-21.75	-31.13	-40.9
Nuclear for Power	NUEL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Convrsn Loss of Pow.	TLEL	-43.8	-48.6	-49.8	-54.2	-55.5	-60.0	-67.1	-98.3	-165.4	-257.4	-367.5
Effic. of Gene.(%)		31.4	30.8	31.6	31.6	31.7	32.3	32.5	32.5	32.5	32.5	32.5
Auto Generation												
Petro. input	PTAU	-5.8	-6.1	-6.1	-4.5	-3.9	-8.0	-8	-8.54	-10.18	-11.3	-12.25
Auto Output	ELAU	1.8	1.9	1.9	1.4	1.2	2.6	2.6	2.831	3.495	4.284	5.131
Loss of auto.	TLAU	-4.0	-4.2	-4.2	-3.1	-2.7	-5.4	-5.4	-11.37	-13.68	-15.58	-17.38
Own Use												
Refinary	PTOW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Power Plant	ELOW	-3.5	-3.5	-3.8	-4.6	-4.5	-5.7	-6.37	-9	-14.57	-20.84	-27.36
Own Use Total	TLOW	-3.5	-3.5	-3.8	-4.6	-4.5	-5.7	-6.4	-9.3	-15.7	-24.4	-34.9
Statistical Difference												
Solid	SOSD	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0
Petroleum	PTSD	-10.0	-4.1	-5.9	-14.5	-14.3	-19.5	-31.1	-31.1	-31.1	-31.1	-31.1
Gas	GASD	0.0	0.0	0.0	0.0	0.0	0.0	0	0	0	0	0
Electricity	ELSD	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total SD	TLSD	-10.0	-4.1	-5.9	-14.5	-14.3	-19.5	-31.1	-31.1	-31.1	-31.1	-31.1

Final Energy Demand Total(最終エネルギー需

		1984	1985	1986	1987	1988	1989	1990	1994	201	2011	2021
Total	TLFN	319.15	329.91	311.29	339.14	347.35	369.60	386.30	505.13	811.16	1,102.51	1,348.53
Solid Fuel	SOFN	6.50	6.40	6.30	6.20	6.40	4.70	4.7	5.127	5.971	7.279	8.873
Petroleum	PTFN	237.19	249.43	228.12	248.78	248.06	255.72	257.1	337	572.4	783.4	946.3
Gas	GAFN	31.20	30.30	28.70	32.90	34.00	48.80	67.9	91.1	132.7	166.9	193.2
Electricity	ELFN	18.40	20.00	21.10	21.80	22.50	25.50	28.5	40.43	67.04	106.95	157.03
Others	OTFN	22.37	20.28	23.57	26.16	33.00	31.68	24.9	27.97	29.37	37.98	43.13
Non-Commercial	NOFN	3.50	3.50	3.50	3.30	3.40	3.20	3.2	3.507	3.682	0	0
Industrial Sector												
Total	TLIN	74.71	78.83	77.31	78.16	78.90	90.63	100.9	110.9	160.3	209.8	236.7
Solid Fuel	SOIN	6.50	6.40	6.30	6.20	6.40	4.70	4.7	5.127	5.971	7.279	8.873
Petroleum Total	PTIN	46.71	51.13	49.91	50.26	50.80	51.63	53.94	57.62	82.05	106.81	120.29
Gas oil		17.93	20.88	19.64	21.12	20.86	21.14	22.64	24.19	34.44	44.83	50.49
Fuel Oil		28.78	30.26	30.27	29.14	29.94	30.49	31.30	33.43	47.61	61.98	69.80
Gas	GAIN	14.90	14.60	14.40	15.50	15.50	26.80	33.6	37.94	57.51	76.3	85.62
Elec.	ELIN	6.60	6.70	6.70	6.20	6.20	7.50	8.7	10.18	14.82	19.4	21.88
Food	TLFO	10.69	11.76	12.32	12.46	12.58	14.44	16.09	19.17	22.48	26.81	30.8
Textile	TLTX	5.01	5.49	4.80	4.86	4.90	5.63	6.27	7.28	13.05	18.58	21.56
Wood & Pro.	TLWO	0.95	0.94	0.92	0.93	0.94	1.08	1.2	1.259	2	2.812	2.998
Paper & Pulp	TLPA	1.32	1.48	0.96	0.97	0.98	1.13	1.25	2.585	4.89	6.555	7.196
Chemical	TLCH	5.04	6.01	7.94	8.03	8.10	9.31	10.36	11.88	17.93	23.92	27.34
Ceramics & Non-metal	TLNM	37.93	38.39	37.19	37.60	37.95	43.60	48.55	50.31	75.6	100.8	113.58
Primary Metal	TLPM	9.19	9.53	8.89	8.99	9.07	10.42	11.61	11.89	16.66	21.35	23.56
Machinary	TLMN	4.54	5.21	4.26	4.31	4.35	5.00	5.57	6.457	7.688	8.875	9.528
Other Manufacturings	TLOT	0.03	0.03	0.02	0.03	0.03	0.03	0.03	0.035	0.054	0.074	0.085

3. Estimation of Energy Balance Table with Forecast to 2021 (6)

	Year	1984	1985	1986	1987	1988	1989	1990	1994	2001	2011	2021
Transportation Sector		1984	1985	1986	1987	1988	1989	1990				
Total	TLTR	74.71	83.62	78.90	84.50	82.88	86.38	90.5	124.4	254.9	358.5	433
Petroleum Total	PTTR	74.71	83.62	78.90	84.50	82.88	86.38	90.5	124.4	254.9	358.5	433
for Road & Train	PTTRR	71.18	80.25	75.39	80.66	80.01	83.66	88.8	120.1	246.4	347.6	420.4
Gasoline		35.32	38.50	36.11	38.42	38.28	40.11	42.93	58.06	119.12	168.05	203.24
Gas oil		35.86	41.75	39.28	42.24	41.72	43.55	45.87	62.04	127.28	179.55	217.16
for Air	PTTRA	3.53	3.37	3.50	3.84	2.88	2.72	1.64	4.268	8.587	10.883	12.591
Jet fuel		3.53	3.37	3.50	3.84	2.88	2.72	1.64	4.268	8.587	10.883	12.591
Agricultural Sector												
Total	TLAG	19.93	23.42	21.92	25.68	24.72	25.37	26.82	39.19	58.93	105.09	169.77
Gas Oil	PTAG	18.83	21.92	20.62	24.18	22.92	23.37	24.62	35.21	47.44	70.14	97.11
Electricity	ELAG	1.10	1.50	1.30	1.50	1.80	2.00	2.2	3.97	11.49	34.96	72.66
Residential/Commercial Sector												
Total	TLRE	125.11	130.54	120.86	134.09	141.75	151.12	144.3	200.4	284.6	362.8	431.1
Solid Fuel	SORE	0.00	0.00	0.00	0.00	0.00	0.00	0	0	0	0	0
Petroleum	PTRE	72.44	79.45	66.59	73.84	74.15	82.44	76.7	98.9	146.1	192.2	228.9
Gas	GARE	16.10	15.50	14.10	16.70	16.70	17.80	21.9	43.69	64.71	79.96	96.59
Electricity	ELRE	10.70	11.80	13.10	14.10	14.50	16.00	17.6	26.28	40.73	52.6	62.49
Other Fuel	OTRE	22.37	20.28	23.57	26.16	33.00	31.68	24.9	27.97	29.37	37.98	43.13
Non-Commercial	NORE	3.50	3.50	3.50	3.30	3.40	3.20	3.2	3.507	3.682	0	0
Household Sector												
Total	TLHO	94.97	102.33	96.22	103.58	113.69	123.52	120.49	149.28	181.92	223.11	265.06
Solid Fuel	SOHO								0.00	0.00	0.00	0.00
Petroleum	PTHO	58.05	64.33	51.45	59.27	59.18	63.69	61.07	73.34	100.43	123.36	139.88
Gas	GAHO	5.13	7.57	10.39	6.82	9.88	15.66	21.12	27.23	23.15	29.61	43.16
Electricity	ELHO	5.92	6.65	7.30	8.04	8.23	9.29	10.2	17.23	25.29	32.16	38.89
Other Fuel	OTHO	22.37	20.28	23.57	26.16	33.00	31.68	24.9	27.97	29.37	37.98	43.13
Non-Commercial	NOHO	3.50	3.50	3.50	3.30	3.40	3.20	3.2	3.507	3.682	0	0
Commercial Sector												
Total	TLCM	30.14	28.20	24.64	30.52	28.06	27.61	23.81	51.08	102.65	139.66	166.08
Solid Fuel	SOCM								0.00	0.00	0.00	0.00
Petroleum	PTCM	14.39	15.13	15.14	14.57	14.97	18.75	15.63	25.57	45.65	68.87	89.04
Gas	GACM	10.97	7.93	3.71	9.88	6.82	2.14	0.78	16.46	41.57	50.35	53.44
Electricity	ELCM	4.78	5.15	5.80	6.06	6.27	6.71	7.4	9.05	15.43	20.44	23.6
Other Fuel	OTCM	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Non-Energy Use												
Total Non-Energy	TLNE	24.70	13.50	12.30	16.70	19.10	16.10	23.8	30.31	52.4	66.32	77.98
petro	PTNE	24.50	13.30	12.10	16.00	17.30	11.90	11.4	20.83	41.94	55.7	67.01
gas	GANE	0.20	0.20	0.20	0.70	1.80	4.20	12.4	9.48	10.47	10.62	10.97

4. Estimation of Emission Volumes by Use of Energy Balance Table (1)

SOx

Unit ; SO2 Million Ton

Year	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
TOTAL EMISSION	0.2044	0.2347	0.2649	0.2787	0.2979	0.3785	0.4155	0.4965	0.5706	0.6721	0.6809	0.7247	0.7061	0.7529	0.8183
Conversion Sector	0.0497	0.0628	0.0767	0.0738	0.0701	0.1025	0.1051	0.1349	0.1518	0.1658	0.1820	0.1826	0.1671	0.2007	0.2077
Industrial Sector	0.0771	0.0849	0.0945	0.1011	0.1098	0.1400	0.1541	0.1758	0.1965	0.2395	0.2227	0.2377	0.2680	0.2837	0.3096
Transportation Sector	0.0270	0.0298	0.0341	0.0387	0.0428	0.0525	0.0609	0.0753	0.0924	0.1148	0.1217	0.1289	0.1164	0.1155	0.1264
Agricultural Sector	0.0076	0.0081	0.0093	0.0103	0.0112	0.0139	0.0156	0.0189	0.0222	0.0278	0.0290	0.0289	0.0284	0.0308	0.0354
Residential/Commercial Sector	0.0431	0.0491	0.0504	0.0548	0.0640	0.0697	0.0798	0.0916	0.1078	0.1243	0.1255	0.1466	0.1263	0.1222	0.1392

NOx

Unit ; NO2 Million Ton

Year	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
TOTAL EMISSION	0.1090	0.1277	0.1395	0.1498	0.1606	0.1917	0.2121	0.2502	0.2911	0.3515	0.3562	0.3799	0.3365	0.3568	0.3915
Conversion Sector	0.0184	0.0307	0.0335	0.0344	0.0347	0.0415	0.0433	0.0501	0.0535	0.0611	0.0586	0.0629	0.0408	0.0628	0.0671
Industrial Sector	0.0114	0.0126	0.0141	0.0154	0.0178	0.0242	0.0268	0.0307	0.0348	0.0444	0.0397	0.0447	0.0478	0.0492	0.0555
Transportation Sector	0.0449	0.0498	0.0572	0.0651	0.0722	0.0885	0.1029	0.1274	0.1566	0.1946	0.2053	0.2161	0.1942	0.1905	0.2086
Agricultural Sector	0.0024	0.0026	0.0030	0.0033	0.0036	0.0044	0.0050	0.0060	0.0071	0.0089	0.0093	0.0093	0.0091	0.0099	0.0114
Residential/Commercial Sector	0.0318	0.0319	0.0318	0.0316	0.0323	0.0331	0.0341	0.0360	0.0392	0.0425	0.0433	0.0469	0.0446	0.0445	0.0490

CO2

Unit; Carbon Million Ton

Year	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982
TOTAL EMISSION	10.67	11.53	12.18	12.70	13.57	15.84	17.18	19.59	22.28	26.03	26.07	28.44	26.85	28.12	31.29
Conversion Sector	0.91	1.34	1.55	1.60	1.66	2.31	2.47	2.99	3.25	3.76	3.79	4.33	3.60	4.54	5.09
Industrial Sector	1.38	1.53	1.71	1.85	2.14	2.92	3.26	3.74	4.29	5.18	4.78	5.45	5.90	6.21	6.71
Transportation Sector	1.42	1.58	1.83	2.09	2.32	2.86	3.32	4.10	5.00	6.22	6.42	6.49	5.89	5.68	6.36
Agricultural Sector	0.37	0.39	0.45	0.50	0.54	0.67	0.75	0.91	1.07	1.34	1.40	1.39	1.37	1.49	1.71
Residential/Commercial Sector	6.59	6.69	6.65	6.66	6.91	7.09	7.38	7.85	8.66	9.53	9.69	10.78	10.09	10.19	11.42

4. Estimation of Emission Volumes by Use of Energy Balance Table (2)

SO_x

Unit ; SO2 Million Ton

Year	1983	1984	1985	1986	1987	1988	1989	1990	1994	2001	2011	2021
TOTAL EMISSION	0.9910	1.0903	1.2164	1.1687	1.1498	1.1742	1.2127	1.2623	1.6528	2.4969	3.7013	4.2626
Conversion Sector	0.2680	0.3251	0.3842	0.3860	0.3354	0.3548	0.3696	0.4077	0.6103	0.8520	1.2855	1.4034
Industrial Sector	0.3463	0.3659	0.3865	0.3829	0.3749	0.3834	0.3773	0.3887	0.4318	0.5985	0.7039	0.6862
Transportation Sector	0.1582	0.1730	0.1949	0.1833	0.1961	0.1941	0.2029	0.2148	0.2809	0.5725	1.1031	1.4838
Agricultural Sector	0.0425	0.0460	0.0536	0.0504	0.0591	0.0560	0.0571	0.0602	0.0843	0.1132	0.1545	0.1957
Residential/Commercial Sector	0.1761	0.1803	0.1972	0.1661	0.1842	0.1858	0.2058	0.1910	0.2456	0.3608	0.4544	0.4935

NO_x

Unit ; NO2 Million Ton

Year	1983	1984	1985	1986	1987	1988	1989	1990	1994	2001	2011	2021
TOTAL EMISSION	0.4785	0.5167	0.5706	0.5440	0.5683	0.5724	0.6127	0.6394	0.8341	1.4821	2.5490	3.3129
Conversion Sector	0.0799	0.0905	0.1012	0.1001	0.0930	0.0957	0.1173	0.1290	0.1785	0.2695	0.4042	0.5247
Industrial Sector	0.0614	0.0641	0.0690	0.0671	0.0683	0.0689	0.0704	0.0752	0.0843	0.1175	0.1384	0.1349
Transportation Sector	0.2616	0.2861	0.3211	0.3021	0.3232	0.3194	0.3336	0.3526	0.4615	0.9416	1.8112	2.4342
Agricultural Sector	0.0136	0.0148	0.0172	0.0162	0.0189	0.0180	0.0183	0.0193	0.0270	0.0363	0.0495	0.0627
Residential/Commercial Sector	0.0620	0.0613	0.0622	0.0585	0.0649	0.0704	0.0730	0.0633	0.0828	0.1172	0.1457	0.1564

CO_2

Unit; Carbon Million Ton

Year	1983	1984	1985	1986	1987	1988	1989	1990	1994	2001	2011	2021
TOTAL EMISSION	38.13	40.53	43.73	41.71	44.44	45.81	49.13	50.48	66.38	104.60	156.11	194.47
Conversion Sector	6.19	7.12	8.00	7.94	8.00	8.37	9.56	10.88	15.83	25.68	39.99	55.19
Industrial Sector	7.45	8.16	8.66	8.48	8.59	8.69	9.55	10.43	11.81	16.72	19.69	18.93
Transportation Sector	7.92	8.62	9.65	9.11	9.76	9.57	9.97	10.44	13.72	28.09	53.71	71.96
Agricultural Sector	2.05	2.22	2.59	2.43	2.85	2.70	2.76	2.91	4.07	5.47	7.46	9.45
Residential/Commercial Sector	14.52	14.41	14.83	13.75	15.25	16.47	17.29	15.81	20.95	28.64	35.27	38.94

5. Selected Ambient Quality Indicators for Various Cites in the World (1)

Country	City	Type of site	Sulfur dioxide: Annual mean concentration (micrograms per cubic meter) 1979-82	1983-86	1987-90	Av ann growth rate for series (percent)		Suspended particulate matter: Annual mean concentration (micrograms per cubic meter) 1979-82	1983-86	1987-90	Av ann growth rate for series (percent)	
Low-income economies												
China	Beijing	CCC	77	119	107	3.5	8	475	500	413	-2.7	8
China	Beijing	CCR	132	141	115	-1.3	8	412	380	370	-1.6	8
China	Guangzhou	CCC	100	78	54	-9.0	9	248	198	163	-6.1	9
China	Guangzhou	CCR	59	107	95	7.7	9	146	209	234	7.4	9
China	Shanghai	CCC	66	59	69	2.5	9	224	214	253	2.5	9
China	Shanghai	CCR	57	84	104	9.2	9	240	230	290	3.8	9
China	Shenyang	CCC	105	100	118	2.5	8	409	475	435	0.3	8
China	Shenyang	CCR	80	127	88	1.8	9	471	481	465	-0.4	9
China	Xian	CCC	138	107	95	-4.7	9	399	515	555	5.7	9
China	Xian	CCR	116	111	100	-1.4	9	401	485	580	6.7	9
Egypt, Arab Rep.	Cairo	CCC	5	101	18	-11.0	8	..	..	..	..	0
Egypt, Arab Rep.	Cairo	SR	..	157	28	-1.2	7	..	..	..	..	0
Ghana	Accra	SI	..	..	..	..	1	119	109	144	2.4	9
Ghana	Accra	SR	..	..	..	..	1	108	107	137	3.5	8
India	Bombay	CCC	23	23	..	1.8	4	154	140	..	-1.1	6
India	Calcutta	CCC	71	54	..	4.6	7	410	393	..	-1.0	13
India	Calcutta	SR	36	36	..	8.9	7	468	310	..	0.5	12
India	Delhi	CCC	42	86	..	12.0	6	460	460	..	-0.3	7
India	Delhi	CCR	16	33	..	23.9	6	312	301	..	-1.3	7
Indonesia	Jakarta	CCR	..	..	..	..	2	254	271	..	2.2	6
Indonesia	Jakarta	SI	..	..	..	..	2	159	204	185	3.5	7
Pakistan	Lahore	SR	..	..	..	..	1	745	..	496	-5.1	6
Middle-income economies												
Brazil	Sao Paulo	..	78	46	41	-7.5	12	134	98	..	-9.1	6
Chile	Santiago	CCC	69	85	..	2.5	10	..	..	..	..	0
Chile	Santiago	CCR	43	46	..	-1.5	9	..	..	..	..	0
Greece	Athens	CCC	57	34	..	-4.8	9	224	178	..	-6.0	9
Greece	Athens	SI	48	27	..	-9.7	9	190	182	..	-4.5	9
Iran, Islamic Rep.	Tehran	CCC	130	115	165	6.9	14	226	248	261	-2.4	14
Iran, Islamic Rep.	Tehran	SR	114	61	64	-2.7	14	215	251	238	-1.3	14
Malaysia	Kuala Lumpur	SC	..	..	..	..	2	172	135	119	-3.9	7
Malaysia	Kuala Lumpur	SI	12	24	..	-12.4	6	155	139	144	-1.5	10
Philippines	Davao	SI	..	..	..	..	3	163	205	..	-2.4	5

5. Selected Ambient Quality Indicators for Various Cites in the World (2)

Country	City	Type of site	Sulfur dioxide: Annual mean concentration (micrograms per cubic meter) 1979-82	1983-86	1987-90	Av ann growth rate for series (percent)		Suspended particulate matter: Annual mean concentration (micrograms per cubic meter) 1979-82	1983-86	1987-90	Av ann growth rate for series (percent)	
Philippines	Manila	SI	73	34	..	-12.0	9	90	..	..	0.8	8
Poland	Warsaw	CCC	42	35	23	-6.4	13	..	..	..	..	0
Poland	Warsaw	CCR	31	31	18	-5.5	13	..	..	..	..	0
Poland	Wroclaw	CCC	41	53	53	2.6	13	..	..	..	..	0
Poland	Wroclaw	CCR	31	42	42	4.5	13	..	..	..	..	0
Portugal	Lisbon	CCR	32	21	27	-3.0	10	99	97	99	0.4	9
Portugal	Lisbon	SR	19	14	20	2.7	8	100	95	86	-2.6	8
Thailand	Bangkok	SI	..	..	..	..	1	213	247	244	0.8	13
Thailand	Bangkok	SR	15	15	14	-1.7	10	136	163	105	-2.4	12
Venezuela	Caracas	CCC	32	27	21	-0.5	13	..	..	..	..	0
Yugoslavia	Zagreb	CCC	79	107	92	-4.3	19	114	127	135	-1.7	19
Yugoslavia	Zagreb	SR	33	66	47	-0.9	19	129	117	91	-2.6	19
High-income economies												
Australia	Melbourne	CCC	7	6	..	-14.3	10	71	58	..	-4.5	9
Australia	Sydney	CCC	51	28	..	-10.9	11	100	114	..	2.2	11
Australia	Sydney	SI	31	15	..	-7.3	11	76	58	..	-8.5	11
Belgium	Brussels	CCC	74	42	..	-11.5	11	24	22	..	-3.3	11
Belgium	Brussels	SR	60	37	..	-9.1	15	..	..	..	..	2
Canada	Hamilton	CCC	..	..	..	..	3	102	89	89	-2.8	13
Canada	Hamilton	SR	32	36	..	-4.4	9	102	99	..	-1.9	9
Canada	Montreal	CCC	41	23	..	-11.0	10	67	55	61	-1.8	12
Canada	Montreal	SR	27	20	..	0.7	11	58	39	35	-8.3	13
Canada	Toronto	CCC	..	11	14	4.0	5	60	60	61	-0.5	8
Canada	Toronto	SR	18	..	..	-16.1	7	70	60	57	-2.2	13
Canada	Vancouver	CCC	21	..	..	-7.0	5	70	50	42	-4.5	14
Canada	Vancouver	CCR	18	..	..	-2.7	11	55	39	..	-5.2	15
Denmark	Copenhagen	CCC	28	30	..	-0.5	7	34	..	..	3.4	6
Denmark	Copenhagen	SI	33	27	..	-5.7	7	53	55	..	3.0	9
Finland	Helsinki	CCC	24	..	..	-2.8	5	72	79	81	2.0	11
Finland	Helsinki	SI	27	28	20	-3.8	12	64	68	62	0.2	11
Germany	Frankfurt	CCC	71	56	36	-7.2	17	24	39	42	0.5	17
Hong Kong	Hong Kong	..	..	25	64	47.3	4	..	99	132	14.9	4
Ireland	Dublin	CCI	40	34	32	-3.2	12	..	..	..	..	0
Ireland	Dublin	CCR	57	44	41	-2.9	12	..	..	..	..	0
Israel	Tel Aviv	CCC	16	30	..	-7.1	11	..	..	..	..	0

5. Selected Ambient Quality Indicators for Various Cites in the World (3)

			Sulfur dioxide					Suspended particulate matter				
			Annual mean concentration (micrograms per cubic meter)			Av ann growth rate for series (percent)		Annual mean concentration (micrograms per cubic meter)			Av ann growth rate for series (percent)	
Country	City	Type of site	1979-82	1983-86	1987-90			1979-82	1983-86	1987-90		
Italy	Milan	CCC	160	90	..	-14.5	7	..	..	..	..	0
Italy	Milan	CCR	259	114	..	-11.4	7	..	..	..	..	0
Japan	Osaka	CCC	37	28	28	-8.4	14	51	41	42	-6.3	13
Japan	Osaka	SR	34	26	24	-8.0	14	61	49	54	-4.1	13
Japan	Tokyo	CCC	42	23	20	-8.9	17	61	50	..	-4.9	13
Japan	Tokyo	SR	42	30	20	-5.7	17	54	51	..	-4.5	14
Netherlands	Amsterdam	CCC	33	24	..	-6.7	15	..	..	..	..	0
Netherlands	Amsterdam	SR	34	29	..	-1.8	13	..	..	..	..	0
New Zealand	Auckland	CCC	10	3	..	-17.6	9	..	..	..	..	0
New Zealand	Auckland	CCR	8	3	..	-37.2	6	..	..	..	..	0
New Zealand	Christchurch	SI	37	43	..	6.9	9	..	..	..	..	0
New Zealand	Christchurch	SR	20	18	19	-3.5	12	..	..	..	..	0
Spain	Madrid	CCC	105	54	36	-9.8	17	..	..	..	..	0
Spain	Madrid	SR	45	28	19	-8.4	18	..	..	..	..	0
United Kingdom	Glasgow	CCC	73	52	..	-8.8	8	..	..	..	..	0
United Kingdom	Glasgow	CCI	62	41	..	-9.8	9	..	..	..	..	0
United Kingdom	London	CCC	66	44	..	-11.4	13	..	..	..	..	0
United Kingdom	London	SI	56	34	..	-11.3	13	..	..	..	..	0
United States	Birmingham	CCC	..	..	..	..	3	83	75	..	-3.0	11
United States	Chicago	CCI	..	..	..	..	2	121	99	..	-6.2	10
United States	Fairfield	SI	..	..	..	..	3	71	53	..	-5.6	11
United States	Harris Co.	SR	..	..	..	..	3	68	54	..	-4.8	11
United States	Houston	CCC	..	..	..	..	3	82	62	..	-7.3	10
United States	Houston	SR	18	8	..	-32.0	8	93.25	64	..	-6.3	11
United States	New York City	CCR	79	60	..	-5.8	9	63	61	..	-2.2	11
United States	New York City	SR	38	31	..	-5.9	9	49	46	..	-2.7	11

Type of site: CCC--city center commercial; CCR--city center residential; SI--suburban industrial; SR--suburban residential; SC--suburban commercial.

Notes: Numbers in parentheses denote the number of years of observations. Data have been presented only when they are available for four or more years. There are two methods for calculating concentrations of suspended particulate matter: gravimetric measurement and the smoke stain method. These methods are not comparable. Because most air monitoring stations use the former method, only data derived from this method are presented. To maximize the number of cities for which data are presented, information is given on only two site types, though more data than this may be available. Growth rates are calculated using the entire time-series available, although only part of that series may appear in the concentration data presented.

Source: The World Bank, 1991