CHAPTER 5

INVESTIGATION ON BCC PROJECTION ANALYSIS AND POTENTIAL IMPROVEMENTS ON THE PARAMETERS

5.1 INTRODUCTION

When utilizing DEA to evaluate a set of DMUs, an efficient frontier is created that determines which DMU is efficient and which ones are not efficient. The efficient set consists of those DMUs which are not inferior to any other DMU or a convex combination of any other DMUs along any dimension. Similarly, the inefficient DMUs are those that are dominated along at least one of the dimensions either by another DMU or a convex combination of other DMUs.

In the input-oriented method, the efficiency score is determined by holding outputs constant and assessing to what extent inputs would have to be improved i.e. decreased for a DMU to be considered efficient. An efficient DMU has no potential improvement, whereas inefficient DMUs have efficiency scores reflecting the potential improvement based on the performance of other DMUs. By using a linear objective function, it is assumed that the efficient frontier is piecewise linear.

According to the literature on DEA analysis, in the input-oriented method, not only are the outputs made constant, but also, for a given DMU, each input is reduced by the same amount. Thus, for a particular inefficient DMU to become efficient the same level of outputs would need to be maintained by using fewer inputs. Thus, the projection onto the frontier is, in

essence, calculated by reducing the input dimension until the DMU reaches the frontier. Of course, in the case where DMU is efficient, the efficiency score will be one and the inputs would not have to change.

This chapter analyses the BCC projection analysis and the necessary potential improvements required in the individual parameters as a whole. Such an analysis can identify marginal contributions in efficiency ratings with either an additional increase in the specific amount of outputs or a decrease in the specific input amounts. This analysis gives insight into the areas where decision has to be made in order to increase the efficiency of the inefficient SOEU.

5.2 PROJECTION ANALYSIS

The solution vector of λ_n in a basic dual CCR and BCC model indicates whether the n^{th} DMU serves as a role model or peer unit for the DMU_o under evaluation. If $\lambda_n = 0$, then the n^{th} DMU is not a peer unit. However, if $\lambda_n > 0$, say $\lambda_n = 0.201$, then, the n^{th} DMU is a peer unit with 20.1% weight placed on it by deriving the target output and input levels for the DMU under consideration. The inefficient DMU can be improved and to become efficient it needs to delete its input (s_i^-) and augment the shortfall output (s_i^+) as follows:

$$\hat{x}_{in} = \theta_m x_{im} - s_i^- = \sum_{n=1}^{N} x_{in}\lambda_n \quad i = 1.....I \tag{5.1}$$

$$\hat{y}_{jn} = y_{jm} + s_i^+ = \sum_{n=1}^{N} y_{jn}\lambda_n \quad j = 1.....J$$

This is called as BCC-projection.

In order to find information indicating how much and in what areas an inefficient DMU needs to improve, a non zero slack analysis is used to find the targets and potential improvements for the inefficient units. Such an analysis can identify marginal contributions in efficiency ratings with either an additional increase in specific outputs amounts or a decrease in specific input amounts.

5.3 RESULTS AND DISCUSSIONS

Table 5.1 represents the actual value, target value and potential improvements for the inefficient SOEUs. By referring to the above table, the "Target Value" row shows the levels of inputs and outputs that an inefficient SOEU should use or produce in order to be more efficient, while the "Potential Improvement" row shows, in percentage terms, the use of inputs or production of outputs that are needed by an inefficient SOEU to become an efficient one. Potential improvement is defined as a difference between the target value and the actual value represented as percentage with respect to the actual value. The '+' sign indicates the shortfall in the parameter and it has to be increased in order to make the inefficient SOEU as efficient as the peer unit. Similarly the '-' sign indicates the surplus in the parameter and this has to be eliminated to make the SOEU as efficient as the peer unit.

For example, the inefficient SOEU Haryana has the VRS efficiency score of 91.17%. It can decrease the installed capacity (x_1) from 3839.4 MW to 3500.635 MW, circuit length (x_2) from 177461 km to 161802.92 km, derived AT & C losses(x_3) from 59.7% to 44.02%. The corresponding potential improvements calculated for the input parameters are 8.8233 % in installed capacity and circuit length, 26.26% in derived AT & C losses and no improvement is required in the output parameters. This result actually implies that the SOEU Haryana should be given serious consideration to reduce the derived AT & C loss which is the critical parameter in every power delivery system.

Table 5.1 Target and potential improvements of inefficient SOEUs

DMU		Arunachal Pradesh	Assam	Bihar	Chattisgarh	Goa
VRS score		0.6012	0.6032	0.9655	0.79856	0.8733
Actual value	X_1	179.4	1130.9	1286.8	1722	470.7
	X_2	14216	78612	132126	120208	14274
	X_3	83.7	56.7	33.7	69	78.7
	Y_1	0.113	1.177	1.25	2.213	0.396
	Y_2	125.01	1920.38	3730.4	5420.83	1376.66
Target Value	X_1	107.8655	682.25	1242.44	1375.13	411.07
	X_2	8547.475	45376.72	58069.12	83566.899	12465.82
	X_3	40.375	34.20	32.54	35.90	43.05
	Y_1	0.1386	1.177	1.25	2.213	0.396
	Y_2	153.97	3249.76	5089.84	5420.83	1376.66
Potential Improvements (%)	X_1	-39.87	-39.67	-3.44	-20.14	-12.66
	X_2	-39.87	-42.27	-56.05	-30.481	-12.66
	X_3	-51.8	-39.7	-3.4	-48	-45.3
	Y_1	+22.7	0	0	0	0
	Y_2	+23.2	+69.2	+36.4	0	0
DMU		**Haryana**	**Himachal Pradesh**	**Karnataka**	**Madhya Pradesh**	**Meghalaya**
VRS score		0.9117	0.6381	0.9769	0.7753	0.5904
Actual value	X_1	3839.4	1803.2	7784.3	6685	288.2
	X_2	177461	75315	597639	582757	15657
	X_3	59.7	90.7	69	58.5	60.7
	Y_1	3.917	1.646	12.889	6.492	0.168
	Y_2	12915.72	2736.2	23143.17	15907.83	797.02
Target Value	X_1	3500.635	1150.732	7604.97	5183.19	170.157
	X_2	161802.92	48063.11	454401.84	256731.9	9244.098
	X_3	44.02	48.88	64.88	45.36	35.83
	Y_1	3.917	1.646	12.899	6.492	0.168
	Y_2	12915.7	3257.23	23143.17	16442.699	797.02
Potential Improvements (%)	X_1	-8.8233	-36.18	-2.30	-22.47	-40.96
	X_2	-8.8233	-36.18	-23.97	-55.95	-40.96
	X_3	-26.26	-46.10	-5.96	-22.47	-40.96
	Y_1	0	0	0	0	0
	Y_2	0	+19.01	0	3.36	0

Table 5.1(Continued)

DMU		Mizoram	Orissa	Punjab	Rajasthan
VRS score		0.8793	0.6813	0.9691	0.8177
Actual value	X_1	116.8	3023.3	6135.3	5427.6
	X_2	14798	100464	287520	441724
	X_3	61.6	56.4	74.5	55.6
	Y_1	0.128	2.149	5.836	5.845
	Y_2	129.9	7157.48	22125.3	14691.24
Target Value	X_1	102.7	2059.8	5946.15	4438.59
	X_2	10675	68477.158	272700.53	229561.16
	X_3	44.5	38.42	51.747	45.468
	Y_1	0.188	2.149	5.836	5.845
	Y_2	136.25	7157.48	22125..3	14691.24
Potential Improvements (%)	X_1	-12.07	-31.87	-3.08	-18.22
	X_2	-27.86	-31.87	-5.15	-48.03
	X_3	-27.86	-31.87	-30.54	-18.22
	Y_1	+46.87	0	0	0
	Y_2	+4.89	0	0	0
DMU		**Tripura**	**Uttar Pradesh**	**Uttranchal**	**West Bengal**
VRS score		0.7398	0.9292	0.5718	0.9099
Actual value	X_1	244.5	8864.6	1968.9	5559.9
	X_2	14238	494417	65583	188789
	X_3	85.2	56.7	56.5	67.1
	Y_1	0.228	8.806	0.961	4.727
	Y_2	414.26	26659.62	2662.15	17815.87
Target Value	X_1	180.885	8237.10	1125.89	5058.991
	X_2	10533.51	375628.35	37503.02	171780.415
	X_3	43.40	52.68	32.308	52.179
	Y_1	0.228	8.806	0.961	4.727
	Y_2	414.26	26659.2	3523.0.91	17815.87
Potential Improvements (%)	X_1	-26.02	-7.08	-42.82	-9.01
	X_2	-26.02	-24.03	-42.82	-9.01
	X_3	-49.06	-7.08	-42.82	-22.24
	Y_1	0	0	0	0
	Y_2	0	0	0	0

X_1=Installed Capacity; X_2=Circuit Length; X_3=A T & C Losses;

Y_1=Number of consumers; Y_2=Quantity of energy supplied

The total potential improvement of the 18 inefficient SOEU is shown in Figure 5.1.

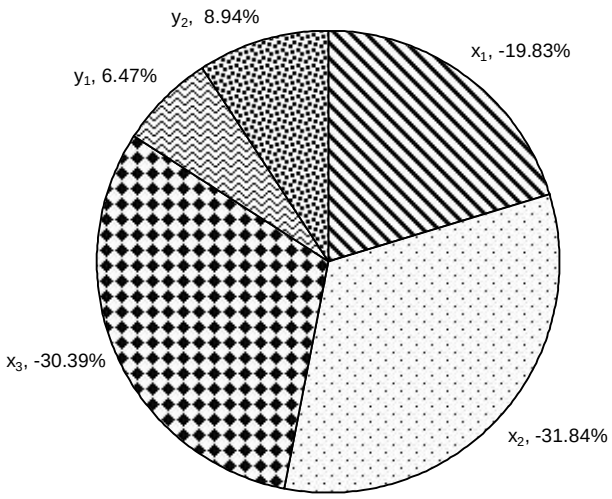

Figure 5.1 Total Potential Improvements for the 18 inefficient SOEU

From Figure 5.1, it is observed that the 18 inefficient SOEUs have the greatest potential in decreasing the input parameters. In the listed input parameters, the installed capacity has to decrease by 19.83%, the circuit length by 31.84% and losses greatly by 30.39%. So mangers and the government have to work on these areas for better utilization of the resources and find innovative methods for loss reduction. While concerning the output parameters, they have less potential for improvement. It is observed that the number of consumers needs to be increased by 6.47% and the energy supplied by 6.94%.

5.4 SUMMARY

This chapter delineated the BCC projection analysis and the necessary improvements in the parameters of the DMU. From this analysis, it is observed that in the BCC model, the inefficient DMUs have used the

resources at a higher rate. It is found that large potential is available in the parameter such as circuit length, AT & C losses and installed capacity. The analysis suggested that it is necessary to reduce these resources so as to make them efficient. Similarly, they have to increase the parameters, namely, quantity of energy supplied and number of consumers. The feasibility of increasing/decreasing the values on this selective parameter has to be decided by the operating personals based on the actual field conditions. But considering the implementation of reducing circuit length, installed capacity and A T & C losses which is not possible in the main grid, it is suggested from the analysis that this could be made possible if the distribution system is off-grid by involving Independent Power Producers or using Hybrid Systems.