POTENTIAL ASSESSMENT STUDY AT MALLIKARJUN FORGING PVT. LIMITED, PUNE

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Mallikarjun Forging Pvt. Ltd. has an average energy bill of Rs. 67 Lacs per year. Through this energy audit, ECPL has assessed a potential to reduce this bill by at least 18 Lacs per annum. The investment proposed shall have an attractive payback of less than two years. The modular investment plan has minimum investment requirement of upto 15 Lacs for demonstration of results.

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PROJECT INTRODUCTION & PREAMBLE:

The efficient use of energy is one of the most important sustainable solutions that allows for economic growth while mitigating green house gas emissions, a key contributor to climate change. The Bureau of Energy Efficiency (**BEE**), Government of India, has taken a lead role in implementing programs to improve energy efficiency, which is one of the key missions of the **GOI** National Climate Change Action Plan.

Despite overall Indian reductions in aggregate energy intensity, the **SME** sector has fallen behind certain larger Indian industry benchmarks in terms of productivity, technology upgradation and energy efficiency (**EE**). While **EE** projects can offer very attractive returns and banks and institutions in India are increasingly willing to finance such **EE** projects, they have not become the norm in Indian **SME** sector despite the best efforts of numerous institutions and organizations over the years. There are clearly several issues/barriers that still need to be addressed before widespread **EE** adoption by **SMEs** is a reality.

The World Bank (**WB**), in conjunction with implementing partner **BEE**, is preparing a new Initiative on **Financing Energy Efficiency in SME** industrial clusters to help overcome some of these barriers. The main objective of this initiative is to improve energy efficiency and reduce **GHG** emissions from Small and Medium Enterprises utilizing increased commercial financing. The project will systematically support development of a large number of **EE** investment proposals under a programmatic approach to aggregate demand for **EE** investment in selected **SME** industrial clusters and will work to create a sustainable mechanism for identifying, preparing and financing these proposals at the local level. The above initiative envisions supporting certain specific industrial clusters in India through provision of assistance for completion of energy audits, preparation of DPRs and support in mobilization of financing from the Indian local banks to ensure that the identified EE measures are implemented. The ultimate goal of the project is to support development of a

large portfolio of **EE** projects in the selected clusters, and help improve market acceptance (both by SMEs and local banks) for this type of product.

World Bank (**WB**) has decided to retain the services of Energetic consulting Pvt. Limited (**ECPL**), an audit firm of repute (3 year award winner of MEDA for excellence in Energy audit area), for providing **EE** facilitation assistance to 5 **SME** units under the proposed **WB** scheme. **ECPL** is required to carry out 5 Potential assessment studies (**PAS**) and then carry out Detailed Energy Audits and develop Investment Grade Detailed Project reports (**DPR**) in 2 **SME** units out of 5 **PAS**. **ECPL** shall also assist the select units in preparation of application to be submitted to banks, if so desired by the units. **WB**'s ultimate objective is to develop bankable **EE** projects in 2 units (with capital expenditure of Rs. 25 Lacs or more) with simple payback period not more than 2 years for the aggregated **EE** measures and ensure that the projects are implemented and units start saving on their energy cost in most cost effective manner. **ECPL** is committed to provide advisory services to the select units during the entire project development cycle till commissioning. WB then proposes to scale up the entire efforts to @ 150 **PAS** and develop @100 bankable **EE** projects for implementation in Forging units in Pune region.

Under the proposed project **WB** will provide entire facilitation, **at its own cost**, to select **SME** units, to address the current gap between energy auditors and bank loan officers and will demonstrate a viable mechanism of synergic tie up between **SMEs**, energy auditors, financial analysts/chartered accountants, local associations and local bankers. The project will also provide complete information on current **EE** lending schemes of Indian banks, to assist the **SME** units to take well informed decision for financing the **EE** project. The ultimate financing choice for identified investments under this project will be demand driven, and participating **SME** units will be free to obtain financing from any of the sources available to them- including their existing banks, new banks who are participating in the **GEF** Project, or other internal/external sources.

A stakeholder workshop was organized by Association to present this new initiative and to solicit response from key SME Forging units in Pune region to participate actively in this WB initiative and take the advantage of soft costs being supported by WB/GEF project to implement the EE project in the SME unit, subject to off course, it being techno-commercially attractive.

FACILITY DESCRIPTION:

Mallikarjun Forging Pvt. Limited, Chakan, Pune, is one of the leading manufacturing firms having production capacity of average 89 MT per month. The facility mainly has forging furnaces (3 numbers), Normalizing furnace (box type). Furnace oil is used for forging applications. LDO is used for box type furnaces and is not used continuously.

Electrical facility comprises of electrical induction heating furnace (1 number with 100 kW) capacity, air compressors of total 121.8 cfm capacity and 482.5 HP additional for hammers and presses. Transformer capacity is 500 kVA and average power factor is 1. Auxiliary system comprises of cooling tower, water pumps, blower, shot blasting machines and lighting.

The facility has a machine shop where large numbers of small motors are used for individual machines with some of the machines having hydraulic systems.

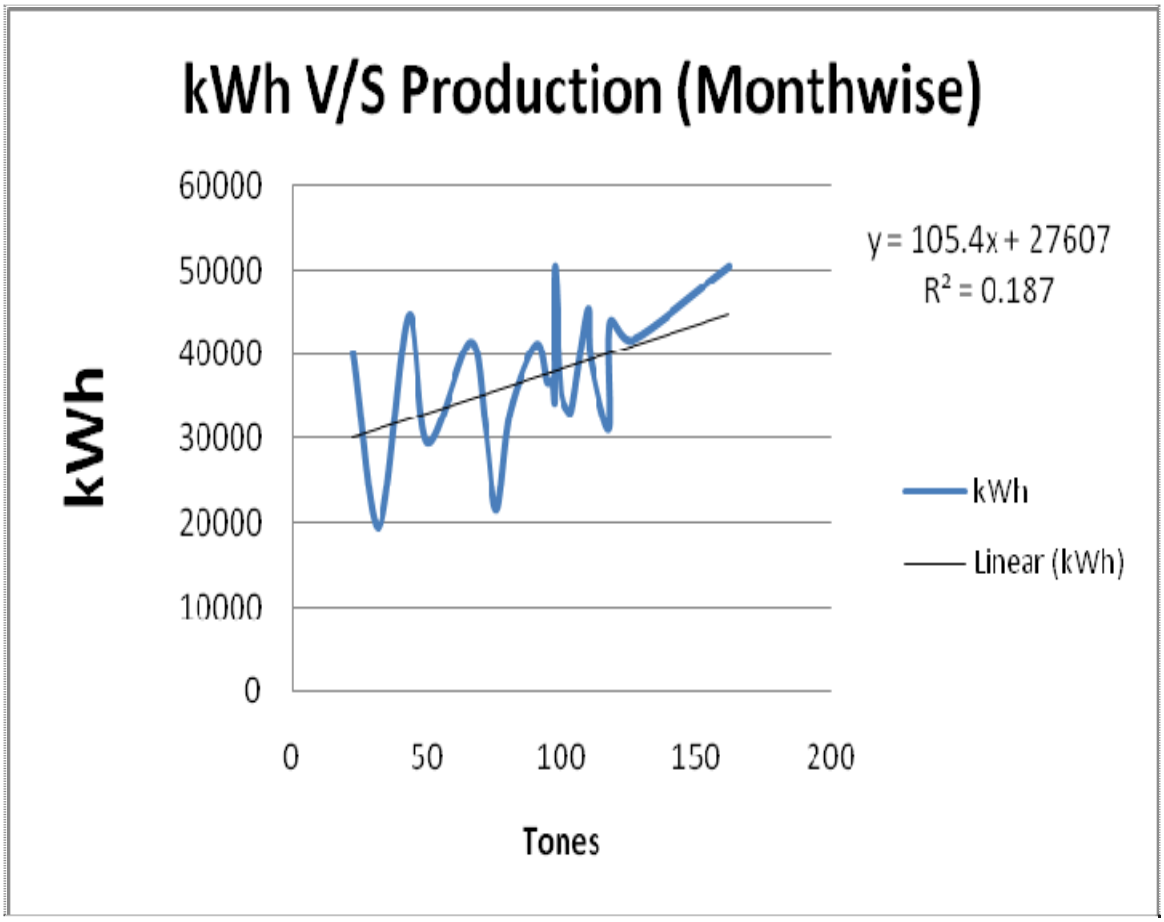
PRESENT ENERGY SCENARIO:

Following table shows energy consumption and production in the plant:

Year	Month	Net Production	Furnace oil		Power	
			Total	Per ton	Total	Per ton
		Tones	liters	liters/ton	kWh	kWh/ton
2007	April	117.84	20432	173.388	43794	371.64
	May	99.799	16643	166.765	35232	353.03
	June	97.05	17690	182.277	34518	355.672
	July	117.39	16631	141.673	31122	265.116
	August	71.586	11677	163.118	31098	434.415
	September	50.16	13713	273.385	29502	588.158
	October	80.722	13501	167.253	33252	411.932
	November	31.953	7979	249.711	19482	609.708
	December	90.47	11632	128.573	41178	455.156
2008	January	97.24	12616	129.741	50442	518.737
	February	110.55	16270	147.173	39360	356.038
	March	75.69	14251	188.281	21558	284.82
	April	102.97	17464	169.603	33042	320.89
	May	109.396	15840	144.795	45210	413.269
	June	161.952	18286	112.91	50442	311.463
	July	126.312	21803	172.612	41706	330.182
	August	96.24	13840	143.807	36900	383.416
	September	103.93	14253	137.14	34164	328.721
	October	94.358	11761	124.642	36678	388.711
	November	65.961	12488	189.324	41442	628.28
	December	42.911	8378	195.241	44502	1037.08
2009	January	22.522	7145	317.245	40086	1779.86
	AVERAGE	**89.409**	**14286.05**	**173.575**	**37032.27**	**496.65**

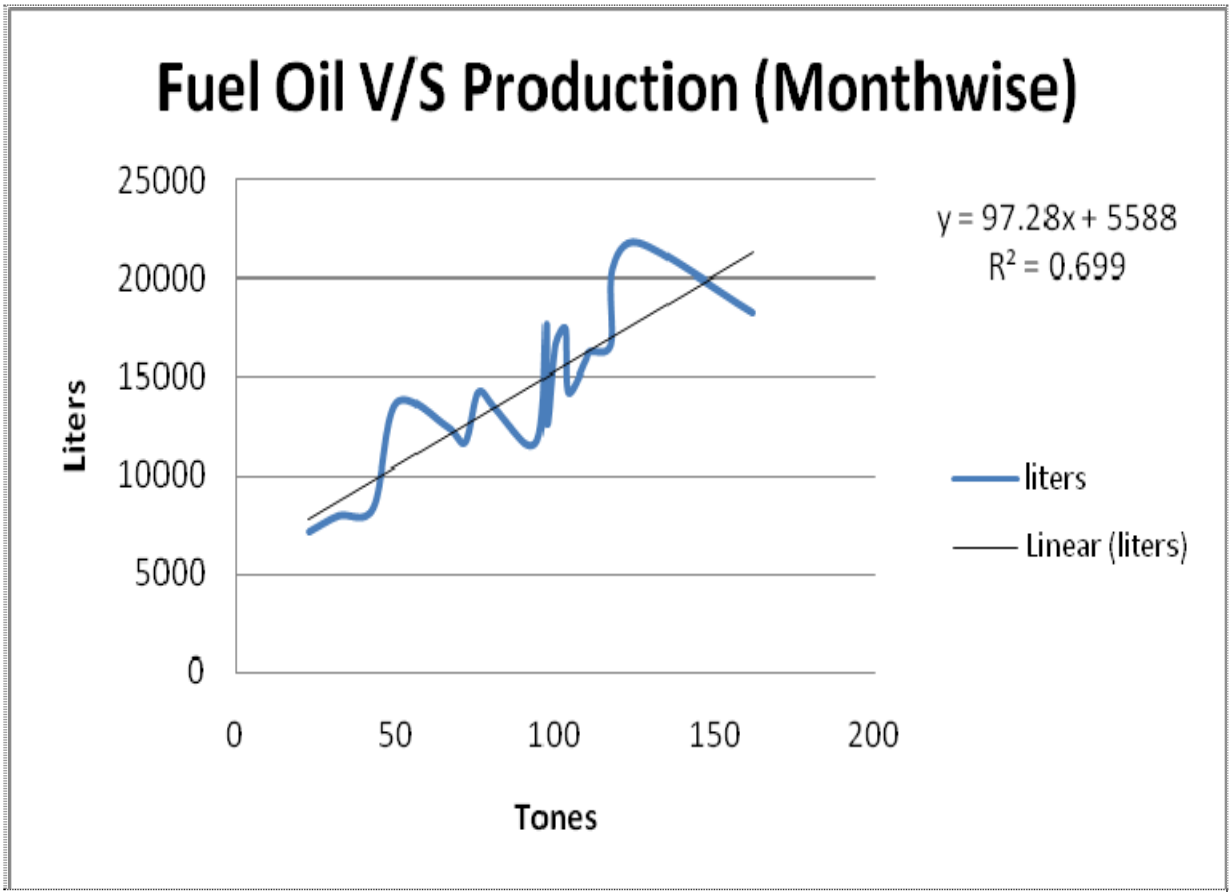
ANALYSIS OF DATA:

The production volumes have changed during the period from a level of 162 MT per month to 23 MT per month. Due to these drastic variations, there is no definite trend in the electrical energy consumption. The regression coefficient (R^2) is very low (0.187), which means that the data is not representative. One of the reasons of large variations in the data could be that the production figures do not distinguish between production output from electrical furnace and production through fuel fired furnace. The error due to that is reflected on both, electrical as well as fuel analysis.



It is evident from the graph that the fixed electrical energy consumption is to the extent of 27607 kWh which is very high for lower production volumes. It is necessary to minimize fixed consumptions in electrical energy.

The fixed oil consumption of the plant is 5588 liters per month and variable consumption is 97.28 liters per ton. Looking at average oil consumption, 14286 liters per month is very reasonable at higher throughputs but at lower levels, it amounts to 55% of the total oil consumption. The regression coefficient (R^2) is 0.7, which means that the data is not representative. One of the reasons of large variations in the data could be that the production figures do not distinguish between production output from electrical furnace and production through fuel fired furnace. The error due to that is reflected on both, electrical as well as fuel analysis



Average overall specific energy consumption is 173.5 liters/Ton out of which 97.3 liters per ton is variable. Considering that the theoretical requirement of heat for metal heating is not more than 20 Liters per ton, 80% of the heat from variable energy is wasted in stack losses which are propotional to the fuel firing(and finally production volume).

RECOMMENDATIONS:

Energy conservation opportunities in forging industry are centered on basic concepts of improving energy efficiency by recouping waste heat from hot gases. There is another way to reduce energy cost by substituting fuel oil or LDO by cheaper fuel like coal or briquettes.

Alternatively, overall system efficiency can be improved by shifting to electrical forging and captive generation of electricity by using Fuel Oil fired generator sets. Though highly capital intensive this option has substantial energy conservation potential. Following chapter provides energy saving potential of each of the ideas and also their budgetary cost benefit analysis:

1. **Waste Heat Recovery though recuperator:**

   Flue gases coming out of the furnace are at 1000 deg C and are vented to the atmosphere. For each furnace, individual chimney has been provided to vent out exhaust gases from furnace.

   It is recommended to install a recuperator to recoup waste heat and utilize it in the furnace through combustion air preheating. It is possible to increase temperature of the combustion air from ambient upto 500 deg C. This combustion air shall then require lesser fuel to achieve desired temperatures, thus resulting in energy conservation.

   Design basis of 15 liters of oil per hour is considered for computation of energy conservation potential and investment analysis. Typical production output from the furnace shall be 0.5 MT/shift or 1.5 MT per day. The recuperator installation is expected to reduce the oil consumption to 11.5 liters per hour expected to result in 3.5 liters of FO saving per hour. Specific fuel consumption per ton shall thus reduce from 174 liters/ton to 130 liters per ton. For average production volume of 1.5 MT per day the savings amount to 66 liters per day. Considering 250 working days per year of the furnace and Rs. 18 per liter of FO, the annual energy savings go upto Rs. 3.00 Lacs per annum **or Rs. 792 per MT**.

   Capital investment proposed shall be in the range of 7.5 Lacs and the simple payback period is expected to be 30 months.

Energy saving potential estimation in Plant forging furnaces based on past 12 months

Year	Month	Net Production	Furnace oil		Proposed	Saving Potential	
			Total	Per ton	Liters/Ton	Liters/month	Rs./month
		Tones	liters	liters/ton			
2007	April	117.84	20432	173	130	5113	92030
	May	99.799	16643	167	130	3669	66044
	June	97.05	17690	182	130	5074	91323
	July	117.39	16631	142	130	1370	24665
	August	71.586	11677	163	130	2371	42675
	September	50.16	13713	273	130	7192	129460
	October	80.722	13501	167	130	3007	54129
	November	31.953	7979	250	130	3825	68852
	December	90.47	11632	129	130	-129	-2324
2008	January	97.24	12616	130	130	-25	-454
	February	110.55	16270	147	130	1899	34173
	March	75.69	14251	188	130	4411	79403
	April	102.97	17464	170	130	4078	73402
	May	109.396	15840	145	130	1619	29133
	June	161.952	18286	113	130	-2768	-49820
	July	126.312	21803	173	130	5382	96884
	August	96.24	13840	144	130	1329	23918
	September	103.93	14253	137	130	742	13358
	October	94.358	11761	125	130	-506	-9100
	November	65.961	12488	189	130	3913	70435
	December	42.911	8378	195	130	2800	50392
2009	January	22.522	7145	317	130	4217	75909

From the above table it is seen that the overall potential to save is in the range of Rs. 10.5 Lacs per annum. Considering the new furnaces having potential to forge 1.5 MT per day, three such furnaces can deliver the desired output. Capital investment for the two furnaces shall be Rs. 15 lacs and simple payback period shall be 18 months.

2. Energy cost reduction through Producer Gas:

Furnace oil, as a fuel can be replaced by coal fired Producer Gas. This gas, which is mixture of carbon Monoxide and Hydrogen, is generated at site by incomplete combustion of coal. There are several advantages of PG over furnace oil viz;

1. Reduction in fuel cost
2. Downsizing of furnace and making it compact thereby reducing radiation losses and improving furnace efficiency
3. Reduction in scaling losses of metal due to clean combustion with less excess air

Once again, design basis of 15 liters of oil per hour is considered for computation of energy conservation potential and investment analysis. Typical production output from the furnace shall be 0.5 MT/shift or 1.5 MT per day. Imported coal is considered as replacement fuel and the PG plant capacity after recuperator installation is expected to be equivalent to 1.0 MT of coal per day. Cost of imported coal shall be Rs. 4500/- per day (@Rs. 4.5 per kg) as against equivalent Furnace oil cost of Rs. 6,480/- per day (@Rs. 18 per liter). The average production volume considered is 1.5 MT per day, and the savings amounts to Rs. 1980/- per day or equivalent to **Rs. 1320 per MT**. Considering 250 working days per year of the furnace the annual energy savings go upto Rs. 5.00 Lacs per annum. ***Please note that this saving is over and above the Rs. 10.50 Lacs saving expected out of recuperator.***

Capital investment proposed shall be in the range of 7 Lacs and the simple payback period is expected to be 17 months.

Overall, the FO consumption is expected to reduce to 130 MT per annum due to recuperator and lower production volumes compared to previous year. Equivalent imported coal consumption is expected to be 360 MT if PG is considered as fuel. Cost reduction potential due to implementation of this suggestion is expected to be Rs. 7.20 Lacs per annum. Though exact investment can be calculated only after knowing number of furnaces (or PG plants), an estimation of 2 furnaces and PGs works out to be Rs. 14 Lacs. The simple payback works out to two years.

3. Furnace oil fired DG set:

Typical fuel consumption of FO fired forging furnace is in the range of 200 liters per MT of production. Several power cuts make it difficult to ensure constant throughput in the production machines. It is possible to reduce these power cut related losses and simultaneously reduce energy cost by shifting to FO fired DG sets.

Once again, design basis of 15 liters of oil per hour is considered for computation of energy conservation potential and investment analysis. Typical production output from the furnace shall be 0.5 MT/shift or 1.5 MT per day. Electrical energy consumption in electrical induction heaters is 650 kW per MT. If same 15 liters of FO is fired in the generator, power output is expected to be 69 kW.

In order to match the production output of 0.5 MT per shift, 53 kW out of 69 kW would be consumed and 16 kW equivalent of surplus energy would be available to operate electrical gadgets and machinery. The savings thus accrued would correspond to Rs. 1536/- per day on account of electrical energy substitution. Therefore, the overall cost reduction potential shall be **Rs. 1000 per MT** of production.

Since the plant already has one induction heater of 100 kW capacity, the production capacity could be matching. It is possible to consider a generator of 250 kW capacities to meet the entire factory demand, including electrical induction heaters and hammers. The capital investment for the generator sets would be in the range of Rs. 0.72 Crores. The FO consumption on account of these engines would be 14 kL per month and equivalent production output of 100 MT per month. The energy saving potential equivalent to Rs. 1000 / MT shall work out to Rs. 0.12 Crores per annum with a simple payback period of 6 years.

It is also possible to replace part of / entire furnace oil with producer gas. This would reduce the cost of power generation by another 40% and payback period of entire project can be brought down to two years.

The project may be viable considering additional benefits like loss due power outages and scaling.

4. Lighting energy controller:

The plant lighting load is around 20 amperes (based on the data provided by plant personnel) which corresponds to 7 kVA equivalent load. Considering average 10 hours per day of light burning hours, the average energy bill of lighting would be Rs. 0.6 Lacs per annum out of which 25% can be reduced by installing lighting controller panel on the lighting feeders. Typical cost of the system would be Rs. 0.35 Lacs depending upon number of panels required. The payback period is expected to be less than 2.5 years. Vendors have been informed to contact facility and provide exact quotation.

5. Oxygen enrichment of air:

This is one of the proven techniques to improve efficiency of furnaces, particularly where the temperature requirements are above 600 deg C. Conceptually, every kg of oxygen required for combustion is associated with 3.27 kg of nitrogen in air. This nitrogen does not contribute to chemical reaction with carbon from fuel but carries heat at very high temperature (around 1000 deg C) amounting to huge heat loss.

It is possible to enrich atmospheric air oxygen content from 23.6% to 35% thereby reducing energy loss by 15%. Cost benefit analysis of this suggestion can be worked out only after detailed study as nitrogen separated from air is available to replace compressed air and composite benefit should be considered.

CONCLUSION

There are several opportunities for the units to reduce their energy cost substantially. Innovation would be the essence of such implementation project. Demonstration projects shall be implemented in this phase of pilot study and the benefits shall be showcased.

Summary of all ideas for energy conservation are as follows:

PARTICULARS OF PROPOSED RECOMMENDATION	GHG REDUCTION POTENTIAL, MT	INVESTMENT, RS. LACS	ENERGY SAVING POTENTIAL, RS. LACS	SIMPLE PAYBACK, MONTHS
Waste Heat Recovery through recuperator	150	15	10.5	18
Energy cost reduction through Producer Gas	NA	14	7.20	24
Furnace oil fired DG set	300	80	20	48
Lighting energy controller	NA	0.35	0.15	28
Oxygen enrichment of air	NA	NOT QUANTIFIED		

Though the figures indicated in the savings and investment column are fairly indicative, the basis of calculations is data provided by the unit. It is essential to verify the data through detailed measurements by auditors at the DPR stage and design the solutions in consultation with the plant management.