July 2018

DETAILED PROJECT REPORT
ON
HYDROXY FUEL GENERATOR FOR FUEL FIRED REHEATING FURNACE

M/s Senor Metals Pvt. Ltd. –Jamnagar Brass Cluster

Submitted to
(Prepared under GEF-UNIDO-BEE Project)

Bureau of Energy Efficiency
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Prepared by

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List of Abbreviations

AC	Alternate Current
ANSI	American National Standards Institute
BEE	Bureau of Energy Efficiency
DC	Direct Current
DPR	Detailed Project Report
EE	Energy Efficiency
GEF	Global Environmental Facility
IRR	Internal Rate of Return
kW	Kilo Watt
LSP	Local Service Provider
MSME	Micro and Medium Scale Industries
NPV	Net Present Value
OEM	Original Equipment Manufacturer
PGVCL	Paschim Gujarat Vij. Company Ltd
TOE	Tonnes of Oil Equivalent
UNIDO	United Nation Development Organization

ACKNOWLEDGEMENT

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CII would also like to give special gratitude to Jamnagar Brass Factory Owners' Association for supporting CII for carrying out this project at Jamnagar Brass Cluster and for their constant support and coordination throughout the activity.

CII is grateful to Mr. Milind Deore, Director, Bureau of Energy Efficiency, Mr. Sanjay Shrestha, Industrial Development Officer, Industrial Energy Efficiency Unit, Energy and Climate Branch, UNIDO , Mr. Suresh Kennit, National Project Coordinator, UNIDO, Mr. Niranjan Rao Deevela, National Technology Coordinator, UNIDO and Mr. Samir Patel, UNIDO ,Cluster Leader, Jamnagar-Brass Cluster for their support and guidance during the project.

Last but not least we are thankful to Senor Metals Pvt. Ltd., especially Mr. Sangani C. G, for showing keen interest in the implementation of this technology and providing their wholehearted support and cooperation for the preparation of this Detailed Project Report.

We would take this opportunity to express our appreciation to the Original Equipment Suppliers and Local Service Providers for their support in giving valuable inputs and ideas for the completion of the Detailed Project Report.

We would also like to mention that the valuable efforts being taken and the enthusiasm displayed towards energy conservation by the Jamnagar Brass Cluster is appreciable and admirable.

1. EXECUTIVE SUMMARY

Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, in collaboration with United Nations Industrial Development Organization (UNIDO) is executing a Global Environment Facility (GEF) funded national project "Promoting energy efficiency and renewable energy in selected MSME clusters in India". The overall aim of the project is to develop and promote a market environment for introducing energy efficiency and enhanced use of renewable energy technologies in process applications in 12 selected energy-intensive MSME clusters across 5 sectors in India (with expansion to more clusters later). This will enable improvement in the productivity and competitiveness of units, as well as reduce overall carbon emissions and improve the local environment.

Key activities involved in the project are as follows:

- **LSP MAPPING:** Detailed Mapping of LSPs in the cluster.
- **TECHNOLOGY FEASIBILITY STUDIES:** Preparation of 10 bankable DPRs.
- **TRAINING MATERIALS:** Development of 5 customized training material based on mapping
- **TRAINING PROGRAM:** Conduct 4 training programs in the cluster for the capacity building of local service providers.
- **LSP's AS LOCAL DISTRIBUTORS:** Mapping of LSPs and OEMs so that LSPs can become local dealers for major OEMs.

1.1 Brief Unit Profile

Table 1: Unit Details

Particulars	Details
Name of Plant	Senor Metals Pvt. Ltd
Name(s) of the Plant Head	Mr. Sangani C G
Contact person	Mr. Sangani C G
Constitution	Private Company
MSME Classification	-
Address:	Plot No 353 GIDC 2, Dared Jamnagar 361005
Industry-sector	Manufacturing

1.2 Proposed EE Measure

During the plant visit it was observed that the plant was operating with furnace oil in reheating furnace to reheat the billets for further extrusion process and the fuel consumption these furnaces is significant. Reheating furnace normally has lower efficiency and create a lot dust pollution problem in the plant. After discussion with the plant team and technology supplier, it

was proposed to install a Hydroxy fuel generator, which is expected to reduce 10% fuel consumption in the reheating furnace. The fuel Hydroxy generator uses very less amount of water to generator a mixture of oxygen and hydrogen gas through electrolysis process, this out gas line should be mixed either with the fuel line or combustion air-line just before the burner. The expected annual reduction in FO consumption will be 19.744Tonnes, which will give a monetary saving of Rs. 6.32 lakhs per annum. The details of the proposed EE measure are given in below:

Table 2: Proposed EE Measure

Sl No	EE Measure	Annual Energy Savings, (TOE)	Monetary Savings (Rs. Lakhs)	Investment (Rs. Lakhs)	Payback (Months)	Annual GHG reduction (T CO_2)
1	**Hydroxy fuel generator for fuel fired reheating furnace**	19.35	6.32	8.24	16	61.32

1.3 Means of Finance

The details of means of finance for the proposed EE measure is as under:

Table 3; Project Finance

Sl. No.	Particulars	Unit	Value
I	**Total Investment (Incl. of Tax)**	Rs. Lakh	8.24
Ii	**Means of Finance**	Self / Bank Finance	Self
Iii	**IRR**	%	101.2
Iv	**NPV at 70 % Debt**	Rs. Lakh	28.2

2. INTRODUCTION ABOUT SENOR METALS PVT. LTD.

2.1 Unit Profile

Senor Metals Pvt. Ltd. (SMPL) was established in 1998 and is involved in the manufacturing wide range of single piece products such as welding consumables, brazing components, aluminum metalizing wire, brass hollow rods & wires, welding accessories and different brass components. SMPL has a strong team of experienced and visionary professionals to achieve higher level of efficiency and excellence to meet the challenging market demands.

SMPL is committed to limiting the environmental impact of its production activities, conserving scarce resources and encouraging pro-environmental activities such as recycling of copper alloys and owns two wind turbines at the west coast of India. 70% of energy requirement of SMPL is met by these two wind turbines. Electricity generated by the turbines is fed into the Gujarat State Electricity Grid which in turn delivers SMPL requirements to the factory.

Exhaust hot gases and zinc oxide are collected and passed through bag houses. Zinc oxide is collected in bag house drums and oxide free gases are released at ambient temperature, while zinc oxide ash is sold to government authorized processors. And SMPL has developed practices to create a hazard free and accident free working environment and has installed safety systems such as fume arrestor and ETP plant for achieving zero discharge of water make the processes friendly to the environment.

Table 4: Unit Profile

Particulars	Details
Name of Plant	Senor Metals Pvt. Ltd
Name(s) of the Plant Head	-
Contact person	Mr. Sangani C G
Contact Mail Id	maintenance@senormetals.in
Contact No	+91 9898266695
Constitution	Private Company
MSME Classification	-
No of operating hrs./day	24 hrs.
No of operating days/year	300 Days
Address:	Plot No 353 GIDC 2, Dared Jamnagar 361005, Gujarat
Industry-sector	Manufacturing
Type of Products manufactured	welding consumables, brazing components, aluminum metalizing wire, brass hollow rods & wires, welding accessories, etc.

2.2 Typical Brass Production Flow Diagram

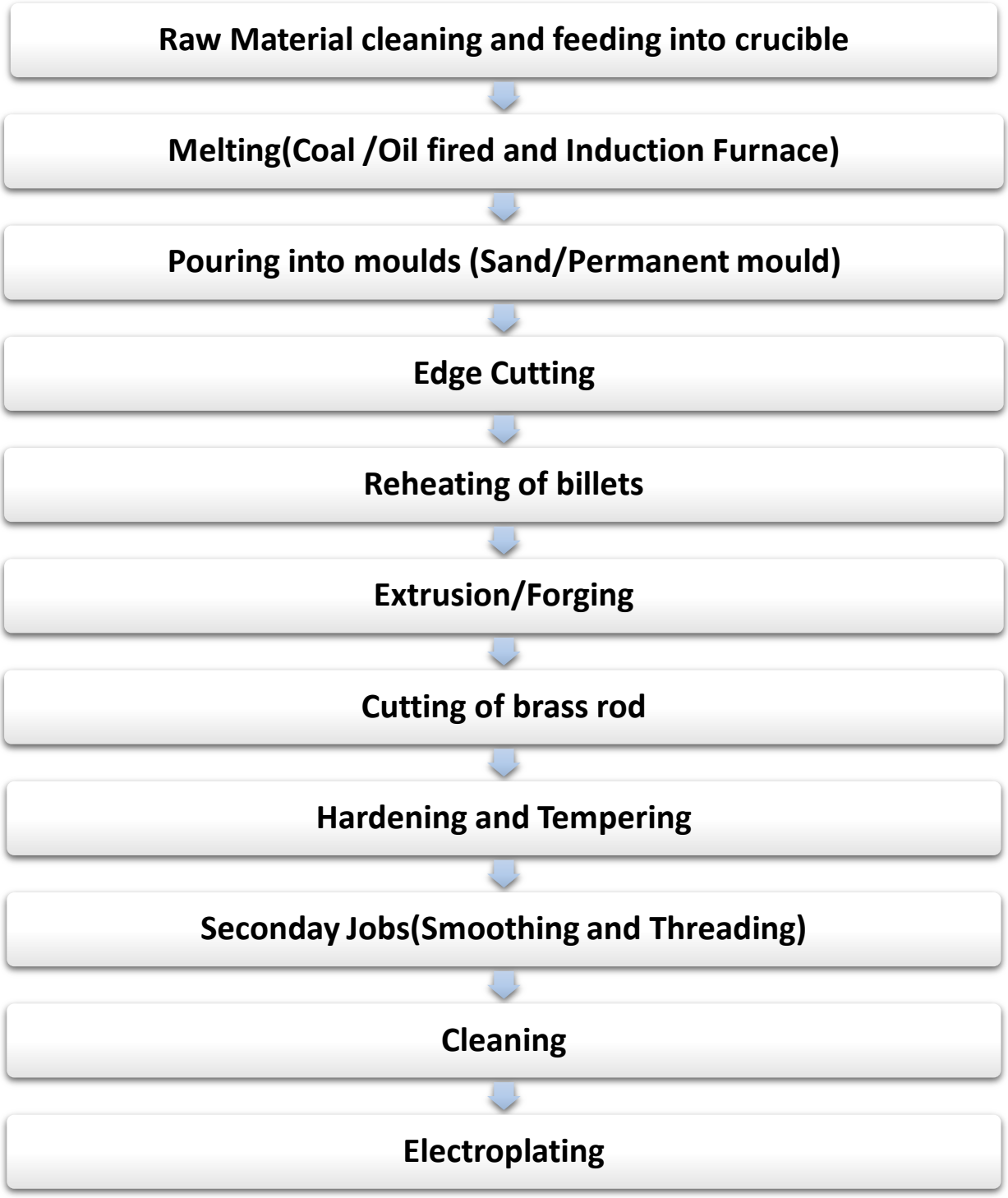


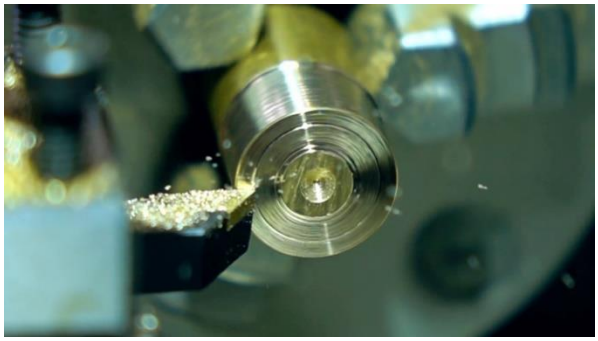
Figure 1: Typical Process Flow Chart

The production process mentioned in the above chart is almost similar to most of brass part manufacturing units in the cluster. However, depending on the final product, quality of final product and raw material properties, some of the stated process flow is altered to suit the requirement of industry. The major processes taking place at a typical Brass industry includes:

Melting: After separating the impurities form the brass scrap, the first step in making most of the products is melting the scarp in small furnace ranging from 100kg to 2000kg. Typically in Jamnagar pit type coal fired and induction melting furnaces are mainly used

Casting: After melting the next step involves casting molten brass in permanent mould or sand mould, depending upon the final product of the company. Sand moulding usually involves the preparing the consolidated sand mould around a pattern held within a supporting metal frame and removing the pattern to leave the mould cavity with cores. The liquid brass is poured into the cavity and allowed to solidify and when it does, the product is taken out of the mould cavity, trimmed and made to shape.

Machining: It is a broad term used to describe removal of material from a workpiece to get the desired shape and size of the material for further use. Machining is one of the key specialty of the products manufactured in Jamnagar clusters. Most of the plants are using traditional machines for grinding, grooving and other secondary jobs along with latest generation CNC machines for some specific jobs.



Electroplating: Is the process that is coating metals through reaction of the electrical conductive and chemical organics. The basic electroplating process consists of a plating bath filled with water containing a small amount of acid or alkali added to improve its conductivity.

- An anode (positive electrode) - either the plating metal or an inert electrode; this is expended as the process goes on and replenished periodically

- A cathode (negative electrode) - the item to be plated; these can be either hung inside the bath or placed in a barrel, which is rotated slowly to make the plating material deposited evenly

Usually, the bath is contained in metal container, lined with acid/alkali resistant membrane e.g. PVC sheet to make it insulated from electric circuit. The application of direct electric current across the bath solution causes the migration of positively charged particles (anions) towards the negative electrode (cathode) and negatively charged particles (cations) towards the positive electrodes (anode).

2.3 Energy Profile

Both electricity and thermal energy are used for carrying out various activities in plant like melting, machining, operation of utilities etc. The following fuels are used in the plant:

Table 5: Type of fuel used

Type of fuel/Energy used	Unit	Tariff	GCV
Electricity	Rs./kWh	**7.8**	-
FO	Rs/kg	**32**	9800

The table below shows the average monthly energy consumption of the plant along with the average production of the finished goods during the last six months:

Table 6: Energy Consumption and Finished product Details

Month	Electricity Consumption (kWh)	Total Electricity Bill , Rs.(Lakhs)	Total FO Consumption, (Tonnes)	Total Fuel Bill, Rs.(Lakhs)	Final Product, (Tonnes)[1]
Nov-17	632000	50.56	16.95	5.42	417.60
Dec-17	690000	55.20	18.50	5.92	435.00
Jan-18	765000	61.20	18.25	5.84	443.70
Feb-18	640000	51.20	16.20	5.18	417.60
Mar-18	767000	61.36	18.65	5.97	443.70
Apr-18	650000	52.00	18.69	5.98	452.40

[1] Average annual final product output of the plant was approximately 1.23% less than the production after reheating due to processing losses of billets

The major form of energy used in the plant is electricity which is imported from PGVCL grid supply at 11kV. Apart from electricity, furnace oil is the major source of thermal energy in the plant. Electricity accounts for 90.62% of the total fuel cost and rest 9.38% thermal cost in the plant. Based on the data collected from the plant during plant visit, the graph below shows the variation of energy/fuel cost over the last 6 months. Electricity cost is Rs. 55.30 Lakhs/month whereas the average thermal energy cost is Rs 5.70 Lakhs/month.

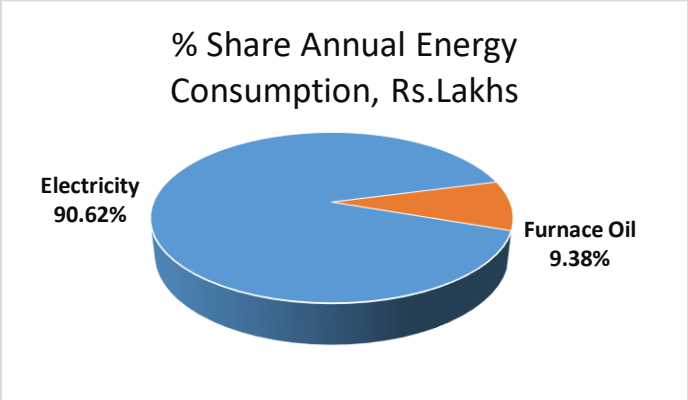


Figure 2: Percentage share of fuel cost

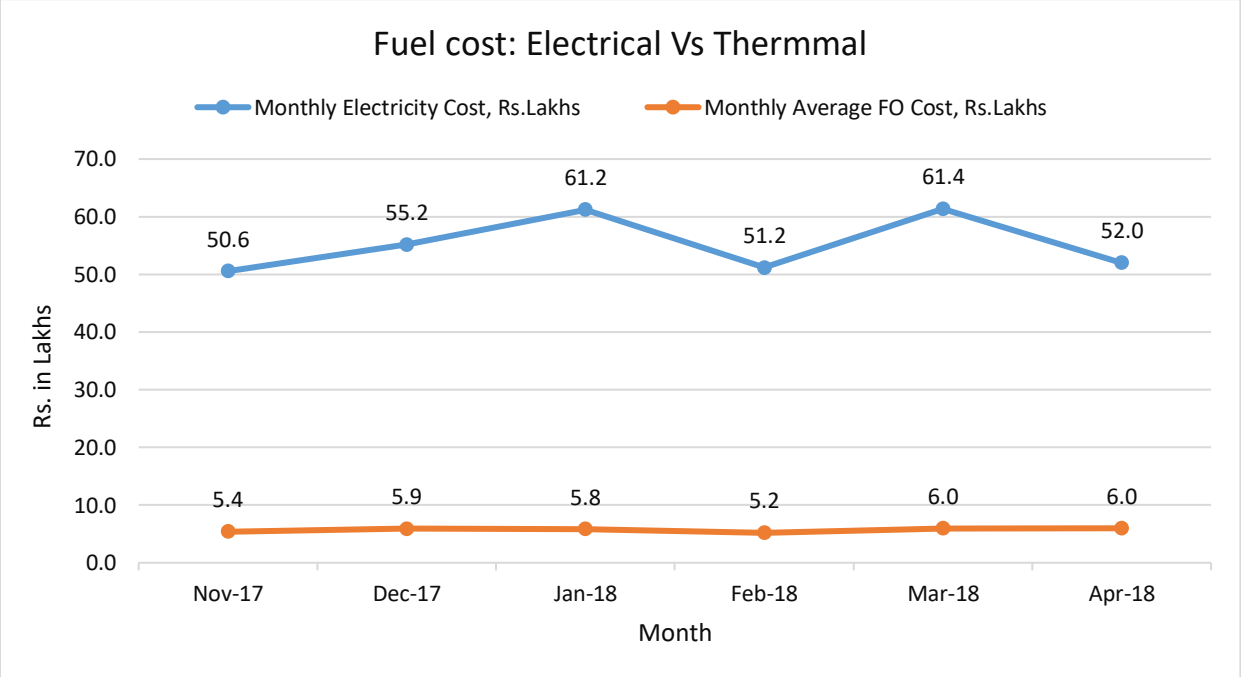


Figure 3: Energy Cost- Fuel & Electricity

3. PROPOSED EE MEASURE- HYDROXY FUEL GENERATOR FOR FUEL FIRED REHEATING FURNACE

3.1 Present System

Furnace oil fired reheating furnaces are used in brass industry to reheat the billets up to 790°C according to the product, for further extrusion process. These furnaces consumes a lot fuel and generally the design of these furnaces is normally handmade and copied from standard furnace design. Apart from the energy and time, final product quality will also depend on time and temperature of reheating of raw material.

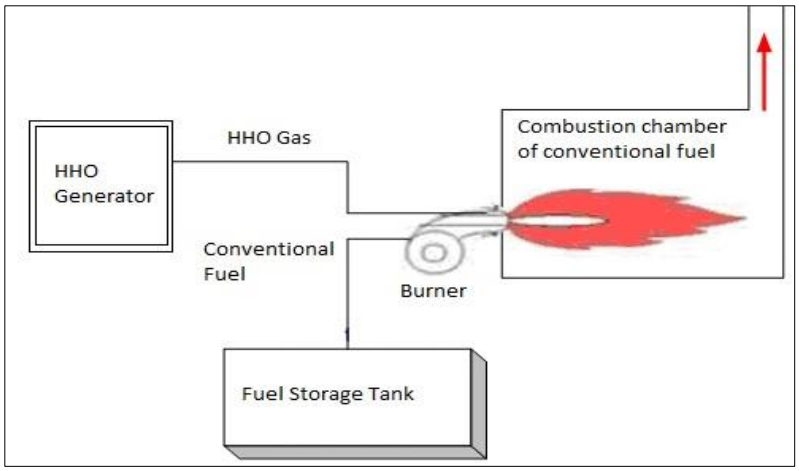
Figure 4: FO Fired Reheating furnace

Normally these furnaces operate in lower efficiency range because of improper air to fuel ratio, use of inefficient burners, loss of heat in exhaust flue gases and use of low-quality refractory material to avoid radiation losses.

3.2 Hydroxy Technology

HHO is generally known as a mixture of Hydrogen- Hydrogen Oxide, which is produced by various means but mainly its production through water electrolysis.

Water is electrolyzed and a mixture of hydrogen & oxygen are produced and this mixture of hydrogen and oxygen is highly efficient energy and can raise temperature of flame up to 1800oc quickly. The addition of this can be done in ether fuel line or combustion air -line. It does not pollute with CO_2, diaxin, sox while combusting itself the flame and the normally the speed of this mixture is seven times faster than other fossil. Fuel hydroxy is being operated on-demand at 1.0 bar hence it is very safe and saves fossil fuel (10% to 25%) when mixed and burned. The flame speed of the mixture is faster and hence it



burns all un-burnt hydro-carbon because the heat transfer co-efficient is higher for steam (hydrogen & oxygen) as against flame .Normally these un-burnt hydro-carbon escapes from burning zone and goes through exhaust gases into the environment in the reheating furnaces. The energy and water consumption requirement in the generator is as follows:

Table 7: Hydroxy -Energy and water consumption

Design Models	Energy Consumption, (kWh)	Water Consumption, (Litre)
300 Liter Per Hour(LPH)	1.1	0.16
500 Liter Per Hour(LPH)	2.2	0.32
1000 Litre Per Hour(LPH)	3.0	0.60
5000 Litre Per Hour(LPH)	15	3.0

3.2 Observation and Analysis

The specific fuel consumption of the furnace was estimated based on the data measured/collected during the field visit in the unit. Furnace operation was observed for 4 bathes and FO consumption and billet output was taken. The unit was charging approximate 100% brass scrap (approximately 60% brass and 40% Zinc) in a batch. The average reheating per batch has been estimated to be 16875.5 kg which has an average FO consumption 32.2kg/Tonne.

The detailed observed parameters for the 4 batches are given below:

Table 8: Operating Parameters for different cycles

Parameters	Batch 1	Batch 2	Batch 3	Batch 4
FO Consumption, kg	51.2	57.35	57.8	52.8
Production Output, kg	1600	1850	1700	1600
Time, Minutes	120.0	125.0	123.0	119.0
SEC(kg FO/Tonne)	32.0	31.0	34.0	33.0
Output temperature of billet,0C	790	780	784	791

3.2 Recommendation

The plant was operating with furnace oil in reheating furnace to reheat the billets for further extrusion process and the fuel consumption these furnaces is significant. Reheating furnace normally has lower efficiency and create a lot of pollution problem in the plant and energy saving opportunity in it will have a significant impact. So it is proposed to install a Hydroxy fuel generator, which is expected to reduce 10% fuel consumption in the reheating furnace. The fuel Hydroxy generator uses very less amount of water to generator a mixture of oxygen and hydrogen gas through electrolysis process, this out gas line should be mixed either with the fuel line or combustion air-line just before the burner.

Key advantages of integrating hydroxy fuel generator are as follows:

Energy from water

- The thermal energy is from heat generation of water not from electricity

Oxygen effect of water energy

- Hydroxy gas is the mixture of hydrogen and oxygen gas in the ratio of 2:1 as it is in water form and since oxygen in nature burns the gas perfectly. It is an ideal fuel and availability of such oxygen in furnace makes better combustion condition to achieve high temperature and heat

High temperature property

- Water energy shows an excellent heat generation in comparison with other kind of energies because of its unique properties like implosion and thermal reaction.

Safety of water energy

- This system does not store Hydroxy gas, it burns the gas as soon it is generated by generator; which makes it free from danger to explode like other high pressure gases

Mixture of hydroxyl gas with oil or Natural gas

- Mixed with liquid as well as natural gas and typically minimum 5% Hydroxy energy (10.5kJ/Litre) will save 20% of fuel and also reduces 30% of CO_2 and NOx emission.

The design specifications of the Hydroxy plant required in the plant is given below:

Table 9: Design Details of the new Furnace

Description (Model: HHO -500LPH)	Parameters
Gas production, Litre/Hour	500
Voltage. V	415
Power Supply, phase	3
Water Consumption, Litre/Hour	0.32
Power Consumption, kWh	2.2
Max. Operating pressure, kg/cm^2	1
Weight of equipment, kg	120
Size of the equipment(WxHxL), mm	770x1300x770

3.3 Supplier Details

Table 10: Supplier Detail

Equipment Detail	Hydroxy Fuel Generator
Supplier Name -1	AL Shorooq Green Energy
Address	P.O. Box : 290, Ajman - Uni ted Arab Emi rates

Email Id	manoharan.e@shrooqal-shams.com
Contact No.	+919003009738
Supplier Name -2	Vaigunth EnerTek (P) Ltd.
Address	C1/20, Snow Housing, Pallikaranai, Chennai, Tamil Nadu, India-600 100
Contact Person	-
Email Id	info@v-enertek.com
Contact No.	+91-44-45575551

3.4 Savings

Energy consumption pattern and feasibility studies revealed that reheating operation in fuel fired furnaces depends on the design of the furnace, type and position of burners etc. A detailed analysis was carried out on conventional furnace and specific furnace oil consumption was found out to be 32.5kg/tonne and a minimum 10%[2] fuel saving can achieve after integrating the hydroxyl generator in the system. The total average annual reheating of billets in the plant was 6,075 tonnes hence; total FO reduction in base case would be 19,744kg per year which will be lead to an annual saving of 19.35 TOE/year and 61.23Tonne/year CO_2 equivalent reduction.

Detailed savings calculations are given in below table:

Table 11: Savings Calculation

Parameters	Value
Average reheating of billets per batch, kg	1,687.5
No of batches per day	12
No of operating days	300
Annual reheating of billets, Tonnes	6,075
Average Specific fuel consumption in reheating furnace, Kg/Tonne	32.5
Conservative Savings in fuel consumption, kg/Tonne	3.25
Annual Saving in fuel consumption, kg	19,744
Total annual monetary saving @Rs 32/kg, Rs. Lakhs	6.32
Investment Including GST@18 + Piping cost, Rs . Lakhs	8.24
Payback period, Months	16
Annual Energy Saving, TOE/Year	19.35
CO_2 Reduction, Tonnes/Annum	61.23

[2] Minimum fuel saving guaranteed by technology supplier

4. FINANCIAL ANALYSIS

4.1 Project Cost

Table 12: Project Cost

Parameter	Amount in Rs Lakhs
Hdroxy generator	6.35
Total GST @18%	1.14
Approx. Erection and commissioning and piping cost	0.75
Total Project Cost	8.24

4.2 Assumptions for Financial Analysis

- Cost of Debt (Interest rate) taken as 12%
- Yearly increase in fuel cost by 2% for cash flow analysis
- Depreciation method: Reducing balance method
- Depreciation rate: 40% [3]
- Life cycle of the project is taken as 7 years
- Three different Capital Structure considered
    - CS1 – 70:30 Debt Equity Ratio
    - CS2 – 50:50 Debt Equity Ratio
    - CS3 – 100 % Equity
- Return on equity is taken as 15 %
- Operation and Maintenance Cost taken as 5% of Initial investment
- For calculating weighted average cost of capital, the corporate tax rate is assumed as 30%

4.3 Cash Flow Analysis

Table 13: Cash flow of the project

Cash flow for the project		1	2	3	4	5	6	7
	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Required Investment	8.24							
Energy Savings		6.3	6.4	6.6	6.7	6.8	7.0	7.1
O&M Cost		-0.4	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
Depreciation		3.3	2.0	1.19	0.7	0.4	0.3	0.2
Net Cash Flow	-8.2	9.2	8.0	7.3	7.0	6.9	6.8	6.9

[3] https://www.incometaxindia.gov.in/charts%20%20tables/depreciation%20rates.htm

The table below shows the WACC at various capital structure assumed for the financial analysis

Table 14: Capital Structure

Capital Structure			
Particulars	CS 1	CS 2	CS 3
Debt	70	50	0
Cost of Debt	0.12	0.12	0.12
Tax 30%	0.3	0.3	0.3
Equity	30	50	100
Sum of debt& Equity	100	100	100
Cost of Equity	0.15	0.15	0.15
WACC	10.38	11.7	15

Table 15: NPV Calculation

NPV Calculation	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	NPV
NPV at CS 1 (70:30)	-8.24	8.3	6.6	5.5	4.7	4.2	3.8	3.4	28.2
NPV at CS 2 (50:50)	-8.24	8.2	6.4	5.3	4.5	3.9	3.5	3.2	26.8
NPV at CS 3 (100% Equity)	-8.24	8.0	6.1	4.8	4.0	3.4	2.9	2.6	23.6

4.4 Sensitivity Analysis

A sensitivity analysis has been carried out to ascertain how the project financials would behave in different situations such as

- Change in energy savings
- Change in operating hours
- Change in interest rate

The sensitivity analysis will help to estimate the impact of key project indicators on attractiveness of the project, thereby helping to understand the financial viability.

Table 16: Sensitivity analysis: based on energy savings

Sensitivity analysis: based on energy savings			
	at 100% Savings	at 75% Savings	at 50% Savings
IRR	101%	80%	56%
NPV at CS 1 (D70:E30)	28.2	20.2	12.2
NPV at CS2 (D50:E50)	26.80	17.75	10.52
NPV at CS3 (D0:E100)	23.59	16.68	9.78

Table 17: Sensitivity analysis: change in operating hrs.

Sensitivity analysis: based on operating hours			
	at 100% Operating hours	at 90% Operating hours	at 80% Operating hours
IRR	101%	93%	84%
NPV at CS 1 (D70:E30)	28.2	25.0	21.8
NPV at CS2 (D50:E50)	26.80	23.7	20.7
NPV at CS3 (D0:E100)	23.59	20.8	18.1

Table 18: Sensitivity analysis: change in interest rate

Sensitivity analysis: change in interest rate						
	at 9.5% Interest rate	at 10.05% Interest rate	at 11% Interest rate	at 12% Interest Rate	at 12.5% Interest Rate	at 13% Interest Rate
NPV (70:30)	29.66	29.08	28.80	28.24	27.97	27.70

5. ENERGY EFFICIENCY FINANCING IN MSMEs

Financing plays a key role in facilitating procurement and implementation of energy efficient technologies and products in any industry. Government has given EE financing in MSMEs top priority since the sector contributes significantly towards India's economic growth. However, existing financing options are not sufficient to meet the financing requirement in the sector due to the large size of the sector. MSMEs using various financing schemes for technological up-gradation are still very less, as most of them use their own capital fund rather than making use of external financing models. Although financing models were very successful in some clusters, the scale-up of such activities is rather slow. This slow pace in implementation of energy efficiency financing in MSMEs is due to the various sector specific challenges in the sector.

Some of the key barriers to finance EE projects in the sector are:-

- Lack of available capital for investment as EE interventions being small may not get financed through FIs as they do not qualify as term loans
- Lack of clarity on financing schemes- repayment mechanism and complex procedural requirements
- Lack of availability of financing model that cater to the particular requirement of the MSME
- Lack of awareness among MSMEs with respect to benefits of implementing EE technologies
- FIs consider MSMEs as a high risk category due to low credit flow to this sector. This is due to several factors such as poor book-keeping practices, weak balance sheets, poor credit history and smaller sizes of MSME loans.
- Collateral based lending, advocated by FIs, restricts MSMEs from availing loans
- No formal M&V procedure available to estimate the savings achieved by implementing EE measure
- Risks associated with repayment of loans which include technical, commercial and performance risks

5.1 FI Schemes in Gujarat

Table 19: FI schemes in Gujarat

Sl.No	Name of Scheme	Purpose	Financial Details	Contact Address
1	**SIDBI Make in India Soft Loan Fund for Micro, Small & Medium Enterprises (SMILE)**	• The focus of the scheme is on technology upgradation which helps in reducing the impacts from process and operations as the reduction in resource consumption and productivity improvements are major outcome of technology upgradation • The program aims to bridge the gap by providing financial support to the companies.	• Rate of interest is according to credit rating • Interest rates for soft loans are from (8.90 % to 8.95 % pa) and term loans are in the range of (9.45% to 9.60% pa) • Min loan amount: Rs 25 Lakhs • Term Loan: 75% of the project cost as debt	Mr.Chandra Kant SIDBI,NO.1-2-3/4,Shreeji Patel Colony,Jamnagar-361008. Contact no : 0288 275 3954 Mail id : chandrakant@sidbi.in
2	**4E scheme (End to End Energy Efficiency Financing scheme)**	• The 4E scheme promoted by SIDBI aims to assist the industries in implementation of energy efficiency and renewable energy projects. • The scheme addresses all aspects of energy efficiency in a company from assessment and identification of energy efficiency interventions to facilitating implementation by providing technical and financial support	• Interest rate - 2.5% below market interest rate • Min loan amount: Rs 10 Lakhs • Max loan amount: Rs 150 Lakhs • 90% of the project cost as debt	Mr.Chandra Kant SIDBI,NO.1-2-3/4,Shreeji Patel Colony,Jamnagar-361008. Contact no : 0288 275 3954 Mail id : chandrakant@sidbi.in

3	**Partial Risk Sharing Facility for Energy Efficiency project (PRSF)**	• The partial risk sharing facility aims at transforming the energy efficiency market in India and promotion of Energy Service Contracting Model for the Energy Efficiency. • The scheme address barrier related to the financing aspects for energy efficiency	• Term Loan: 12%-15% • Min loan amount: Rs 10 Lakhs • Max loan amount: Rs 15 Cr • Total Project funding of – USD 43 million • Risk Sharing facility component of USD 37 million to be managed by SIDBI • Technical assistance component of USD 6 billion to be managed by SIDBI and EESL	Mr Chandra Kant SIDBI, NO.1-2-3/4, Shreeji Patel Colony, Jamnagar-361008. Contact no : 0288 275 3954 Mail id : chandrakant@sidbi.in
4	**Bank of Baroda's Scheme for Financing Energy Efficiency Projects**	All these Schemes from various banks (SBI, Bank of Baroda, and Canara Bank) have their focus towards technology upgradation. Technology upgradation can lead to improvement in energy, productivity, and lower emission from the MSME company. As technology upgradation could be capital intensive most of the	• Loans of up to 75% of the total project cost, subject to maximum of Rs. 1 crore, will be provided. (Minimum amount of loan Rs. 5 Lakhs • Collateral will be required for all loans. An interest rate of bank base rate + 4% will be applicable, to be paid back over a period of 5 years.	Bank of Baroda Saru Section Road,Swastik Society,Park colony,Jamnagar,Gujarat,361008 Contact no : 0288 266 0779 Mail Id : Jamnag@bankofbaroda.com
5	**Canara Bank's Loan scheme for Energy Savings for SMEs**		• The scheme covers up to 90% of project costs of up to INR 1 million (EUR 13,000). • Max. loan: INR 10 million (EUR 130,000) • Security: collateral free up to INR 5 million (EUR 65,000), beyond INR 5 million collateral required as determined by the bank • Margin: 10% of project costs	Canara Bank, 1st Floor,New Super Market,Bedi Road,Jamnagar,Gujarat,361001 Ph no: 0288 267 6597

6	**SBI's Project Uptech for Energy Efficiency**	schemes from banking institutions aim at bridging the gaps for access to finance for MSME sector	• SBI identifies industrial clusters with potential for quick technology upgradation and a supporting environment. Based on studies in interested units, technology upgradation is undertaken if the same in viable. • With a ceiling of INR 1 lakh, an amount equal to that invested by the unit is provided under this loan. There is a start-up period of 3 years, with a repayment period of 5-7 years, at zero interest.	SBI Regional Office Junagadh Jamnagar Highway, Maheswari Nagar, Opp Anupam Cinema Hall, Kadiawad, Jamnagar, Gujarat 361001. Ph no : 0288 2554026 Mail id : sbi.01816@sbi.co.in
7	**Solar Roof Top Financing Scheme IREDA**	The loan scheme is applicable to grid interactive, rooftop solar PV plants for industries, institutions and commercial establishments. Financing can be accessed for single or aggregated investments.	• Interest rate: 9.9% - 10.75% • Max. repayment time: 9 years • Minimum promoter's contribution: 30% • The applicant's minimum capacity needs to be 1MW	IREDA Camp Office 603, Atlanta Towers Near Panchvati Circle, Gulabi Tekra Ahmedabad Ph No : 9811889805 Email Id : ashokyadav@ireda.in

6. ENVIRONMENTAL AND SOCIAL BENEFIT

6.1 Environmental Benefit

A resource-efficient business demonstrates a responsibility towards the environment. Energy and the environment are so closely linked, that, in addition to saving energy and reducing utility expenses, there are additional and often unreported benefits from conserving energy, saving natural resources being an important benefit.

Energy efficiency plays a major role, even where company output is increased, energy efficiency improvements can contribute significantly in most cases to reducing the negative impact of energy consumption per unit of output. Any increase in pollutant emissions will thus be minimized. Significant environmental benefits gained by adopting energy efficient technologies and processes may include lowering the demand for natural resources, reducing the emission of air pollutants, improving water quality, reducing the accumulation of solid waste and also reducing climate change impacts. Improving energy conservation at the facility can improve the facility's overall efficiency, which leads to a cleaner environment.

Reduction in Pollution Parameters

The proposed energy efficiency measure of installing energy efficient furnace will result in reduction of 19.35TOE per annum. The proposed EE measure will result in decrease of CO_2 emissions by 61.03 TCO_2 annually, thus resulting in reduced GHG effect.

6.2 Social Benefit

Work Environment

The Factories Act, 1948 covers various aspects relating to working environment maintenance and improvement. The good maintenance practices, technology up gradation, efficient use of energy and resource conservation not only contribute to energy and pollutant reduction but also contributes in ensuring safe and clean working environment to the employees of the organization. Many units have also been doing review of safety process and have provided access to safe working environment to the workers. Basic facilities such as first aid kit, PPE gears and many others have been made available

Skill Improvement

Implementing energy efficiency measures requires mix of people and skills. It involves upskilling workers at all levels from the shop floor to the board room to understand how companies manage their energy use—and to identify, evaluate and implement opportunities to improve

energy performance. As the project involved identifying energy saving projects, implementing and verifying the savings, the unit have understood how to estimate energy savings with respect to energy saving proposals and also energy wastage have been identified. The activity has been successful in bringing the awareness among workers on energy wastage reduction, technology up gradation possible, etc. Each new technology implemented in a brass unit will create an impact on the entire cluster as each unit can replicate the new technology and promote the concept of energy efficiency and renewable energy in entire Cluster and thus reduce the overall energy consumption of the cluster as a whole. Technical skills of persons will be definitely improved as the training provided by the OEMS' on latest technology will create awareness among the employees on new trends happening in market. The training also helps in improving the operational and maintenance skills of manpower required for efficient operation of the equipment.

7. CONCLUSION

Energy efficiency is an instrument to address the issue of energy crisis and also be employed as a cost-effective means to attain sustainability and business. Cost of energy is considered as a vital component for industries and warrant judicious use of energy. Amid spiraling power cost energy efficiency assumes at most importance for the sector to remain competitive.

The GEF, UNIDO and BEE project through its various engagements is able to demonstrate energy efficiency potential in Jamnagar Brass cluster. The project is able to promote the concept of energy efficiency and renewable energy in brass cluster through various capacity building programs for local service providers, technology feasibility studies in brass units, training programs on EE/RE technologies and also helped in penetrating new /latest technologies into the cluster.

The DPR on installing hydroxy fuel generator is prepared after the OEM came to the unit and also did a detailed feasibility study. This measure will significantly reduce the dependency on furnace oil which will result in an annual energy savings of 19.34TOE per year with 61.03 TCO_2 reduction annually.

The following table gives the overall summary of the savings achieved: -

Table 20: Proposed EE Measure

Sl No	EE Measure	Annual Energy Savings, (TOE)	Monetary Savings (Rs. Lakhs)	Investment (Rs. Lakhs)	Payback (Months)	Annual GHG reduction (T CO_2)
1	**Hydroxy fuel generator for fuel fired reheating furnace**	19.35	6.32	8.24	16	61.32

The summary of financial analysis given in the below table clearly indicates that implementation of this project is economically and financially viable with an attractive payback period. So it is recommended to install new NG fired furnace.

Table 21: Financial Analysis

Sl. No.	Particulars	Unit	Value
i	**Total Investment (Incl. of Tax)**	Rs. Lakh	8.24
ii	**Means of Finance**	Self / Bank Finance	Self
Iii	**IRR**	%	101.2
Iv	**NPV at 70 % Debt**	Rs. Lakh	28.2

7.1 Replication Potential

Most of the units in Jamnagar brass cluster are using basic design reheating furnaces and has huge replication potential of fuel saving. The implementation of this project will inspire other units to take up similar energy efficiency initiatives which eventually will lower the bottom line and increase the top line therefore the margin increases. Secondly, the very clear specifications on vendor and the cost base is already available which makes it easy for other units in the Jamnagar Brass cluster to access the technology and gives them a very good idea about the cost and benefits associated with the projects. Overall, the holistic approach adopted by the project will be extremely useful in achieving the goal of improving EE in the cluster.

8. ANNEXURE

8.1 Financial Quotation – Technology supplier

AL SHOROOQ Green Energy

Ref: SGE/BD/JI/116
24TH May, 2018

Senor Metals Pvt Ltd
Plot No. 353, GIDC - II
JAMNAGAR

Kind Attn. Mr C. G. Sangani

Sub. Energy Conservation Proposal for your Plant

Dear Sir,

This has reference to the discussion we had on the captioned subject. We sincerely thank you for the hospitality extended by you during our visit to your office.

We take pleasure in submitting our initial proposal for hydroxyl system which will achieve a minimum saving of 10% on your present LPG/FO furnace fuel consumptions. Subsequently, we will study the option of waste heat recovery system from your flue gas exhaust. The return on investment with hydroxyl system for fuel saving will be much faster than any other energy conservation measures. A brief technical specification of the hydroxyl system offered is furnished below. The estimated operation and maintenance cost is attached in Annexure A.

Hydroxy Model	HXY-300/600/1000/1500/2000 L
Gas Delivery (Per Hr)	300/600/1000/1500/2000 Liter
Operating pressure	0.5 – 1.0 Bar
Water inlet quality	Less than 300 PPM
Catalyst (30 Gram per Lit)	Na OH
Fuel Cell and critical pipeline Material	SS – 316 and Copper
Cooling system	Air
Power and water consumption	1.1 TO 5.0 KWH & 0.16 1.2 LPH
Control Valves	Solenoid Operated valves
Auto Cut off	In-line with Furnace operation & power shout down

The built-in safety control system and the visual indication are as follows..
Auto cut off - When the burner fuel closed
Auto cut off - When the power shut down

Visual Indicator

a)	Phase voltage	e)	Electrolyze Temperature indicator
b)	Phase current	f)	Cooling system temperature indicator
c)	Fuel Cell voltage	g)	Gas flow meter
d)	Fuel Cell current	h)	Electrolyze level indicator

P.O. Box : 290, Ajman - United Arab Emirates Tel.: +971 6 7421441, Fax : +971 6 7422413
Sales and Support Contact
E-mail : info@ashgreenenergy.com Web : www.ashgreenenrgy.com

AL SHOROOQ Green Energy

The scope of work will be restricted to supply of complete hydroxyl system to deliver the performance indicated in this offer. The local site pipeline work / connection of pipes to the burners shall be executed by you at your cost. However, we will send our trained supervisor to supervise the work being executed by your contractor.

During the supervision period, the to and fro travel ticket, food, accommodation and local transport for our supervisors shall be provided by you at your cost.

The offer price for supply of proposed hydroxyl system to achieve a minimum fuel saving of 10% is attached with a price list on Ex-works Kanyakumari basis including GST. All other charges from the Kanyakumar to your site and other statutory taxes if any shall be paid by you at actual.

The hydroxyl system can be dispatch within 12 weeks from the date of receipt of confirmed purchase of order on agreed payment terms.

We guarantee for the performance as well as workmanship of the system for a period of 12 months from the date of commissioning or 18 months from the date of supply whichever is earlier.

Please let us know your convenient time to visit our demo plant at UAE . Kanyakumari.

In case you need any further information, please do feel free to contact us.

Thanking you and assuring our best services at all times,

Best Regards

(E MANOHARAN)
General Manager (Business Development)

P.O. Box : 290, Ajman - United Arab Emirates Tel.: +971 6 7421441, Fax : +971 6 7422413
Sales and Support Contact
E-mail : info@ashgreenenergy.com Web : www.ashgreenenrgy.com

HYDROXY SELECTION CHART AND PRICE LIST

Sl No.	Description	Furnaces using Fuel Oil				Furnaces using Natural Gas			
		Consideration	Ltrs / hr	Hxy Req	Hxy Cap	Consideration	SCM/hr	Hxy Req	Hxy Cap
1.0	**Assumptions / Considerations**								
	Calorific Value in Kj/Kg	*43,000.00*				*51,875.00*			
	Bulk Density of the fuel	*0.87*				*0.68*			
	Calorific Value of Hydroxy Mixture Kj/Ltr	*10.50*				*10.50*			
	Hydroxy mixing % on total GCV used	*0.40%*				*0.55%*			
2.0	*Fuel Consumption in case of Furnaces using fuel oil are furnished in Liters per hour where as Furnaces using Natural Gas are furnished in Standard Cubic Meter. The Hydroxy capacities are derived at liters per hour and then the standard available design size have been furnished in table*		20.00	285.03	300.00		20.00	369.55	600.00
			25.00	356.29	600.00		25.00	461.93	600.00
			30.00	427.54	600.00		30.00	554.32	600.00
			35.00	498.80	600.00		35.00	646.71	1,000.00
			40.00	570.06	600.00		40.00	739.10	1,000.00
			45.00	641.31	1,000.00		45.00	831.48	1,000.00
			50.00	712.57	1,000.00		50.00	923.87	1,000.00
			55.00	783.83	1,000.00		55.00	1,016.26	1,500.00
			60.00	855.09	1,000.00		60.00	1,108.64	1,500.00
			65.00	926.34	1,000.00		65.00	1,201.03	1,500.00
			70.00	997.60	1,000.00		70.00	1,293.42	1,500.00
			75.00	1,068.86	1,500.00		75.00	1,385.80	1,500.00

Hydroxy Model No. / Capacity (LPH)	Power Consumption / Hr	Water Consumption / Hr	Ex-works Price in INR with GST
Hydroxy 300 - / 300 LPH	1.1 KWH PER HOUR	0.16 LPH	465,000.00
Hydroxy 300 - / 600 LPH	2.2 KWH PER HOUR	0.36 LPH	635,000.00
Hydroxy 1000 - / 1000 LPH	3.0 KWH PER HOUR	0.60 LPH	904,000.00
Hydroxy 1500 - / 1500 LPH	4.0 KWH PER HOUR	0.90 LPH	1,105,000.00
Hydroxy 2000 - / 2000 LPH	5.0 KWH PER HOUR	1.2 LPH	1,300,000.00