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Old AC Compressor Exchange Programme

- (i) Comment on the proposal to have a national programme to replace old inefficient compressors with new efficient compressors in Air Conditioners. Does it make sense ? How can it be implemented ?.

Feasibility of replacement of energy efficient compressors and their implementation

- An independent agency promoted by the provisions of the energy conservation act, 2001 should establish the energy efficiency claimed by the manufacturer. This would facilitate easy acceptance by the end user.
 - If the existing compressor is new and in the warranty period the supplier normally gives free maintenance. Replacement by energy efficient compressor will have to offer free maintenance. Where the AC operates for 8 hrs/day, inclusion of maintenance cost will make the net cash flow negative. (Please refer (ii)).
 - Existing compressor is old and not in the warranty period, energy efficient compressor supplier can consider the option of replacement (where the A/C operates for more than 16 hrs /day), as the IRR in such a situation will be attractive as above. Existing installations of **Voltas & Shriram** Compressors only qualify for replacements. Energy efficient compressor supplier must be in a position to convince the end users. This becomes easier once the certification by an independent agency is obtained. Replacement of the **Carrier & Tecumesens** compressors by most energy efficient compressor (**i.e Kirloskar Copeland**) do not work out financially feasible as a replacement option.
- (ii) **Evaluate the figures and assumptions in the table carefully, and tell us what you would have done differently, or to what extent the data used for the comparison is realistic.**

The following approach would be more realistic. The replacement of A/C compressors in Bangalore city is analyzed and the same approach can be adopted appropriately in respect of other places.

- Each utility will have its own tariff structure for LT & HT classes of consumers. The current tariff structure followed by Bangalore Electric Supply Company Ltd (bescom) along with tariff rates are summarized in **Appendix 1**. The unit power rate needs to be worked out for different tariff structure. Higher the unit power rate, better the financial attractiveness for the same annual energy savings. Summary of unit power rate for various tariffs (bescom) are given below.

Unit power rate (Rs / kWh)	Type of tariff
3 to 4	LT – 6, HT - 4
4 to 5	LT 2a, LT –5, HT 2a
5 to 6	LT2b, HT 2b
>6	LT3

Financial attractiveness for the minimum unit power rate obviously would be more encouraging for the highest unit power rate. In each of the tariff structure (i.e say LT-6), financial attractiveness for the highest unit power rate consumer would be more than the lowest one.

- The varying cooling loads of different makes being marginally different, ignored for comparison purposes.
- Estimation of actual annual energy consumption for the various “**make**” compressors is the first step. For a typical office / industry etc the A/C is normally operated for about 8 hours per day. The actual estimated on time between 0900 hrs to 1700 hrs is as follows. The typical running hours would be different for summer (April – Oct) and other months i.e Nov, Feb & March.

Period 1 – (April – Oct)

Time	Compressor running time	# Blower running time
0900 hrs – 1100 hrs	1/3 of the total time	Continuous
1100 hrs – 1500 hrs	2/3 rd of the total time	Continuous
1500 hrs – 1700 hrs	1/3 of the total time	Continuous

Blower capacity, which would be about 200 kW, is assumed to be the same for all the brands. Hence not considered for analysis. Maintenance cost is Assumed to be constant for all the brands.

Period 2 – (Nov, Feb & March)

Time	Compressor running time	# Blower running time
0900 hrs – 1100 hrs	1/5 of the total time	Continuous

1100 hrs – 1500 hrs	1/3 rd of the total time	Continuous
1500 hrs – 1700 hrs	1/5 of the total time	Continuous

Blower capacity, which would be about 200 kW, is assumed to be the same for all the brands. Hence not considered for analysis.

During Dec & Jan, it is assumed that only blower will be running. Considering Kirloskar – Copeland compressor to be more efficient, the increased annual power consumption of other makes in comparison to Kirloskar-Cope land are summarized below. Calculation is given in Appendix –2.

Total increased annual power consumption (Period 1 & Period 2)

Kirloskar kWh	Shriram kWh	Voltas kWh	Tecumesen kWh	Carrier kWh
-	430	342	86	44

- For a new installation, the incremental investment cost vis –a- vis incremental energy cost savings need to be considered. For evaluation of alternatives, maintenance cost is assumed to be the same for all makes over 10 year period considered for cash flow analysis. Cost of power is assumed to be escalating at 3 % forevery year. Debt : equity ratio of 80 : 20 is considered. Realistic debt repayment interest of 10 % and equity dividend of 15 % is assumed. Financial analysis using NPV / IRR that would be more appropriate for evaluation rather than the simple payback criterion is adopted.

- Higher NPV and / or Higher IRR would be the criteria for selecting an appropriate option.

SUMMARY - Tariff LT2a - Rs 4.1 /kWh					
Make	Initial Investment	Incremental Cost	Annual Energy Savings (kWh)	NPV	IRR
	Rs	Rs	kWh	Rs	%
Shriram	4850	4003	430	4481	37
Kirl-Copeland	8853				
Voltas	4200	4653	342	3717	75
Kir-Copeland	8853				
Tecumesen	5500	3353	86	-1428	Not Feasible
Kirl-Copeland	8853				
Carrier	5150	3703	44	-2239	Not Feasible
Kirl-Copeland	8853				

SUMMARY - Tariff LT2a - Rs 5 /kWh					
Make	Initial Investment	Incremental Cost	Annual Energy Savings (kWh)	NPV	IRR
	Rs	Rs	kWh	Rs	%
Shriram	4850	4003	430	7056	51
Kirl-Copeland	8853				
Voltas	4200	4653	342	5764	110
Kir-Copeland	8853				
Tecumesen	5500	3353	86	-916	Not Feasible
Kirl-Copeland	8853				

Carrier	5150	3703	44	-1976	Not Feasible
Kirl-Copeland	8853				

Simple payback for Shriram Compressor replacement is 2.3 years ; Simple payback for Voltas Compressor is 3.3 years. However IRR is almost double for Voltas compressor replacement in comparison with Shriram Compressor. Typical Cashflow analysis is attached .

Appendix - 1

Bangalore Electricity Supply Company Ltd

LT - TARIFFS

Type of Tariff	Connected Load	Monthly Energy Conspn (kWh)	Tariff (Rs/kWh)
LT2a	3 kW	300	4.1
	3 kW	400	4.8
	3 kW	450	5.0

Type of Tariff	Connected Load	Monthly Energy Conspn (kWh)	Tariff (Rs/kWh)
LT2b	3 kW	200	5.1
	3 kW	300	5.3
	3 kW	450	5.5

Type of Tariff	Connected Load	Monthly Energy Conspn (kWh)	Tariff (Rs/kWh)
LT-3	5 kW	1200	5.9
	10 kW	2000	6.0
	15 kW	3000	6.0

Type of Tariff	Connected Load	Monthly Energy Conspn (kWh)	Tariff (Rs/kWh)
LT-5	3.7 kW	800	3.9
	30 kW	5000	4.3
	51 kW	8500	4.4
	70 kW	11650	4.9

Type of Tariff	Connected Load	Monthly Energy Conspn (kWh)	Tariff (Rs/kWh)
LT-6	3 kW	250	3.7
	5 kW	400	3.7

HT - TARIFFS

Type of Tariff	Contract demand KVA	Monthly Energy Conspn (kWh)	Tariff (Rs/kWh)
HT-2a	200	31200	4.5
	200	78000	3.9
	400	62400	4.5
	400	124800	4.5

Type of Tariff	Contract demand KVA	Monthly Energy Conspn (kWh)	Tariff (Rs/kWh)
HT-2b	200	31200	5.3
	200	78000	4.7
	400	62400	5.3
	400	124800	5.1

Type of Tariff	Contract demand KVA	Monthly Energy Conspn (kWh)	Tariff (Rs/kWh)
HT- 4	200	31200	3.7
	200	78000	3.4
	400	62400	3.7
	400	124800	3.4

Appendix -2

Based on the above running hours, summary of expected daily, monthly and yearly power consumptions for different compressor makes are tabulated below.

Period 1 – (April – Oct)

Time	Kirloskar kWh	Shriram kWh	Voltas kWh	Tecumesen kWh	Carrier kWh
0900 – 1100	1.2	1.5	1.4	1.2	1.2
1100 – 1500	4.7	6.0	5.8	5.0	4.9
1500 - 1700	1.2	1.5	1.4	1.2	1.2
Total	7.1	9.0	8.6	7.4	7.3
Extra power per day	-	1.9	1.5	0.3	0.2
Extra power per month (26 days)	-	49	39	8	5
Extra power For Period 1	-	343	273	56	35

Period 2 – (Nov, Feb & March)

Time	Kirloskar kWh	Shriram kWh	Voltas kWh	Tecumesen kWh	Carrier kWh
0900 – 1100	0.7	0.9	0.9	0.8	0.7
1100 – 1500	2.3	3.0	2.8	2.5	2.4
1500 - 1700	0.7	0.9	0.9	0.8	0.7
Total	3.7	4.8	4.6	4.1	3.8
Extra power per day	-	1.1	0.9	0.4	0.1
Extra power per month (26 days)	-	29	23	10	3
Extra power For Period 2	-	87	69	30	9

