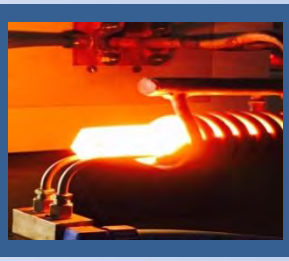
BEE's National Program

on

Energy Efficiency and Technology Up-gradation in SMEs

Ludhiana Forging Cluster

Post Implementation Audit Report
Khalon International

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Preface

The project titled "BEE's National Program on Energy Efficiency and Technology Up-gradation in SMEs" supported by Bureau of Energy Efficiency (BEE), Ministry of MSME and Ludhiana Auto Parts Manufacturers Association aims to bring down the energy demand of MSME industries located at Ludhiana Forging cluster. The project aims to support the MSME units in Ludhiana cluster to implement Energy Efficient Technologies.

There are more than 1500 Small and Medium Enterprise (SME) forging units operating in the various industrial pockets in and around Ludhiana, manufacturing products suitable for automotive, industrial and agricultural sector. The project aims to initially diffuse energy efficient technologies in selected units in the cluster. These units will act as demonstration units for long term and sustainable penetration of energy efficient technologies in the entire cluster. InsPIRE Network for Environment, New Delhi has been appointed as the executing agency to carry out the following activities in the cluster:

- Conducting pre-activity cluster workshop in the cluster.
- Conducting initial walk through audits in 5 representative units of the cluster.
- Identify and proposes BEE on energy efficient process technologies, relevant to the cluster, with highest energy saving and replication potential, and their cost benefit analysis.
- Identify local technology/service providers (LSP) for the above technologies in the cluster
- Identify SME units willing to implement and demonstrate the energy efficient technologies
- Assist BEE to enter into a contract with each of the shortlisted SME units to enable implementation and showcasing of Energy Efficient technology.
- Conduct comprehensive Baseline Energy Audits in the shortlisted SME units wherein these technologies can be implemented and document the findings in the form of a report.
- Develop technology specific case studies (Audio-Visual and print) for each technology
- Prepare Best Operating Practices (BOP) document for the top 5 energy using equipment / process in the industry cluster
- Enumeration of common regularly monitorable parameter at the process level which have impact on energy performance, and listing of appropriate instrumentation for the same with options including make, supplier, indicative cost specifications and accuracy of measurements.
- Carry out post implementation energy audit in the implemented units to verify energy savings as a result of EE technology implementation.
- Verify and submit to BEE all the relevant documents of each participating unit owner indicating his complete credentials, proof of purchasing the equipment, evidence of implementation and commissioning of the EE technology in the unit.

Based on the confirmation on installation from a unit, a 5 member team consisting of Shri Tarun Dixit, Project Engineer, BEE; Shri Madhur Gupta, Financial Expert, Ludhiana Forging Cluster, Shri Arindam Mukherjee, Sr. Program Officer; Shri S. Vamsi Krishna, Program Officer and Shri Chaman Shukla, Sr. Program Associate from InsPIRE Network for Environment carried out a cross-verification of the implementation. As part of the activities under the energy efficiency program in Ludhiana Forging cluster, post implementation energy audits in 8 forging units under Ludhiana cluster was conducted in the month of June'2016. This specific audit report details the findings of the post implementation energy audit study carried out at ***Kalhon International.***

Executive Summary

1. Unit Details

Unit Name	:	**Kalhon International**
Address	:	C-26, Phase-II Focal Point, Ludhiana
Contact Person	:	Mr. Tej Prakash Mishra / Mrs. Pritam Kaur, Mr. Jashandeep Singh Kahlon (Owner) (Cell No: 7837638337)
Products	:	Bolts, Nuts and Auto Parts
Production	:	1000 Kgs per day
DIC Number	:	030091200250 (Part-II)
Bank Details	:	State Bank of India; SME Branch – Ludhiana Account No. 10318976943; IFSC Code – SBIN0006265
TIN / PAN No.	:	PAN: ACDPM6432B
Contract demand	:	630 kVA

2. Energy Efficient Technologies implemented vis-à-vis baseline energy audit recommendation

Technology recommended as per baseline energy audit (as approved by steering committee)	Technology implementation and cross-verified during post implementation energy audit
SPM – Turning Machine -4no's	SPM – Turning Machine -4no's

3. Cost Economics Analysis: Projected (as per baseline) vs. Actual

Technology	Estimated Energy Savings (%)	Savings	Investment	Simple Payback period (years)
Baseline (Projected) SPM – Turning Machine- 1	83	413,100	550,000	1.33 years
Post Implementation (Actual) SPM – Turning Machine – 1	89	4,56,624	5,83,275	1.28 years
Baseline (Projected) SPM – Turning Machine – 2	83	413,100	550,000	1.33 years
Post Implementation (Actual) SPM – Turning Machine – 2	91	4,78,318	5,83,275	1.22 years
Baseline (Projected) SPM – Turning Machine - 3	83	413,100	550,000	1.33 years
Post Implementation (Actual) SPM – Turning Machine -3	90	4,27,997	5,83,275	1.36 years
Baseline (Projected) SPM – Turning Machine - 4	83	413,100	550,000	1.33 years
Post Implementation (Actual) SPM – Turning Machine -4	89	4,04,892	5,83,275	1.44 years

4. Project Impacts

Energy Efficient Technology implemented	Percentage Savings in specific energy consumption from baseline (%)	Annual Energy Savings (TOE)	Annual CO_2 emission reduction (tCO_2/year)
SPM – Turning Machine - 1	89	5.24	54.79

Energy Efficient Technology implemented	Percentage Savings in specific energy consumption from baseline (%)	Annual Energy Savings (TOE)	Annual CO_2 emission reduction (tCO_2/year)
SPM – Turning Machine - 2	91	5.48	57.40
SPM – Turning Machine - 3	90	4.91	51.36
SPM – Turning Machine - 4	89	4.64	48.59

Assumptions / conversion factors:

- 1 toe = 1 x 10 ^-7
- Emission factor power is 0.9 tCO2 per MWh
- CO2 emission reduction calculation has been considered based on equivalent reduction in energy consumption.

CHAPTER 1:

Introduction

1.1 MSME SECTOR – AN OVERVIEW

The MSME sector is an important pillar of Indian economy as it contributes greatly to growth of Indian economy with a vast network of around 30 million units, creating employment of about 70 million, manufacturing more than 6000 products, contributing about 45% to manufacturing output and about 40% of exports, directly and indirectly. This sector even assumes greater importance now as the country moves towards a faster and inclusive growth agenda. Moreover, it is the MSME sector which can help realize the target of proposed National Manufacturing Policy of raising the share of manufacturing sector in GDP from 16% at present to 25% by the end of 2022. However, owing to the recent insecure market conditions and escalating energy expense, the economic scenario of MSME sector, is transpiring gloomier endangering the long term profitability, competitiveness and sustainability.

However, a significant portion of the MSME units are energy-intensive where the cost of energy is 20-40% of the production cost, which implies huge energy saving potential. A study by BEE appraises the total energy efficiency market in India as INR 74,603 crore out of which, the share for MSME sector has been estimated at INR 12100 crore. But, in spite of huge energy efficiency potential in MSME sector, it is hurdled largely by following major barriers:

- Obsolete technology and lack of access to modern technological solutions resulting in low productivity.
- Very few programs to support technology development.
- Lack of local service providers to sustain energy efficient technologies.
- Lack of knowledge, financing and dedicated personnel for identifying energy efficiency improvements & opportunities.
- 90% of units are proprietorship concerns, which are limited on their managerial skills as well as amenability to new ideas.
- Perceptions of Energy efficiency measures are financially unviable.
- MSME units are reluctant to change & seek external technical assistance.

In the wake of the need, Government of India has set ambitious target of energy saving of 44.85 BU at consumer side by the terminal year 2016-17 of 12th Five year Plan which is equivalent to 60.17 BU on Bus bar side translating into 12,350 MW avoided capacity. In addition, total thermal energy saving equivalent to 21.30 Mtoe is targeted.

1.2 BEE-SME PROJECT AT A GLANCE

Under the 12th Five Year Plan, the Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India, has taken an ambitious program on energy efficiency and technology up gradation in SME clusters in India. The program titled "BEE's National Program on Energy Efficiency and Technology Up gradation in SMEs" is being implemented by BEE with support from Ministry of MSME in five selected clusters in India. These clusters include Ludhiana, Punjab; Pali, Rajasthan; Kochi, Kerala; Indore, Madhya Pradesh and Varanasi, Uttar Pradesh. The project aims to set up demonstration units in these clusters, wherein energy efficient technologies will be implemented. Efforts will also be made to replicate the successful technologies and wider penetration of energy efficient technologies in the sector as a whole. The key components of the project include:

- Conducting pre-activity cluster workshop in the cluster.
- Conducting initial walk through audits in 5 representative units of the cluster.
- Approve energy efficient process technologies, relevant to the cluster, with highest energy saving and replication potential, and establish their cost benefit analysis.
- Identify local technology/service providers (LSP) for the above technologies in the cluster
- Identify SME units willing to implement and demonstrate the energy efficient technologies
- Enter into a contract with each of the shortlisted SME units to enable implementation and showcasing of Energy Efficient technology.
- Conduct comprehensive Baseline Energy Audits in the shortlisted SME units wherein these technologies can be implemented and document the findings in the form of a report.
- Support the units towards implementation of energy efficient technologies.
- Carry out post implementation energy audit in the implemented units to verify energy savings as a result of EE technology implementation.
- Develop technology specific case studies (Audio-Visual and print) for each technology
- Prepare Best Operating Practices (BOP) document for the top 5 energy using equipment / process in the industry cluster
- Enumeration of common regularly monitorable parameter at the process level which have impact on energy performance, and listing of appropriate instrumentation for the same with options including make, supplier, indicative cost specifications and accuracy of measurements.
- Release of financial incentive to units on submission of the relevant documents of each participating unit owner indicating his complete credentials, proof of purchasing the equipment, evidence of implementation and commissioning of the EE technology in the unit.

The forging cluster located at Ludhiana, Punjab is one of the selected clusters under the BEE-SME program.

1.3 LUDHIANA FORGING CLUSTER – AN INSIGHT

Ludhiana is one among the biggest forging cluster in India consisting of over 1500 units, manufacturing a wide range of products, suitable for the use of automotive, agricultural and other engineering industry. A significant portion of the manufactured goods are also exported from the cluster. The units usually get raw materials in the form of steel and other ferrous products from the local industries and process the same using forging, machining and finishing process. The finished product is directly dispatched for the use of the target industry. The units are located in clusters in areas such as Focal Point (Ludhiana), Industrial Area (Jalandhar City), Industrial Area (Phagwara) and Industrial Area (Moga). Electricity is the main source of energy in these units. Majority of the units uses free hammer to forge the heated steel. The temperature required for forging is around 1150 - 1200 ^{o}C.

Despite being in large numbers, most of the units in the clusters are un-organized, using obsolete and high energy consuming equipment. Also, the cluster has seen limited development in terms of technology up gradation and automation, over the years. Some of the important barriers towards accelerated adoption of energy efficient technologies have been lack of knowledge, lack of government scheme to support technology up gradation, lack of skill manpower and lack of financing options available with these units. Because of the lower penetration about the knowledge of energy efficient technologies in the cluster, the units has been using age old practices of manual lathes for machining and batch furnaces for heating operations.

Twenty (20) units were selected from the cluster with the purpose of conducting baseline audit. Out of these, eight (8) nos. of units has completed implementation, within the stipulated time period and as per the guidelines of implementation.

1.4 ABOUT THE UNIT

Kalhon International was manufacturing of different types of centre bolts, nuts and bolts, centre bolt flat type and auto fasteners in various sizes as per the customer requirement. The manufacturing unit is located at C-26, Focal Point, Ludhiana.

The daily production lies in the range of 1 Ton/day. Kalhon International is using energy in the form of electricity supply from Punjab State Electricity Board, for various process and utility applications in its premises. During baseline energy audit, it was observed that the average monthly electricity consumption was 37121 kWh.

1.5 PROJECT IMPLEMENTATION METHODOLOGY

The BEE's National Program on Energy Efficiency and Technology Up gradation at Ludhiana Forging Cluster followed the following implementation methodology:

Figure 1.1: ***Project implementation methodology***

1.6 PRODUCTION PROCESS OF PLANT

The following figure shows the typical process employed at manufacturing of forged products at Global Exports India, Jalandhar:

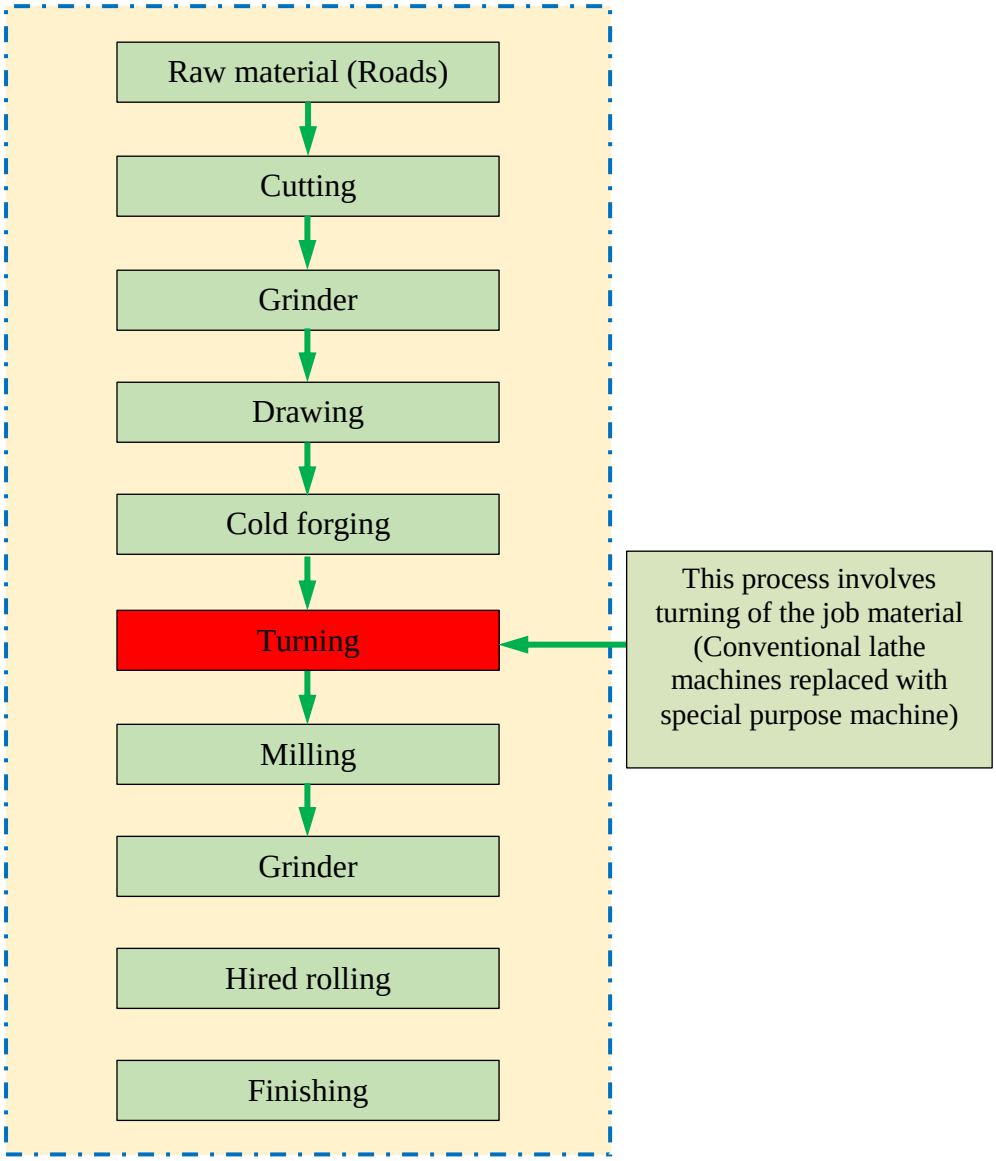

Figure 1.2: ***Production process***

1.7 ENERGY AUDIT METHODOLOGY

The primary objective of the baseline energy audit was to quantify the baseline energy consumption pattern and identify technologies which can lead to reduction in energy consumption. Based on the suggestions under the baseline audit, the units have implemented the technologies. The primary objective of the post implementation energy audit is cross-verify the implementation and document the impact. The key points targeted through energy audits were determination of specific energy consumption, both thermal and electrical, productivity etc. Pre – planned methodology was followed to conduct the

energy audits. The energy audit methodology followed for baseline and post implementation energy audits is depicted in ***Figure 1.3*** below:

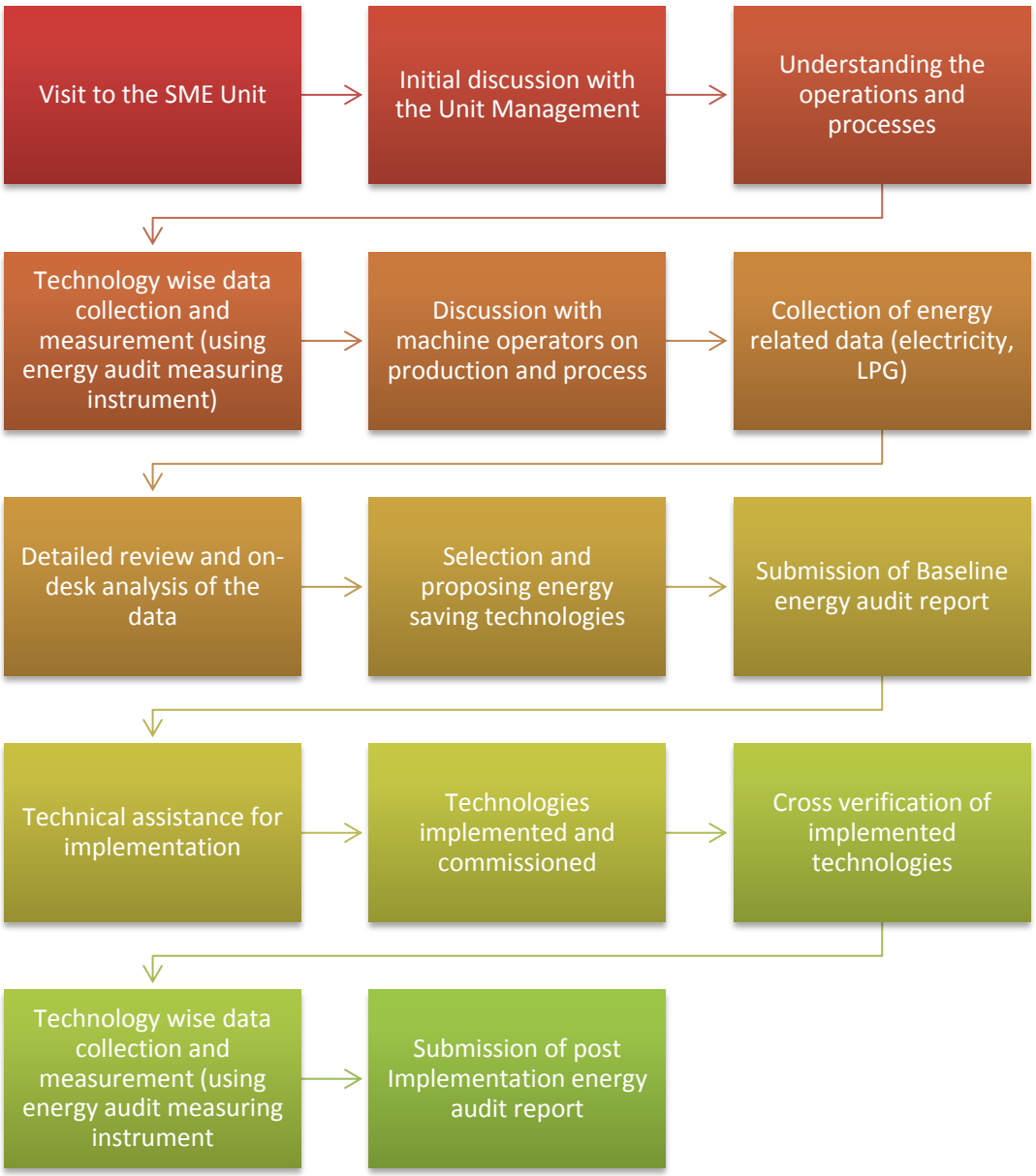

Figure 1.3: ***Energy audit methodology***

Post implementation energy audit outcome and results

2.1 INSTALLATION OF SPECIAL PURPOSE MACHINE

2.1.1 Baseline Scenario

Kalhon International has installed manually operated conventional machines for various components machining job work like turning, undercut, threading, Nut threading etc. These machine runs on electrical motors having the capacity varying from 3 HP to 10 HP with production/ machining of 1000- 2000 pcs/day.

Since these machines are manually operated, the process through which components are manufactured is very slow and time consuming. Apart from the slow process, the components manufactured are not very precise and of high quality. Some times what happens that the machine keeps on running even there is no component on the machine or the operator is busy in some other work. All these factors lead to the loss of energy and production of low quality components.

2.1.2 Present Scenario

The conventional lathe machines are replaced by automatic special purpose machine (The conventional lathe machine has been replaced by automatic special purpose machine (SPMs). These machines run on pre-installed programs, and are equipped to carry out multi-tasking at a single time. Thus, consumption of electricity only happens when there is a function or operation required on the component. In the ideal condition the machine remains in dead mode/ no operation mode. The machine also has an automatic feeder to automatically load the component for machining. The cycle time of the each component is fixed in the business logic of the PLC / SPM; therefore each component will take specific time for processing or machining. The SPM machines results in 30-50% percent of the energy savings depending upon the type of component, operation, material, cycle time. The details and operating principle of SPM has been summarized below.

A **Special Purpose Machine (SPM)** is a kind of multi-tasking machine used for machining purpose. A special purpose machine is used as a replacement to conventional machines like lathe, drilling or trimming machine. A special purpose machine is designed based on the customized requirement of a unit and may be used for one or multiple task as per the design. For example, a conventional lathe machine takes 3 mins (say) to machine (turn) a metal piece. Thereafter it is transferred to another machine for facing and trimming operations. In some cases, a third machine is used for threading operations. A special purpose machine specifically designed can replace all the three machines with a single machine. The replaced special purpose machine can perform all the four activities i.e. turning, facing, trimming, and threading on sequential manner. The sequence of operation is pre-set using timers and sensors. The entire operation is

maintained using pneumatic and mechanical control. For ease of operation, each special purpose machine is equipped with an automatic feeder. Replacement of conventional machines with special purpose machines usually increases machine productivity by 5 times, easing the life of the operators by avoiding manual intervention during each operation.

▶ Operating Principle

A special purpose machine (SPM) is usually customized based on the specific requirement of a unit. A SPM is used for multi-task operation, which are typically performed in more than one conventional machine. The sequence of operation in a SPM is pre-set using timers and sensors. Usually, a SPM is equipped with two or more machine tools fitted in different axis. The operations are carried out in sequential manner. The axial motion of the machine tool is usually powered by pneumatic controls, whereas positioning of the tool is done using sensors. A particular operation e.g. turning operation in a metal piece of 400 mm is pre-set using timers. Once the operation is over, the sensor directs the next sequence of operations, which are also pre-fed programs in the machine. Thus, manual intervention in each operation can be prevented. Also, two or more operational can be performed simultaneously in a SPM.

Figure 2.1: ***Special Purpose Machine- Turning***

Similar is the case for SPM-drilling machine, where the time taken in conventional drilling machine which performs one drilling operation at a time, can be significant reduced by simultaneously performing two or more drilling operations at a time.

2.1.3 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

The table below summarizes the post implementation energy consumption figures of the unit vis-à-vis the baseline energy audit data.

Parameter	Unit	Value
Baseline Scenario		
Power consumed per conventional turning machine (3 machines of 4 hp each)	kW	8.952
Productivity per conventional turning machine	Pcs/hr	30
Specific power consumption per conventional machine	kWh/Pcs	0.298
Specific fuel consumption in terms of kcal	kcal/pcs	256.624
Cost of energy consumption	Rs/pcs	2.238
Annual production per machine (based on baseline productivity)	pcs/annum	72000
Post Implementation Scenario		
Power consumed by SPM turning machine (based on actual on-site measurement)		
Note: SPM machine was observed to be running at 80% loading)	kW	2.98

Parameter	Unit	Value
Productivity on SPM turning machine	Pcs/hr	95
Specific power consumption on conventional machine	kWh/Pcs	0.031
Specific fuel consumption in terms of kcal	kcal/pcs	26.977
Cost of energy consumption	Rs/pcs	0.235
Annual production (based on post implementation productivity)	pcs/annum	228000
Savings		
Reduction in cost of energy	Rs/pcs	2.00
Reduction in specific energy consumption in kcal	kcal/pcs	229.6
Annual Cost Savings (in terms of post implementation production)	Rs	456624
Annual Reduction in Energy Consumption (based on post implementation production)	toe	5.24
Percentage reduction in energy consumption	%	89.49
SPM turning machine	Rs	583275
Simple payback period	years	1.28
Annual CO_2 emission reduction	t CO_2/year	54.79

Assumption / conversion factors:

- 1 toe = 0.0148 TJ
- Emission factor power is 0.9 tCO2 per MWh
  CO_2 emission reduction calculation has been considered based on equivalent reduction in energy consumption

The energy cost saved per piece of forged material is Rs. 2.00. The actual investment made to implement the energy efficient SPM technology is Rs 5.83 lakhs with annual saving of Rs. 4.56 Lakhs. Thus, the investment made will be recovered within 1.28 years.

2.1.4 Snap-shot of implementation (before and after)

A comparison of the snap-shots of conventional lathe machine used during the baseline vis-à-vis the Special Purpose Machine used in the post implementation study has been shown below:

Figure 2.2: ***Snap shot of conventional lathe machine at Khalon International***

Figure 2.3: ***Special Purpose Machine installed at Khalon International***

2.1.5 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

Parameter	Unit	Value
Baseline Scenario		
Power consumed per conventional turning machine (3 machines of 4 hp each)	kW	8.952
Productivity per conventional turning machine	Pcs/hr	30
Specific power consumption per conventional machine	kWh/Pcs	0.298
Specific fuel consumption in terms of kcal	kcal/pcs	256.624
Cost of energy consumption	Rs/pcs	2.238
Annual production per machine (based on baseline productivity)	pcs/annum	72000
Post Implementation Scenario		
Power consumed by SPM turning machine (based on actual on-site measurement) Note: SPM machine was observed to be running at 80% loading)	kW	2.67
Productivity on SPM turning machine	Pcs/hr	98
Specific power consumption on conventional machine	kWh/Pcs	0.027
Specific fuel consumption in terms of kcal	kcal/pcs	23.431
Cost of energy consumption	Rs/pcs	0.204
Annual production (based on post implementation productivity)	pcs/annum	235200
Savings		
Reduction in cost of energy	Rs/pcs	2.03
Reduction in specific energy consumption in kcal	kcal/pcs	233.2
Annual Cost Savings (in terms of post implementation production)	Rs	478318
Annual Reduction in Energy Consumption (based on post implementation production)	toe	5.48
Percentage reduction in energy consumption	%	90.87
SPM turning machine	Rs	583275
Simple payback period	years	1.22
Annual CO_2 emission reduction	t CO_2/year	57.40

Assumption / conversion factors:

- 1 toe = 0.0148 TJ
- Emission factor power is 0.9 tCO2 per MWh
  CO_2 emission reduction calculation has been considered based on equivalent reduction in energy consumption

The energy cost saved per piece of forged material is Rs. 2.03. The actual investment made to implement the energy efficient SPM technology is Rs 5.83 lakhs with annual saving of Rs. 4.78 Lakhs. Thus, the investment made will be recovered within 1.22 years.

2.1.6 Snap-shot of implementation (before and after)

A comparison of the snap-shots of conventional lathe machine used during the baseline vis-à-vis the Special Purpose Machine used in the post implementation study has been shown below:

Figure 2.4: ***Snap shot of conventional lathe machine at Khalon International***

Figure 2.5: ***Special Purpose Machine installed at Khalon International***

2.1.7 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

Parameter	Unit	Value
Baseline Scenario		
Power consumed per conventional turning machine (3 machines of 4 hp each)	kW	8.952
Productivity per conventional turning machine	Pcs/hr	30
Specific power consumption per conventional machine	kWh/Pcs	0.298
Specific fuel consumption in terms of kcal	kcal/pcs	256.624
Cost of energy consumption	Rs/pcs	2.238
Annual production per machine (based on baseline productivity)	pcs/annum	72000
Post Implementation Scenario		
Power consumed by SPM turning machine (based on actual on-site measurement) Note: SPM machine was observed to be running at 80% loading)	kW	2.78
Productivity on SPM turning machine	Pcs/hr	89
Specific power consumption on conventional machine	kWh/Pcs	0.031
Specific fuel consumption in terms of kcal	kcal/pcs	26.863
Cost of energy consumption	Rs/pcs	0.234
Annual production (based on post implementation productivity)	pcs/annum	213600
Savings		
Reduction in cost of energy	Rs/pcs	2.00
Reduction in specific energy consumption in kcal	kcal/pcs	229.8
Annual Cost Savings (in terms of post implementation production)	Rs	427997
Annual Reduction in Energy Consumption (based on post implementation production)	toe	4.91
Percentage reduction in energy consumption	%	89.53

Parameter	Unit	Value
SPM turning machine	Rs	583275
Simple payback period	years	1.36
Annual CO_2 emission reduction	t CO_2/year	51.36

Assumption / conversion factors:

- 1 toe = 0.0148 TJ
- Emission factor power is 0.9 tCO2 per MWh
  CO_2 emission reduction calculation has been considered based on equivalent reduction in energy consumption

The energy cost saved per piece of forged material is Rs. 2.00. The actual investment made to implement the energy efficient SPM technology is Rs 5.83 lakhs with annual saving of Rs. 4.27 Lakhs. Thus, the investment made will be recovered within 1.36 years.

2.1.8 Snap-shot of implementation (before and after)

A comparison of the snap-shots of conventional lathe machine used during the baseline vis-à-vis the Special Purpose Machine used in the post implementation study has been shown below:

Figure 2.6: ***Snap shot of conventional lathe machine at Khalon International***

Figure 2.7: ***Special Purpose Machine installed at Khalon International***

2.1.9 Energy saving and Cost Economics Analysis (baseline vis-à-vis post implementation)

Parameter	Unit	Value
Baseline Scenario		
Power consumed per conventional turning machine (3 machines of 4 hp each)	kW	8.952
Productivity per conventional turning machine	Pcs/hr	30
Specific power consumption per conventional machine	kWh/Pcs	0.298
Specific fuel consumption in terms of kcal	kcal/pcs	256.624
Cost of energy consumption	Rs/pcs	2.238
Annual production per machine (based on baseline productivity)	pcs/annum	72000
Post Implementation Scenario		

Parameter	Unit	Value
Power consumed by SPM turning machine (based on actual on-site measurement) Note: SPM machine was observed to be running at 80% loading)	kW	2.87
Productivity on SPM turning machine	Pcs/hr	85
Specific power consumption on conventional machine	kWh/Pcs	0.034
Specific fuel consumption in terms of kcal	kcal/pcs	29.038
Cost of energy consumption	Rs/pcs	0.253
Annual production (based on post implementation productivity)	pcs/annum	204000
Savings		
Reduction in cost of energy	Rs/pcs	1.98
Reduction in specific energy consumption in kcal	kcal/pcs	227.6
Annual Cost Savings (in terms of post implementation production)	Rs	404892
Annual Reduction in Energy Consumption (based on post implementation production)	toe	4.64
Percentage reduction in energy consumption	%	88.68
SPM turning machine	Rs	583275
Simple payback period	years	1.44
Annual CO_2 emission reduction	t CO_2/year	48.59

Assumption / conversion factors:

- 1 toe = 0.0148 TJ
- Emission factor power is 0.9 tCO2 per MWh
  CO_2 emission reduction calculation has been considered based on equivalent reduction in energy consumption

The energy cost saved per piece of forged material is Rs. 1.98. The actual investment made to implement the energy efficient SPM technology is Rs 5.83 lakhs with annual saving of Rs. 4.04 Lakhs. Thus, the investment made will be recovered within 1.44 years.

2.1.10 Snap-shot of implementation (before and after)

A comparison of the snap-shots of conventional lathe machine used during the baseline vis-à-vis the Special Purpose Machine used in the post implementation study has been shown below:

Figure 2.8: ***Snap shot of conventional lathe machine at Khalon International***

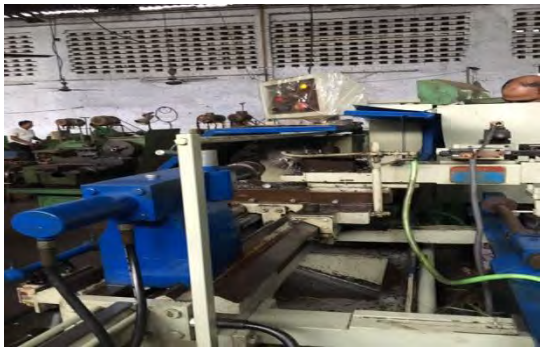

Figure 2.9: ***Special Purpose Machine installed at Khalon International***

Base Executive Summary

Executive Summary

1. Unit Details

Unit Name	:	**Kalhon International**
Address	:	C-26, Phase-II Focal Point, Ludhiana
Contact Person	:	Mr. Tej Prakash Mishra / Mrs. Pritam Kaur, Mr. Jashandeep Singh Kahlon (Owner) (Cell No: 7837638337)
Products	:	Bolts, Nuts and Auto Parts
Production	:	1000 Kgs per day
DIC Number	:	030091200250 (Part-II)
Bank Details	:	State Bank of India; SME Branch – Ludhiana Account No. 10318976943; IFSC Code – SBIN0006265
TAN / PAN No.	:	PAN: ACDPM6432B
Contract demand	:	630 kVA

2. Existing Major Energy Consuming Technology

Lathe Machine

- Manually operated lathe machines for machining job work including threading, turning, grinding, drilling etc.
- Electrical motor rating of 3 HP with production of 80-100 pieces per hour per set of lathe machine.

3. Proposed Energy Saving Technologies with Cost Economics

Proposed Energy Saving Measures

- Replacement of manual lathe machines by four numbers of CNC based Special Purpose Machine (SPM), for carrying out machining operation

Table 1: *Cost Economic Analysis*

Proposed Technology	Estimated Energy Savings (%)	Savings (in Rs.)	Investment (in Rs.)	Simple Payback period (Years)
SPM - Turning Machine (4 Nos)	83	1,652,402	2,200,000	1.33
Total		**1,652,402**	**2,200,000**	

Clearance by CA

ADHUR GUPTA
CHARTERED ACCOUNTANT
687 PREM NAGAR
CIVIL LINES, LUDHIANA
+99155-12967, 0161-5053340

To
M/s Kahlon International
C-26, Focal Point
Ludhiana

Subject:- Recommendation to place an order for procurement of Machinery.

Sir

This is in reference to your request letter, in which your goodself has asked for clearance to place an order with least amount quoted supplier to purchase an energy efficiency equipment.

The details of quotations submitted by you are mentioned in below table:-

Suggested Technology Measures	Summary of Quotation (L-1)	Summary of Quotation (L-2)	Summary of Quotation (L-3)
Special Purpose Machine (SPM)	Hydraulic Automatic Multi Purpose Special Purpose Machine (SPM) for facing, boring and centring of U.J. cross with PLC Control- 4 in No. amounting to Rs.22.00 lacs	Hydraulic Automatic Multi Purpose Special Purpose Machine (SPM) for facing, boring and centring of U.J. cross with PLC Control-4 in No. amounting to Rs.22.40 lacs	Hydraulic Automatic Multi Purpose Special Purpose Machine (SPM) for facing, boring and centringof U.J. cross with PLC Control- 4 in No. amounting to Rs.23.00 lacs
Name of Service Provider	M/s Harkaram Enterprises	M/s Bhambar Engineers	M/s Harjit Turners

Note:- The above said prices are ex-works prices and taxes are not included in it. However taxes are levied on as is basis i.e.rate prevailing at time of dispatch of machine hence their impact can not be judged today. Thus comparison of quotations has been done on bases of tax excluded prices

Accordingly we recommend to place and order 4 SPM with M/s Harkaram Enterprises, being lowest among all.

You are requested to intimate us once the procurement and installation process is complete

Thanking You

Madhur Gupta

Chartered Accountant

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KAHLON
INTERNATIONAL
STAR EXPORT HOUSE (RECOGNISED BY GOVT OF INDIA)

C-26, Focal Point, Ludhiana- 141010 (INDIA)
Ph : +91-161-2674502, 2670269, 2675859
Fax : +91-161-2670285
E-mail : litlite@litlite.com, gskahlon150@gmail.com
kahlonjashan@gmail.com
Website : www.lit-lite.com, www.litlite.com

Dated: 16.2.2016

Sh. Madhur Gupta,
Chartered Accountant,
Nominated Financial Expert for BEE,
Civil Lines, Ludhiana.

Subject:- Implementation of demonstration projects in Ludhiana (Forging) Cluster –reg.

Dear Sir,

With reference to above it is to inform you that we have received quotations from the following parties against the proposed EE equipments. The same are enclosed for your perusal please.

1. M/s Harkaram Enterprises, Ludhiana.
2. M/s Harjit Turners, Ludhiana.
3. M/s Bhamber Engineers (Regd.), Ludhiana.

We are willing to place order to the supplier quoted least amount. Please do the needful and give us clearance, so that needful furtheraction may be taken accordingly.

Thanking you,

Yours faithfully,
For Kahlon International,

Partner.

Encl: Quotations.

VAT No. : 03481034391
C.ST.No. 46518919, Dt. 17-6-95

Tele Fax : 0161-5027178
Ph. : 0161-5076178
(M) : 93169 - 17985

HARKARAM ENTERPRISES

Specialist In : Hydraulic Copying Attachment And Auto Lathes

Mfrs. & Suppliers of :TURNNING MACHINERY, SPECIAL PURPOSE MACHINERY & COPY MILLING MACHINES

10529, St. No: 10, Partap Nagar, Bhagwan Chowk, Industrial Area-B, Ludhiana-141003.
Head Off. St. No. 15, Plot No.7166, New Janta Nagar, Daba Road, LUDHIANA-141003.

Ref. No. .....

Dated.....

DATE:- 04 FEB 2016

QUATATION

M/S. KAHLON INTERNATIONAL.
C-26, FOCAL POINT,PHASE-II
LUDHIANA.

DISCRIPTION OF MACHINE	QTY.	RATE PER MACHINE	TOTAL
HYDRAULIC AUTOMATIC MULTI PURPOSE SPECIAL PURPOSE MACHINE (SPM) FOR FACING ,BORING & CENTERING OF U.J CROSS WITH PLC CONTROL.	4NOS.	5,50,000/-	22,00,000/-

TERMS AND CONITIONS.

1. ADVANCE 35% AND BALANCE BEFORE DELIVERY.
2. **VAT 6.05% WILL BE EXTRA.**
3. DELIVERY IN 45 DAYS.
4. OIL AND TOOLING WILL BE EXTRA.

HARKARAM ENTERPRISES

AUTH SIGN

VAT No. 03531060990

97797-31313
93179-91313

HARJIT TURNERS

J. B. Industrial Estate, Near Sunny Kharay Dharam Kanda,
Jaspal Bangar Road, Ludhiana.
E-mail : harjitturners@gmail.com, Web. www.harjitturners.com

Dated: 11.2.2016

Ref. No.....

QUOTATION

Quotation.

Dated.....

M/s Kahlon International,
C-26, Focal Point, Phase-II,
Ludhiana.

Dear Sirs,

We are pleased to quote our lowest possible rates, as per your telephonic request

Detail of machine & specification	***Qty.***	***Rate per machine***	***Amount***
Hydraulic Automatic Multi Purpose \ Special Purpose Machine (SPM) for facing, boring & Centering of UJ Cross with PLC Control.	*4 Nos.*	*5,75,000/-*	*23,00,000/-*

Business Terms & conditions:

- *FOR ex-works at Ludhiana.*
- *VAT and other taxes, as applicable, will be charged extra.*
- *Delivery within 40 days after receipt of confirmed order with 35% advance payment.*
- *The above rates are valid up to 50 days only.*

We hope that you will find our rates quite reasonable and competitive. Please favour us with your valued order, so that the machines may be supplied accordingly.

Thanking you,

Yours faithfully,
For Harjit Turners,

Manager

Subject to Ludhiana Jurisdiction only

BHAMBAR®

Registered Trade Mark No 689498

BHAMBAR ENGINEERS (Regd.)

1208, G.T. Road, Dhandari Khurd, Ludhiana-141010 (Pb.) INDIA Tel. +91-161-2510183
Telefax : +91-161-2510002 E-mail : info@bhambar.in Visit us at www.bhambar.in

Mfrs. & Exporters : All Geared & Universal, Vertical, Ram Turret & Special Purpose Milling Machines

Dated: 12.2.2016

M/s Kahlon International,
C-26, Focal Point, Phase-II,
Ludhiana.

Dear Sirs,

With reference to your enquiry, we are pleased to quote our minimum possible rates as under:-

Description of machine	Qty.	Rate per machine	Amount
Special Purpose Machine (SPM) Hydraulic Automatic for facing, boring & Centering of UJ Cross with PLC Control and all standard accessories.	4Nos.	5,60,000/-	22,40,000/-

Terms & conditions:

- FOR ex-works at Ludhiana.
- VAT will be charged extra as applicable.
- Delivery within 45 days after receipt of confirmed order with 40% advance payment.
- Rates are valid up to 3 months only.

Thanking you and awaiting your valued order accordingly,

Yours faithfully,
For Bhambar Engineers (Regd.),

Authorized Signatory

VAT No. : 03481034391
C.ST.No. 46518919, Dt. 17-6-95

HE-TRACE®

Tele Fax : 0161-5027178
Ph. : 0161-5076178
(M) : 93169 - 17985

HARKARAM ENTERPRISES

Specialist In : Hydraulic Copying Attachment And Auto Lathes
Mfrs. & Suppliers of :TURNNING MACHINERY, SPECIAL PURPOSE MACHINERY & COPY MILLING MACHINES

10529, St. No: 10, Partap Nagar, Bhagwan Chowk, Industrial Area-B, Ludhiana-141003.
Head Off. St. No. 15, Plot No.7166, New Janta Nagar, Daba Road, LUDHIANA-141003.

Ref. No. .....

Dated.....

DATE:- 04 FEB 2016

QUATATION

M/S. KAHLON INTERNATIONAL.
C-26, FOCAL POINT,PHASE-II
LUDHIANA.

DISCRIPTION OF MACHINE	QTY.	RATE PER MACHINE	TOTAL
HYDRAULIC AUTOMATIC MULTI PURPOSE SPECIAL PURPOSE MACHINE (SPM) FOR FACING ,BORING & CENTERING OF U.J CROSS WITH PLC CONTROL.	4NOS.	5,50,000/-	22,00,000/-

TERMS AND CONITIONS.

1. ADVANCE 35% AND BALANCE BEFORE DELIVERY.
2. VAT 6.05% WILL BE EXTRA.
3. DELIVERY IN 45 DAYS.
4. OIL AND TOOLING WILL BE EXTRA.

HARKARAM ENTERPRISES

AUTH SIGN.

For Kahlon International

Partner

BHAMBAR ENGINEERS (Regd.)
1208, G.T. Road, Dhandari Khurd, Ludhiana-141010 (Pb.) INDIA Tel : +91-161-2510183
Telefax : +91-161-2510002 E-mail : info@bhambar.in Visit us at www.bhambar.in
Registered Trade Mark No 689498
Mfrs. & Exporters : All Geared CE Universal, Vertical, Ram Turret & Special Purpose Milling Machines

Dated: 1.3.2016

M/s Kahlon International,
C-26, Focal Point, Phase-II,
Ludhiana.

Dear Sirs,

With reference to your enquiry, we are pleased to quote our revised minimum possible rates as under:-

Description of machine	Qty.	Rate per machine	Amount
Special Purpose Machine (SPM) Hydraulic Automatic for facing, boring & Centering of UJ Cross with PLC Control and all standard accessories and electrical.	2 Nos.	5,50,000/-	11,00,000/-

Terms & conditions:

- FOR ex-works at Ludhiana.
- VAT will be charged extra as applicable.
- Delivery within 45 days after receipt of confirmed order with 40% advance payment.
- Rates are valid up to 3 months only.

Thanking you and awaiting your valued order accordingly,

Yours faithfully,
For Bhambar Engineers (Regd.),

Authorized Signatory

For Kahlon International

Partner

Completion Letter

ਵਰ ਸਰਿਕੁਲ ਪੁਸਾਦਿ

KAHLON
INTERNATIONAL
STAR EXPORT HOUSE (RECOGNISED BY GOVT. OF INDIA)

C-26 Focal Point Ludhiana 141010 (INDIA)
Ph. +91-161-2674502, 2670269, 2670859
Fax +91-161-2670265
E-mail: lilite@lilite.com, gskahlon150@gmail.com
kahlonjashan@gmail.com
Website: www.lilite.com, www.lilite.com

Dated 31.5.2016

The Energy Economist,
Bureau of Energy Efficiency,
4th Floor, Sewa Bhawan, R.K. Puram,
New Delhi – 110 066

Subject:- Implementation of demonstration projects in Ludhiana Forging Cluster.

Dear Sir,

We are pleased to inform you that the recommended technologies under BEE SME Programme have been successfully implemented and commissioned in our unit.

You are requested to do the needful action in this regard.

Thanking you,

Yours faithfully,
For Kahlon International,

Partner.

Energy Saving calculation SPM turning machine

Parameter	Unit	Value
Baseline Scenario		
Power consumed per conventional turning machine (3 machines of 4 hp each)	kW	8.952
Productivity per conventional turning machine	Pcs/hr	30
Specific power consumption per conventional machine	kWh/Pcs	0.298
Specific fuel consumption interims of kcal	kcal/pcs	256.624
Cost of energy consumption	Rs/pcs	2.238
Annual production per machine (based on baseline productivity)	pcs/annum	72000
Post Implementation Scenario		
Power consumed by SPM turning machine (based on actual on-site measurement) Note: SPM machine was observed to be running at 80% loading)	kW	2.98
Productivity on SPM turning machine	Pcs/hr	95
Specific power consumption on conventional machine	kWh/Pcs	0.031
Specific fuel consumption inters of kcal	kcal/pcs	26.977
Cost of energy consumption	Rs/pcs	0.235
Annual production (based on post implementation productivity)	pcs/annum	228000
Savings		
Reduction in cost of energy	Rs/pcs	2.00
Reduction in specific energy consumption in kcal	kcal/pcs	229.6
Annual Cost Savings (in terms of post implementation production)	Rs	456624
Annual Reduction in Energy Consumption (based on post implementation production)	toe	5.24
Percentage reduction in energy consumption	%	89.49
SPM turning machine	Rs	583275
Simple payback period	years	1.28
Annual CO_2 emission reduction	t CO_2/year	54.79

Parameter	Unit	Value
Baseline Scenario		
Power consumed per conventional turning machine (3 machines of 4 hp each)	kW	8.952
Productivity per conventional turning machine	Pcs/hr	30
Specific power consumption per conventional machine	kWh/Pcs	0.298
Specific fuel consumption interns of kcal	kcal/pcs	256.624
Cost of energy consumption	Rs/pcs	2.238
Annual production per machine (based on baseline productivity)	pcs/annum	72000
Post Implementation Scenario		
Power consumed by SPM turning machine (based on actual on-site measurement)		
Note: SPM machine was observed to be running at 80% loading)	kW	2.67
Productivity on SPM turning machine	Pcs/hr	98
Specific power consumption on conventional machine	kWh/Pcs	0.027
Specific fuel consumption in terms of kcal	kcal/pcs	23.431
Cost of energy consumption	Rs/pcs	0.204
Annual production (based on post implementation productivity)	pcs/annum	235200
Savings		
Reduction in cost of energy	Rs/pcs	2.03
Reduction in specific energy consumption in kcal	kcal/pcs	233.2
Annual Cost Savings (in terms of post implementation production)	Rs	478318
Annual Reduction in Energy Consumption (based on post implementation production)	toe	5.48
Percentage reduction in energy consumption	%	90.87
SPM turning machine	Rs	583275
Simple payback period	years	1.22
Annual CO_2 emission reduction	t CO_2/year	57.40

Parameter	Unit	Value
Baseline Scenario		
Power consumed per conventional turning machine (3 machines of 4 hp each)	kW	8.952
Productivity per conventional turning machine	Pcs/hr	30
Specific power consumption per conventional machine	kWh/Pcs	0.298
Specific fuel consumption in terms of kcal	kcal/pcs	256.624
Cost of energy consumption	Rs/pcs	2.238
Annual production per machine (based on baseline productivity)	pcs/annum	72000
Post Implementation Scenario		
Power consumed by SPM turning machine (based on actual on-site measurement)		
Note: SPM machine was observed to be running at 80% loading)	kW	2.78
Productivity on SPM turning machine	Pcs/hr	89
Specific power consumption on conventional machine	kWh/Pcs	0.031
Specific fuel consumption in terms of kcal	kcal/pcs	26.863
Cost of energy consumption	Rs/pcs	0.234
Annual production (based on post implementation productivity)	pcs/annum	213600
Savings		
Reduction in cost of energy	Rs/pcs	2.00
Reduction in specific energy consumption in kcal	kcal/pcs	229.8
Annual Cost Savings (in terms of post implementation production)	Rs	427997
Annual Reduction in Energy Consumption (based on post implementation production)	toe	4.91
Percentage reduction in energy consumption	%	89.53
SPM turning machine	Rs	583275
Simple payback period	years	1.36
Annual CO_2 emission reduction	t CO_2/year	51.36

Parameter	Unit	Value
Baseline Scenario		
Power consumed per conventional turning machine (3 machines of 4 hp each)	kW	8.952
Productivity per conventional turning machine	Pcs/hr	30
Specific power consumption per conventional machine	kWh/Pcs	0.298
Specific fuel consumption in terms of kcal	kcal/pcs	256.624
Cost of energy consumption	Rs/pcs	2.238
Annual production per machine (based on baseline productivity)	pcs/annum	72000
Post Implementation Scenario		
Power consumed by SPM turning machine (based on actual on-site measurement) Note: SPM machine was observed to be running at 80% loading)	kW	2.87
Productivity on SPM turning machine	Pcs/hr	85
Specific power consumption on conventional machine	kWh/Pcs	0.034
Specific fuel consumption in terms of kcal	kcal/pcs	29.038
Cost of energy consumption	Rs/pcs	0.253
Annual production (based on post implementation productivity)	pcs/annum	204000
Savings		
Reduction in cost of energy	Rs/pcs	1.98
Reduction in specific energy consumption in kcal	kcal/pcs	227.6
Annual Cost Savings (in terms of post implementation production)	Rs	404892
Annual Reduction in Energy Consumption (based on post implementation production)	toe	4.64
Percentage reduction in energy consumption	%	88.68
SPM turning machine	Rs	583275
Simple payback period	years	1.44
Annual CO_2 emission reduction	t CO_2/year	48.59

GHG Emission Factor

Emission Factors for Greenhouse Gas Inventories

Last Modified: 4 April 2014

Red text indicates an update from the 2011 version of this document.

Typically, greenhouse gas emissions are reported in units of carbon dioxide equivalent (CO_2e). Gases are converted to CO_2e by multiplying by their global warming potential (GWP). The emission factors listed in this document have not been converted to CO_2e. To do so, multiply the emissions by the corresponding GWP listed in the table below.

Gas	100-year GWP
CH_4	25
N_2O	298

Source: Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007. See the source note to Table 9 for further explanation.

Table 1 Stationary Combustion Emission Factors

Fuel Type	Heating Value	CO_2 Factor	CH_4 Factor	N_2O Factor	CO_2 Factor	CH_4 Factor	N_2O Factor	Unit
	mmBtu per short ton	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per short ton	g CH_4 per short ton	g N_2O per short ton	
Coal and Coke								
Anthracite Coal	25.09	103.69	11	1.6	2,602	276	40	short tons
Bituminous Coal	24.93	93.28	11	1.6	2,325	274	40	short tons
Sub-bituminous Coal	17.25	97.17	11	1.6	1,676	190	28	short tons
Lignite Coal	14.21	97.72	11	1.6	1,389	156	23	short tons
Mixed (Commercial Sector)	21.39	94.27	11	1.6	2,016	235	34	short tons
Mixed (Electric Power Sector)	19.73	95.52	11	1.6	1,885	217	32	short tons
Mixed (Industrial Coking)	26.28	93.90	11	1.6	2,468	289	42	short tons
Mixed (Industrial Sector)	22.35	94.67	11	1.6	2,116	246	36	short tons
Coal Coke	24.80	113.67	11	1.6	2,819	273	40	short tons
Fossil Fuel-derived Fuels (Solid)								
Municipal Solid Waste	9.95	90.70	32	4.2	902	318	42	short tons
Petroleum Coke (Solid)	30.00	102.41	32	4.2	3,072	960	126	short tons
Plastics	38.00	75.00	32	4.2	2,850	1,216	160	short tons
Tires	28.00	85.97	32	4.2	2,407	896	118	short tons
Biomass Fuels (Solid)								
Agricultural Byproducts	8.25	118.17	32	4.2	975	264	35	short tons
Peat	8.00	111.84	32	4.2	895	256	34	short tons
Solid Byproducts	10.39	105.51	32	4.2	1,096	332	44	short tons
Wood and Wood Residuals	17.48	93.80	7.2	3.6	1,640	126	63	short tons
	mmBtu per scf	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per scf	g CH_4 per scf	g N_2O per scf	
Natural Gas								
Natural Gas (per scf)	0.001026	53.06	1.0	0.10	0.05444	0.00103	0.00010	scf
Fossil-derived Fuels (Gaseous)								
Blast Furnace Gas	0.000092	274.32	0.022	0.10	0.02524	0.000002	0.000009	scf
Coke Oven Gas	0.000599	46.85	0.48	0.10	0.02806	0.000288	0.000060	scf
Fuel Gas	0.001388	59.00	3.0	0.60	0.08189	0.004164	0.000833	scf
Propane Gas	0.002516	61.46	0.022	0.10	0.15463	0.000055	0.000252	scf
Biomass Fuels (Gaseous)								
Landfill Gas	0.000485	52.07	3.2	0.63	0.025254	0.001552	0.000306	scf
Other Biomass Gases	0.000655	52.07	3.2	0.63	0.034106	0.002096	0.000413	scf
	mmBtu per gallon	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu	kg CO_2 per gallon	g CH_4 per gallon	g N_2O per gallon	
Petroleum Products								
Asphalt and Road Oil	0.158	75.36	3.0	0.60	11.91	0.47	0.09	gallon
Aviation Gasoline	0.120	69.25	3.0	0.60	8.31	0.36	0.07	gallon
Butane	0.103	64.77	3.0	0.60	6.67	0.31	0.06	gallon
Butylene	0.105	68.72	3.0	0.60	7.22	0.32	0.06	gallon
Crude Oil	0.138	74.54	3.0	0.60	10.29	0.41	0.08	gallon
Distillate Fuel Oil No. 1	0.139	73.25	3.0	0.60	10.18	0.42	0.08	gallon
Distillate Fuel Oil No. 2	0.138	73.96	3.0	0.60	10.21	0.41	0.08	gallon
Distillate Fuel Oil No. 4	0.146	75.04	3.0	0.60	10.96	0.44	0.09	gallon
Ethane	0.068	59.60	3.0	0.60	4.05	0.20	0.04	gallon
Ethylene	0.058	65.96	3.0	0.60	3.83	0.17	0.03	gallon
Heavy Gas Oils	0.148	74.92	3.0	0.60	11.09	0.44	0.09	gallon
Isobutane	0.099	64.94	3.0	0.60	6.43	0.30	0.06	gallon
Isobutylene	0.103	68.86	3.0	0.60	7.09	0.31	0.06	gallon
Kerosene	0.135	75.20	3.0	0.60	10.15	0.41	0.08	gallon
Kerosene-type Jet Fuel	0.135	72.22	3.0	0.60	9.75	0.41	0.08	gallon
Liquefied Petroleum Gases (LPG)	0.092	61.71	3.0	0.60	5.68	0.28	0.06	gallon
Lubricants	0.144	74.27	3.0	0.60	10.69	0.43	0.09	gallon
Motor Gasoline	0.125	70.22	3.0	0.60	8.78	0.38	0.08	gallon
Naphtha (<401 deg F)	0.125	68.02	3.0	0.60	8.50	0.38	0.08	gallon
Natural Gasoline	0.110	66.88	3.0	0.60	7.36	0.33	0.07	gallon
Other Oil (>401 deg F)	0.139	76.22	3.0	0.60	10.59	0.42	0.08	gallon
Pentanes Plus	0.110	70.02	3.0	0.60	7.70	0.33	0.07	gallon
Petrochemical Feedstocks	0.125	71.02	3.0	0.60	8.88	0.38	0.08	gallon
Petroleum Coke	0.143	102.41	3.0	0.60	14.64	0.43	0.09	gallon
Propane	0.091	62.87	3.0	0.60	5.72	0.27	0.05	gallon
Propylene	0.091	65.95	3.0	0.60	6.00	0.27	0.05	gallon
Residual Fuel Oil No. 5	0.140	72.93	3.0	0.60	10.21	0.42	0.08	gallon
Residual Fuel Oil No. 6	0.150	75.10	3.0	0.60	11.27	0.45	0.09	gallon
Special Naphtha	0.125	72.34	3.0	0.60	9.04	0.38	0.08	gallon
Still Gas	0.143	66.72	3.0	0.60	9.54	0.43	0.09	gallon
Unfinished Oils	0.139	74.54	3.0	0.60	10.36	0.42	0.08	gallon
Used Oil	0.138	74.00	3.0	0.60	10.21	0.41	0.08	gallon
Biomass Fuels (Liquid)								
Biodiesel (100%)	0.128	73.84	1.1	0.11	9.45	0.14	0.01	gallon
Ethanol (100%)	0.084	68.44	1.1	0.11	5.75	0.09	0.01	gallon
Rendered Animal Fat	0.125	71.06	1.1	0.11	8.88	0.14	0.01	gallon
Vegetable Oil	0.120	81.55	1.1	0.11	9.79	0.13	0.01	gallon
	mmBtu per gallon	kg CO_2 per mmBtu	g CH_4 per mmBtu	g N_2O per mmBtu				
Steam and Hot Water								
Steam and Hot Water		66.33	1.250	0.125				mmBtu

Source:

Solid, gaseous, liquid and biomass fuels: Federal Register (2009) EPA; *40 CFR Parts 86, 87, 89 et al; Mandatory Reporting of Greenhouse Gases; Final Rule*, 30Oct09, 261 pp. Tables C-1 and C-2 at FR pp. 56409-56410. Revised emission factors for selected fuels: Federal Register (2010) EPA; 40 CFR Part 98; Mandatory Reporting of Greenhouse Gases: Final Rule, 17Dec10, 81 pp. With Amendments from Memo: Table of Final 2013 Revisions to the Greenhouse Gas Reporting Rule (PDF) to 40 CFR part 98, subpart C: Table C–1 to Subpart C—Default CO2 Emission Factors and High Heat Values for Various Types of Fuel and Table C–2 to Subpart C—Default CH4 and N2O Emission Factors for Various Types of Fuel.

Steam and Hot Water: EPA (2008) *Climate Leaders Greenhouse Gas Inventory Protocol Core Module Guidance - Indirect Emissions from Purchases/Sales of Electricity and Steam*. Assumption: 80% boiler efficiency and fuel type assumed natural gas. Factors are per mmBtu of steam or hot water purchased.

http://www.epa.gov/ghgreporting/documents/pdf/2013/documents/memo-2013-technical-revisions.pdf
http://www.epa.gov/ghgreporting/reporters/subpart/c.html