POTENTIAL ASSESSMENT STUDY AT LAXMI AGNI COMPONENTS & FORGING PVT. LIMITED, AURANGABAD

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Laxmi Agni Components & Forging Pvt. Ltd. has an average energy bill of Rs. 400 Lacs per year. Through this energy audit, ECPL has assessed a potential to reduce this bill by at least Rs. 50 Lacs per annum. The investment proposed shall have an attractive payback of slightly more than one year. The modular investment plan has minimum investment requirement of upto 30 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:

Laxmi Agni Components & Forging Pvt. Limited, Chikhalthan, Arangabad, is one of the leading manufacturing firms having production capacity of average 425 MT per month. The facility mainly has forging furnaces (3 number fuel oil fired and 2 nos. induction), heat treatment furnace (1 number) where thermal energy is used. Furnace oil is used for forging applications. LDO is used for box type furnaces and are not used as continuously as other furnaces.

Electrical facility comprises of electrical induction heating furnaces (2 numbers with total 350 kVA and 500 kVA) capacity, air compressors of total 800 cfm capacity and 360 HP additional to hammers and presses. Transformer capacity is 1600 kVA and average power factor is 0.98. Auxiliary system comprises of cooling tower (1 number), water pumps, blowers, 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.

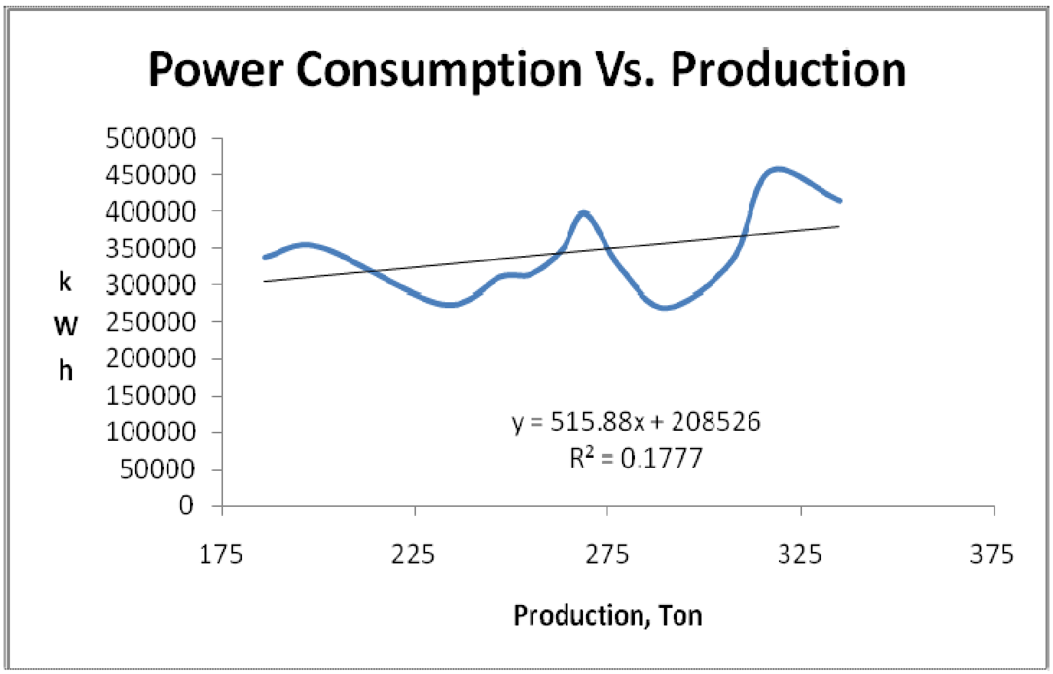
PRESENT ENERGY SCENARIO:

Following table shows energy consumption and production in the plant:

Year	Month	Fuel for Production, liters/month	Production, TONS	Fuel for HT, liters/month	Production HT, TON	Total Fuel In Liter/ Month	ENERGY , kWh/month	Demand, KVA	PF
2008	April	38697	428	33681	402	72378	311640	1104	0.99
	May	29864	393	33907	402	63771	315444	1133	0.98
	June	43537	454	40630	480	84167	398640	1117	0.98
	July	43436	436	37906	473	81342	325644	1090	0.97
	August	55247	515	45093	532	100340	414672	1141	0.97
	September	43312	511	42945	532	86257	456252	1133	0.98
	October	61703	445	34566	470	96269	348744	1133	1.00
	November	43842	409	31760	383	75602	338616	1048	0.92
	December	43042	437	39274	494	82316	270060	1136	0.99
2009	January	13658	288	28592	337	42250	353388	1091	0.98
	February	46492	325	33249	386	76741	275304	1084	0.99
	March	15955	457	39445	451	55400	333878	1118	0.99

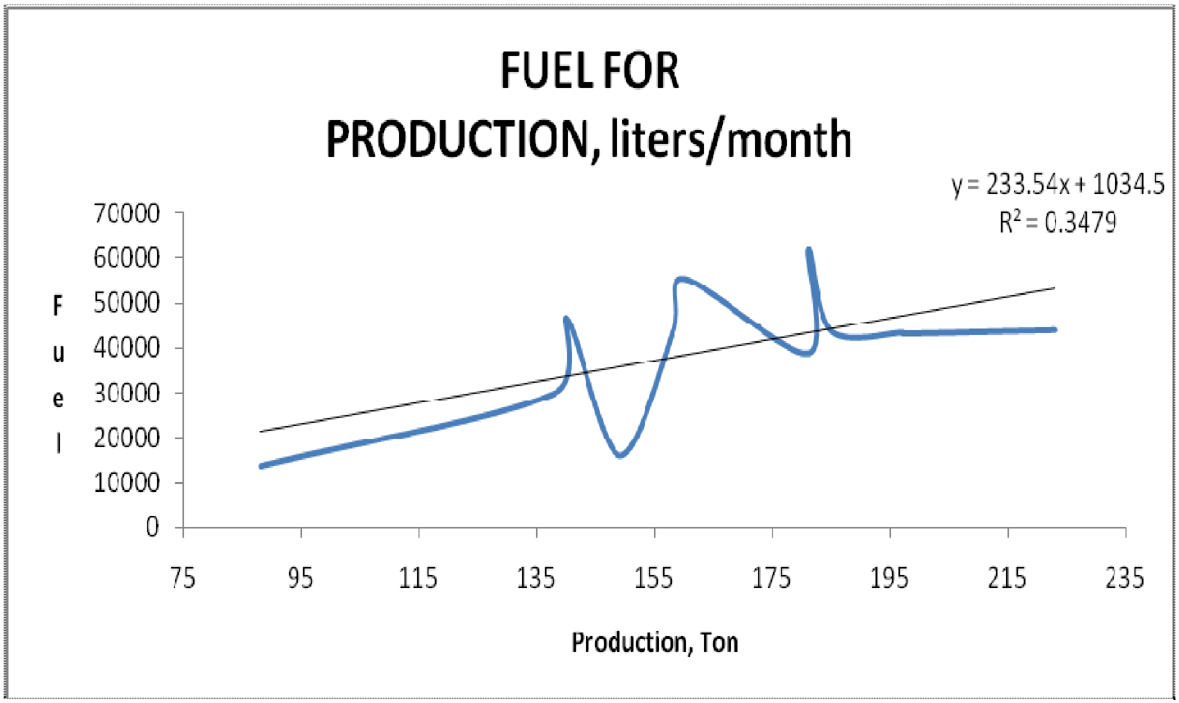
ANALYSIS OF DATA:

The production volumes have changed during the period from a level of 515 MT per month to 288 MT per month. Due to these drastic variations, there is no definite trend in the electrical energy consumption. The regression coefficient (R^2) is low (0.18), 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 done from electrical furnace and production through fuel fired furnace. The error due to that is reflected on both, electrical as well as fuel analysis.



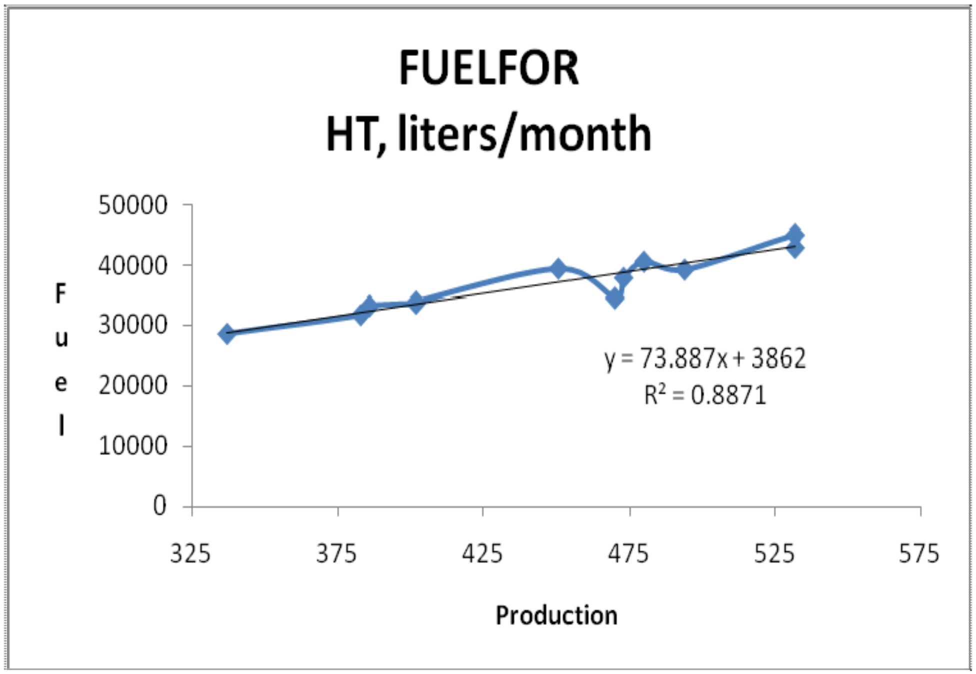
It is evident from the graph that the fixed electrical energy consumption is to the extent of 208526 kWh which is very high for lower production volumes. It is necessary to minimize fixed consumptions in electrical energy.

The fixed oil consumption of the plant is 1035 liters per month and variable consumption is 234 liters per ton. Looking at overall oil consumption, 39900 liters per month is very reasonable at higher throughputs but at lower levels, it amounts to 65% of the total oil consumption. The regression coefficient (R^2) is 0.35, which means that the data is not representative.



Average overall specific energy consumption is 238 liters/Ton out of which 234 liters per ton is variable. Considering that the theoretical requirement of heat for metal heating is not more than 20 Liters per ton, 85% of the heat from variable energy is wasted in stack losses which are propotional to the fuel firing(and finally production volume).

The fixed oil consumption of the plant is 3862 liters per month and variable consumption is 74 liters per ton. Looking at overall oil consumption, 3862 liters per month of fixed oil is very reasonable. The regression coefficient (R^2) is 0.89, which means that the data is representative.



The plant mainly would use LDO for heat treatment and the overall average oil consumption is 83 liters per ton, out of which 74 liters per ton is variable.

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. There is a common chimney through which all the furnace exhausts are connected.

   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 30 liters of oil per hour is considered for computation of energy conservation potential and investment analysis. Typical production output from the furnace shall be 1 MT/shift or 3 MT per day. The recuperator installation is expected to reduce the oil consumption to 23 liters per hour expected to result in 7 liters of FO saving per hour. Specific fuel consumption per ton shall thus reduce from 238 liters/ton to 180 liters per ton. For average production volume of 3 MT per day the savings amount to 175 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. 8.00 lacs per annum **or Rs. 1066 per MT**.

   Capital investment proposed shall be in the range of 12 lacs and the simple payback period is expected to be 1.5 year.

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

Year	Months	Fuel For Production, liters/month	Hammer In Ton	Fuel Consumption per ton of Hammer	Proposed Fuel Consumption, Liters/ton	Saving Potential, Liters/month	Saving Potential, Rs./month
2008	April	38697	181	213.80	180.00	6117	110106
	May	29864	138	216.41	180.00	5024	90432
	June	43537	185	235.34	180.00	10237	184266
	July	43436	158	274.91	180.00	14996	269928
	August	55247	160	345.29	180.00	26447	476046
	September	43312	197	219.86	180.00	7852	141336
	October	61703	181	340.90	180.00	29123	524214
	November	43842	223	196.60	180.00	3702	66636
	December	43042	197	218.49	180.00	7582	136476
2009	January	13658	88	155.20	180.00	-2182	-39276
	February	46492	140	332.09	180.00	21292	383256
	March	15955	149	107.08	180.00	-10865	-195570

From the above table it is seen that the overall potential to save is in the range of Rs. 21.50 Lacs per annum. Considering the new furnaces having potential to forge 3 MT per day, two such furnaces can deliver the desired output. Capital investment for the two furnaces shall be Rs. 24 Lacs and simple payback period shall be slightly more than 1 year.

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 30 liters of oil per hour is considered for computation of energy conservation potential and investment analysis. Typical production output from the furnace shall be 1 MT/shift or 3 MT per day. Imported coal is considered as replacement fuel and the PG plant capacity after recuperator installation is expected to be equivalent to 2.0 MT of coal per day. Cost of imported coal shall be Rs. 9000/- per day (@Rs. 4.5 per kg) as against equivalent Furnace oil cost of Rs. 12,960/- (@Rs. 18 per liter). The average production volume considered is 3 MT per day, and the savings amounts to Rs. 3960/- 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. 10.00 Lacs per annum. ***Please note that this saving is over and above the Rs. 31 Lacs saving expected out of recuperator.***

Capital investment proposed shall be in the range of 12 Lacs and the simple payback period is expected to be less than 15 months.

Overall, the FO consumption is expected to reduce to 360 MT per annum due to recuperator and lower production volumes compared to previous year. Equivalent imported coal consumption is expected to be 970 MT if PG is considered as fuel. Cost reduction potential due to implementation of this suggestion is expected to be Rs. 21 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. 24 Lacs. The simple payback works out to be just above one year.

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 30 liters of oil per hour is considered for computation of energy conservation potential and investment analysis. Typical production output from the furnace shall be 1 MT/shift or 3 MT per day. Electrical energy consumption in electrical induction heaters is 650 kW per MT. If same 30 liters of FO is fired in the generator, power output is expected to be 138 kW.

In order to match the production output of 1 MT per shift, 105 kW out of 138 kW would be consumed and 33 kW equivalent of surplus energy would be available to operate electrical gadgets and machinery. The savings thus accrued would correspond to Rs. 3170/- 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 two induction heaters of 300 kVA and 500 kVA capacity, the production capacity of 265 MT /month could be matched if we provide electricity through furnace oil fired D.G. sets. However, typical configuration of hammers and presses does not allow these two furnaces to feed hot metal to all. It is possible to consider a generator of 0.6 MW capacity 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. 1.7 Crores. The FO consumption on account of these engines would be 72 kL per month and equivalent production output of 500 MT per month. The energy saving potential equivalent to Rs. 1000 / MT shall work out to Rs. 60 Lac per annum with a simple payback period of 3 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. **Power factor improvement to Unity:**

   Present power factor is maintained at 0.98 due to constraints of power quality (harmonic related issues) due to induction heaters. There is an incentive equivalent to 3% of energy bill if the PF is improved from 0.98 to Unity. Financial benefit due to PF improvement shall be Rs. 6.6 Lacs per annum on incentives and insignificant amount due to demand reduction.

   Investment proposed in the system shall be in the range of Rs. 6.0 Lacs and simple payback period is expected to be less than 1 year. Please note that the investment would also include certain components required for power quality improvements. It is possible to provide accurate solutions for power quality problems only after design and detail engineering.

5. **Lighting energy controller:**

   The plant lighting load is around 60 amperes (based on the data provided by plant personnel) which corresponds to 20 kVA equivalent load. Considering 12 hours per day of light burning hours, the average energy bill of lighting would be Rs. 2.7 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. 1 Lacs depending upon number of panels required. The payback period is expected to be in the range of 18 months or less. Vendors have been informed to contact facility and provide exact quotation.

6. **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	INVESTMENT, Rs. Lacs	Energy Saving potential, Rs. Lacs	Simple Payback, Months	GHG Reduction Potential, ton of CO_2
Waste Heat Recovery though recuperator	24	21.5	14	300
Energy cost reduction through Producer Gas	24	21	14	NA
Furnace oil fired DG set	170	60	34	850
Power factor improvement to Unity	6	6.6	11	NA
Lighting energy controller	1	0.68	18	NA
Oxygen enrichment of air	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.