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










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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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Petroleum Conservation Research Association

Ahmedabad

Contents

List of Annexure

List of Table

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:

S.No	*Particular*	*Unit*	*Value*
1	Project cost	(Rs. in Lakh)	1.44
2	Expected Electricity Savings	kWh/annum	11520
3	Expected Additional Fuel Consumption	SCM/year	0

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

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 stake holders 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

a) A Typical Dairy (With majority of products mix)

Energy Type	Unit	Monthly Average Consumption	% Contribution (MCal Basis)	% Contribution (Cost Basis)
Electricity	kWh	1539108	16%	53%
NG	SCM	597934	66%	25%
FO	Ltrs	141855	18%	22%

b) A Typical Milk Chilling Center

Energy Type	Unit	Monthly Average Consumption	% Contribution (Mcal Basis)	% Contribution (Cost Basis)
Electricity	kWh	149056	14%	65%
FO	kgs	17671	59%	35%

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.

S.No.	Particulars of SME	Dairy / Chilling Center	Production Capacity in ltrs/day
1.	Unit 1	Dairy	25000
2.	Unit 2	Dairy	14500
3.	Unit 3	Dairy	9000

S.No.	Particulars of SME	Dairy / Chilling Center	Production Capacity in ltrs/day
4.	Unit 4	Chilling Center	30000
5.	Unit 5	Chilling Center	140000
6.	Unit 6	Chilling Center	165000
7.	Unit 7	Chilling Center	160000
8.	Unit 8	Chilling Center	160000
9.	Unit 9	Chilling Center	150000
10.	Unit 10	Chilling Center	140000
11.	Unit 11	Chilling Center	160000
12.	Unit 12	Chilling Center	36000
13.	Unit 13	Chilling Center	20000
14.	Unit 14	Chilling Center	20000
15.	Unit 15	Chilling Center	30000
16.	Unit 16	Dairy	160000
17.	Unit 17	Dairy	1280000
18.	Unit 18	Dairy	5000
19.	Unit 19	Dairy	500000
20.	Unit 20	Dairy	400000
21.	Unit 21	Chilling Center	450000
22.	Unit 22	Chilling Center	200000

Energy usages pattern

Electricity is mainly used for dairy cluster units apart from other fuels such as FO, PNG, Bio-mass (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

Name of Unit	Electricity	FO	PNG	Wood	HSD	LDO	Other
Unit 1	☼	☼					
Unit 2	☼						
Unit 3	☼	☼					
Unit 4	☼				☼		
Unit 5	☼			☼		☼	
Unit 6	☼	☼					
Unit 7	☼	☼					
Unit 8	☼						
Unit 9	☼						
Unit 10	☼					☼	
Unit 11	☼	☼					

Name of Unit	Electricity	FO	PNG	Wood	HSD	LDO	Other
Unit 12	☼	☼					
Unit 13	☼			☼			
Unit 14	☼			☼			
Unit 15	☼	☼					
Unit 16	☼	☼	☼				
Unit 17	☼			☼			
Unit 18	☼	☼	☼				☼ (Castor DOC)
Unit 19	☼			☼ (Saw Mill Dust)			☼ (Steam from Outside)
Unit 20	☼	☼					
Unit 21	☼	☼					
Unit 22	☼	☼					

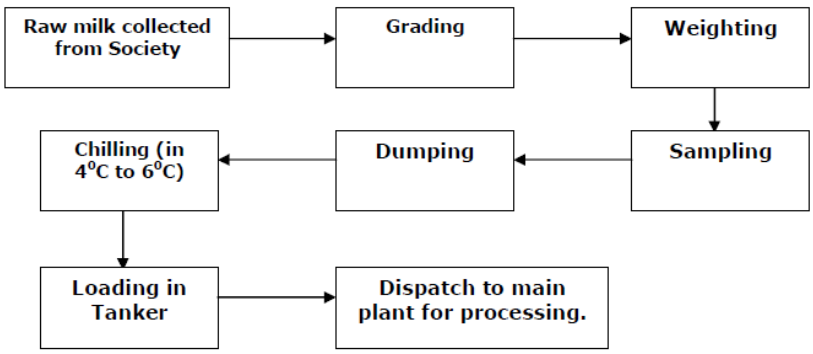
General production process for Dairy cluster

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



Pasteurization

Pasteurization is the process that purifies milk and helps it stay fresher, longer. Milk is pasteurized by heating it to 72℃ for 16 seconds then quickly cooling it to 4℃. 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 in to 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℃. This prevents the development of extra bacteria and keeps the milk its freshest.

Cream Extraction & Butter

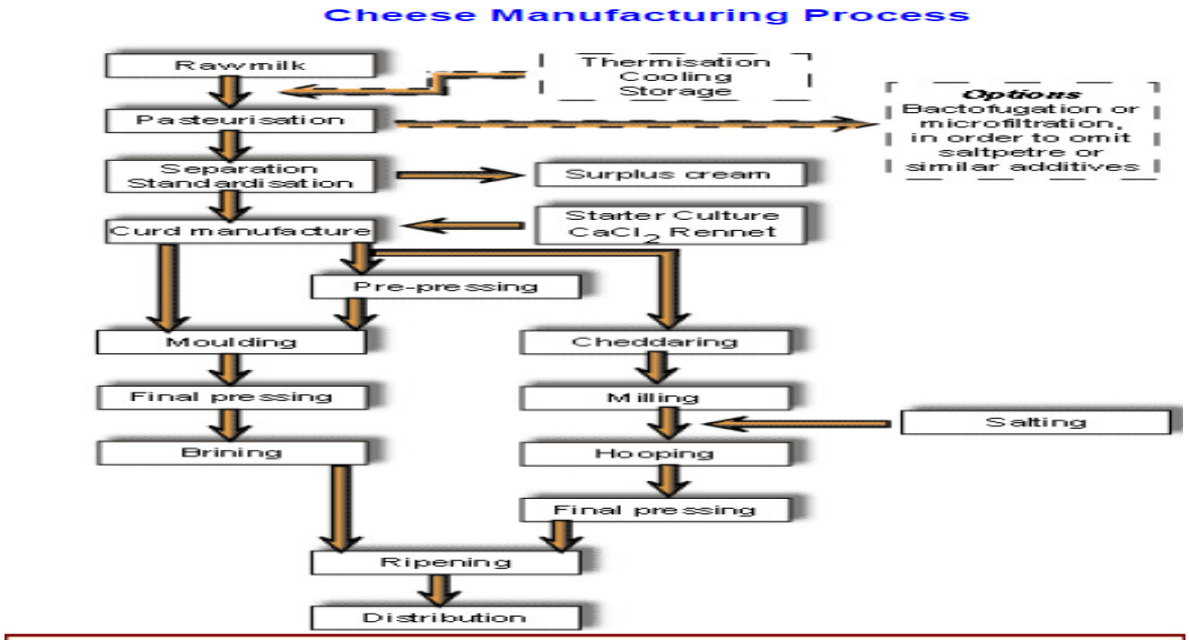
Milk cream is extracted from Milk using centrifuge. The butter making process involves quite a number of stages. The continuous butter maker has become the most common type of equipment used. The cream can be either supplied by a fluid milk dairy or separated from whole milk by the butter manufacturer. 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.

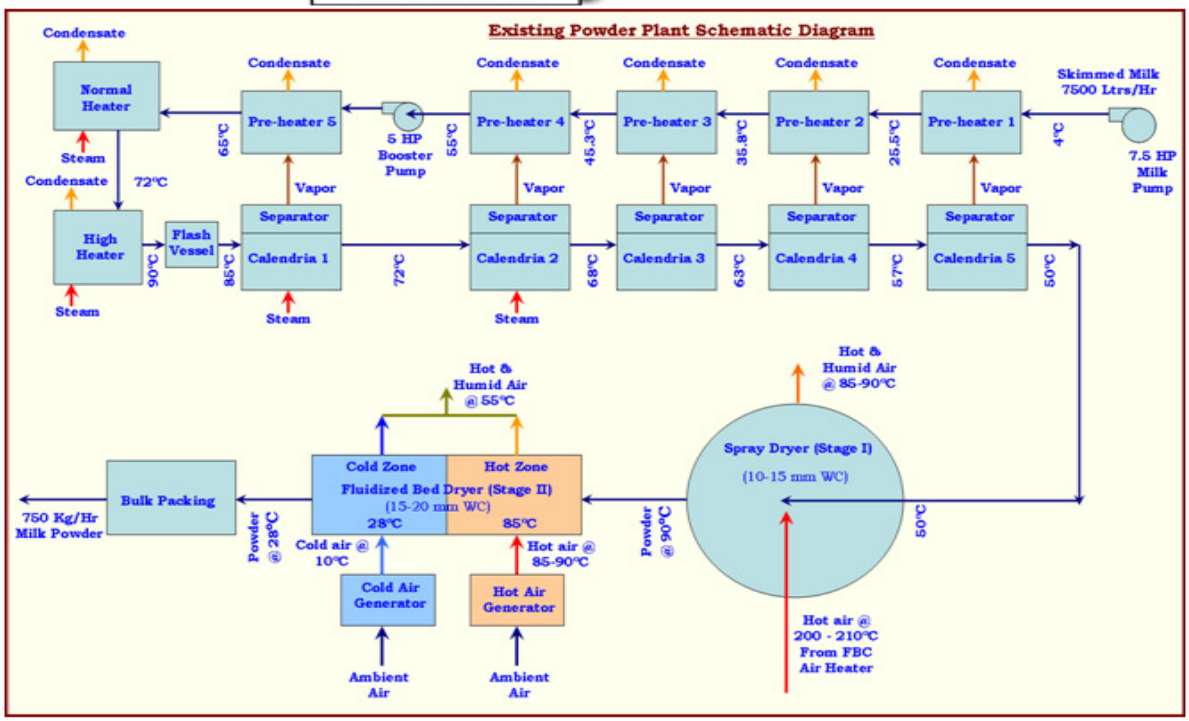
Cheese

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

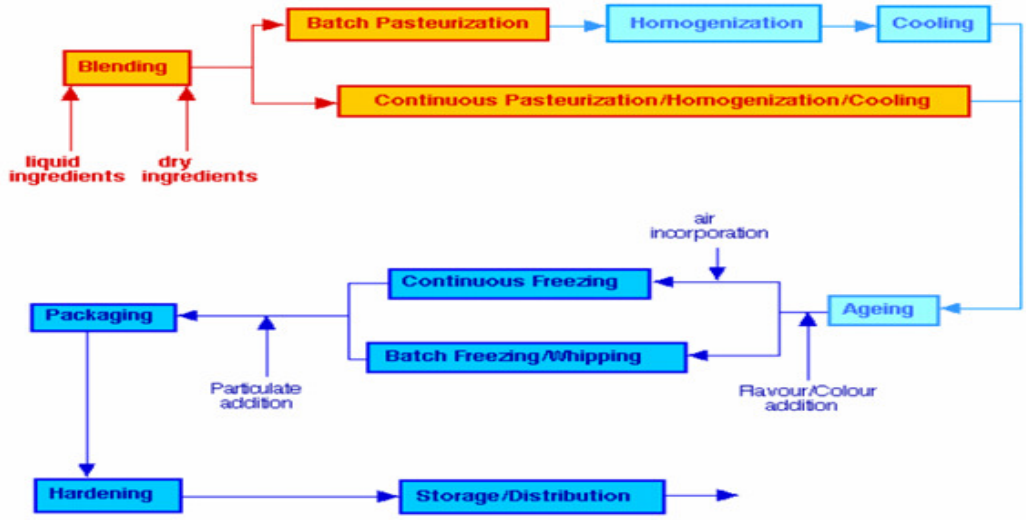
Milk Powder

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

a) On Mcal Basis

Energy Type	Unit	Monthly Average Consumption	Monthly Consumption in MCal
Electricity	kWh	1539108	1323632.9
NG	SCM	597934	5381406.0
FO	Ltrs	141855	1489477.5
Total	MCal	-----	8194516.4

b) On Cost Basis

Energy Type	Average Monthly Consumption
Electricity	9988810.92
NG	4783472
FO	4113795
Total in Rs.	18886078

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:

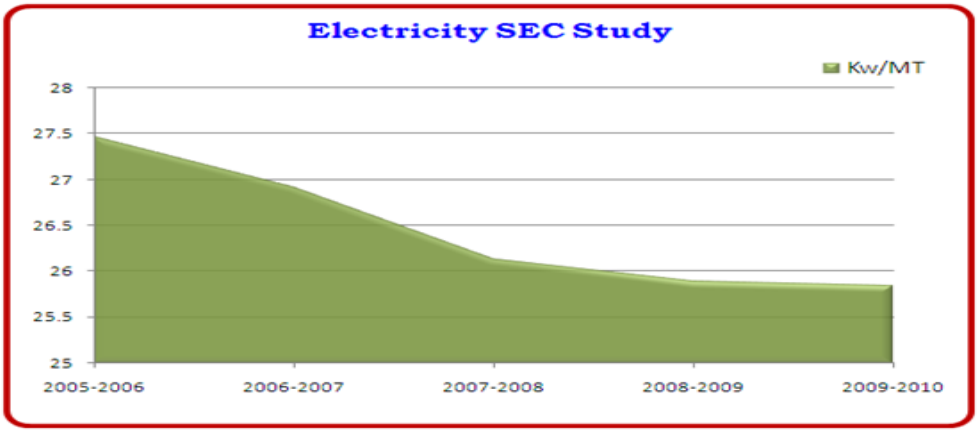
Table 1.5 Average annual production

Month	Butter	Ghee	Paneer	Khoa	Masti Dahi	Shrikhand	Amul Kool	S.M.P.	W.M.P.	Amulya	A.S.P.	White Butter
Apr-08	575978	189680	256118	1584	513452	143034	54316	173702	0	119587	1448676	0
May-08	507932	207837	249070	2194	534548	139859	112387	136202	197120	168263	1357065	0
Jun-08	364098	218436	221571	6272	428235	102749	79282	181035	156395	130695	1111404	0
Jul-08	286876	261851	140133	10430	465042	59437	20395	79653	156670	131594	872464	0
Aug-08	339197	286478	182647	25238	471037	171928	38304	179587	0	174919	1228071	0
Sep-08	491342	130691	211473	26482	476500	127843	0	188894	0	176953	1279321	0
Oct-08	417499	249239	243018	15382	565186	89376	47505	151032	0	65639	1692232	0
Nov-08	641696	242069	199052	4160	471105	89793	46766	324071	0	108567	1279682	0
Dec-08	886070	276967	265026	2004	462144	83644	10531	673321	0	123342	1180249	20500
Jan-09	850727	332264	224976	3952	461303	80787	21811	755462	0	80019	1236977	148035
Feb-09	792976	216979	230908	1238	436874	189645	4570	444278	70560	76862	1190432	48510
Mar-09	830203	242737	246304	768	619591	260349	64675	280888	0	89862	1711364	0
Apr-09	592886	232994	241562	9268	729099	159234	42346	247185	0	114262	1469411	10740
May-09	343760	202062	222580	6238	756364	193894	49075	206245	0	127661	1385012	0
Jun-09	190937	196763	259340	2430	717423	106483	59928	139687	0	81213	854819	0
Jul-09	267301	302857	57230	7104	663288	120180	10862	21075	0	15541	646280	0
Aug-09	360404	150111	142175	21386	729928	159988	16555	55147	0	92258	1024997	0
Sep-09	326550	256971	138200	15868	593518	98544	30619	100520	0	31009	999004	6150
Oct-09	503432	228263	180021	20136	620770	93232	32362	170815	0	72966	1404444	0
Nov-09	582951	243360	162538	3564	486056	44187	17453	288975	0	197931	1650920	0
Dec-09	563161	243172	213106	3126	481483	97244	45336	323287	0	81506	1576643	147630
Jan-10	941065	184012	236080	5884	459258	86421	57922	315275	0	46227	1663932	37605
Feb-10	818991	181823	197486	8352	487500	174375	57158	286889	0	108915	1458871	5220
Average	542436	229462	205244	8829	549118	124879	40007	248836	25250	105034	1292273	18452

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

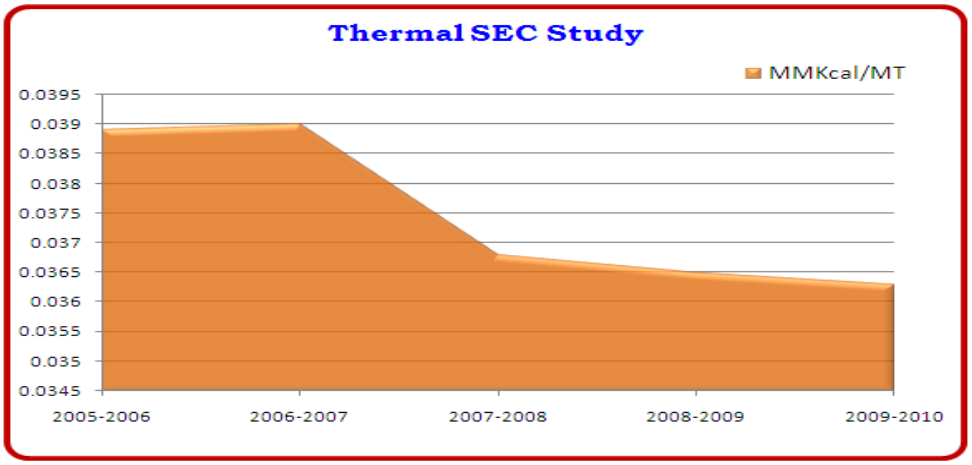


Figure 1.1 SEC Study in Dairy Cluster over Past Few Years

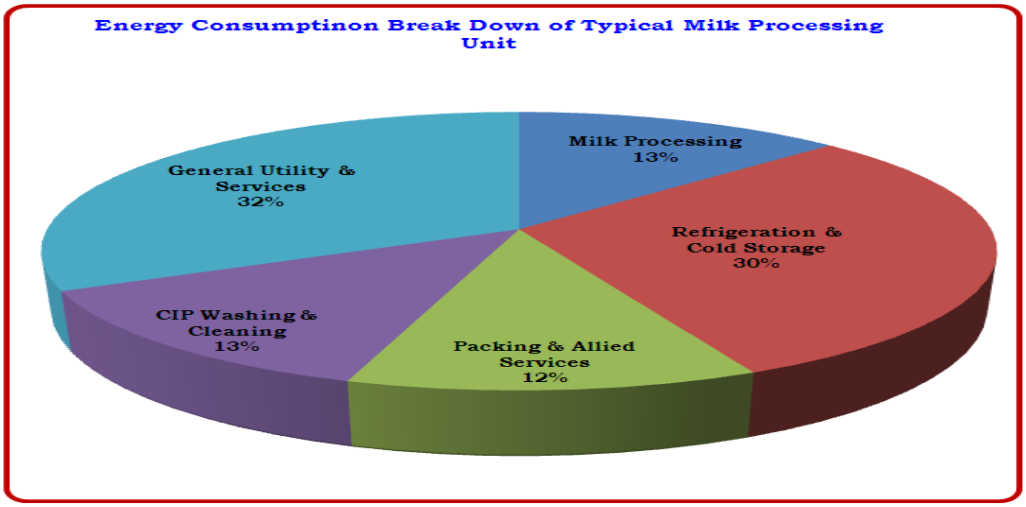
Process (Main Equipments) wise cost of energy consumption

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

S.No.	Process Name	% age of Cost
1	Milk Processing	13
2	Refrigeration & Cold Storage	30
3	Packing & Allied Services	12
4	CIP Washing & Cleaning	13

5	General Utility & Services	32



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

S. No.	Contract Demand, kVA	Energy Charges, Rs/kWh
1	Up to 1000	3.85
2	From 1001 to 2500	4.05
3	Above 2500	4.15

Demand Charges

Table 1.8 Demand charge

Sr. No.	Billing Demand, kVA	Demand Charges, Rs/kVA
1	For first 500	98
2	For next 500	139
3	For next 1500	208
4	Billing demand in Excess of 2500	237
5	Billing Demand Excess of contract demand	369

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.

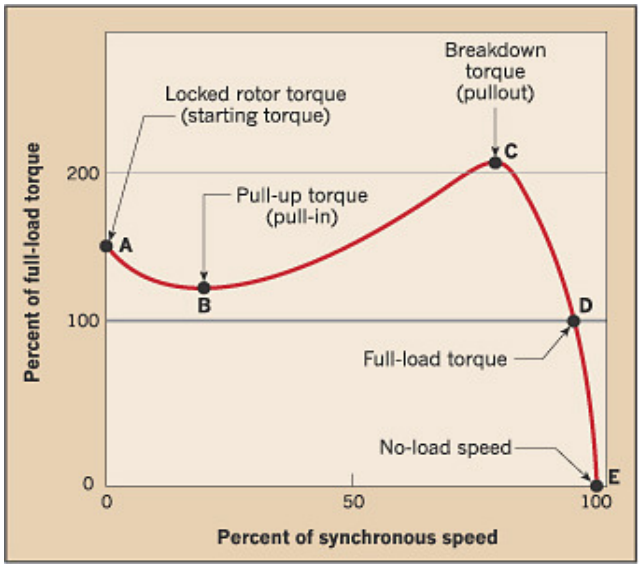
1.4 Baseline establishment for existing technology

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

SN	Ammonia Compressor Particulars	Model	Motor Rated kW	Measured kW
1)	Chilled Water Section Comp. No.1	Sinco	30	21.7
		Total	30	21.7
Total Actual on Load			30	21.7

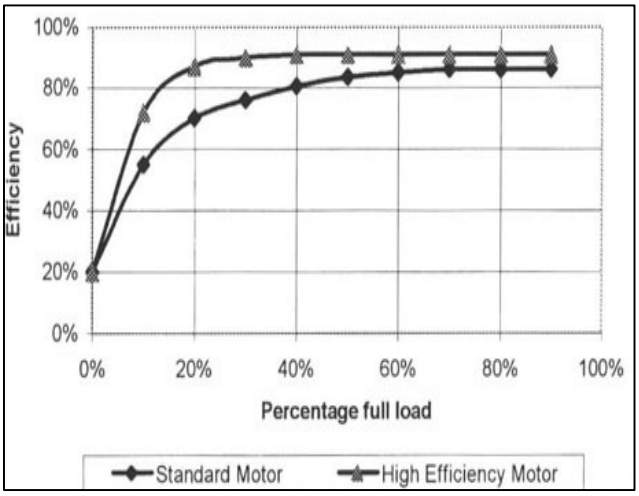
The actual consumption of compressor motor considered for soft starter with energy saver is 21.7 kW per hour i.e.156240 kWh per annum.

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.

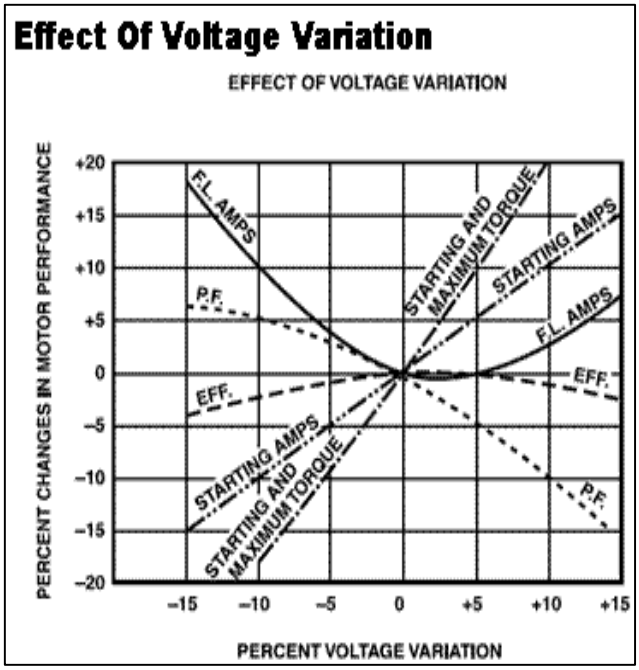


That's not all, the acceleration on start-up has a massive impact on the electricity supply charges, and in turn this also leads to heat losses dramatically reducing the life of the motor.

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.

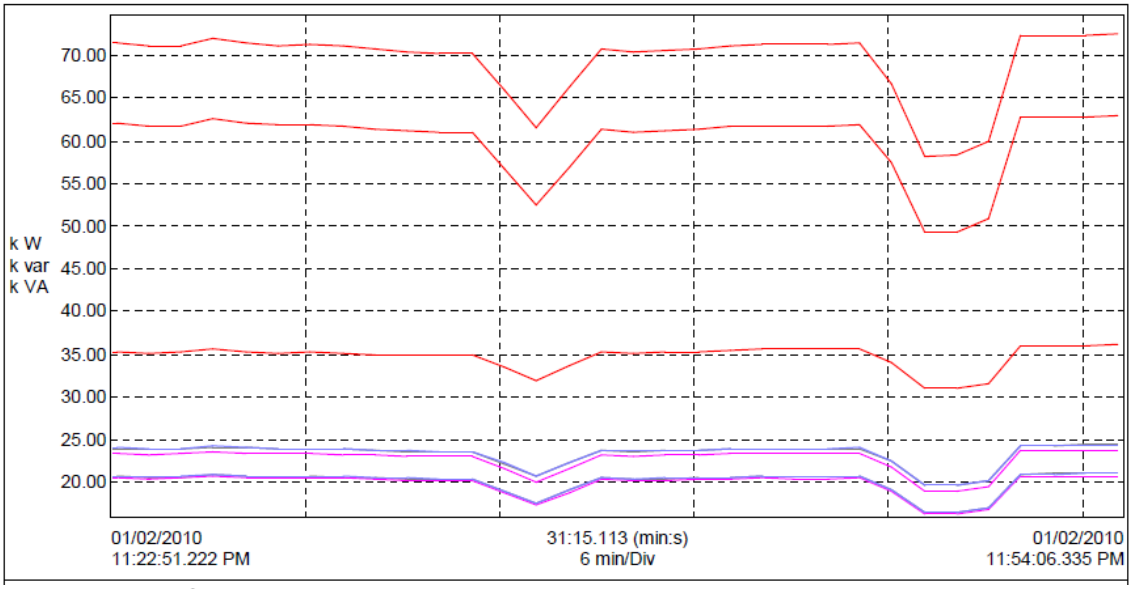
Characteristic	Voltage	
	110%	90%
Torque, starting & maximum running	Increase 21%	Decrease 19%
Speed		
Synchronous	No change	No change
Full Load	Increase 1%	Decrease 1.5%
% slip	Decrease 17%	Increase 23%
Efficiency		
Full load	Increase 0.5 to 1 point	Decrease 2 points
¾ load	Little change	Little change
½ load	Decrease 1 to 2 points	Increase 1 to 2 points
Power Factor		
Full load	Decrease 3 points	Increase 1 point
¾ load	Decrease 4 points	Increase 2 to 3 points
½ load	Decrease 5 to 6 points	Increase 4 to 5 points
Current		
Starting	Increase 10 to 12%	Decrease 10 to 12%
Full load	Decrease 7%	Increase 11%

1.4.2 Operating efficiency analysis (Existing Loss Study)

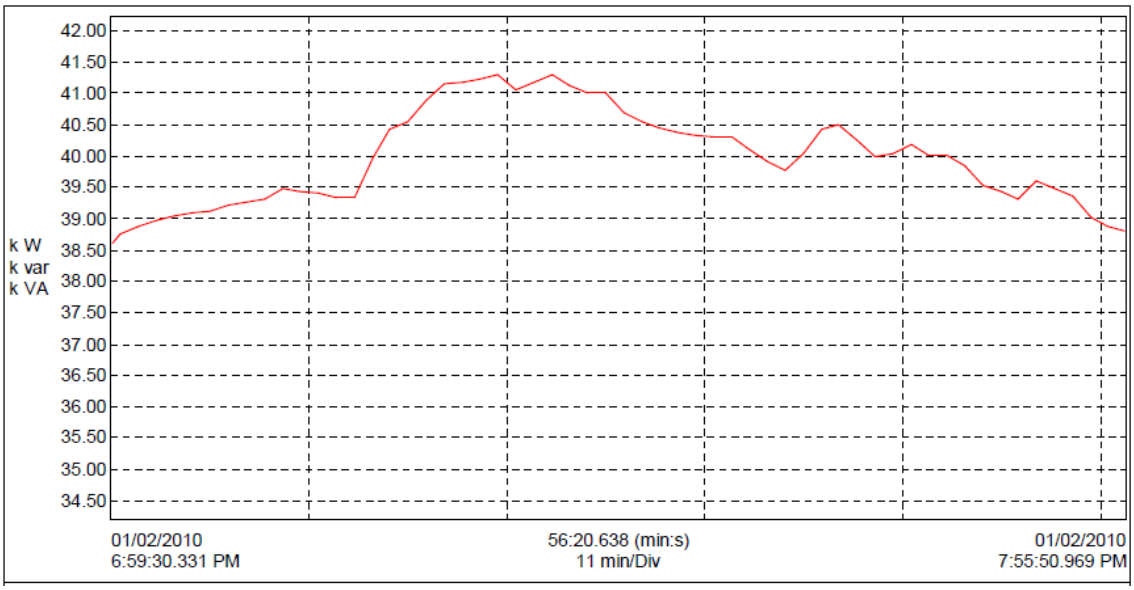
Load profile (kW Vs Time) of existing ammonia compressor using data logger carried for few ammonia compressors. It was observed that the ammonia compressors are subjected to frequent part load values depending on the demand for chilling.

Load Profile of Compressor No.1

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



Load Profile of Compressor No.2



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 EFFICENCY 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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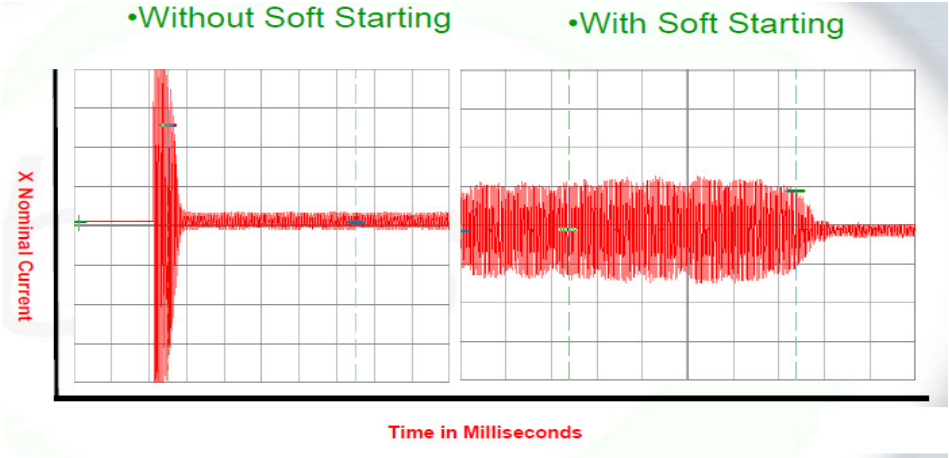
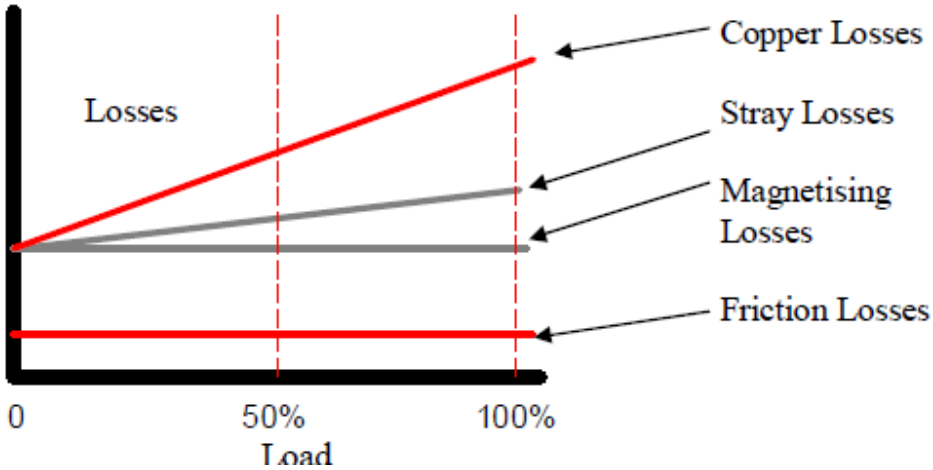
Soft Start Effect



Losses of Typical Electric Motor



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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 –

Details	Specification
Power input	415/440 volts AC -+ 10% 3 phase 50 hz.
Recommended load	A.C. motor, three phase, Multiple Motors or other loads are not recommended except under specific circumstances.
Maximum Overload capacity	115% continuous, 150% for 10 seconds and 200% for 5 seconds.

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.

»	Where system voltage drops is to be eliminated or undue loading of generators is to be avoided.
»	Where in-rush current is to be limited to avoid heavy line voltage drop while start in high capacity motors or high inertia loads.
»	For reduction of maximum demand when motors are started frequently.
»	Where energy saving is desired under partial or cyclic load conditions and to improve power factor.

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 warrantee 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 up gradation 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)

Energy and monetary benefit			
1)	Expected Savings per Annum in kWh	kWh/Annum	11520
2)	Expected Saving per Annum (Considering 360 Working Days)	Rs./Annum	68659
3)	No of Motors for Compressor on load	Nos.	1
4)	Expected Investment Needed for providing soft starter with energy saver.	Rs.	144000
5)	Simple Payback	Yrs	2.10
		Months	25
6)	KLOE Saving per Annum	KLOE/Annum	0.99

*****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

Details of Proposed Technology Project Cost			
SN	**Particulars**	**Unit**	**Value**
1	Cost of Retrofit/Additional Plan & Machinery For Energy Saving	Rs. (in Lacs)	1.39
2	Detail Engineering, Design & related expenses	Rs. (in Lacs)	0.01
3	Erection & Commissioning cost	Rs. (in Lacs)	0.02
4	Cost of civil work	Rs. (in Lacs)	0.01
5	Custom Clearance & Transportation Charges	Rs. (in Lacs)	0
6	Import duty	Rs. (in Lacs)	0
7	Other charges (Including Contingency 10%)	Rs. (in Lacs)	0.01
	Total cost	Rs. (in Lacs)	1.44

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 4.2 Financial indicators of proposed technology/equipment

SN	Scenario	IRR	NPV	ROI	DSCR
1	Normal	34.73%	1.57	22.28%	2.37

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

SN	Scenario	IRR	NPV	ROI	DSCR
1	Normal	34.74%	1.58	22.28%	2.37
2	5% Increase in Fuel Saving	36.92%	1.72	22.88%	2.48
3	5% Decrease in Fuel Saving	32.54%	1.43	22.59%	2.25

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

SN	Activities	Weeks			
		1	-	7	8
1	Order placement				
2	Delivery				
3	Foundation & civil work				
4	Commissioning				
5	Cabling & electrical panel fitting				
6	Testing and trial				
7	On site operator training				

Annexure

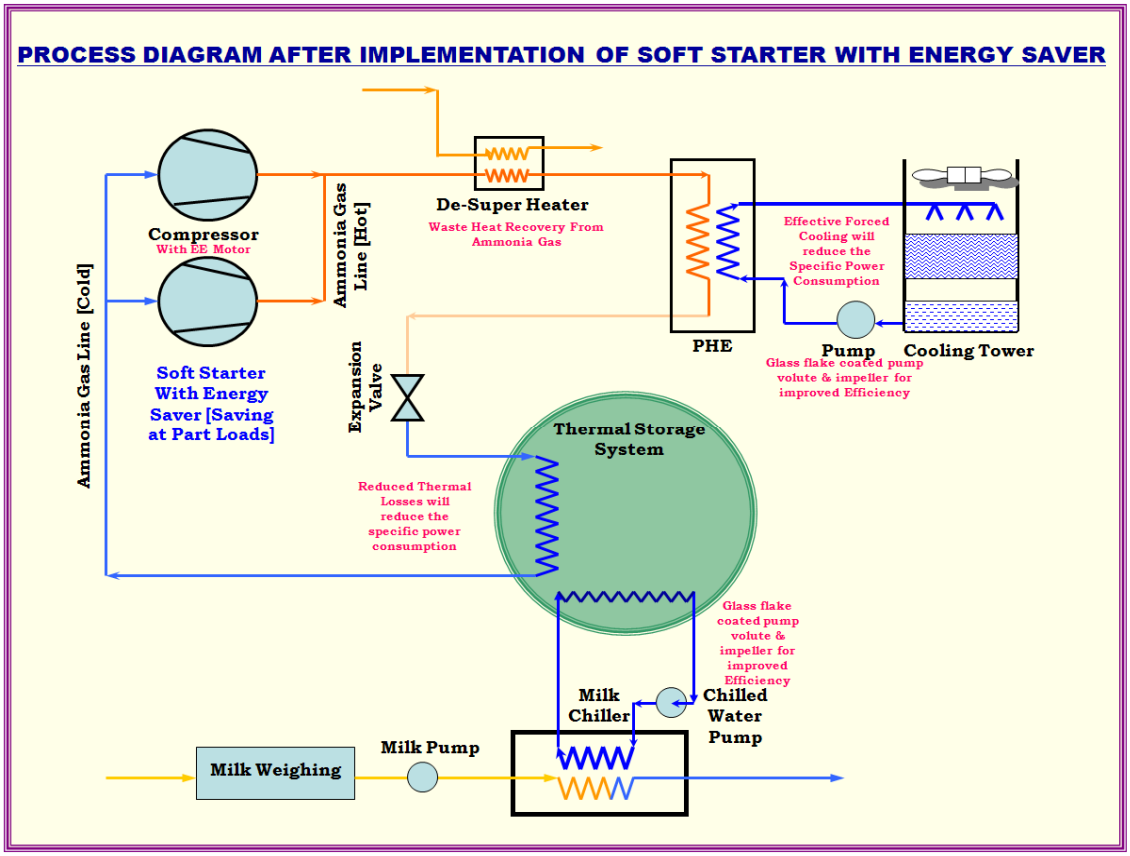
Annexure -1: Energy audit data used for baseline establishment

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

SN	Ammonia Compressor Particulars	Model	Motor Rated kW	Measured kW
1)	Chilled Water Section Comp. No.1	Sinco	30	26.7
		Total	30	26.7
Total Actual on Load			30	26.7

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

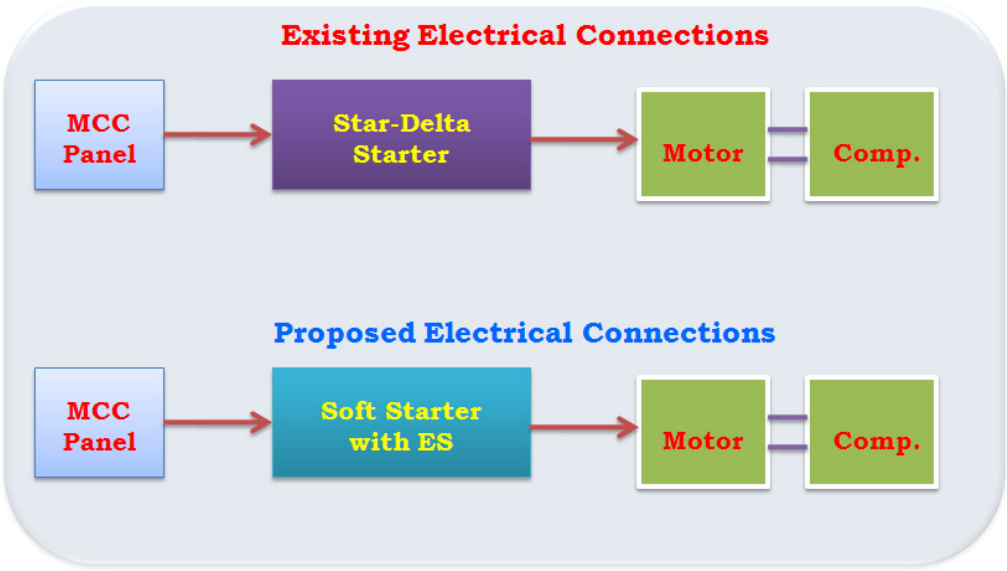
The ammonia compressors are subjected to load-unload due to change in no of cylinders loaded. At part loads only one / two /three cylinders are working. The percentage loading on motor may be lower up to 25% at times. At part loads, soft starter with energy saver, by changing firing angle of thyrister, 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 –

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

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

Name of the Technology	SOFT STARTER WITH ENERGY SAVER		
Rated Capacity			
Details	**Unit**	**Value**	**Basis**
Installed Capacity	kW	30	
No of working days	Days	360	
No of Shifts per day	Shifts	3	
Proposed Investment			
Plant & Machinery	Rs. in lakhs	1.40	
Civil Work	Rs. in lakhs	0.01	
Erection & Commissioning (1% on Plant & Equip)	Rs. in lakhs	0.02	
Investment without IDC	Rs. in lakhs	1.43	
Interest During Implementation	Rs. in lakhs	0.00	
Misc. cost	Rs. in lakhs	0.01	
Total Investment	Rs. in lakhs	1.44	
Financing pattern			
Own Funds (Internal Accruals)	Rs. in lakhs	0.36	
Loan Funds (Term Loan)	Rs. in lakhs	1.08	
Loan Tenure	Years	7.00	
Moratorium Period	Months	6.00	
Repayment Period	Months	90.00	
Interest Rate	%	10.00%	SIDBI Lending rate
Estimation of Costs			
O & M Costs	% on Plant & Equip	2.00%	
Annual Escalation	%	5.00%	
Estimation of Revenue			
Electricity savings	kWh/Year	11520	
Cost	Rs. / kWh	5.96	
St. line Depn.	%	2.00%	Indian Companies Act
IT Depreciation i.e. WDV	%	80.00%	Income Tax Rules
Income Tax rate	%	33.99%	Income Tax

Estimation of Interest on Term Loan **Rs. (in lakh)**

Years	Opening Balance	Repayment	Closing Balance	Interest
1	1.08	0.03	1.05	0.13
2	1.05	0.06	0.99	0.10
3	0.99	0.08	0.91	0.10
4	0.91	0.14	0.77	0.09
5	0.77	0.18	0.59	0.07
6	0.59	0.20	0.39	0.05
7	0.39	0.24	0.15	0.03
8	0.15	0.15	0.00	0.01
		1.08		

WDV Depreciation **Rs. (in lakh)**

Particulars / years	1	2
Plant and Machinery		
Cost	1.44	0.29
Depreciation	1.15	0.23
WDV	0.29	0.06

Projected Profitability **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Fuel savings	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
Total Revenue (A)	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
Expenses										
O & M Expenses	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
Total Expenses (B)	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
PBDIT (A)-(B)	0.66	0.66	0.65	0.65	0.65	0.65	0.65	0.65	0.64	0.64
Interest	0.13	0.10	0.10	0.09	0.07	0.05	0.03	0.01	0.00	0.00
PBDT	0.53	0.55	0.56	0.57	0.58	0.60	0.62	0.64	0.64	0.64
Depreciation	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
PBT	0.50	0.53	0.53	0.54	0.55	0.57	0.59	0.61	0.62	0.61
Income tax	0.00	0.11	0.19	0.19	0.20	0.20	0.21	0.22	0.22	0.22
Profit after tax (PAT)	0.50	0.42	0.34	0.35	0.35	0.37	0.38	0.39	0.40	0.39

Computation of Tax **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Profit before tax	0.50	0.53	0.53	0.54	0.55	0.57	0.59	0.61	0.62	0.61
Add: Book depreciation	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Less: WDV depreciation	1.15	0.23	-	-	-	-	-	-	-	-
Taxable profit	(0.62)	0.32	0.56	0.57	0.58	0.60	0.62	0.64	0.64	0.64
Income Tax	-	0.11	0.19	0.19	0.20	0.20	0.21	0.22	0.22	0.22

Projected Balance Sheet **Rs. (in lakh)**

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Share Capital (D)	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36	0.36
Reserves & Surplus (E)	0.50	0.92	1.26	1.60	1.96	2.33	2.71	3.10	3.50	3.89
Term Loans (F)	1.05	0.99	0.91	0.77	0.59	0.39	0.15	0.00	0.00	0.00
Total Liabilities (D)+(E)+(F)	1.91	2.27	2.53	2.73	2.91	3.08	3.22	3.46	3.86	4.25

Assets	1	2	3	4	5	6	7	8	9	10
Gross Fixed Assets	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44	1.44
Less Accm. Depreciation	0.03	0.06	0.09	0.12	0.14	0.17	0.20	0.23	0.26	0.29
Net Fixed Assets	1.41	1.38	1.35	1.32	1.30	1.27	1.24	1.21	1.18	1.15
Cash & Bank Balance	0.50	0.89	1.18	1.41	1.61	1.81	1.98	2.25	2.68	3.10
TOTAL ASSETS	1.91	2.27	2.53	2.73	2.91	3.08	3.22	3.46	3.86	4.25
Net Worth	0.86	1.28	1.62	1.96	2.32	2.69	3.07	3.46	3.86	4.25
Debt Equity Ratio	2.92	2.75	2.53	2.14	1.64	1.08	0.42	0.00	0.00	0.00

Projected Cash Flow **Rs. (in lakh)**

Particulars / Years	0	1	2	3	4	5	6	7	8	9	10
Sources											
Share Capital	0.36	-	-	-	-	-	-	-	-	-	-
Term Loan	1.08										
Profit After tax		0.50	0.42	0.34	0.35	0.35	0.37	0.38	0.39	0.40	0.39
Depreciation		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Total Sources	1.44	0.53	0.44	0.37	0.37	0.38	0.39	0.41	0.42	0.43	0.42
Application											
Capital Expenditure	1.44										
Repayment Of Loan	-	0.03	0.06	0.08	0.14	0.18	0.20	0.24	0.15	0.00	0.00
Total Application	1.44	0.03	0.06	0.08	0.14	0.18	0.20	0.24	0.15	0.00	0.00
Net Surplus	-	0.50	0.38	0.29	0.23	0.20	0.19	0.17	0.27	0.43	0.42
Add: Opening Balance	-	-	0.50	0.89	1.18	1.41	1.61	1.81	1.98	2.25	2.68
Closing Balance	-	0.50	0.89	1.18	1.41	1.61	1.81	1.98	2.25	2.68	3.10

IRR **Rs. (in lakh)**

Particulars / months	0	1	2	3	4	5	6	7	8	9	10
Profit after Tax		0.50	0.42	0.34	0.35	0.35	0.37	0.38	0.39	0.40	0.39
Depreciation		0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Interest on Term Loan		0.13	0.10	0.10	0.09	0.07	0.05	0.03	0.01	-	-
Cash outflow					-	-	-	-	-	-	-
Net Cash flow	(1.44)	-	-	-	-	-	-	-	-	-	-
IRR	34.73										
NPV	1.57										

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

Particulars / Years	1	2	3	4	5	6	7	8	9	10
Variable Expenses										
Oper. & Maintenance Exp (75%)	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Sub Total(G)	0.02	0.02	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Fixed Expenses										
Oper. & Maintenance Exp (25%)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Interest on Term Loan	0.13	0.10	0.10	0.09	0.07	0.05	0.03	0.01	0.00	0.00
Depreciation (H)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Sub Total (I)	0.16	0.14	0.13	0.12	0.11	0.09	0.07	0.04	0.04	0.04
Sales (J)	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69
Contribution (K)	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.66	0.65	0.65
Break Even Point (L= G/I)%	24.32%	20.88%	20.03%	18.53%	16.36%	13.63%	10.19%	6.71%	6.02%	6.12%
Cash Break Even {(I)-(H)}%	19.99%	16.54%	15.69%	14.18%	12.00%	9.26%	5.81%	2.32%	1.62%	1.71%
Break Even Sales (J)*(L)	0.17	0.14	0.14	0.13	0.11	0.09	0.07	0.05	0.04	0.04

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

Particulars / Years	1	2	3	4	5	6	7	8	9	10	Total
Net Profit Before Taxes	0.50	0.53	0.53	0.54	0.55	0.57	0.59	0.61	0.62	0.61	5.65
Net Worth	0.86	1.28	1.62	1.96	2.32	2.69	3.07	3.46	3.86	4.25	25.36
											22.28%

Debt Service Coverage Ratio **Rs. (in lakh)**

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

DEBT

Interest on Term Loan	0.13	0.10	0.10	0.09	0.07	0.05	0.03	0.01	0.00	0.00	0.57
Repayment of Term Loan	0.03	0.06	0.08	0.14	0.18	0.20	0.24	0.15	0.00	0.00	1.08
Total (N)	0.16	0.16	0.18	0.23	0.25	0.25	0.27	0.16	0.00	0.00	1.65
	4.22	3.37	2.64	2.04	1.81	1.77	1.63	2.76	0.00	0.00	2.37
Average DSCR (M/N)	2.37										

Annexure:-6 Procurement and implementation schedule

Day wise break up of implementation Schedule

SN	Activities	Days			
		1	2	3	4
1	Foundation & civil work				
2	Commissioning				
3	Cabling & electrical panel fitting				
4	Testing and trial				
5	On site operator training				

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

S.No.	Name of Service Provider	Address	Contact Person and No.
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 Avanue, 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

An ISO 9001:2008 Certified Company

Q-1016 / ELECT / SJC DATE: 16-03-2011

TO,
PETROLEUM CONSERVATION
RESEARCH ASSOCIATION
AHMEDABAD

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:

Sr. No	Description	Qty.
1.	Allen Bradley make Soft Starter: • Suitable for 30 KW, 40 H.P. • Current range: 97A, • Rated voltage 415 AC, • Control voltage 100-240V AC • Inbuilt LCD display	1 No.

General Components:

Sr.No.	Description	Qty.
1.	Incoming SFU of suitable rating with SCR fuse link	1 Set
2.	Input/output isolation contactor of suitable rating	2 Nos.
3.	DOL bypass contactor of suitable rating	1 No.
4.	Thermal overload Relay of suitable rating	1 No.
5.	Control transformer of suitable rating	1 No.
6.	Selector Switch	1 No.
7.	DP Miniature Circuit Breaker	As reqd.
8.	Control Relay	As reqd.
9.	Control Fuse with link	3 Nos.
10.	LED Indicating Lamps run, fault, phase	5 Nos.
11.	Push Buttons start/stop	2 Nos.
12.	Necessary Control and power terminals.	As reqd.
13.	Necessary Control and Power Wiring	As reqd.

ENCL.: Q-1016 / ELECT / SJC

ANNEXURE-II
PRICE WITH COMMERCIAL TERMS AND CONDITIONS

PRICE

Sr. No.	Description	Qty.	Unit price (Rs.)
1	**30 KW** Soft starter Control Panel as mentioned in annexure I Sr no.[1]	1 No.	1,39,500/-

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