DETAILED PROJECT REPORT
ON
ENERGY CONSERVATION FOR MOTOR (30 kW) BY SS
WITH ENERGY OPTIMIZATION TECHNOLOGY
(GUJARAT DAIRY CLUSTER)

Bureau of Energy Efficiency

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ENERGY CONSERVATION FOR MOTOR (30 kW) BY SS WITH ENERGY OPTIMIZATION TECHNOLOGY

GUJARAT DAIRY CLUSTER
BEE, 2010

*Detailed Project Report on Energy Conservation For Motor (30 kW)*
*By Soft starter With Energy Optimization Technology*

Gujarat Dairy Cluster, Gujarat (India)
New Delhi: Bureau of Energy Efficiency;
Detail Project Report No.: **GUJ/DRY/SSA/14**
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PCRA is also thankful to all the SME owners, plant in charges and all workers of the SME units for their support during the energy use and technology audit studies and in implementation of the project objectives.

Petroleum Conservation Research Association
Ahmedabad
# Contents

List of Annexure ................................................................. iv  
List of Tables ................................................................. v  
List of Figures ................................................................. vi  
List of Abbreviation .......................................................... vii  
Executive summary ............................................................ viii  
About BEE’S SME program .................................................... ix  

1 INTRODUCTION ............................................................................................................................ 1  
1.1 Brief introduction about cluster ................................................................. 1  
1.2 Energy performance in existing system ......................................................... 7  
1.2.1 Fuel consumption ..................................................................................... 7  
1.2.2 Average annual production ...................................................................... 8  
1.2.3 Specific energy consumption .................................................................... 10  
1.3 Existing technology/equipment ................................................................. 11  
1.3.1 Description of existing technology ......................................................... 11  
1.3.2 Role in process ....................................................................................... 12  
1.4 Baseline establishment for existing technology ........................................... 12  
1.4.1 Design and operating parameters ......................................................... 13  
1.4.2 Operating efficiency analysis (Existing Loss Study) ............................... 15  
1.5 Barriers in adoption of proposed equipment ............................................. 16  
1.5.1 Technological barrier ............................................................................. 16  
1.5.2 Financial barrier ................................................................................... 16  
1.5.3 Skilled manpower .................................................................................. 17  
1.5.4 Other barrier (If any) ........................................................................... 17  

2. PROPOSED EQUIPMENT FOR ENERGY EFFICIENCY IMPROVEMENT ........ 18  
2.1 Description of proposed equipment ......................................................... 18
2.1.1 Detailed of proposed equipment ............................................................................. 19
2.1.2 Equipment/technology specification ..................................................................... 19
2.1.4 Superiority over existing system ........................................................................... 22
2.1.5 Source of equipment ............................................................................................ 23
2.1.6 Availability of technology/equipment .................................................................... 23
2.1.7 Service providers ................................................................................................ 23
2.1.8 Terms and conditions in sales of equipment ....................................................... 23
2.1.9 Process down time ............................................................................................... 23
2.2 Life cycle assessment and risks analysis ................................................................. 23
2.3 Suitable unit for implementation of proposed technology ......................................... 24

3. ECONOMIC BENEFITS FROM PROPOSED TECHNOLOGY ........................................... 25
3.1 Technical benefit ...................................................................................................... 25
3.1.1 Fuel saving ........................................................................................................... 25
3.1.2 Electricity saving .................................................................................................. 25
3.1.3 Improvement in product quality .......................................................................... 25
3.1.4 Increase in production ......................................................................................... 25
3.1.5 Reduction in raw material ................................................................................... 25
3.1.6 Reduction in other losses .................................................................................... 25
3.2 Monetary benefits .................................................................................................... 25
3.3 Social benefits .......................................................................................................... 26
3.3.1 Improvement in working environment ................................................................. 26
3.3.2 Improvement in workers skill ............................................................................. 26
3.4 Environmental benefits ........................................................................................... 26
3.4.1 Reduction in effluent generation .......................................................................... 26
3.4.2 Reduction in GHG emission ................................................................................ 26

4 INSTALLATION OF PROPOSED EQUIPMENT ................................................................ 27
4.1 Cost of project ............................................................................................................ 27
4.1.1 Equipment cost ...................................................................................................... 27
4.1.2 Erection, commissioning and other misc. cost .......................................................... 27
4.2 Arrangements of funds ............................................................................................... 27
4.2.1 Entrepreneur’s contribution .................................................................................... 27
4.2.2 Loan amount ........................................................................................................... 27
4.2.3 Terms & conditions of loan .................................................................................... 27
4.3 Financial indicators .................................................................................................... 28
4.3.1 Cash flow analysis .................................................................................................. 28
4.3.2 Simple payback period ........................................................................................... 28
4.3.3 Net Present Value (NPV) ....................................................................................... 28
4.3.4 Internal rate of return (IRR) .................................................................................. 28
4.3.5 Return on investment (ROI) ................................................................................... 28
4.4 Sensitivity analysis ..................................................................................................... 28
4.5 Procurement and implementation schedule .................................................................. 29
List of Annexure

Annexure -1: Energy audit data used for baseline establishment ........................................ 30
Annexure -2: Process flow diagram after project implementation ........................................ 31
Annexure -3: Detailed technology assessment report .......................................................... 32
Annexure -4: Drawings for proposed electrical & civil works ............................................. 33
Annexure -5: Detailed financial analysis ............................................................................. 34
Annexure -6: Procurement and implementation schedule .................................................... 38
Annexure -7: Details of technology service providers .......................................................... 39
Annexure -8: Quotations or Techno-commercial bids for new technology/equipment ....... 40

List of Table

Table 1.1 Details of annual energy consumption ................................................................. 1
Table 1.2 Details of types of product manufactured ............................................................. 2
Table 1.3 Energy usages pattern ....................................................................................... 3
Table 1.4 Average fuel and electricity consumption .......................................................... 7
Table 1.5 Average annual production ................................................................................. 9
Table 1.6 Process wise (Main Equipment) wise cost of energy consumption ............... 10
Table 1.7 Energy charges .................................................................................................. 12
Table 1.8 Demand charge ................................................................................................. 12
Table 3.1 Energy and monetary benefit (For One Typical Unit of Gujarat Dairy Cluster) .... 25
Table 4.1 Details of proposed technology project cost ........................................................ 27
Table 4.2 Financial indicators of proposed technology/equipment .................................... 28
Table 4.3 Sensitivity analysis at different scenarios ............................................................... 29
Table 4.4 Procurement and implementation schedule ....................................................... 29
List of Abbreviation

BEE  Bureau of Energy Efficiency
CDM  Clean Development Mechanism
DPR  Detailed Project Report
DSCR  Debt Service Coverage Ratio
DSH  De-super Heater
GHG  Green House Gases
IRR  Internal Rate of Return
MT  Million Tonne
MW  Mega Watt
NPV  Net Present Value
ROI  Return on Investment
SCM  Standard Cubic Meter
SIDBI  Small Industrial Development Bank of India
MoMSME  Ministry of Micro Small and Medium Enterprises
SSES  Soft Starter with Energy Saver
WHR  Waste Heat Recovery
EXECUTIVE SUMMARY

Petroleum Conservation & Research Association (PCRA) is executing BEE-SME program in Gujarat Dairy Cluster, supported by Bureau of Energy Efficiency (BEE) with an overall objective of improving the energy efficiency in cluster units.

Gujarat Dairy cluster is one of the very important clusters in India. Gujarat is 5th largest milk producer state in India. This itself explains the importance of dairy cluster in Gujarat State. Accordingly this cluster was chosen for energy efficiency improvements by implementing energy efficient measures/technological upgradation, so as to facilitate maximum replication in other dairy clusters in India. The main energy forms used in the cluster units are grid electricity, Natural gas and small quantity of diesel oil.

The cluster comprises of mainly two type of dairy activity viz Milk chilling center & main dairy. In milk chilling center energy is mainly consumed for milk chilling process while in dairy the major consumer of energy is various milk processes. The cluster comprises of about 80% milk chilling center & 20% dairies. In a typical milk chilling center, cost wise 61% electrical energy & 39% thermal energy being consumed.

This DPR highlights the details of the study conducted for the use of Soft Starter to replace conventional starter for electric motor, possible Energy saving and its monetary benefit, availability of the technologies/design, local service providers, technical features & proposed equipment specifications, various barriers in implementation, environmental aspects, estimated GHG reductions, capital cost, financial analysis, sensitivity analysis in different scenarios and schedule of Project Implementation.

This bankable DPR also found eligible for subsidy scheme of MoMSME for “Technology and Quality Upgradation Support to Micro, Small and Medium Enterprises” under “National Manufacturing and Competitiveness Programme”. The key indicators of the DPR including the Project cost, debt equity ratio, monetary benefit and other necessary parameters are given in table below:

<table>
<thead>
<tr>
<th>S.No</th>
<th>Particular</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Project cost</td>
<td>(Rs. in Lakh)</td>
<td>1.44</td>
</tr>
<tr>
<td>2</td>
<td>Expected Electricity Savings</td>
<td>kWh/annum</td>
<td>11520</td>
</tr>
<tr>
<td>3</td>
<td>Expected Additional Fuel</td>
<td>SCM/year</td>
<td>0</td>
</tr>
</tbody>
</table>


<table>
<thead>
<tr>
<th>S.No</th>
<th>Particular</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Monetary benefit</td>
<td>(₹ in Lakh)/annum</td>
<td>0.69</td>
</tr>
<tr>
<td>5</td>
<td>Debit equity ratio</td>
<td>Ratio</td>
<td>3:1</td>
</tr>
<tr>
<td>6</td>
<td>Simple payback period</td>
<td>Yrs</td>
<td>2.10</td>
</tr>
<tr>
<td>7</td>
<td>NPV</td>
<td>(₹ in Lakh)</td>
<td>1.57</td>
</tr>
<tr>
<td>8</td>
<td>IRR</td>
<td>%age</td>
<td>34.73</td>
</tr>
<tr>
<td>9</td>
<td>ROI</td>
<td>%age</td>
<td>22.28</td>
</tr>
<tr>
<td>10</td>
<td>DSCR</td>
<td>Ratio</td>
<td>2.37</td>
</tr>
<tr>
<td>11</td>
<td>Process down time</td>
<td>Days</td>
<td>1</td>
</tr>
</tbody>
</table>

The projected profitability and cash flow statements indicate that the project implementation will be financially viable and technically feasible solution for Gujarat Dairy cluster.
ABOUT BEE’S SME PROGRAM

Bureau of Energy Efficiency (BEE) is implementing a BEE-SME Programme to improve the energy performance in 25 selected SMEs clusters. Gujarat Dairy Cluster is one of them. The BEE’s SME Programme intends to enhance the energy efficiency awareness by funding/subsidizing need based studies in SME clusters and giving energy conservation recommendations. For addressing the specific problems of these SMEs and enhancing energy efficiency in the clusters, BEE will be focusing on energy efficiency, energy conservation and technology up-gradation through studies and pilot projects in these SMEs clusters.

Major activities in the BEE -SME program are furnished below:

Activity 1: Energy use and technology audit

The energy use technology studies would provide information on technology status, best operating practices, gaps in skills and knowledge on energy conservation opportunities, energy saving potential and new energy efficient technologies, etc for each of the sub sector in SMEs.

Activity 2: Capacity building of stakeholders in cluster on energy efficiency

In most of the cases SME entrepreneurs are dependent on the locally available technologies, service providers for various reasons. To address this issue BEE has also undertaken capacity building of local service providers and entrepreneurs/ Managers of SMEs on energy efficiency improvement in their units as well as clusters. The local service providers will be trained in order to be able to provide the local services in setting up of energy efficiency projects in the clusters.

Activity 3: Implementation of energy efficiency measures

To implement the technology up-gradation project in the clusters, BEE has proposed to prepare the technology based detailed project reports (DPRs) for a minimum of five technologies in three capacities for each technology.

Activity 4: Facilitation of innovative financing mechanisms for implementation of energy efficiency projects

The objective of this activity is to facilitate the uptake of energy efficiency measures through innovative financing mechanisms without creating market distortion.
1 INTRODUCTION

1.1 Brief introduction about cluster

The global objective of the BEE SME programme is to improve the energy intensity of the Indian economy by undertaking actions in the SME sector which directly or indirectly produced 60% of the GDP. The immediate objective of this programme is to create the awareness to accelerate the adoption of EE technologies and practices in 29 chosen clusters in the SME sector through knowledge sharing, capacity building and development of innovative financing mechanisms. To build the energy efficiency awareness by funding/subsidizing need based studies in large number units in the SMEs and giving energy conservation recommendations including technology up-gradation opportunities.

Under “BEE-SME Programme - Gujarat Dairy”, the primary task was to carry preliminary energy audit in 15 units & detail audit in 7 units. The aim of conducting preliminary energy audit in 15 Units is to identify the areas of high energy consumption and to carry out detailed audit and comprehensive technology gap assessment in remaining 7 Units. Preliminary energy audit has been carried out for, assessing the overall energy use in the unit, based on measurements such as various monthly energy consumption rate, production rate, temperature measurement of thermal & chilling system, illumination etc. Energy audit and Technology gap assessment study at the plant results in identification of the following energy saving opportunities and however the detail calculations of the identified saving measures is given in detail energy audit study.

The main form of energy used by the cluster units are grid electricity, Natural Gas, charcoal, lignite, and diesel oil. Major consumptions of energy are in the form of Natural Gas and lignite. Details of total energy consumption at Gujarat Dairy cluster are furnished in Table 1.1 below:

Table 1.1 Details of annual energy consumption

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Unit</th>
<th>Monthly Average Consumption</th>
<th>% Contribution (MCal Basis)</th>
<th>% Contribution (Cost Basis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>kWh</td>
<td>1539108</td>
<td>16%</td>
<td>53%</td>
</tr>
<tr>
<td>NG</td>
<td>SCM</td>
<td>597934</td>
<td>66%</td>
<td>25%</td>
</tr>
<tr>
<td>FO</td>
<td>Ltrs</td>
<td>141855</td>
<td>18%</td>
<td>22%</td>
</tr>
</tbody>
</table>

b) A Typical Milk Chilling Center

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Unit</th>
<th>Monthly Average Consumption</th>
<th>% Contribution (Mcal Basis)</th>
<th>% Contribution (Cost Basis)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>kWh</td>
<td>149056</td>
<td>14%</td>
<td>65%</td>
</tr>
<tr>
<td>FO</td>
<td>kgs</td>
<td>17671</td>
<td>59%</td>
<td>35%</td>
</tr>
</tbody>
</table>
Classification of Units

The Gujarat Dairy Cluster units can be broadly categorized into two types based on types of process.

- Milk Chilling Center
- Dairy Units

Preliminary Energy Carried in 15 Nos. of units out of which 12 Nos. milk chilling centers & 03 Nos. are dairies. Detailed Energy audit carried in 7 units out which 5 Nos. of Dairies & 02 Nos. of milk chilling center.

Products Manufactured

The various product manufactured in dairies covered under ‘Gujarat Dairy Cluster’ are as follow-

Dairies process following products from Milk while milk chilling center collects milk, weighs, chills & dispatch to dairy.

1) Tone Milk / Tetra Pack Milk
2) Tea Milk / Flavored Milk
3) Butter Milk / Curd
4) Milk Cream
5) Butter / Ghee
6) Paneer / Cheese
7) Skimmed Milk Powder
8) Whole Milk Powder
9) Baby Food (Milk Powder Based)
10) Ice Cream / Indian Sweets.

In dairy industry production capacity is mainly decided by milk processed in Kgs(Ltrs) per day.

Table 1.2 Details of types of product manufactured

Details of units of cluster subjected to Preliminary Energy Audit.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Particulars of SME</th>
<th>Dairy / Chilling Center</th>
<th>Production Capacity in ltrs/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Unit 1</td>
<td>Dairy</td>
<td>25000</td>
</tr>
<tr>
<td>2.</td>
<td>Unit 2</td>
<td>Dairy</td>
<td>14500</td>
</tr>
<tr>
<td>3.</td>
<td>Unit 3</td>
<td>Dairy</td>
<td>9000</td>
</tr>
</tbody>
</table>
**EC FOR MOTOR (30 kW) BY SS WITH ENERGY OPTIMIZATION TECHNOLOGY**

### Particulars of SME Dairy / Chilling Center

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Unit</th>
<th>Dairy / Chilling Center</th>
<th>Production Capacity in ltrs/day</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.</td>
<td>Unit 4</td>
<td>Chilling Center</td>
<td>30000</td>
</tr>
<tr>
<td>5.</td>
<td>Unit 5</td>
<td>Chilling Center</td>
<td>140000</td>
</tr>
<tr>
<td>6.</td>
<td>Unit 6</td>
<td>Chilling Center</td>
<td>165000</td>
</tr>
<tr>
<td>7.</td>
<td>Unit 7</td>
<td>Chilling Center</td>
<td>160000</td>
</tr>
<tr>
<td>8.</td>
<td>Unit 8</td>
<td>Chilling Center</td>
<td>160000</td>
</tr>
<tr>
<td>9.</td>
<td>Unit 9</td>
<td>Chilling Center</td>
<td>150000</td>
</tr>
<tr>
<td>10.</td>
<td>Unit 10</td>
<td>Chilling Center</td>
<td>140000</td>
</tr>
<tr>
<td>11.</td>
<td>Unit 11</td>
<td>Chilling Center</td>
<td>160000</td>
</tr>
<tr>
<td>12.</td>
<td>Unit 12</td>
<td>Chilling Center</td>
<td>360000</td>
</tr>
<tr>
<td>13.</td>
<td>Unit 13</td>
<td>Chilling Center</td>
<td>200000</td>
</tr>
<tr>
<td>14.</td>
<td>Unit 14</td>
<td>Chilling Center</td>
<td>200000</td>
</tr>
<tr>
<td>15.</td>
<td>Unit 15</td>
<td>Chilling Center</td>
<td>300000</td>
</tr>
<tr>
<td>16.</td>
<td>Unit 16</td>
<td>Dairy</td>
<td>160000</td>
</tr>
<tr>
<td>17.</td>
<td>Unit 17</td>
<td>Dairy</td>
<td>1280000</td>
</tr>
<tr>
<td>18.</td>
<td>Unit 18</td>
<td>Dairy</td>
<td>5000</td>
</tr>
<tr>
<td>19.</td>
<td>Unit 19</td>
<td>Dairy</td>
<td>500000</td>
</tr>
<tr>
<td>20.</td>
<td>Unit 20</td>
<td>Dairy</td>
<td>400000</td>
</tr>
<tr>
<td>21.</td>
<td>Unit 21</td>
<td>Chilling Center</td>
<td>4500000</td>
</tr>
<tr>
<td>22.</td>
<td>Unit 22</td>
<td>Chilling Center</td>
<td>200000</td>
</tr>
</tbody>
</table>

**Energy usages pattern**

Electricity is mainly used for dairy cluster units apart from other fuels such as FO, PNG, Biomass (wood), HSD, LDO etc. The dairy wise the pattern varies. The details of energy uses pattern are as given below-

**Table 1.3 Energy usages pattern**

<table>
<thead>
<tr>
<th>Name of Unit</th>
<th>Electricity</th>
<th>FO</th>
<th>PNG</th>
<th>Wood</th>
<th>HSD</th>
<th>LDO</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>☀</td>
<td>☀</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 2</td>
<td>☀</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 3</td>
<td>☀</td>
<td>☀</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 4</td>
<td>☀</td>
<td>☀</td>
<td></td>
<td></td>
<td>☀</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 5</td>
<td>☀</td>
<td></td>
<td>☀</td>
<td>☀</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 6</td>
<td>☀</td>
<td>☀</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 7</td>
<td>☀</td>
<td></td>
<td>☀</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 8</td>
<td>☀</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 9</td>
<td>☀</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 10</td>
<td>☀</td>
<td></td>
<td></td>
<td></td>
<td>☀</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 11</td>
<td>☀</td>
<td>☀</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### General production process for Dairy cluster

The units of Gujarat Dairy cluster are basically two types i.e. Milk Chilling Centers & Dairies. The process at milk chilling center is basically to collect the milk, segregation based on type of animal (cow or buffalo), weighing, Quality study, milk chilling & dispatch to mother dairy.

While the process at mother dairy comprises of various products mix such as packaged milk, curd, butter, butter milk, Ghee, Various types of milk powder etc.

Milk collection process involves Grading, Weighing (Milk is recorded in Kgs), Chilling, Dumping, Sampling, Loading in Tanker & dispatch to main processing plant. Most of the chilling centers are located in remote villages to collect the milk from various local ‘Mandalis’. Now a days a new trend of providing BMC (Bulk Milk Storage) is emerging. These give added advantages of directly preserving milk even in small space. At few places even BMC are further divided in small numbers & placed in various remote places.

### Process Diagram for Typical Milk Chilling Center

![Process Diagram](image)

### Pasteurization
Pasteurization is the process that purifies milk and helps it stay fresher, longer. Milk is pasteurized by heating it to 72°C for 16 seconds then quickly cooling it to 4°C. Pasteurization is named after Louis Pasteur, the famous scientist who discovered that the process destroyed bacteria that naturally develops in raw milk. By destroying the bacteria, milk becomes safe to drink and holds its delicious flavor for much longer.

**Homogenization**

Milk must then be homogenized. Without homogenization, the milk fat would separate from the milk and rise to the top. Milk fat is what gives milk its rich and creamy taste. Homogenization makes sure that the fat is spread out evenly in the milk so that every sip of milk has the same delicious flavor and creamy texture. Milk is transferred to a piece of equipment called a homogenizer. In this machine the milk fat is forced, under high pressure, through tiny holes that break the fat cells up into tiny particles, 1/8 their original size. Protein, contained in the milk, quickly forms around each particle and this prevents the fat from rejoining. The milk fat cells then stay suspended evenly throughout the milk.

**Packaging Milk**

Milk is pumped through automatic filling machines direct into bags, cartons and jugs. The machines are carefully sanitized and packages are filled and sealed without human hands. This keeps outside bacteria out of the milk which helps keep the milk stay fresh. During the entire time that milk is at the dairy, it is kept at 1° - 2°C. This prevents the development of extra bacteria and keeps the milk its freshest.

**Cream Extraction & Butter**

Milk cream is extracted from Milk using centrifuge. The butter making process involves quite a number of stages. The continuous butter maker has become the most common type of equipment used. The cream can be either supplied by a fluid milk dairy or separated from whole milk by the butter manufacturer. The cream should be sweet (pH >6.6, TA = 0.10 - 0.12%), not rancid and not oxidized. If the cream is separated by the butter manufacturer, the whole milk is preheated to the required temperature in a milk pasteurizer before being passed through a separator. The cream is cooled and led to a storage tank where the fat content is analyzed and adjusted to the desired value, if necessary. The skim milk from the separator is pasteurized and cooled before being pumped to storage. It is usually destined for concentration and drying. From the intermediate storage tanks, the cream goes to pasteurization at a temperature of 95oC or more. The high temperature is needed to destroy enzymes and micro-organisms that would impair the keeping quality of the butter.
Cheese

Cheese is an important product of fermentative lactic acid bacteria. Due to its reduced water content, and acidic pH, bacterial growth is severely inhibited.

Milk Powder

Skimmed Milk powder, Whole milk powder, baby food etc are various types of milk powder processes employed in units of dairy.
**Ice Cream:** The Ice cream process can be briefly explained from sketch below.

1.2 Energy performance in existing system

1.2.1 Fuel consumption

Average fuel and electricity consumption in a typical Gujarat Dairy Cluster unit is given in Table 1.4 below:

**Table 1.4 Average fuel and electricity consumption**

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Unit</th>
<th>Monthly Average Consumption</th>
<th>Monthly Consumption in Mcal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>kWh</td>
<td>1539108</td>
<td>1323632.9</td>
</tr>
<tr>
<td>NG</td>
<td>SCM</td>
<td>597934</td>
<td>5381406.0</td>
</tr>
<tr>
<td>FO</td>
<td>Ltrs</td>
<td>141855</td>
<td>1489477.5</td>
</tr>
<tr>
<td>Total</td>
<td>Mcal</td>
<td>----</td>
<td>8194516.4</td>
</tr>
</tbody>
</table>

b) On Cost Basis

<table>
<thead>
<tr>
<th>Energy Type</th>
<th>Average Monthly Consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>9988810.92</td>
</tr>
<tr>
<td>NG</td>
<td>4783472</td>
</tr>
<tr>
<td>FO</td>
<td>4113795</td>
</tr>
<tr>
<td>Total in Rs.</td>
<td>18886078</td>
</tr>
</tbody>
</table>
1.2.2 Average annual production

Annual production in terms of liters per/year is taken in case of Milk and Milk products solids and semi solids are in their liter equivalent are given in the following Table 1.5 below:
Table 1.5 Average annual production

<table>
<thead>
<tr>
<th>Month</th>
<th>Butter</th>
<th>Ghee</th>
<th>Paner</th>
<th>Khoa</th>
<th>Masti Dahi</th>
<th>Shrikhand</th>
<th>Amul Kool</th>
<th>S.M.P.</th>
<th>W.M.P.</th>
<th>Amulya</th>
<th>A.S.P.</th>
<th>White Butter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apr-08</td>
<td>575978</td>
<td>189680</td>
<td>256118</td>
<td>1584</td>
<td>513452</td>
<td>143034</td>
<td>54316</td>
<td>173702</td>
<td>0</td>
<td>119587</td>
<td>1448676</td>
<td>0</td>
</tr>
<tr>
<td>May-08</td>
<td>507932</td>
<td>207837</td>
<td>249070</td>
<td>2194</td>
<td>534548</td>
<td>139859</td>
<td>112387</td>
<td>136202</td>
<td>197120</td>
<td>168263</td>
<td>1357065</td>
<td>0</td>
</tr>
<tr>
<td>Jun-08</td>
<td>364098</td>
<td>218436</td>
<td>221571</td>
<td>6272</td>
<td>428235</td>
<td>102749</td>
<td>79282</td>
<td>181035</td>
<td>156395</td>
<td>130695</td>
<td>1111404</td>
<td>0</td>
</tr>
<tr>
<td>Jul-08</td>
<td>286876</td>
<td>261851</td>
<td>140133</td>
<td>10430</td>
<td>465042</td>
<td>59437</td>
<td>20395</td>
<td>79653</td>
<td>156670</td>
<td>131594</td>
<td>872464</td>
<td>0</td>
</tr>
<tr>
<td>Aug-08</td>
<td>339197</td>
<td>286478</td>
<td>182647</td>
<td>25238</td>
<td>471037</td>
<td>171928</td>
<td>38304</td>
<td>179587</td>
<td>0</td>
<td>174919</td>
<td>1228071</td>
<td>0</td>
</tr>
<tr>
<td>Sep-08</td>
<td>491342</td>
<td>130091</td>
<td>211473</td>
<td>26482</td>
<td>47500</td>
<td>127843</td>
<td>0</td>
<td>188894</td>
<td>0</td>
<td>176953</td>
<td>1279321</td>
<td>0</td>
</tr>
<tr>
<td>Oct-08</td>
<td>417499</td>
<td>249239</td>
<td>243018</td>
<td>15382</td>
<td>565186</td>
<td>89376</td>
<td>47505</td>
<td>151032</td>
<td>0</td>
<td>65639</td>
<td>1692232</td>
<td>0</td>
</tr>
<tr>
<td>Nov-08</td>
<td>641696</td>
<td>242069</td>
<td>199052</td>
<td>4160</td>
<td>471105</td>
<td>89793</td>
<td>46766</td>
<td>324071</td>
<td>0</td>
<td>108567</td>
<td>1279682</td>
<td>0</td>
</tr>
<tr>
<td>Dec-08</td>
<td>886070</td>
<td>276967</td>
<td>265026</td>
<td>2004</td>
<td>462144</td>
<td>83644</td>
<td>10531</td>
<td>673321</td>
<td>0</td>
<td>123342</td>
<td>1180249</td>
<td>20500</td>
</tr>
<tr>
<td>Jan-09</td>
<td>850727</td>
<td>332264</td>
<td>224976</td>
<td>3952</td>
<td>461303</td>
<td>80787</td>
<td>21811</td>
<td>755462</td>
<td>0</td>
<td>80019</td>
<td>1236977</td>
<td>148035</td>
</tr>
<tr>
<td>Feb-09</td>
<td>792976</td>
<td>216979</td>
<td>230908</td>
<td>1238</td>
<td>436874</td>
<td>189645</td>
<td>4570</td>
<td>444278</td>
<td>70560</td>
<td>76862</td>
<td>1190432</td>
<td>48510</td>
</tr>
<tr>
<td>Mar-09</td>
<td>830203</td>
<td>242737</td>
<td>246304</td>
<td>768</td>
<td>619591</td>
<td>260349</td>
<td>64675</td>
<td>280888</td>
<td>0</td>
<td>89862</td>
<td>1711364</td>
<td>0</td>
</tr>
<tr>
<td>Apr-09</td>
<td>592886</td>
<td>232994</td>
<td>241562</td>
<td>9268</td>
<td>729099</td>
<td>159234</td>
<td>42346</td>
<td>247185</td>
<td>0</td>
<td>114262</td>
<td>1469411</td>
<td>10740</td>
</tr>
<tr>
<td>May-09</td>
<td>343760</td>
<td>202062</td>
<td>222580</td>
<td>6238</td>
<td>756364</td>
<td>193894</td>
<td>49075</td>
<td>206245</td>
<td>0</td>
<td>127661</td>
<td>1385012</td>
<td>0</td>
</tr>
<tr>
<td>Jun-09</td>
<td>190937</td>
<td>196763</td>
<td>259340</td>
<td>2430</td>
<td>717423</td>
<td>106483</td>
<td>59928</td>
<td>139587</td>
<td>0</td>
<td>81213</td>
<td>854891</td>
<td>0</td>
</tr>
<tr>
<td>Jul-09</td>
<td>267301</td>
<td>302857</td>
<td>57230</td>
<td>7104</td>
<td>663288</td>
<td>120180</td>
<td>10862</td>
<td>21075</td>
<td>0</td>
<td>15541</td>
<td>646280</td>
<td>0</td>
</tr>
<tr>
<td>Aug-09</td>
<td>360404</td>
<td>150111</td>
<td>142175</td>
<td>21386</td>
<td>729928</td>
<td>159988</td>
<td>16555</td>
<td>55147</td>
<td>0</td>
<td>92258</td>
<td>1024997</td>
<td>0</td>
</tr>
<tr>
<td>Sep-09</td>
<td>326550</td>
<td>256971</td>
<td>138200</td>
<td>15868</td>
<td>593518</td>
<td>98544</td>
<td>30619</td>
<td>100520</td>
<td>0</td>
<td>31009</td>
<td>999004</td>
<td>6150</td>
</tr>
<tr>
<td>Oct-09</td>
<td>503432</td>
<td>228263</td>
<td>180021</td>
<td>20136</td>
<td>620770</td>
<td>93323</td>
<td>32362</td>
<td>170815</td>
<td>0</td>
<td>72966</td>
<td>1404444</td>
<td>0</td>
</tr>
<tr>
<td>Nov-09</td>
<td>582951</td>
<td>243360</td>
<td>162538</td>
<td>3564</td>
<td>486056</td>
<td>44187</td>
<td>17453</td>
<td>288975</td>
<td>0</td>
<td>197931</td>
<td>1650920</td>
<td>0</td>
</tr>
<tr>
<td>Dec-09</td>
<td>563161</td>
<td>243172</td>
<td>213106</td>
<td>3126</td>
<td>481483</td>
<td>97244</td>
<td>45336</td>
<td>323287</td>
<td>0</td>
<td>81506</td>
<td>1576643</td>
<td>147630</td>
</tr>
<tr>
<td>Jan-10</td>
<td>941065</td>
<td>184012</td>
<td>236080</td>
<td>5884</td>
<td>459258</td>
<td>86421</td>
<td>57922</td>
<td>315275</td>
<td>0</td>
<td>46227</td>
<td>1663932</td>
<td>37605</td>
</tr>
<tr>
<td>Feb-10</td>
<td>818991</td>
<td>181823</td>
<td>197486</td>
<td>8352</td>
<td>487500</td>
<td>174375</td>
<td>57158</td>
<td>286889</td>
<td>0</td>
<td>108915</td>
<td>1458871</td>
<td>5220</td>
</tr>
<tr>
<td>Average</td>
<td>542436</td>
<td>229462</td>
<td>205244</td>
<td>8829</td>
<td>549118</td>
<td>124879</td>
<td>40007</td>
<td>248836</td>
<td>25250</td>
<td>105034</td>
<td>1292273</td>
<td>18452</td>
</tr>
</tbody>
</table>
1.2.3 Specific energy consumption

In dairy industry the specific energy consumption individual product wise cannot be maintained due to wide range of production mix variation depending on market condition, season and availability of Milk etc.

Electricity SEC Study in Dairy Cluster over Past Few Years

Thermal Energy SEC Study in Dairy Cluster over Past Few Years

Process (Main Equipments) wise cost of energy consumption

The cost of energy consumption of the typical Industry is as given in Table 1.6 below-

Table 1.6 Process wise (Main Equipment) wise cost of energy consumption

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Process Name</th>
<th>% age of Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Milk Processing</td>
<td>13</td>
</tr>
<tr>
<td>2</td>
<td>Refrigeration &amp; Cold Storage</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>Packing &amp; Allied Services</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>CIP Washing &amp; Cleaning</td>
<td>13</td>
</tr>
</tbody>
</table>
1.3 Existing technology/equipment

1.3.1 Description of existing technology

In Dairy cluster at least 30% of energy consumed by refrigeration system. All the units are employing vapor compression based ammonia cycle for refrigeration requirements. The main purpose of providing Soft starter with energy saver to ammonia compressor is to save the energy of compressor motor at part loads.

The refrigeration system typically comprises of the following:-

- A reciprocating refrigeration compressor for compressor refrigerant gas from the evaporator.
- A condenser heat exchanger for condensing high pressure high temperature discharge from the compressor.
- A cooling tower for supplying cooling water to the condenser. Alternatively, instead of a condenser & cooling tower, an atmospheric condenser is installed at a number of chilling centers.
- An ice bank tank for heat storage. The condensed refrigerant (ammonia) is sent to an accumulator from the receiver. The ammonia is expanded in expansion valves for sending low pressure low temperature ammonia to the cooling coils in the ice bank tank. Belt driven agitators are used for homogenizing the chilled water temperature in the ice bank tank.
- Chilled water is circulated by a chilled water pump to the milk chiller for reducing the temperature of raw milk from ambient to 6 – 8 deg c.
- The chilled water return from the milk chiller is around 15-20 deg c depending on the milk:chilled water circulation ratio. Ammonia pre-chiller is installed to pre-chill the chilled water.
from 15-20 deg c to 8 – 12 deg c. The chilled water temperature difference achieved in the ammonia pre-chiller is 6 – 8 deg c.

The refrigeration system is typically operated for 3 hours during morning milk receiving & 3 hours during evening milk receiving.

Due to fluctuating demand on reciprocating ammonia compressor based refrigeration system leads to part load operation of ammonia compressor. The compressor modulate by load-unload of few cylinders depending on load.

**Energy charges**

**Table 1.7 Energy charges**

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Contract Demand, kVA</th>
<th>Energy Charges, Rs/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Up to 1000</td>
<td>3.85</td>
</tr>
<tr>
<td>2</td>
<td>From 1001 to 2500</td>
<td>4.05</td>
</tr>
<tr>
<td>3</td>
<td>Above 2500</td>
<td>4.15</td>
</tr>
</tbody>
</table>

**Demand Charges**

**Table 1.8 Demand charge**

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Billing Demand, kVA</th>
<th>Demand Charges, Rs/kVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>For first 500</td>
<td>98</td>
</tr>
<tr>
<td>2</td>
<td>For next 500</td>
<td>139</td>
</tr>
<tr>
<td>3</td>
<td>For next 1500</td>
<td>208</td>
</tr>
<tr>
<td>4</td>
<td>Billing demand in Excess of 2500</td>
<td>237</td>
</tr>
<tr>
<td>5</td>
<td>Billing Demand Excess of contract demand</td>
<td>369</td>
</tr>
</tbody>
</table>

Therefore, total electricity Charges (including the maximum demand charges & other taxes) is Rs. 5.96 per kWh in considered case.

**1.3.2 Role in process**

The refrigeration system is the heart of the chilling centre. The very purpose of the chilling centre is to chill the raw milk received from distant societies & transport it to the main dairy. Thus the refrigeration system is fundamental to the operation of the chilling centre. In Dairy cluster at least 30% of energy consumed by refrigeration system. All the units are employing vapor compression based ammonia cycle for refrigeration requirements. The main purpose of providing Soft starter with energy saver to ammonia compressor is to save the energy of compressor motor at part loads.

**1.4 Baseline establishment for existing technology**

In a typical dairy reciprocating compressor for ammonia vapor compression cycle are provided.
The actual consumption of compressor motor considered for soft starter with energy saver is 21.7 kW per hour i.e. 156240 kWh per annum.

### 1.4.1 Design and operating parameters

During preliminary & detailed energy audit, it was observed that the ammonia compressors in vapor compression system, which consumes one of the major components of electricity consumptions, are subjected to frequent part load. This results in partial loading of electric motor frequently.

Motors consume 70% of Industrial Electricity. Energy is wasted when machines operate at less than full load, since motors have no intelligent way of adjusting this energy it gets wasted. When a motor starts a huge amount of energy is required substantially developing more torque than required in order to reach full speed. This extra energy places stress on the mechanical transmission systems producing excessive wear and premature failure.

That's not all, the acceleration on start-up has a massive impact on the electricity supply charges, and in turn this also leads to heat losses dramatically reducing the life of the motor.

Soft starter with energy saver delivers the exact amount of power required by the motor. Soft starter with energy saver also saves energy by switching off the motor during periods of 'no load' or when operating at partial load for long periods of time i.e. when not required to be running. Soft starter with energy saver is energy saving product, simply by giving the motor the exact amount of power it needs at any time energy is saved.
Typically most AC motors are under full load only for a few seconds at initial start up. The motor itself has no way of adjusting the amount of electricity it draws in relation to the load required by the system. For most of the time, therefore, the motor will draw excess electricity that is "burned off" principally as heat.

Soft starter with energy saver monitors the load at the motor and accordingly optimizes the voltage, current and power factor thereby reducing the running cost of the electric motor. It also acts as soft starter for 3 phase induction motors.

The efficiency of electric motor varies with % loading. Please refer following figure.

From efficiency curve & effect of voltage on torque of electric motor, it is clear that at part load values the torque of motor can be reduced by changing voltage.

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Torque, starting &amp; maximum running</td>
<td>Increase 21%</td>
</tr>
<tr>
<td>Speed</td>
<td>No change</td>
</tr>
<tr>
<td>Synchronous</td>
<td>Increase 1%</td>
</tr>
<tr>
<td>Full Load</td>
<td>Decrease 17%</td>
</tr>
<tr>
<td>% slip</td>
<td>Increase 0.5 to 1 point</td>
</tr>
<tr>
<td>Efficiency</td>
<td>Little change</td>
</tr>
<tr>
<td>Full load</td>
<td>Decrease 1 to 2 points</td>
</tr>
<tr>
<td>3/4 load</td>
<td>Decrease 3 points</td>
</tr>
<tr>
<td>1/2 load</td>
<td>Decrease 4 points</td>
</tr>
<tr>
<td>Power Factor</td>
<td>Decrease 5 to 6 points</td>
</tr>
<tr>
<td>Starting</td>
<td>Increase 10 to 12%</td>
</tr>
<tr>
<td>Full load</td>
<td>Decrease 7%</td>
</tr>
</tbody>
</table>
1.4.2 Operating efficiency analysis (Existing Loss Study)

Load profile (kW Vs Time) of existing ammonia compressor using data logger carried for few ammonia compressors. It was observed that the ammonia compressors are subjected to frequent part load values depending on the demand for chilling.

Load Profile of Compressor No.1

Please refer following load curve on a ammonia compressor at Sabar Dairy.

From load profile it is clear that the motor of ammonia compressor subjected to frequent load-unload. At part load the efficiency of motor drops considerably resulting in the less efficient operations. The ammonia compressors are subjected to load-unload due to change in no of cylinders loaded. At part
loads only one / two / three cylinders are working. The percentage loading on motor may be lower up to 25% at times.

At part loads, soft starter with energy saver, by changing firing angle of thyristor, reduces the voltage till the current is not increased. The saving up to 6 to 8% of consumption of compressor motor, which is primary energy consumer in chilling center can be achieved. Along with energy saving, MD of the chilling center can be controlled & overall life of components of compressor can be enhanced due to soft starter feature.

It was concluded by the energy audit team that though the losses may be on higher side, considering efficiencies, the energy saving of 6% is definitely achievable by providing soft starter with energy saver to ammonia compressor motor.

1.5 Barriers in adoption of proposed equipment

1.5.1 Technological barrier

In Gujarat Dairy Cluster, overall technical understanding on Dairy product manufacturing is good and rapidly increasing. Many of the dairy engineers/managers are well informed and ready to adopt new technology. It has been observed that at cluster level there is committed interested for leadership and following up is quick. In general, there is readiness to adopt provided delivery, outcome and results are demonstrated.

However the first change is still a challenge, upon success, later on duplication and adaptation is extremely prevalent in the cluster. The technologies need to be demonstrated within the cluster. While carrying out the audits and presenting the Energy audit reports to the units, in the discussion with the plant owners & other personnel, many of them agreed with many of the identified energy saving measures and technologies but they demanded demonstration of the energy saving technologies in any plant and thereafter they have readiness to follow.

Milk chilling centers and dairy plants are using conventional technology. The design and operation of the plant is standardized as per old practices. It was fine, till energy was available relatively cheap and there was no global drive to better energy management.

While carrying out the audits and presenting the Energy audit reports to the units, it was found that significant energy can be saved by provision of soft starter with energy savers. And hence there is a need for a better technology for efficient energy management.

1.5.2 Financial barrier

Availing finance is not the major issue. Among the SMEs, the larger units, if convinced are capable of either financing it themselves or get the finance from their banks. The smaller units will require competitive loan and other support to raise the loan. However as most of them have been able to expand their setup and grow, there is readiness to spend for energy efficiency technologies which
have good returns. Energy Efficiency Financing Schemes such as SIDBI’s, if focused on the cluster, will play a catalytic role in implementation of identified energy conservation projects & technologies.

The cluster has significant potential of technological upgradation. However though there are good returns, this project is highly capital intensive and requires support of policy as well as innovative financial mechanisms. CDM needs to be duly applied to generate additional cash flow to further improve the returns from the project.

1.5.3 Skilled manpower

In Gujarat Dairy cluster, the availability of skilled manpower is one of the problems due to more number of units. Local technical persons available at individual location take care of maintenance or repair works of major equipments. Maintenance or repair work of major equipments of Dairy units like ammonia compressors, hot air generators for spray dryers etc, are generally taken care by the equipment suppliers itself as they station one of their experienced technical representative at Ahmadabad for the maintenance work.

Specialized and focused training of the local service providers on better operation and maintenance of the equipments, importance of the energy and its use and energy conservation measures will improve awareness among the unit owners and workforce. Original equipment suppliers should also participate in these programs.

1.5.4 Other barrier (If any)

No other barrier is seen. It appears that apart from high initial cost of energy efficient electric motor, there is no other barrier.
2. PROPOSED EQUIPMENT FOR ENERGY EFFICIENCY IMPROVEMENT

2.1 Description of proposed equipment

**Soft Start and Soft Stop:** - When starting, an AC Induction motor develops more torque than is required at full speed. This stress is transferred to the mechanical transmission system resulting in excessive wear and premature failure of chains, belts, gears, mechanical seals, etc. Additionally, rapid acceleration also has a massive impact on electricity supply charges with high inrush currents drawing +600% of the normal run current. The use of Star Delta only provides a partial solution to the problem. Should the motor slow down during the transition period the high peaks are repeated and can even exceed direct on line current. Soft starter with energy saver provides a reliable and economical solution to these problems by delivering a controlled release of power to the motor, thereby providing smooth, step less acceleration and deceleration. Motor life will be extended as damage to windings and bearings is reduced.

Soft Start & Soft Stop is built into 3 phase Soft starter with energy saver units, providing controlled starting and stopping with a selection of ramp times and current limit settings to suit all applications.

- Less mechanical stress.
- Improved power factor.
- Lower maximum demand.
- Less mechanical maintenance.

Soft Start and Soft Stop is especially useful with compressor where torque transients often cause liquid hammer effects, and in some instances, failure to gradually slow the fluid down before stopping, can cause the kinetic energy to rupture pipes and couplings.

Intelligent Energy Savings When a motor is operating under less than full load a large amount of energy is being wasted. Both NASA and the British Energy Efficiency Office have stated "in typical applications, levels of utilization are approximately 50% with power losses estimated to be between 40% and 80% of the motor full load rating". Although they play a vital role in modern life in the production of almost all products, industry pays dearly for these inefficiencies. Soft starter with energy saver can recover these losses, reduce costs and thus increase profits.

Soft starter with energy saver utilizes a powerful micro-controller, which continuously monitors motor ‘efficiency’ and ensures the optimum amount of power is used to complete the job of work. Slight changes in demand will be recognized and Soft starter with energy saver will respond immediately by matching the input power exactly as the load changes – thus saving energy. Soft starter with energy saver are available from 1kW to 600kW range.
2.1.1 Detailed of proposed equipment

In the normal uncontrolled operation of an induction motor, the voltage sine wave has the same value regardless of whether the motor is fully or lightly loaded. Excessive and wasteful levels of power are consumed when the motor’s load is minimal. Subsequently, the current sine wave reaches greater than required levels to maintain the load.

In accordance with the Soft starter with energy saver, the power factor can be determined without the use of an electromagnetic sensing element. The determination has been made that the absolute current measurements are not required. In order to detect the power factor in accordance with the principles of the Soft starter with energy saver, only the zero crossing of the current relative to the voltage needs to be detected.

Soft starter with energy saver constantly adjusts the voltage to the terminals of an AC Induction motor to that which is just sufficient to meet the load on the motor. It is able to instantly detect, by microprocessor control any change in a varying load and to adjust the voltage output accordingly. By matching output to load, the losses (iron/ magnetizing, copper and friction losses) inherent in all AC Induction motors are considerably reduced thereby dramatically improving the motor efficiency and reducing running costs.

The inherent design of an induction motor causes it to use excessive current and voltage even under light or no-load conditions. The research shows that a typical industrial or commercial motor may be loaded at between only 50% and 60% of full amp or wattage draw. The Soft starter with energy saver software energy management algorithms sense the load on the motor by monitoring the “zero crossing” points of both the voltage and current sine waves and, the use of a Thyristors, it cuts the voltage during times of excessive voltage. While the Thyristors are switched off, the motor generates no current and therefore the current sine wave is reduced as well.

2.1.2 Equipment/technology specification

DESCRIPTION

Since its invention one hundred years ago, the standard 3-phase induction motor has become one of the most familiar items of industrial equipment ever known. Due to its simplicity of construction, low cost, reliability and relatively high efficiency, it is likely to remain the prime source of mechanical energy for the foreseeable future.

In a motor controller for AC induction motors in accordance with the Soft starter with energy saver, a Thyristor (Back to Back) is placed in the circuit with each phase winding of the motor. The voltage at the Thyristor gate is monitored. The gate voltage is used to provide a signal that indicates when current flows through the motor and crosses zero. A voltage sampler circuit provides signals, which identify when the voltage applied to the motor crosses zero. Both signals are supplied to a
microcontroller, which provides a pulse width modulated digital output signal that, in turn, controls the Thyristors to control the power supplied to the motor by varying the duty cycle of the power applied to the motor windings.

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**Soft Start Effect**

![Soft Start Effect](image)

**Losses of Typical Electric Motor**

![Losses of Typical Electric Motor](image)

In a motor controller for AC induction motors in accordance with the Soft starter with energy saver, a Thyristor (Back to Back) is placed in the circuit with each phase winding of the motor. The voltage at
the Thyristor gate is monitored. The gate voltage is used to provide a signal that indicates when current flows through the motor and crosses zero. A voltage sampler circuit provides signals, which identify when the voltage applied to the motor crosses zero. Both signals are supplied to a microcontroller, which provides a pulse width modulated digital output signal that, in turn, controls the thyristors to control the power supplied to the motor by varying the duty cycle of the power applied to the motor windings.

The width of this reduction is determined by the actual load on the motor, which the soft starter with energy saver calculates by comparing current and voltage phase angles. The result of this voltage and current reduction is that less energy is consumed and the motor is subjected to minimal heat stress.

Under light loads, the "width of the reduction" removed from the A/C signal will be significant. As the load demanded by the motor increases, the width of the reduction will decrease, to the point where under fully loaded conditions the "width of the reduction" removed is negligible and full power is allowed to flow to the motor, producing a more efficient, quieter operation and smaller utility bills. Since the induction motor's rotor has inertia, the "width of the reduction"(which lasts only a fraction of a second) has no effect on the motor speed or torque output.

The above method of voltage and current regulation has proven that the Soft starter with energy saver saves anywhere from 10% to 40% electricity (In this case energy audit team of the opinion that about 3% saving can be very much realistic & on conservative side) on appliances in and around the Industry.

The main problems are the motor’s inability to match motor torque to load torque both during starting and running and the high starting current. During starting the motor usually produces 150 - 200% torque (see Figure 1) accelerating the load to full speed in a fraction of a second, which can cause damage to the drive train. At the same time the motor can commonly draw 8 times nominal current (In) causing supply stability problems.

When the motor is operating at light load for extended periods the motor’s efficiency falls due to the over-fluxing of the windings for the particular torque required to drive the load. At a constant terminal voltage this flux, often referred to as magnetizing current, is fixed and accounts for around 30-50% of the motors total losses.

**Technical Specification considered –**

<table>
<thead>
<tr>
<th>Details</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power input</td>
<td>415/440 volts AC +/- 10% 3 phase 50 hz.</td>
</tr>
<tr>
<td>Recommended load</td>
<td>A.C. motor, three phase, Multiple Motors or other loads are not recommended except under specific circumstances.</td>
</tr>
<tr>
<td>Maximum Overload capacity</td>
<td>115% continuous, 150% for 10 seconds and 200% for 5 seconds.</td>
</tr>
</tbody>
</table>
### Details | Specification
--- | ---
Altitude of Installation | 1000 meters. (Above 1000 meters de rating has to be done).
Voltage rating of Thyristors | 1400 PIV.
Type Of Cooling | Air-cooled upto 75 HP. Force-cooled above 75 HP.
SCR Protection | MOV transient voltage suppressors to absorb high energy voltage transients provided across the input supply points. RC Snubber circuit is provided across SCR to prevent misfiring due to rapid rise of voltage. (dv/dt).

#### 2.1.3 Integration with existing equipment

It is proposed that soft starter with energy saver will be installed in place of existing star-delta starter. There is no problem expected in installing & integration of soft starter with the existing system.

The following are the reasons for selection of this technology

- The proposed system does not consume additional space.
- It will reduce the total operating energy cost of the plant.
- It reduces the GHG emissions.
- The overall mechanical stresses on the compressor system will be reduced.
- It is a clean technology.
- Soft start portion will help to reduce the instantaneous Maximum demand.

#### 2.1.4 Superiority over existing system

The proposed electric motors are more energy efficient that existing one and are technologically superior. Use of this technology reduces the overall plant energy cost. It also reduces the dependency for electricity on the state electricity grid. The proposed measures bear better technology than the existing one results in both energy saving and technological up gradation.

---

**Soft start portion of soft starter with energy saver technology has following advantages**

- Smooth start and Step less Gradual acceleration of motor and consequent elimination of shocks during starting.
- Reduction in peak motor current during starting.
- Reduction in maximum demand.
- Reduction in motor temperature increased motor life and decreased maintenance.
- Comfortable inching without any damage.
- Power factor improvement.
- Reduced power consumption and hence reduced Energy bills.
- No moving parts that can be affected by dust, dirt or other such environmental factors.
- Easy installation and Retrofit capacity (3 wires in 3 wires out) - solid state - low maintenance.
- Replaces electro - magnetic starters as well as fluid couplings.

**Energy saving portion of soft starter with energy saver technology has following advantages**

- Where a smooth start is desirable to avoid shocks to the drive systems or where a gradual start is required to avoid damage to the product / process / drive system and accessories.
2.1.5 Source of equipment

The recommended technology is proven one and in various industries on normal basis. These are running successfully and the unit owners had observed the savings in terms of energy.

2.1.6 Availability of technology/equipment

Suppliers of this technology are available at local level as well as at international level very easily. Even most of the suppliers took initiative and interacting with the dairy unit owners for creating the awareness of use of this technology.

2.1.7 Service providers

Details of technology service providers are shown in Annexure 7.

2.1.8 Terms and conditions in sales of equipment

The suppliers have already extended standard warranette conditions for exchange, replace or repair against manufacturing defects for a period of 12 months after the date of commissioning. Promoters will have to promptly notify the supplier in writing of obvious defects or deficiencies after detection thereof. Replaced parts shall become the property of the supplier upon request of the supplier.

Supplier is not liable or defects or deficiencies which are resulting from the following reasons, as long as they are not resulting from a default of Supplier: Improper, unsuitable or negligent use, handling and/or operation of the system by promoters or by third parties; use of spare parts other than Genuine Parts; normal wear and tear; use of unsuitable consumables (such as, fuel, oil cooling liquid or any other consumables), particularly the use of consumables not conciliated in the operation manuals; improper building ground; chemical, electro-chemical or electric influences.

All conditions associated with this system are standard in nature. No special clause is incorporated. The conditions are very common in most of the plant & machinery sales.

2.1.9 Process down time

Process down time of Milk Chilling Unit of about 5 Hours maximum will be required for the installation & commissioning of the soft starter with energy saver with the existing system.

2.2 Life cycle assessment and risks analysis

Life of the equipment is about 15 years. Risk involves in the installation of proposed project are as follows:
➢ Risk involved in delay in implementation of the proposed project is due to the high initial investment cost.

2.3 Suitable unit for implementation of proposed technology

The measure & technology is suitable for the milk chilling center & dairy units under the Gujarat Dairy Cluster & similar units outside cluster. This measure in fact will result in technological upgradation in vital energy consuming area of these units.
3. ECONOMIC BENEFITS FROM PROPOSED TECHNOLOGY

3.1 TECHNICAL BENEFIT

3.1.1 Fuel saving
No direct fuel saving by this measure. The electricity saved may indirectly save the fuel.

3.1.2 Electricity saving
It is estimated that this system will save 11520 kWh per Annum for the unit at the rate of 5.96 per kWh.

3.1.3 Improvement in product quality
The measure does not have any impact on quality of product *directly or indirectly*.

3.1.4 Increase in production
Production will be the same as in present.

3.1.5 Reduction in raw material
Raw material consumption is same even after the implementation of proposed technology.

3.1.6 Reduction in other losses
No impact on other losses *directly or indirectly*.

3.2 Monetary benefits
Implementation of project will result in good, consistent monetary benefit. It is estimated that this system will save on an average 11520 kWh per Annum for the unit.

Please refer following table.

**Table 3.1 Energy and monetary benefit (For One Typical Unit of Gujarat Dairy Cluster)**

<table>
<thead>
<tr>
<th>Energy and monetary benefit</th>
<th>Energy and monetary benefit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Expected Savings per Annum in kWh</td>
<td>kWh/Annum</td>
</tr>
<tr>
<td>2) Expected Saving per Annum (Considering 360 Working Days)</td>
<td>Rs./Annum</td>
</tr>
<tr>
<td>3) No of Motors for Compressor on load</td>
<td>Nos.</td>
</tr>
<tr>
<td>4) Expected Investment Needed for providing soft starter with energy saver.</td>
<td>Rs.</td>
</tr>
<tr>
<td>5) Simple Payback</td>
<td>Yrs</td>
</tr>
<tr>
<td></td>
<td>Months</td>
</tr>
<tr>
<td>6) KLOE Saving per Annum</td>
<td>KLOE/Annum</td>
</tr>
</tbody>
</table>

**Further details of total monetary benefit are given in Annexure 3.**
3.3 SOCIAL BENEFITS

3.3.1 Improvement in working environment

Use of energy efficient electric motor technology in Dairy Industry reduces the energy consumption. This improves efficiency of refrigeration system and reduces CO$_2$ generation.

3.3.2 Improvement in workers skill

Technical skills of persons will definitely be improved. As the training will be provided by equipment suppliers which improve the technical skills of manpower required for operating of the equipment and also the technology implementation will create awareness among the workforce about energy efficiency and energy saving.

3.4 ENVIRONMENTAL BENEFITS

3.4.1 Reduction in effluent generation

There is no impact in effluent generation due to implementation of the project.

3.4.2 Reduction in GHG emission

Implementation of this technology will reduce the CO$_2$ emissions. Reduction in CO$_2$ emissions will be possible due to Energy saving. This project results in reduction of peak demand and uses off-peak electricity. Hence it will help in reducing CO$_2$ emission up to the average limit of 9 tonnes (9.79 tonnes exact).

3.4.3 Reduction in other emissions like SO$_X$

Amount of SO$_X$ will be reducing due to improved efficiency of the power plants due to better plant load factor.
4 INSTALLATION OF PROPOSED EQUIPMENT

4.1 COST OF PROJECT

4.1.1 Equipment cost

Cost of soft starter with energy saver is Rs.1.44 Lacs for suitable to 30 kW Capacity.

4.1.2 Erection, commissioning and other misc. cost

Total erection and commissioning cost is Rs. 0.02 lakh. The details of project cost is as given in table 4.1 given below-

Table 4.1 Details of proposed technology project cost

<table>
<thead>
<tr>
<th>SN</th>
<th>Particulars</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Cost of Retrofit/Additional Plan &amp; Machinery For Energy Saving</td>
<td>Rs. (in Lacs)</td>
<td>1.39</td>
</tr>
<tr>
<td>2</td>
<td>Detail Engineering, Design &amp; related expenses</td>
<td>Rs. (in Lacs)</td>
<td>0.01</td>
</tr>
<tr>
<td>3</td>
<td>Erection &amp; Commissioning cost</td>
<td>Rs. (in Lacs)</td>
<td>0.02</td>
</tr>
<tr>
<td>4</td>
<td>Cost of civil work</td>
<td>Rs. (in Lacs)</td>
<td>0.01</td>
</tr>
<tr>
<td>5</td>
<td>Custom Clearance &amp; Transportation Charges</td>
<td>Rs. (in Lacs)</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>Import duty</td>
<td>Rs. (in Lacs)</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>Other charges (Including Contingency 10%)</td>
<td>Rs. (in Lacs)</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td><strong>Total cost</strong></td>
<td><strong>Rs. (in Lacs)</strong></td>
<td><strong>1.44</strong></td>
</tr>
</tbody>
</table>

4.2 ARRANGEMENTS OF FUNDS

4.2.1 Entrepreneur’s contribution

Entrepreneur will contribute 25% of the total project cost i.e. Rs. 0.36 Lakh & financial institutes can extend loan of 75%.

4.2.2 Loan amount.

The term loan is 75% of the total project cost i.e. Rs 1.08 Lakh, with repayment of 7 years considered for the estimation purpose.

4.2.3 Terms & conditions of loan

The interest rate is considered at 10% which is SIDBI’s rate of interest for energy efficient projects. The loan tenure is 7 years excluding initial moratorium period is 6 months from the date of first disbursement of loan.
4.3 FINANCIAL INDICATORS

4.3.1 Cash flow analysis

Profitability and cash flow statements have been worked out for a period of 10 years. The financials have been worked out on the basis of certain reasonable assumptions, which are outlined below.

The project is expected to achieve monetary savings of Rs. 0.69 lakh.

- The Operation and Maintenance cost is estimated at 2% of cost of total project with 5% increase in every year as escalations.
- Interest on term loan is estimated at 10%.
- Depreciation is provided as per the rates provided in the companies act.

Considering the above mentioned assumptions, the net cash accruals starting with Rs. 0.50 lakh in the first year operation and to Rs. 3.10 lakh at the end of tenth year.

4.3.2 Simple payback period

The estimated payback period is about 2.10 years or about 25 months.

4.3.3 Net Present Value (NPV)

The Net present value of the investment at 10% works out to be 1.57 lakh.

4.3.4 Internal rate of return (IRR)

The after tax IRR of the project works out to be 34.73%. Thus the project is financially viable for both types of fuels.

4.3.5 Return on investment (ROI)

The average return on investment of the project activity works out at 22.28%.

Financial indicator of proposed technology is furnished in Table 4.2 below:

<table>
<thead>
<tr>
<th>SN</th>
<th>Scenario</th>
<th>IRR</th>
<th>NPV</th>
<th>ROI</th>
<th>DSCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal</td>
<td>34.73%</td>
<td>1.57</td>
<td>22.28%</td>
<td>2.37</td>
</tr>
</tbody>
</table>

4.4 SENSITIVITY ANALYSIS

A sensitivity analysis has been carried out to ascertain how the project financials would behave in different situations like when there is an increase in fuel savings or decrease in fuel savings. For the purpose of sensitive analysis, two following scenarios has been considered

- Optimistic scenario (Increase in energy savings by 5%)
- Pessimistic scenario (Decrease in energy savings by 5%)
In each scenario, other inputs are assumed as a constant. The financial indicators in each of the above situation are indicated along with standard indicators.

Details of sensitivity analysis at different scenarios are shown in Table 4.3 below:

Table 4.3 Sensitivity analysis at different scenarios

<table>
<thead>
<tr>
<th>SN</th>
<th>Scenario</th>
<th>IRR</th>
<th>NPV</th>
<th>ROI%</th>
<th>DSCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Normal</td>
<td>34.74%</td>
<td>1.58</td>
<td>22.28%</td>
<td>2.37</td>
</tr>
<tr>
<td>2</td>
<td>5% Increase in Fuel Saving</td>
<td>36.92%</td>
<td>1.72</td>
<td>22.88%</td>
<td>2.48</td>
</tr>
<tr>
<td>3</td>
<td>5% Decrease in Fuel Saving</td>
<td>32.54%</td>
<td>1.43</td>
<td>22.59%</td>
<td>2.25</td>
</tr>
</tbody>
</table>

4.5 PROCUREMENT AND IMPLEMENTATION SCHEDULE

Procurement and implementation schedule for proposed project are shown in Table 4.4 below and further details of process break down are shown in Annexure 6.

Table 4.4 Procurement and implementation schedule

<table>
<thead>
<tr>
<th>SN</th>
<th>Activities</th>
<th>Weeks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Order placement</td>
<td>1 -</td>
</tr>
<tr>
<td>2</td>
<td>Delivery</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Foundation &amp; civil work</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Commissioning</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Cabling &amp; electrical panel fitting</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Testing and trial</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>On site operator training</td>
<td></td>
</tr>
</tbody>
</table>
Annexure -1: Energy audit data used for baseline establishment

In a typical dairy reciprocating compressor for ammonia vapor compression cycle are provided.

<table>
<thead>
<tr>
<th>SN</th>
<th>Ammonia Compressor Particulars</th>
<th>Model</th>
<th>Motor Rated kW</th>
<th>Measured kW</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Chilled Water Section Comp. No.1</td>
<td>Sinco</td>
<td>30</td>
<td>26.7</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td></td>
<td>30</td>
<td>26.7</td>
</tr>
<tr>
<td></td>
<td>Total Actual on Load</td>
<td></td>
<td>30</td>
<td>26.7</td>
</tr>
</tbody>
</table>

The existing consumption for EFF2 or lower efficiency electric motor is 26.7 kW i.e. 192240 kW/Annum.
Annexure -2: Process flow diagram after project implementation

The process flow will not change. The only change will be the ammonia compressor will be provided with soft starter with energy saver instead of star-delta starter.
Annexure -3: Detailed technology assessment report

The ammonia compressors are subjected to load-unload due to change in no of cylinders loaded. At part loads only one / two /three cylinders are working. The percentage loading on motor may be lower up to 25% at times. At part loads, soft starter with energy saver, by changing firing angle of thyristor, reduces the voltage till the current is not increased. The saving upto 6% of consumption of compressor motor, which is primary energy consumer in chilling center, can be achieved. Along with energy saving, MD of the chilling center can be controlled & overall life of components of compressor can be enhanced due to soft starter feature.

The details of cost benefit analysis are as given below –

<table>
<thead>
<tr>
<th>S.no.</th>
<th>Parameters</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1)</td>
<td>Rated capacity of existing VC Cycle refrigeration system (Working on load)</td>
<td>TR</td>
<td>35</td>
</tr>
<tr>
<td>2)</td>
<td>Actual TR generated by existing VC Cycle Compressor (Working or on-load)</td>
<td>TR</td>
<td>28.7</td>
</tr>
<tr>
<td>2)</td>
<td>Working Hours for Compressor/Day</td>
<td>Hrs/Day</td>
<td>20</td>
</tr>
<tr>
<td>3)</td>
<td>Actual kWh Consumption of Compressor</td>
<td>kWh /Hr</td>
<td>26.7</td>
</tr>
<tr>
<td>4)</td>
<td>Expected Saving by Providing Soft starter with energy saver for VC Compressor Motor working on variable load. (Expected Saving of 6%)</td>
<td>kWh /Hr</td>
<td>1.6</td>
</tr>
<tr>
<td>5)</td>
<td>Cost of Electricity</td>
<td>Rs./ kWh</td>
<td>5.96</td>
</tr>
<tr>
<td>6)</td>
<td>Expected Savings per Annum in kWh</td>
<td>kWh /Annum</td>
<td>11520</td>
</tr>
<tr>
<td>7)</td>
<td>Expected Saving per Annum (Considering 360 Working Days)</td>
<td>Rs./Annum</td>
<td>68659</td>
</tr>
<tr>
<td>8)</td>
<td>No of Motors for Compressor on load</td>
<td>Nos.</td>
<td>1</td>
</tr>
<tr>
<td>9)</td>
<td>Expected Investment Needed for providing soft starter with energy saver.</td>
<td>Rs.</td>
<td>144000</td>
</tr>
<tr>
<td>10)</td>
<td>Simple Payback</td>
<td>Yrs</td>
<td>2.10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Months</td>
<td>25</td>
</tr>
<tr>
<td>11)</td>
<td>KLOE Saving per Annum</td>
<td>KLOE/Annum</td>
<td>0.99</td>
</tr>
</tbody>
</table>
Annexure -4  Drawings for proposed electrical & civil works

No additional civil work is required. Conventional star-delta starter is removed & soft starter with energy saver provided. Only other change which will require at few places will be to shift the capacitor provided between motor & starter to out of this circuit. No other changes required.

Some minor civil grouting for saddle frame grouting for soft starter may require as the fixture hole may not with existing frame for star-delta starters. The minor grouting for saddle frame, installation, erection expenses under the said heading of Foundation & Civil Works.
Annexure -5: Detailed financial analysis

<table>
<thead>
<tr>
<th>Name of the Technology</th>
<th>SOFT STARTER WITH ENERGY SAVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Capacity</td>
<td></td>
</tr>
<tr>
<td>Details</td>
<td>Unit</td>
</tr>
<tr>
<td>Installed Capacity</td>
<td>kW</td>
</tr>
<tr>
<td>No of working days</td>
<td>Days</td>
</tr>
<tr>
<td>No of Shifts per day</td>
<td>Shifts</td>
</tr>
</tbody>
</table>

**Proposed Investment**

<table>
<thead>
<tr>
<th></th>
<th>Rs. in lakhs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant &amp; Machinery</td>
<td>1.40</td>
<td></td>
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<td>Civil Work</td>
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<td>Erection &amp; Commissioning (1% on Plant &amp; Equip)</td>
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**Financing pattern**

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<td>Loan Funds (Term Loan)</td>
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**Estimation of Costs**

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**Estimation of Revenue**

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<tr>
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**Estimation of Interest on Term Loan**

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## WDV Depreciation

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## Projected Profitability

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## Expenses

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<tbody>
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<td>0.03</td>
<td>0.03</td>
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<td>0.22</td>
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<td>0.35</td>
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## Computation of Tax

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<tbody>
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## Projected Balance Sheet

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<tbody>
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<td>0.36</td>
<td>0.36</td>
<td>0.36</td>
<td>0.36</td>
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<td>0.36</td>
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<tr>
<td>Reserves &amp; Surplus (E)</td>
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<td>1.96</td>
<td>2.33</td>
<td>2.71</td>
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<td>2.73</td>
<td>2.91</td>
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<td>3.22</td>
<td>3.46</td>
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## Assets

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### IRR (Rs. in lakh)

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<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Profit after Tax</td>
<td>0.50</td>
<td>0.42</td>
<td>0.34</td>
<td>0.35</td>
<td>0.35</td>
<td>0.37</td>
<td>0.38</td>
<td>0.39</td>
<td>0.40</td>
<td>0.39</td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Interest on Term Loan</td>
<td>0.13</td>
<td>0.10</td>
<td>0.10</td>
<td>0.09</td>
<td>0.07</td>
<td>0.05</td>
<td>0.03</td>
<td>0.01</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cash outflow</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Net Cash flow</td>
<td>(1.44)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>IRR</strong></td>
<td>34.73</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>NPV</strong></td>
<td>1.57</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Break Even Point (Rs. in lakh)

<table>
<thead>
<tr>
<th>Particulars / Years</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable Expenses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oper. &amp; Maintenance Exp (75%)</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Sub Total(G)</td>
<td>0.02</td>
<td>0.02</td>
<td>0.02</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Fixed Expenses</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oper. &amp; Maintenance Exp (25%)</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td>Interest on Term Loan</td>
<td>0.13</td>
<td>0.10</td>
<td>0.10</td>
<td>0.09</td>
<td>0.07</td>
<td>0.05</td>
<td>0.03</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Depreciation(H)</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Sub Total(I)</td>
<td>0.16</td>
<td>0.14</td>
<td>0.13</td>
<td>0.12</td>
<td>0.11</td>
<td>0.09</td>
<td>0.07</td>
<td>0.04</td>
<td>0.04</td>
<td>0.04</td>
</tr>
<tr>
<td>Sales (J)</td>
<td>0.69</td>
<td>0.69</td>
<td>0.69</td>
<td>0.69</td>
<td>0.69</td>
<td>0.69</td>
<td>0.69</td>
<td>0.69</td>
<td>0.69</td>
<td>0.69</td>
</tr>
<tr>
<td>Contribution(K)</td>
<td>0.66</td>
<td>0.66</td>
<td>0.66</td>
<td>0.66</td>
<td>0.66</td>
<td>0.66</td>
<td>0.66</td>
<td>0.66</td>
<td>0.65</td>
<td>0.65</td>
</tr>
<tr>
<td>Cash Break Even ((I)-(H))%</td>
<td>19.99</td>
<td>16.54</td>
<td>15.69</td>
<td>14.18</td>
<td>12.00</td>
<td>9.26</td>
<td>5.81</td>
<td>2.32</td>
<td>1.62</td>
<td>1.71</td>
</tr>
<tr>
<td>Break Even Sales (J)*L</td>
<td>0.17</td>
<td>0.14</td>
<td>0.14</td>
<td>0.13</td>
<td>0.11</td>
<td>0.09</td>
<td>0.07</td>
<td>0.05</td>
<td>0.04</td>
<td>0.04</td>
</tr>
</tbody>
</table>

### Return on Investment (Rs. in lakh)

<table>
<thead>
<tr>
<th>Particulars / Years</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Net Profit Before Taxes</strong></td>
<td>0.50</td>
<td>0.53</td>
<td>0.53</td>
<td>0.54</td>
<td>0.55</td>
<td>0.57</td>
<td>0.59</td>
<td>0.61</td>
<td>0.62</td>
<td>0.61</td>
<td>5.65</td>
</tr>
<tr>
<td><strong>Net Worth</strong></td>
<td>0.86</td>
<td>1.28</td>
<td>1.62</td>
<td>1.96</td>
<td>2.32</td>
<td>2.69</td>
<td>3.07</td>
<td>3.46</td>
<td>3.86</td>
<td>4.25</td>
<td>25.36</td>
</tr>
</tbody>
</table>

Overall Return on Investment: **22.28%**
### Debt Service Coverage Ratio

<table>
<thead>
<tr>
<th>Particulars / Years</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cash Inflow</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profit after Tax</td>
<td>0.50</td>
<td>0.42</td>
<td>0.34</td>
<td>0.35</td>
<td>0.37</td>
<td>0.38</td>
<td>0.39</td>
<td>0.40</td>
<td>0.39</td>
<td>3.10</td>
<td></td>
</tr>
<tr>
<td>Depreciation</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.03</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td>Interest on Term Loan</td>
<td>0.13</td>
<td>0.10</td>
<td>0.10</td>
<td>0.09</td>
<td>0.07</td>
<td>0.05</td>
<td>0.03</td>
<td>0.01</td>
<td>0.00</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>Total (M)</td>
<td>0.66</td>
<td>0.55</td>
<td>0.46</td>
<td>0.46</td>
<td>0.45</td>
<td>0.45</td>
<td>0.44</td>
<td>0.43</td>
<td>0.42</td>
<td>3.90</td>
<td></td>
</tr>
</tbody>
</table>

### DEBT

<table>
<thead>
<tr>
<th>Particulars</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest on Term Loan</td>
<td>0.13</td>
<td>0.10</td>
<td>0.10</td>
<td>0.09</td>
<td>0.07</td>
<td>0.05</td>
<td>0.03</td>
<td>0.01</td>
<td>0.00</td>
<td>0.57</td>
<td></td>
</tr>
<tr>
<td>Repayment of Term Loan</td>
<td>0.03</td>
<td>0.06</td>
<td>0.08</td>
<td>0.14</td>
<td>0.18</td>
<td>0.20</td>
<td>0.24</td>
<td>0.15</td>
<td>0.00</td>
<td>1.08</td>
<td></td>
</tr>
<tr>
<td>Total (N)</td>
<td>0.16</td>
<td>0.16</td>
<td>0.18</td>
<td>0.23</td>
<td>0.25</td>
<td>0.25</td>
<td>0.27</td>
<td>0.16</td>
<td>0.00</td>
<td>1.65</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4.22</td>
<td>3.37</td>
<td>2.64</td>
<td>2.04</td>
<td>1.81</td>
<td>1.77</td>
<td>1.63</td>
<td>2.76</td>
<td>0.00</td>
<td>2.37</td>
<td></td>
</tr>
<tr>
<td>Average DSCR (M/N)</td>
<td>2.37</td>
<td>2.37</td>
<td>2.37</td>
<td>2.37</td>
<td>2.37</td>
<td>2.37</td>
<td>2.37</td>
<td>2.37</td>
<td>2.37</td>
<td>2.37</td>
<td></td>
</tr>
</tbody>
</table>
Annexure:-6  Procurement and implementation schedule

Day wise break up of implementation Schedule

<table>
<thead>
<tr>
<th>SN</th>
<th>Activities</th>
<th>Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Foundation &amp; civil work</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Commissioning</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Cabling &amp; electrical panel fitting</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Testing and trial</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>On site operator training</td>
<td>2</td>
</tr>
</tbody>
</table>

The word foundation & civil work is alternatively used for installation & erection (that includes minor/major civil work, grouting required for saddle plates, foundation modification etc).

Some minor civil grouting for saddle frame grouting for soft starter may require as the fixture hole may not with existing frame for star-delta starters. The minor grouting for saddle frame, installation, erection expenses under the said heading of Foundation & Civil Works.
Annexure -7: Details of technology service providers

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Name of Service Provider</th>
<th>Address</th>
<th>Contact Person and No.</th>
</tr>
</thead>
</table>
| 1     | Pima Controls Pvt. Ltd.             | 4A, New York Corner, Bodakdev, Ahmedabad - 380015. INDIA. | Mr. Madhukar Parikh  
Phone: +91-79-40210400  
Fax: +91-79-40210410 |
| 2     | Shandilya Energy System Pvt. Ltd.   | B4/5, Utkarsh Nagar, Hadapsar, Pune-411028    | Mr. Pankaj Pande  
- 020-65783335 |
| 3     | Baldor Electric India Pvt Ltd       | 19, Commerce Ave,  
Mahaganesh Colony  
Paud Road, Kothrud  
PUNE 411038  
TEL-02025452717/18/19F | Mr.Bhalchandra Bansod  
- 09766342489  
www.baldor.com |
Annexure–8: Quotations or Techno-commercial bids for new technology/equipment

Q-1016 / ELECT / SJC

TO,
PETROLEUM CONSERVATION
RESEARCH ASSOCIATION
AHMEDABAD

DATE: 16-03-2011

Dear Sir,

SUB.: YOUR REQUIREMENT OF 30 KW SOFT STARTER
CONTROL PANEL

REF: YOUR EMAIL DT. 16-03-2011

We refer to the telephonic discussion with Mr. Madhukar Parikh had with you and subsequent your email.

Based on the discussion had with you, we are pleased to submit herewith our quotation as per following for your kind consideration.

1. Annexure I Scope of supply
2. Annexure-II Price with commercial terms & conditions

We trust you will find our offer as per your requirement and look forward to the pleasure of receiving your valued order.

Thanking you and assuring you of our best and prompt services at all times.

Yours faithfully,
For Pima Controls Pvt. Ltd.

Narendra Sisodia
Manager
ANNEXURE-I
SCOPE OF SUPPLY

[1] 30 KW Soft-Starter control panel QTY: 1 NO.

Soft-Starter Control Panel in 14 /16 SWG CRCA Sheet Steel Enclosure, Powder Coating along with the following components, ready to install.

**Allen-Bradley Hardware:**

<table>
<thead>
<tr>
<th>Sr. No</th>
<th>Description</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>• Suitable for 30 KW, 40 H.P.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Current range: 97A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Rated voltage 415 AC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Control voltage 100-240V AC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Inbuilt LCD display</td>
<td></td>
</tr>
</tbody>
</table>

**General Components:**

<table>
<thead>
<tr>
<th>Sr.No.</th>
<th>Description</th>
<th>Qty.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Incoming SFU of suitable rating with SCR fuse link</td>
<td>1 Set</td>
</tr>
<tr>
<td>2.</td>
<td>Input/output isolation contactor of suitable rating</td>
<td>2 Nos.</td>
</tr>
<tr>
<td>3.</td>
<td>DOL bypass contactor of suitable rating</td>
<td>1 No.</td>
</tr>
<tr>
<td>4.</td>
<td>Thermal overload Relay of suitable rating</td>
<td>1 No.</td>
</tr>
<tr>
<td>5.</td>
<td>Control transformer of suitable rating</td>
<td>1 No.</td>
</tr>
<tr>
<td>6.</td>
<td>Selector Switch</td>
<td>1 No.</td>
</tr>
<tr>
<td>7.</td>
<td>DP Miniature Circuit Breaker</td>
<td>As reqd.</td>
</tr>
<tr>
<td>8.</td>
<td>Control Relay</td>
<td>As reqd.</td>
</tr>
<tr>
<td>9.</td>
<td>Control Fuse with link</td>
<td>3 Nos.</td>
</tr>
<tr>
<td>10.</td>
<td>LED Indicating Lamps run, fault, phase</td>
<td>5 Nos.</td>
</tr>
<tr>
<td>12.</td>
<td>Necessary Control and power terminals.</td>
<td>As reqd.</td>
</tr>
</tbody>
</table>

**EC FOR MOTOR (30 kW) BY SS WITH ENERGY OPTIMIZATION TECHNOLOGY**
ANNEXURE-II
PRICE WITH COMMERCIAL TERMS AND CONDITIONS

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description</th>
<th>Qty.</th>
<th>Unit price (Rs.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30 KW Soft starter Control Panel as mentioned in annexure I Sr no.[1]</td>
<td>1 No.</td>
<td>1,39,500/-</td>
</tr>
</tbody>
</table>

PRICE BASIS

Ex-works Changodar, excluding Excise Duty, Education CESS, Secondary Higher Education CESS on Excise duty, VAT plus Additional Tax, Packing & Forwarding, Freight or any other taxes / duties which if applicable will be charged extra at actuals. Insurance shall be on your account.

TERMS OF PAYMENT

25% advance along with the order and balance 75% along with 100% taxes and duties against Performa Invoice. Performa Invoice will be submitted in advance.

DELIVERY SCHEDULE

Within 8 to 10 weeks from the date of receipt of your technically and commercially clear order, advance payment or drawing approval whichever is later.

VALIDITY

The offer is valid for your acceptance so that we receive your technically and commercially clear order within 30 days hereof. Beyond this, it will be subject to our confirmation in writing.

ORDER ACCEPTANCE

An order based of this offer is subject to our written acceptance and confirmation of the same.

Yours faithfully,

For Pima Controls Pvt. Ltd.

Narendra Sisodia
Manager
Bureau of Energy Efficiency (BEE)
(Ministry of Power, Government of India)
4th Floor, Sewa Bhawan, R. K. Puram, New Delhi – 110066
Ph.: +91 – 11 – 26179699 (5 Lines), Fax: +91 – 11 – 26178352
Websites: www.bee-india.nic.in, www.energymanagertraining.com

Petroleum Conservation & Research Association
Office Address :- Western Region
C-5, Keshava Building, Bandra-Kurla Complex; Mumbai – 400051
Website: www.pcra.org

India SME Technology Services Ltd
DFC Building, Plot No.37-38,
D-Block, Pankha Road,
Institutional Area, Janakpuri, New Delhi-110058
Tel: +91-11-28525534, Fax: +91-11-28525535
Website: www.techsmall.com