3.5 MAIN ENERGY CONSERVATION MEASURES IDENTIFIED

3.5.1.1 Waste heat recovery by providing De-super heater in ammonia vapor compression based refrigeration system.

3.5.1.1.1 Background

During vapor compression of ammonia, the ammonia hot gas at out let of ammonia compressor is substantially hot (about 102°C). The heat drawn from IBT and work done by compressor is thrown to condenser. If De-super heater is provided for harnessing the waste heat from this hot ammonia gas, hot water up to 70 to 75°C can be harnessed. This hot water can be used for CIP needs or for other hot water requirements such as preheating of boiler makeup water.

3.5.1.1.2 Benefit of Proposal

De-super heater to be provided on Reciprocating Chiller system to harness waste heat of NH3 gas. De-super heater is installed on discharge side of NH3 compressor. The temperature of NH3 gas observed to be 92 to 95ºC. It is standard practice to harness 12 to 15% of Waste heat rejected in condenser by providing De-super heater. The arrangement of de-super heater can be by providing PHE or in case of small reciprocating NH3 compressor by providing shell and tube type heat exchanger. The hot water temperature can be maintained up to 70ºC by proper design of de-super heater along with maintaining flow rate. Apart from the direct energy saving after getting hot water, the heat load on condensing coil or cooling system will be reduced which will further open possibilities of downgrading the cooling water pumps.

The energy saving considered for implementation of De-super heater measure is 12% (Only direct saving is considered. Though when de-super heater is provided, down grading of condenser pump can be done or overall performance of condenser will enhance resulting in increased in COP of refrigeration system.]

3.5.1.1.3 Cost Benefit Analysis :

1)	Capacity of Existing VC Cycle Compressor (Working or on-load. But Actual average load may be lower due to load modulation)	=	28.7	TR
2)	Working Hours for Compressor/day	=	20	hrs/day
3)	Ambient Water Temperature	=	30	ºC
4)	Temperature of Hot NH3 Gas available for WHR from Desuperheater	=	91	ºC
5)	Waste Heat Available from Desuper Heater (Considering 12% WHR possible in De-super heater i.e. 12% of total kWh consumed can be recovered)	=	2239	kCal/hr
6)	Expected Temperature of Hot water from De-super heater (Considering Flow Rate and Design of De-super heater to get 65ºC hot water for winter conditions)	=	65	ºC
7)	Quantity of Hot Water Available	=	64	ltrs/hr

8)	Total Quantity of Hot water that can be generated from De-super heater	=	1280	ltrs/day
	Thus Total Hot water at 65 ºC can be generated	=	1.28	kill/day
9]	Cost of Electricity	=	5.5	Rs./kWh
10]	Expected Saving per Day (kWh energy for Compressor recovered, considering above Working Hours)	=	2.6	kWh/hr
11]	Expected Saving Per Annum in kWh	=	18720	kWh/annum
12]	Expected Saving per Annum (Considering 360 Working Days)	=	102960	Rs./annum
13]	Expected Investment Needed	=	143500	Rs.
14)	Simple Payback	=	1.39	Year
			17	Months

3.5.1.1.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure
- Ü High Initial Cost.

3.5.1.2 Improvement in steam & Hot water pipe line insulation to prevent thermal energy loss.

3.5.1.2.1 Background

During energy audit it was observed that the insulation for steam & hot water pipe line are not scientifically (with economical insulation thickness) done across entire stretched of pipe line carrying steam and hot water. The thermal insulation was found to be damaged at many locations. The pipe fittings, flanges & other mountings are not thermally insulated. Hot water pump casing and associated mountings are not thermally insulated.

3.5.1.2.2 Benefit of Proposal

Detailed inspection of entire pipe line for thermal insulation carried which suggest energy saving opportunity exist if thermal insulation is provided for entire pipe line, along with pipe fittings, mountings, accessories. Also scientific preventive maintenance of thermal insulation will also result in energy savings. The estimated loss due to thermal insulation varies from unit to unit depending on actual condition of thermal insulation. The general observation for saving indicates saving from 7 to 12% by providing proper thermal insulation for steam & hot water pipe line.

3.5.1.2.3 Cost Benefit Analysis

1)	Fuel Used	=	Wood	
2)	Average Quantity of fuel Consumed Per Month	=	6000	kgs
3)	Cost of Per Ltrs of fuel	=	2.5	Rs./kg

	Estimated area of existing thermal insulation including pipe line, pipe fittings, mountings and allied accessories.	=	35	m^2
4)	Estimated area of thermal insulation that can be additional provided, along with repair and reconditioning of existing thermal insulation.	=	3.5	m^2
5)	Estimated % Loss due to improper insulation and exposed area	=	10	%
6)	Expected Saving by Improving Thermal insulation for Hot water pipe line by considering improper insulation and exposed area.	=	600	kgs/Month
7)	Expected Saving per Annum	=	18000	Rs./annum
8)	Investment Needed for providing additional insulation and improving thermal insulation for hot water pipe line	=	28000	Rs.
9)	Simple Payback	=	1.56	Yrs
		=	19	Months

3.5.1.2.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure

3.5.1.3 Improvement in chilled water pipe line insulation to prevent the heat ingress and thus energy loss.

3.5.1.3.1 Background

During energy audit it was observed that the insulation for chilled water pipe line is not scientifically (with economical insulation thickness) done across entire stretched of pipe line carrying chilled water. The thermal insulation was found to be damaged at many locations. The pipe fittings, flanges & other mountings are not thermally insulated. Chilled water pump casing and associated mountings are not thermally insulated.

3.5.1.3.2 Benefit of Proposal

Insulation of chilled water pipe line found to be not scientifically done at few places. The existing insulation provided is same as that of provided for hot water pipe line. It is recommended to provide the proper insulation suitable for chilled water. Proper layers as required for chilled water to be provided. Insulation to be provided to casing of pump, all the pipe fittings, flanges and other mountings. Detailed inspections of chilled water pipe line insulation suggest energy saving opportunities.

3.5.1.3.3 Cost Benefit Analysis

1)	Capacity of Existing VC Cycle Compressor (Working or on-load)	=	28.7	TR
2)	Working Hours for Compressors/day	=	20	hrs/day
3)	Actual kWh Consumption of Compressor	=	21.7	kWh/hr

4)	Estimated area of existing insulation for chilled water including pipe line, pipe fittings, mountings and allied accessories.	=	40	m^2
5)	Estimated area of chilled water insulation that can be additionally provided along with repairs and reconditioning of existing insulation.	=	3.6	m^2
6)	Estimated % Loss due to improper insulation and exposed area	=	9	%
7)	Expected Saving by Improving Thermal insulation for Chilled water pipe line by considering improper insulation and exposed area.	=	2	kWh/hr
8)	Cost of Electricity	=	5.5	Rs./kWh
9)	Expected Saving Per Annum in kWh	=	14400	kWh/annum
10)	Expected Saving per Annum (Considering 360 Working Days)	=	79200	Rs./annum
11	Expected Investment Needed for Improving Thermal Insulation for Chilled Water Pipe Line	=	28000	Rs.
12)	Simple Payback	=	0.35	Yrs
		=	5	Months

3.5.1.3.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure

3.5.1.4 Energy Saving by Replacing Conventional V-belt with cogged belt.

3.5.1.4.1 Background

V-belts use a trapezoidal cross section to create a wedging action on the pulleys to increase friction and the belt's power transfer capability. Joined or multiple belts are specified for heavy loads. V-belt drives can have a peak efficiency of 95% to 98% at the time of installation. Efficiency is also dependent on pulley size, driven torque, under or over-belting, and V-belt design and construction. Efficiency deteriorates by as much as 5% (to a nominal efficiency of 93%) over time if slippage occurs because the belt is not periodically re-tensioned.

3.5.1.4.2 Benefit of Proposal

Cogged belts have slots that run perpendicular to the belt's length. The slots reduce the belt's bending resistance. Cogged belts can be used with the same pulleys as equivalently rated Vbelts.

They run cooler, last longer, and have an efficiency that is about 2% higher than that of standard V-belts. All the chiller compressors are provided with conventional V-belt drives. It is recommended to replace these conventional V-belts with cogged belt to improve transmission efficiency by 2%.

3.5.1.4.3 Cost Benefit Analysis

1)	Capacity of Existing VC Cycle Compressor (Working or on-load)	=	28.7	TR
2)	Working Hours for Compressors/day	=	20	hrs/day
3)	Actual kWh Consumption of Compressor	=	21.7	kWh/hr
4)	Expected Saving by Providing Cogged belt in Place of Conventional V-Belt (About 2%)	=	0.4	kWh/hr
5)	Cost of Electricity	=	5.5	Rs./kWh
6)	Expected Saving Per Annum in kWh	=	2880	kWh/annum
7)	Expected Saving per Annum (Considering 360 Working Days)	=	15840	Rs./annum
8)	Expected Investment Needed for Replacing Conventional V-belt with Cogged V-belt.	=	8610	Rs.
9]	Simple Payback	=	0.54	Yrs
		=	7	Months

3.5.1.4.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure

3.5.1.5 Energy Saving by Replacing Reciprocating Air Compressor with Screw Compressor with VFD.

3.5.1.5.1 Background

Reciprocating air compressor for higher capacities (about more than 85 cfm demand) are generally less energy efficient than that of Screw compressor. Also reciprocating air compressor needs higher maintenances cost as compare to screw compressor.

3.5.1.5.2 Benefit of Proposal

The specific power consumption of existing reciprocating compressor found to be higher. Replacing these compressor with screw compressor with VFD which has considerable lower specific power consumption, will result in energy saving. The reciprocating compressors are prone to lower volumetric efficiency. Also the maintenance cost of screw compressor is lower as compared to reciprocating compressor.

3.5.1.5.3 Cost Benefit Analysis

1)	Actual air FAD required	=	68.5	cfm
2)	Existing Specific Power Consumption	=	0.26	kW/cfm
3)	Average working hours per day	=	20	hrs/day
4)	Average existing consumption per hour	=	17.8	kw/hr
5)	Existing consumption per day for air compressor	=	356	kWh/day
6)	Cost of Electricity	=	5.86	Rs./kWh
7)	Specific Power Consumption of analogs screw	=	0.18	kW/

	compressor (100 cfm capacity with VFD)			
8)	Average Saving for same consumption by screw compressor (with VFD)	=	246.6	kWh/day
9)	Expected saving in kWh per day	=	109.4	kWh/day
10)	Expected saving in kWh per annum	=	39384	kWh/annum
11)	Expected saving in Rs. Per Annum	=	230790	Rs./annum
12)	Investment needed for screw compressor with VFD	=	800000	Rs.
13)	Simple payback period	=	3.47	Yrs.
		=	42	Months

3.5.1.5.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure
- Ü High initial cost.

3.5.1.6 Energy saving by providing condensate recovery system for Boiler.

3.5.1.6.1 Background

Currently in many units the condensate recovery is not done or not as per required standard they also returned condensate temperature is 50ºC, which is lower than higher achievable temperature of about 60 to 65ºC by providing proper insulation for condensate recovery pipe line along with condensate recovery tank in power section (Combined condensate tank for powder section).

3.5.1.6.2 Benefit of Proposal

Currently no condensate is recovered from the process. It is recommended to recover maximum possible condensate as it will save considerable energy directly, auxiliary energy consumption such as energy consumption for water softener; makeup water pump etc will be saved. Energy audit team is of the opinion that at least 50% condensate can be recovered from various processing section as mentioned above. Though in few sections such as crate washer where open steam is used, condensate recovery is not possible.

3.5.1.6.3 Cost Benefit Analysis

1)	Fuel Used	=	FO	
2)	Calorific Value of FO	=	10500	kCal./ltr
3)	Cost of Per Ltrs of fuel	=	29	Rs./
4)	Daily Steam Generation	=	14	Tons/day
5)	Condensate amount that can be recovered (40% condensate recovery at 70°C.)	=	7	Tons/day
6)	Make up water temperature	=	30	°C
7)	Total kCal that can be saved per Day	=	280000	kCal/day

8)	Boiler Efficiency	=	83	%
9)	Expected FO Saving per day	=	32.13	ltrs/day
10)	Expected FO Saving per Annum	=	11566.8	ltrs/annum
11)	Expected Saving in Rs. Annum	=	335437	Rs./annum
12)	Investment needed for Condensate Recovery	=	425000	Rs.
10)	Simple Payback	=	1.27	Yrs
		=	16	Months

3.5.1.6.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure
- Ü High initial cost.

3.5.1.7 Energy Saving by Reducing Operating Pressure of Compressed Air by providing Ring Mains & properly sized Compressed

3.5.1.7.1 Background

As operating pressure of compressor increases, specific power consumption increases. It is observed that due to improper compressed air pipe line size, fittings & lack of ring mains lead to higher pressure drop in compressed air system which results in higher operating pressure.

3.5.1.7.2 Benefit of Proposal

The existing operating pressure range of compressor is higher resulting in higher specific power consumption for the air compressors. By reducing operating pressure by 1 kg/cm², 6% energy can be saved. Provision of ring mains and allied mountings such as moisture traps etc will enable to reduce the operating pressure.

3.5.1.7.3 Cost Benefit Analysis

1)	Existing Operating Compressed Air Pressure	=	8	kg/cm²
2)	Proposed Operating air pressure	=	5	kg/cm²
3)	Average working hours per day for compressor	=	20	hrs/day
4)	Average existing consumption per hour for air compressor	=	17.8	kw/hr
5)	Existing consumption per day for air compressor	=	356	kWh/day
6)	Cost of Electricity	=	5.86	Rs./kWh
7)	Expected saving by reduction in operating pressure (6% energy saving for reduction in operating pressure by 1 kg/cm²)	=	0.53	kW/hr
8)	Expected saving in kWh per day	=	10.6	kWh/day
9)	Expected saving in kWh per annum	=	3816	kWh/annum
10)	Expected saving in Rs. Per Annum	=	22361.8	Rs./annum

11)	Investment needed for providing ring main with proper size of compressed air pipe	=	89000	Rs.
12)	Simple payback period	=	3.98	Yrs.
		=	48	Months

3.5.1.7.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure

3.5.1.8 Energy saving by interlocking agitator of Milk Cylo working with level of milk inside cylo.

3.5.1.8.1 Background

Various milk cylos are provided for storing in process milk. It was observed that even if the cylos are empty, the agitator found to be working. This results in energy loss.

3.5.1.8.2 Benefit of Proposal

The agitator for milk cylo is provided with motor along with reduction gear box. During field study idle working of cylo agitator observed. By interlocking the working of agitator with level of milk inside the cylo will avoided idle working of the agitator for average 5 hours per day resulting in energy saving.

3.5.1.8.3 Cost Benefit Analysis

1]	Expected Saving per day	=	58.5	kWh
2]	No of Days working per annum	=	360	Days
3)	Expected kWh Saving per Annum	=	21060	kWh/annum
4)	Cost of Electricity	=	5.22	Rs./kWh
5)	Expected Saving Per Annum	=	109933	Rs./annum
6)	Total Number of Agitators	=	18	Nos.
7)	Expected Investment for One agitator for interlocking	=	20000	Rs./Machine
8)	Total Expected investment	=	360000	Rs.
9)	Simple Payback Period	=	3.27	Yrs
		=	39	Months

3.5.1.8.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure

3.6 MAIN ENERGY CONSERVATION & TECHNOLOGY UPGRADATION PROPOSALS

3.6.1.1 Provision of Soft Starter with Energy Saver for Ammonia Compressor.

3.6.1.1.1 Background

Ammonia compressor motors are subjected to frequent part load operation due to variation of load. Energy saving in Ammonia compressor motor can be done by providing soft starter with energy saver.

3.6.1.1.2 Benefit of Proposal

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 thyrist0r, reduces the voltage till the current is not increased. The saving up to 3% 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.

3.6.1.1.3 Cost Benefit Analysis

1)	Rated capacity of existing VC Cycle refrigeration system (Working on load)	=	735	TR
2)	Actual TR generated by existing VC Cycle Compressor (Working or on-load)	=	472.5	TR
2)	Working Hours for Compressor/day	=	20	hrs/day
3)	Actual kWh Consumption of Compressor	=	611.5	kWh/hr
4)	Expected Saving by Providing Soft starter with energy saver for VC Compressor Motor working on variable load. (Expected Saving of 3%)	=	18.35	kWh/hr
5)	Cost of Electricity	=	6.49	Rs./kWh
6)	Expected Savings per Annum in kWh	=	132120	kWh/annum
7)	Expected Saving per Annum (Considering 360 Working Days)	=	857459	Rs./annum
8)	No of Motors for Compressor on load	=	9	Nos.
9)	Expected Investment Needed for providing soft starter with energy saver.	=	288000	Rs.
10)	Simple Payback	=	0.34	Yrs
		=	5	Months

3.6.1.1.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure

3.6.1.2 Energy saving by improving efficiency of pumps by providing the glass flake coating.

3.6.1.2.1 Background

Due to friction in impeller & casing substantial energy of pump is reduced. By providing glass flake coating to impeller & casing this friction can be reduced resulting in higher efficiency of pump. During glass flake coating the impeller is also dynamically balanced which further improves performance of pump.

3.6.1.2.2 Benefit of Proposal

Improving efficiency of pumps by providing the glass flake coating with proper mixing of different resins to provide smooth coating on impeller and casing along with dynamic balancing of impeller. Due to coating friction loss of fluid and impeller, casing reduces resulting in lower power consumption. Glass Flake coatings have proven to be very effective in extending the life of pumps and other components of system and improving efficiency of pumping operation. The efficiency of pump can be improved by 6 to 12% depending on actual pump condition. For saving calculation purpose we can consider overall saving up to 4% of pump energy consumption.

3.6.1.2.3 Cost Benefit Analysis

1]	No. of pumps considered suitable for glass flake coating.	=	6	Nos.
2]	Combined consumption (at 70% average motor loading)	=	111.9	Kw
3)	No. of normal hours of operation per day	=	20	hrs/day
4)	Expected Saving by providing Glass Fake Coating to pump impeller & to pump casing.	=	6.71	kW/hr.
5)	Cost of Electricity	=	6.49	Rs./kWh
6)	Expected kWh Saving Per Day	=	134.2	kWh/day
7)	Expected Saving in kWh/annum	=	48312	kWh/annum
8)	Expected Saving in Rs. Per Annum	=	313545	Rs./annum
9)	Expected Investment needed for all pumps	=	270000	Rs./Machine
10]	Simple Payback Period	=	0.86	Yrs
		=	10	Months

3.6.1.2.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure
- Ü High initial cost of implementation.

3.6.1.3 Energy saving by replacing conventional pneumatic pouch filling machine with PLC based mechanical type pouch filling machine.

3.6.1.3.1 Background

Conventional pneumatic type pouch filling machine requires compressed air for its operation, which consumes extra energy. The latest PLC based mechanical pouch filling machines are more energy efficiency as compared to conventional milk pouch filling machine.

3.6.1.3.2 Benefit of Proposal

Pneumatic pouch filling machine to be replaced by more energy efficient PLC based mechanical pouch filling machines. The pneumatic operated pouch filling machine itself consumes 2.5 HP along with 10 HP air compressors, working with pressure modulation as long as the pouch filling machine works. The average consumption of pneumatic pouch filling machine is 8 Kw. The PLC based mechanical pouch filling machine does not need compressed air and its own consumption is 4.5 HP. The average consumption of PLC based mechanical pouch filling machine is 2.5 Kw. Thus the expected saving is 5.5 kW/Hour.

3.6.1.3.3 Cost Benefit Analysis

1]	No. of Existing Conventional Pneumatic Pouch Filling Machine	=	2	Nos.
2]	No. of Hours of operation per day	=	8	hrs/day
3)	Expected Saving per Machine	=	5.5	kW/hr.
4)	Cost of Electricity	=	5.5	Rs./kWh
5)	Expected kWh Saving Per Day	=	88	kWh/day
6)	Expected Saving in kWh/annum	=	31680	kWh/annum
7)	Expected Saving in Rs. Per Annum	=	174240	Rs./annum
8)	Expected Investment for total machines	=	1400000	Rs./Machine
9)	Simple Payback Period	=	8.03	Yrs
		=	96	Months

3.6.1.3.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure
- Ü High initial cost of implementation.

3.6.1.4 Energy saving by providing thermal storage system in place of conventional IBT tank for energy saving & availing TOD benefits.

3.6.1.4.1 Background

The conventional IBT (Ice Bank Tank) System is provided in all the milk chilling center and dairies. The conventional IBT Tank is civil constructed tank provided with all civil constructed wall (except bottom side) thermally insulation. While top face of tank is open and covered by wooden planks supported on MS angle fabricated support structure. The IBT tank is not air tight and top portion of tank covered with wooden planks have many gaps and thin spaces where outside atmospheric air comes directly in the contact of chilled water inside the IBT Tank. These leakages are one of the major components of loss of IBT tank. Individual standing on top of IBT tank feels the air conditioning effect in

surrounding. Mechanical stirrers (agitator) are provided (one in each section of IBT tank) for creating forced circulation inside IBT tank for uniform cooling of water inside IBT Tank. These stirrers also induce heat inside the IBT tank proportional to BHP of shaft of stirrer at motor end. As the IBT tank is used in refrigeration system for making ice during off peak hours and using this thermal stored energy during peak hours. The charging of the IBT tank is done almost 20 hrs to 24 hrs per day depending on milk quantity received and ambient conditions.

3.6.1.4.2 Benefit of Proposal

Advantages of Thermal Storage System

1) Lower losses result in considerable energy.
2) TOD benefits or advantages provided by electricity company can be availed.
3) Compact and consumes very small space.
4) The compressor can be avoided to work on part load resulting in higher specific power consumption.
5) Agitator (Stirrer) which consumes additional energy and induces heat by way of churning is avoided.
6) Performance of refrigeration system can be improved by charging in night conditions which results in lower specific power consumption.
7) Reliable and negligible maintenance.
8) Provision of latest thermal storage system will result in better housekeeping and safer working condition.
9) Increased thermal storage capacity for 4 hours, will result in time space for preventive maintenance of refrigeration system resulting in better consistent performance of the entire system.
10) Through liquid overfeed system by operating at higher suction pressure, with screw compressor with economizer and rust free water quality. Savings are about 15% to 20% (Source of information IDMC)

3.6.1.4.3 Cost Benefit Analysis

1)	Total rated capacity of refrigeration system per hour (Excluding Stand by)	=	35	TR
2)	Normal working hours of refrigeration system per day	=	20	Hours
3)	Actual refrigeration TR generated	=	28.7	TR
4)	Actual electricity consumption	=	21.7	Kw
5)	Specific Power Consumption based on actual performance and actual consumption	=	0.76	kW/TR
6)	Expected Capacity in Hours for Thermal Storage System (Considering Working hours in peak milk received load and Peak TOD tariff)	=	4	hrs/day
7)	Thermal loss through conventional concrete constructed IBT tank with wooden plank cover and due to agitator provided for water churning (Actual study carried at	=	8	%

	dairies)			
8)	Expected losses in proposed thermal storage system	=	1.5	%
9)	Expected net saving in thermal losses by replacing conventional IBT tank with latest thermal storage system.	=	6.5	%
10)	Expected saving in kWh by replacing conventional IBT tank system with latest thermal storage system (Without considering saving in power of agitators)	=	1.41	kW/Hour
11)	Expected saving in kWh per Day	=	28	kWh/day
12)	Cost of electricity	=	5.5	Rs./kWh.
13)	Expected saving in kWh per annum	=	10080	kWh/annum
14)	Expected saving per day	=	154	Rs./day
15)	Expected saving per annum (Without considering TOD benefits)	=	55440	Rs./annum
16)	Expected saving per annum from TOD benefits of Rs.0.75/kWh for morning and evening peak hours.	=	46872	Rs./annum
17)	Total expected saving considering TOD benefits	=	102312	Rs./annum
18)	Expected Investment needed for proposed thermal storage system (Rated demand for peak hours without additional charging system)	=	630000	Rs.
19)	Simple Payback period (Without TOD benefits)	=	11.36	Yrs
		=	137	Months
20)	Simple Payback period (With TOD benefits)	=	6.16	Yrs
		=	74	Months

3.6.1.4.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure
- Ü High initial cost of implementation.

3.6.1.5 Replacing metallic blades for cooling tower with FRP blade to save energy.

3.6.1.5.1 Background

Metallic blades for cooling tower are heavier. This results in more energy consumption of fan motor. If the blades are retrofitted with lighter FRP Blades, lower energy will be consumed.

3.6.1.5.2 Benefit of Proposal

The existing aluminum Blades are heavier than the latest available FRP blades. Lighter FRP blades will consume lesser energy for CT Fan motor. The saving of almost 15% can be achieved by replacing CT Fan blade and subsequently down grading CT Fan motor.

3.6.1.5.3 Cost Benefit Analysis

1]	Expected Saving per day	=	27	kWh
2]	No of Days working per annum	=	360	Days
3)	Expected kWh Saving per Annum	=	9720	kWh/annum
4)	Cost of Electricity	=	5.33	Rs./kWh
5)	Expected Saving Per Annum	=	51807.6	Rs./annum
6)	Total Number of CT Fans	=	2	Nos.
7)	Expected Investment for two FRP Fans as specified above.	=	65000	Rs.
8)	Total Expected investment including installation & erection	=	70000	Rs.
9)	Simple Payback Period	=	1.35	Yrs
		=	16	Months

3.6.1.5.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure.

3.6.1.6 Methane Capture from Effluent & Utilization as fuel for boiler / Hot air generator to save energy.

3.6.1.6.1 Background

Effluents of typical dairy contain high COD & BOD contain. This results in suitable case for anaerobic methane capture. Currently aerobic ETP treatment is carried using various mechanical equipments which consume energy. Capture of methane results in energy saving & benefit to environment.

3.6.1.6.2 Benefit of Proposal

The bio-degradable effluent have high COD which results in liberation of methane gas in to atmosphere which is not desirable. Conventional ETP method both consumes high energy along with liberation of methane in the atmosphere. By various latest techniques such as anaerobic digestion and various other processes, this methane can be captured as fuel to be utilized either in boiler or hot air generator. Along with saving environment, considerable energy can also be saved.

	Untreated Effluent Data for Typical Dairy			
1)	BOD	=	2500	mg/
2)	COD	=	5000	mg/
3)	Effluent Quantity	=	41666	ltrs/hr
	(1 kg=1000000 mg & Considering for ETP, 1kg=1Ltr)			

3.6.1.6.3 Cost Benefit Analysis

	Calculations for Bio-gas Generation			
1)	COD Load per Day	=	5000	kg/day
2)	COD Reduction Percentage Considered	=	80	%
3)	Actual Reduced COD Load	=	4000	kg/day
4)	Bio-gas Generated	=	0.5	m^3/kg of Reduced COD Load
5)	Thus Actual Bio-Gas Generated	=	2000	m^3/day
6)	Calorific Value of Bio-Gas	=	4900	kCal/m^3
7)	Total heat that can be generated from Bio-gas	=	9800000	kCal/day
8)	Calorific Value of FO	=	10000	kCal/
9)	FO Equivalent of Bio-gas Generated	=	980	kg/day
10)	Cost of FO	=	29	Rs./
11)	Saving from Bio-gas Generation	=	28420	Rs./day
12)	No. of Working Days/annum	=	360	Days
13)	Total Expected Saving per Annum	=	10231200	Rs./annum
14)	Expected KLOE Saving Per Annum	=	353	kloe/annum
15)	Expected Investment for Civil Work, Mechanical Works, electrical works etc	=	22500000	Rs.
16)	Simple Payback Period	=	2.2	Yrs
		=	26	Months
17)	Expected FO Equivalent Saved per Annum	=	352800	KL/annum

3.6.1.6.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure.
- Ü Higher Initial Cost.
- Ü High awareness requirement.

3.6.1.7 Replacing existing lower efficiency electric motor, with EFF1 or higher level efficiency of motor.

3.6.1.7.1 Background

Existing motors in many industries under cluster are lower efficiency type (EFF3) type & many motors are old many time re-winded electric motor. These motors can be replaced by technological superior EFF1 or higher level of electric motors.

3.6.1.7.2 Benefit of Proposal

Electric motor having efficiency less than EFF1 level of efficiency, old many time rewound electric motors to be replaced by electric motors of at least EFF1 or higher level of efficiency. The reciprocating chiller compressor motors, condenser water pump motors,

chiller pump motors, motors for can washing machine etc with efficiency less than EFF1 level can be replaced by EFF1 or higher level of electric motors. It is strongly recommended to adopt standard rewinding practices along with standard rewinding material to maintain the efficiency level of electric motors. The existing older motors are of efficiency level of EFF2 or lower efficiency. Thus by replacing these motors with energy efficient motors of EFF1 or higher level can result in energy saving up to 5% of electricity consumption by major Non EFF1 electric motors.

3.6.1.7.3 Cost Benefit Analysis

1)	Capacity of Existing VC Cycle Compressor (Working or on-load)	=	585	Kw
2)	Working Hours for Compressor/day	=	20	hrs/day
3)	Actual kWh Consumption of Compressor	=	611.5	kWh/hr
4)	Expected Saving by replacing electric motors having efficiency less than that of EFF1 level with EE motor having Efficiency level of at least EFF1 or higher level (5% Expected)	=	30.58	kWh/hr
5)	Cost of Electricity	=	6.49	Rs./kWh
6)	Expected Saving in kWh/annum	=	220176	kWh/annum
7)	Expected Saving per Annum (Considering 360 Working Days)	=	1428942	Rs./annum
8)	Expected Investment Needed for replacing existing motor with EE motor.	=	2459000	Rs.
9]	Simple Payback	=	1.72	Yrs
		=	21	Months

3.6.1.7.4 Issue in Implementation

- Ü Lack of awareness on proposed energy conservation measure.
- Ü High Initial Cost.

3.6.1.8 Energy saving by replacing conventional motor & gear box based drive for CT Fan by permanent magnet motor & Drive.

3.6.1.8.1 Background

Cooling towers are subjected to mainly chillers system load. The nature of load is fluctuating & continuously varying. There are lot of variables such as variation of chilled water requirement load, seasonal variation, day & night condition variation etc. But currently the cooling tower fan is continuously working at same rating. By providing the permanent magnet motor with drive will make the cooling tower load responsive.

3.6.1.8.2 Benefit of Proposal

Cooling tower fan currently works at same rating across year & also subjected to transmission efficiency loss for reduction gear box (about 8%). Replacing these with

permanent magnet motor (which is much higher efficient than conventional motor) along with drive arrangement will result in energy saving for CT fan. The expected energy saving is about 15% (8% transmission efficiency + 2% motor efficiency + 5% due to variation in load using drive)

3.6.1.8.3 Cost Benefit Analysis

1]	Expected Saving per day	=	17.55	kWh
2]	No of Days working per annum	=	360	Days
3)	Expected kWh Saving per Annum	=	6318	kWh/annum
4)	Cost of Electricity	=	5.33	Rs./kWh
5)	Expected Saving Per Annum	=	33675	Rs./annum
6)	Total Number of CT Fans	=	1	Nos.
7)	Expected Investment for two FRP Fans as specified above.	=	100000	Rs.
8)	Total Expected investment including installation & erection	=	105000	Rs.
9)	Simple Payback Period	=	3.12	Yrs
		=	37	Months

3.6.1.8.4 Issue in Implementation

Ü Lack of awareness on proposed energy conservation measure

3.7 OTHER ENERGY RECOMMENDATIONS

ECM-1 Power Factor Improvement & Installation of APFC Panel

During the energy audit study of power sources, the power parameters of electricity supply company for Gujarat were also studied and analysed to identify the deviation from the rated and operational pattern as per installed equipments and machinery in the plant and the applied tariff for power supply. In this context, the power factor was also studied at main incomer feeder of the unit. It has been observed that the power factor at main comer is on lower side. The units are not able to achieve full PF incentives given by electricity supply company. It is recommended to improve the power factor to unity at main incomer level by applying the fixed capacitor banks or automatic power factor controller. The electricity supply company offers incentive of 0.5% for every percentage point improvement from 0.95 PF to Unity. Apart from incentive in electricity bill, improved PF reduces line losses and improves voltage at load terminals. Maintaining unity PF in beneficial in all respects. It is recommended to provide additional capacitors or Provision of APFC panel of proper rating and setting will ensure Unity PF.

1)	Average Monthly Consumption	=	24138	kWh/Month
2)	Maintained PF as per last bill	=	0.818	
3)	Expected Additional PF incentive by maintaining Unity PF (For Demand and Electricity charges only).	=	9	%
4)	Cost of Electricity in Rs./kWh	=	5.5	Rs./kWh
5)	Estimated cost of Electricity for Demand & Electricity Charges (Excluding variable and fixed monthly Duty, taxes, Meter charges, FAC etc)	=	4.68	Rs./kWh
6)	Total Expected PF incentive per Month	=	10166.9	Rs./Month
7)	Total Expected Saving Per Annum	=	122003	Rs./annum
8)	Expected Investment Needed for maintaining Unity PF (Additional Capacitor / APFC)	=	175000	Rs.
9)	Simple Payback	=	1.43	Yrs
		=	17	Months

ECM-2 Energy saving by providing Solar Water heater for boiler water pre-heating & hot water requirements

Solar water heating system to be provided for hot water requirements. Hot water is required for both process & for cleaning purpose. The properly maintained solar system of 5000 ltrs/day capacity will result in hot water at 70ºC. Solar hot water system, do not have any costly maintenance along with literally lowest operation cost.

The solar system can be effectively utilized for post heating hot water (65 ºC) obtained from de-super heater to heat the water up to 85 ºC so that most of the fuel requirement for boiler can be saved.

1]	Heat energy saved by providing solar water heater (5000 ltrs/day capacity providing hot water at 70˚C from ambient water temperature from 27˚C)	=	215000	kCal/day
2]	Fuel used currently for hot water generator	=	Wood	
3)	Calorific Value of currently used fuel	=	3000	kCal/kg

4)	Specific Gravity Considered for Fuel	=	1	
5)	Expected Saving of Currently used fuel considering hot water generator eff. Of 65%	=	110.26	kg/day
6)	Cost of Fuel on day of computation	=	2.5	Rs./kg
7)	Expected Saving of Fuel per Annum (Considering effective full working day for solar system to be 300 days only)	=	33078	kg/annum
8)	Expected Saving of Fuel per Annum (Considering effective full working day for solar system to be 300 days only)	=	33078	ltrs/annum
9]	Expected Saving in Rs/annum	=	82695	Rs./annum
10]	Expected Investment for Solar Heating System with Insulated Storage Tank, Pipe lines and associated insulation	=	750000	Rs./Machine
11)	Simple Payback Period	=	9.07	Yrs
		=	109	Months

ECM-3 Replacement of conventional tube lights with energy efficient ones

In maintenance & facility areas about 78 numbers Fluorescent TL with 40W and 36 W with conventional ballast is provided. The conventional ballast consumes about 12 W, which is nearly 33% of lamp wattage. The electronic ballast consumes only 2W and has additional advantage of wide voltage variation, enhances life of the Fluorescent tube. Further the T5 lamp with electronic ballast would consume about 30 W as against 52 W by fitting with normal ballast, without compromise in the lux level.

1)	Total Number of FTL with Conventional Magnetic Ballast	=	21	Nos.
2)	Working Hours for these FTL/day	=	12	hrs/day
3)	Existing Consumption by these FTL	=	13.1	kWh/day
4)	Expected Saving by Providing Electronic Ballast / T5 FTL / CFL (Expected saving of 25%)	=	3.28	kWh/day
5)	Expected Savings in kWh/annum	=	1181	kWh/annum
6)	Cost of Electricity	=	5.5	Rs./kWh
7)	Expected Saving per Annum (Considering 360 Working Days)	=	6494	Rs./annum
8)	Expected Investment Needed for Retrofit	=	17850	Rs.
9)	Simple Payback	=	2.75	Yrs
		=	33	Months

3.8 AVAILABILITY OF TECHNOLOGY SUPPLIERS/LOCAL SERVICE PROVIDERS FOR IDENTIFIED ENERGY CONSERVATION PROPOSALS

The technology recommended in the detailed energy audit is easily available. Various manufacturers of the energy efficiency improvement products, systems have already been contacted & discussion held with them regarding the applicability, feasibility & expected lines of implementation. The PCRA team does not foresee any problem in availing the recommended technology within nation market itself. India is one of the major dairy product producers in the world having good infrastructure for dairy development & dairy technology. Batteries of manufacturers are available for implementation of energy conservation as well as technological up gradation measures.

Details of the identified technology supplier/local service providers in Gujarat (Dairy) SME Cluster are furnished as per Annexure 2

3.9 IDENTIFIED TECHNOLOGIES FOR DPR PREPARATION

For selecting the technologies & products for DPRs, energy efficiency & technological up gradation was prime criteria. Some measures are resulting in better saving of and some measures on long term will induce a better technology in the units of cluster. During field study and during discussion the feedback received from various unit managements was also at the core of the selection of DPR. Various other factors such as cost of implementation, possibility of capacity building of LSP etc was also considered while selecting the technologies for DPR.

Item/Description	Potential for Replication in No. of Units
Energy saving in Ammonia compressor motor by providing soft starter with energy saver at part loads (During modulation at lower loads due to firing of one or two cylinders only)	21
Energy saving by improving efficiency of condenser water circulation pumps by providing the glass flake coating to pump impellers and to pump casing.	12
Upgrading conventional pneumatic pouch filling machine by PLC based mechanical pouch filling machine which saves energy.	6
Energy saving in refrigeration system by providing Thermal energy storage system in place of conventional IBT (Ice Bank Tank) system.	22
Energy Saving by replacing existing heavier metallic cooling tower blade with lighter FRP blades.	7
Methane Capture from Effluent & Utilization as fuel for boiler /	3

Hot air generator.	
Energy saving by replacing older lower efficiency electric motor with energy efficient motor of at least EFF1 level.	15
Waste heat recovery by providing De-super heater in ammonia vapor compression based refrigeration system.	14
Improvement in steam & Hot water pipe line insulation to prevent thermal energy loss.	22
Improvement in chilled water pipe line insulation to prevent the heat ingress and thus energy loss.	22
Energy saving by improving transmission efficiency in chiller compressor and other machines by providing cogged belt in place of conventional V-belt (For Reciprocating Chiller Compresors).(deletion)	21
Replacing reciprocating compressor (with higher specific power consumption) by screw compressor with VFD to save energy.	5
Maintaining unity PF to get maximum PF incentive along with reducing line losses and improve terminal voltage.	15
Energy Saving by utilization of renewable solar energy for hot water generation.(2)	12
Energy saving in lighting system by providing T5 type FTL and or CFL in place of conventional FTL with magnetic ballast. Also providing luminaries for improvement in lighting system performance. Also Replacing Mercury Vapor Lamps with Metal Halide Lamps.(deletion)	22

4 CHAPTER 4

4.1 SYSTEMATIC APPROACH FOR ENERGY CONSERVATION BY TEM/SGA

4.2 INTRODUCTION

Energy is one of the most important resources to sustain our lives. At present we still depend a lot on fossil fuels and other kinds of non-renewable energy. The extensive use of renewable energy including solar energy needs more time for technology development. In this situation Energy Conservation (EC) is the critical needs in any countries in the world.

Special importances of Energy Conservation are the following two aspects:

(1) Economic factors

(2) Environmental impacts

4.2.1.1 Economic factors of Energy Conservation

Energy saving is important and effective at all levels of human organizations – in the whole world, as a nation, as companies or individuals. Energy Conservation reduces the energy costs and improves the profitability.

Notably, the wave of energy conservation had struck the Indian intelligentsia 3 years earlier when a Fuel Policy Committee was set up by the Government of India in 1970, which finally bore fruits three decades hence in the form of enactment of the much awaited Energy Conservation Act, 2001 by the Government of India. This Act made provisions for setting up of the Bureau of Energy Efficiency, a body corporate incorporated under the Act, for supervising and monitoring the efforts on energy conservation in India.

Brief History of energy efficiency movement in India and associated major milestones are as follows

- Ü 1974: setting up of fuel efficiency team by IOC, NPC and DGTD (focus still on industry)
- Ü 1975: setting up of PCAG (NPC main support provider) : focus expanded to include agriculture, domestic and transport
- Ü 1978: Energy Policy Report of GOI: for the first time, EE as an integral part of national energy policy – provided detailed investigation into options for promoting EE
- Ü Post 1980, several organizations started working in EC area on specific programs (conduct of audits, training, promotion, awareness creation, demonstration projects, films, booklets, awareness campaigns, consultant/product directories)

- Ü Some line Ministries and organizations like BICP, BIS, NPC, PCRA, REC, Ministry of Agriculture, TERI, IGIDR, CSIR, PETS (NPTI)
- Ü State energy development agencies
- Ü Industry associations
- Ü All India financial institutions

The Government of India set up Bureau of Energy Efficiency (BEE) on 1st March 2002 under the provisions of the Energy Conservation Act, 2001. The mission of the Bureau of Energy Efficiency is to assist in developing policies and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act, 2001 with the primary objective of reducing energy intensity of the Indian economy. This will be achieved with active participation of all stakeholders, resulting in accelerated and sustained adoption of energy efficiency in all sectors.

Private companies are also sensitive to energy costs, which directly affects their profitability and even their viability in many cases. Especially factories in the industrial sectors are of much concern, because reduced costs by Energy Conservation mean the more competitive product prices in the world markets and that is good for the national trade balance, too.

4.2.1.2 Environmental impacts of Energy Conservation

Energy Conservation is closely related also to the environmental issues. The problem of global warming or climate change is caused by emission of carbon dioxide and other Green House Gases (GHG). Energy Conservation, especially saving use of fossil fuels, shall be the first among the various countermeasures of the problem, with due considerations of the aforementioned economic factors.

4.3 TOTAL ENERGY MANAGEMENT (TEM)

Every point in factories has potential for Energy Conservation. Total Energy Management is implemented, by all the people's participation, step by step utilizing "Key Step Approach" in a systematic manner, as shown below:

(1) Top management policy/Goal

- Ü Develop a policy statement
- Ü Set targets

(2) Proper EC Organization including Assignment of Energy Manager

- Ü Establish proper EC organization (utilizing SGA)
- Ü Assignment of Energy Manager

(3) Data collection and Analysis

- Ü Collect data on current energy use
- Ü Analyze the collected data

- Ü Identify management strength and weakness
- Ü Analyze stakeholders' needs
- Ü Anticipate barriers to implement
- Ü Estimate the future trend

(4) Selecting EC Measures/Projects

- Ü Selecting EC Measures
- Ü Selecting EC Projects
- Ü Make out a plan/program

(5) Prioritizing

(6) Developing an Action Plan

(7) Training the related members

(8) Awareness-raising and Motivation

(9) Implementing the Action Plan (including monitoring and controlling)

(10) Evaluation (Management review)

(11) Analysis for future planning (Standardization and Dissemination)

The following figure shows these Key Steps for implementing Energy Conservation activities.

Each step is explained in this order as below:

4.3.1 Step 1 : Top Management policy/Goal

It is the most important for the success of Energy Conservation activities within companies or factories to have clear and official commitment of top management – either the corporate top (senior) management or factory managers. The top (senior) management shall announce explicit commitment to the Energy Management (or Energy Conservation) and behave along this line – for example, participate in EC (Energy Conservation) events and encourage the people there for EC promotion.

This Handbook is primarily meant for Energy Managers for the use of EC promotion within factories, on the assumption that top management has already committed to that. However, there may be cases where top management would learn about Energy Management (or Energy Conservation) by this Handbook, or Energy Managers would make efforts to persuade top management to support or commit to Energy Management (or Energy Conservation) with the help of this Handbook.

(1) Develop a policy statement

It is desired that the top (senior) management announces the "Energy Policy Statement". This is very effective to let people inside and outside the companies clearly know the management's commitment to Energy Management (or Energy Conservation). The format of the energy policy statement is various, but it usually includes the goal or

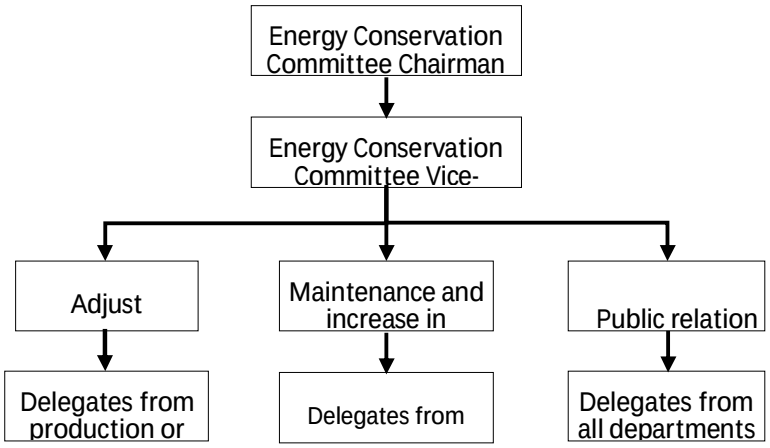
objective of the company and the more concrete targets in the field of Energy Management (or Energy Conservation). It often shows the major measures and timetables. The statement shall match the company's mission statement or overall management strategy plan.

(2) Set targets

The targets shall be concrete and specific so that everyone can understand it.

4.3.2 Step 2 : Proper EC Organization including Assignment of Energy Manager

In some countries, where the EC Promotion Act is in force, the designated factories have obligation of assigning Energy Managers. In relation to Energy Management, however, the word "Energy Managers" is here used as a Manager or a Coordinator, separate from the above-said legal obligation, who works exclusively for Energy Management (or Energy Conservation) purposes, ranging from gathering energy-related information to drafting EC plans/programs and promoting or coordinating during implementation. To the proper Energy Management, this type of Energy Manager is indispensable. How to position this Energy Manager within the company organization is also an important issue and needs careful decision. In some cases, Energy Committee, with members from the major departments, may be formed to assure the company-wide or factory-wide cooperation, as shown in the following figure.



Actually there are many ways of forming EC organization, depending on the situation of factories or institutions, such as the size, kind of business, etc. In any case, it is very effective to utilize SGA (Small Group Activities) and there are also many ways to do that. The important thing is to design and make out the organization carefully to meet the purpose. In practical sense to do that, there may be the following five widely applicable ways of establishing the organization.

(1) Utilize Line (Formal) Job-related Organization for TEM purpose

(2) Use TPM Organization for TEM purpose

(3) Use TQM Organization for TEM purpose

(4) Add Employee Suggestion System to Energy Conservation Organization for TEM purpose

(5) Utilize another organization for TEM purpose

The easy and practical way may be starting from easy form of TQM, or QCC (Quality Control Circle) activities. Furthermore, because TPM is closely related to job-related organization, (1) and (2) may be often give the same kind of results. (An example of this form is shown in Part 3, 2 "How is SGA related to Energy Conservation?"

4.3.3 Step 3 : Data collection and Analysis

Before trying to make out any future programs or action plans, it is essential for the company or factory management to understand the current situation in a proper and accurate manner. This includes not only the status of their own operation but also other relevant information such as competitors' operation, circumstances around the company and their trend in future, positioning the company itself in the local and global markets, and so on.

The key steps for this purpose are shown below:

(1) Collect data on current energy use and analyze them

The current data of energy consumption shall be obtained by measurement, calculation or estimation for the individual operation units (energy cost centers) with classification of kinds of energy (fuels types, utility types, etc.). The data shall be gathered regularly and arranged/summarized daily, weekly, monthly, by seasons or annually. Then the data shall be checked for the past historical trend and interpreted with relation to operational modes and production scales. That shall also be utilized for the forecast of future trends.

(2) Identify Management Strength and Weakness

Then the data shall be compared with the best practice data or benchmarks in the industry. If such reference data are hardly available, the historical data of their own operation and estimated data for the competitors would be utilized for this purpose. At the same time, the strength and the weakness of the company shall be evaluated considering the competitors' situations in the local and global markets. This would serve the purpose of making out a realistic Energy Management plan later.

(3) Analyze stakeholders' needs

Stakeholders are top (and senior) management, middle managers, staff/engineers and workers/operators. Other stakeholders in the normal business sense, such as the

shareholders and lenders, need not be considered here for the moment. The needs and intention of those stakeholders shall be summarized and taken into consideration.

(4) Anticipate barriers to implement

Making out a realistic and practical program also needs consideration of anticipated barriers for the implementation of Energy Management program or action plan. Some possible examples of such barriers are:

- Ü Insufficient understanding and support by top management
- Ü Insufficient understanding and cooperation of managers within factories
- Ü Insufficient awareness of people to get successful results
- Ü Insufficient capability of people due to lack of training
- Ü Insufficient available technology due to lack of information
- Ü Insufficient availability of manpower for EC activities within factories
- Ü Insufficient budget for EC activities due to the company's financial status

(5) Estimate the future trend

The future trend of energy supply-demand balance is estimated based on checking and analysis of the historical data. That data of future trend would also be a basis of the program of excellent—Energy Management. In analyzing the collected data and developing ideas of Energy Conservation, it is very often useful to think of the following techniques of finding problems and solutions:

Suppress - Using during the time in which it is not necessary to use. Examples include using electricity before or after working hours or when there is no one working.

Stop - Using equipment when it is not necessary. Examples include using all lightings during break time.

Reduce - Amount, pressure, temperature, speed, or brightness, or quality that exceed requirement. Examples include reducing intensity of lighting if not necessary.

Prevent - Prevent leakage or loss of energy. Examples include reducing space that leads to outside in order to prevent the leakage of heat into air.

Improve - Improve or repair machines to increase efficiency or modify manufacturing process to the one which enables us to conserve energy more. Examples include changing transparent sheet over the roof.

Store - Re-use the discarded energy. Examples include re-using heat from exhaust fume in order to reduce use of electric heater to warm heavy oil.

Change - Change how to use, type of energy, or energy sources to a suitable one from technical or economic point of view. Examples include changing the grade of heavy oil to an appropriate one or changing furnace systems or welding machines to the ones that use gas.

Increase production - Examples include improving production process. This will lead to the reduction of energy usage per production amount.

4.3.4 Step 4 : Selecting EC Measures/Projects

Based on the aforesaid understanding of the current status and position of the company (factory), various EC measures are studied and many EC Projects are proposed. Comparison among these measures and projects are made with consideration of a lot of factors, such as technical, economic, intangible, and so on.

Then a plan/program is developed based on these study results. To do this, it is very important to consider the following issues:

The plan/program shall be realistic, practical and attainable with due consideration of many related elements and management resources of the company or factory. It also shall be expressed in terms of the measurable or quantifiable parameters, including Fuel Usage Index, Electricity Usage Index, Energy Usage Index, etc. It usually includes a lot of managerial measures of Energy Management (or Energy Conservation) promotion activities such as motivation techniques, means to improve awareness, training, and so on. In other words, the following items are often useful in comparing and selecting alternative plans:

(1) Effects of energy conservation: Activities that can conserve energy more than others are more promising.

(2) Investment amount: Activities that require less investment are more promising.

(3) Pay-back period: Activities with short pay-back period for investment amount in equipment are more promising because all energy conservation will be profits after pay-back period.

(4) Length of implementation: Activities that can be performed in a short period are more promising because they do not influence production process of the factory.

(5) Number of personnel required: Activities that require a large number of personnel tend to be burdensome.

(6) Importance to executives and reputation of the company: Some activities provide little financial benefit but cause good image or reputation.

(7) Risk of the project: Some activities bring about big financial benefits but involve high risk from various factors. In this case projects have less importance.

4.3.5 Step 5 : Prioritizing

Many EC measures and projects are prioritized based on the internal studies including comparison among their alternatives, in the manner explained in the above.

4.3.6 Step 6 : Developing an Action Plan

The priority consideration then gives birth to the Action Plan. The plan shall be clear, practical and comprehensive with proper schedule and budgeting.

Shown below is an example of such a plan.

Table 8 : Example of energy saving plan

Detail of the plan	Length (Months)						Person in charge	Budget	Inspected by
	1	2	3	4	5	6			
1. Turn off electricity when there is no one around	←	—	—	—	—	→	Mr.Prayat		
2. Turn off air-conditioner 30 minutes before stop working	←	—	—	—	—	→	Miss Aom		
3. Reduce welding machine's current according to the specification of the metal used for welding	←	—	—	—	—	→	Mr. Matthayas		
4. Close welding machine after working	←	—	—	—	—	→	Miss Thanom		

4.3.7 Step 7 : Training the related members

This issue is very important to secure the success of project Implementation, because the people are the most important resources that determine the success of the plan.

4.3.8 Step 8: Awareness-raising and Motivation

To have the total power of "all members' participation" combined together, it is also very crucial how to raise awareness and motivation of related people within the company (or factory).

Shown below is an example of awareness raising plan.

Table 9 : Example of awareness raising campaign

Detail of the plan	Length (Months)						Person in charge	Budget	Inspected by
	1	2	3	4	5	6			
1. Display the results of energy conservation every month	*	*	*	*	*	*	Mr.Prayat	-	Mr. Laaied
2. Evaluate every month	*	*	*	*	*		Miss Aom	-	Mr. Laaied
3. Perform energy conservation activity every 6 months	*					*	Mr. Matthayas	-	Mr. Laaied
4. Perform "Finding measures" activity in order to make energy conservation plan	*					*	Miss Thanom	-	Mr. Laaied
5. Provide rewards to sections that have achieved high efficiency						*		-	

4.3.9 Step 9 : Implementing the Action Plan (including monitoring and controlling)

The organizational force established in the said planning step shall be utilized fully to ensure smooth implementation of the program. Energy Manager and/or the committee shall continue working to promote the activities and report to top management on the status quo.

The actual records of implementation shall be closely watched and monitored. If some problems arise, or some variance between the planned figures and the actual record is observed, then necessary actions shall be taken immediately.

4.3.10 Step 10 : Evaluation (Management Review)

After the program is completed, the report shall be submitted to the top (senior) management. The results shall be assessed and analyzed for any good and bad points. The lesson shall be utilized as a feedback in the subsequent plan/program.

Thus the activities are repeated to form a cyclic movement. The result of evaluation must be announced on the board in order to inform employees, so that they will be given motivation for the next activities. Evaluation can be divided into 2 types as follows.

- Ü Short-term evaluation for the follow-up of the performance

- Ü Long-term evaluation for the evaluation of the whole project that will be used for the future planning

Evaluation can be made in the following 3 levels.

Self Audit: Self evaluation that is made in a small group or a department based on the predefined form. (Inspection may be made every month.)

Upper Manager Audit: Evaluation that is made by the section/department manager intended to raise performance of the activity. (Inspection may be made every 3 month.)

Top Management Audit: Evaluation made by the executives of the organization that will be used for the evaluation of annual bonus. (Inspection may be made every 6 month.)

In some cases, top management could think of adopting external people (outside consultants) to evaluate the results of Energy Conservation activities. Even in those cases, internal evaluation should be made to gain the fruits as much as possible.

4.3.11 Step 11 : Analysis for future planning (Standardization and Dissemination)

The successful results and the lessons learned are to be analyzed and arranged into the standard form which can be easily utilized by anyone in the factory. The standardized documents or information are to be disseminated all over the company.

Moreover, Energy Conservation should be incorporated as a part of daily jobs and performed continuously in a systematic manner. For this purpose, activities for energy conservation must be incorporated as a part of company's basic or business plan. If a problem is found as a result of evaluation, improvement or modification will be done and the objectives will be achieved. If the results reach or exceed the objective, information must be gathered in order to set it as a "Work Standard," which will be used in setting a new activity plan.

4.4 SMALL GROUP ACTIVITIES (SGA)

Small Group Activity (SGA) gives employees the problem solving tools they need to eliminate obstacles to Total Productivity, the culmination of zero break-downs, zero defects, and zero waste. Enterprising employees identify the problem, are it in "man, material, method, or machine," and develop cost-effective and practical methods for solving the problem.

4.4.1.1 Importance of SGA

SGA are activities by group of employees at operator (working Group) level. They aim to solve problems that occur at the place taken care of by each employee and put emphasis on participation and team work. Factories can apply small group activities to many kinds of work along with normal work or other measures that are already underway. The burden on employees will not increase because of small group activities. They are not only bringing benefits to factories but also boosting the knowledge and ability in

performing jobs of employees, improving communication among employees, increasing creativity, and make it possible to express their own proposal with less hesitation to management. As a result, employees will start to think "This is our problem." This SGA can be applied to Energy Conservation, too, with successful results, as shown in Figure 13.

4.4.1.2 How SGA leads to Energy Conservation?

An excellent example of organizational structure that promotes energy management emphasizing participation is that they form overlapping small groups as in figure 14. The feature of this structure is that a small group for energy management is distributed to various sections as in figure 15, which is a recipe for success of Total Energy Management (TEM) and makes various communications and management of activities more efficient and effective.

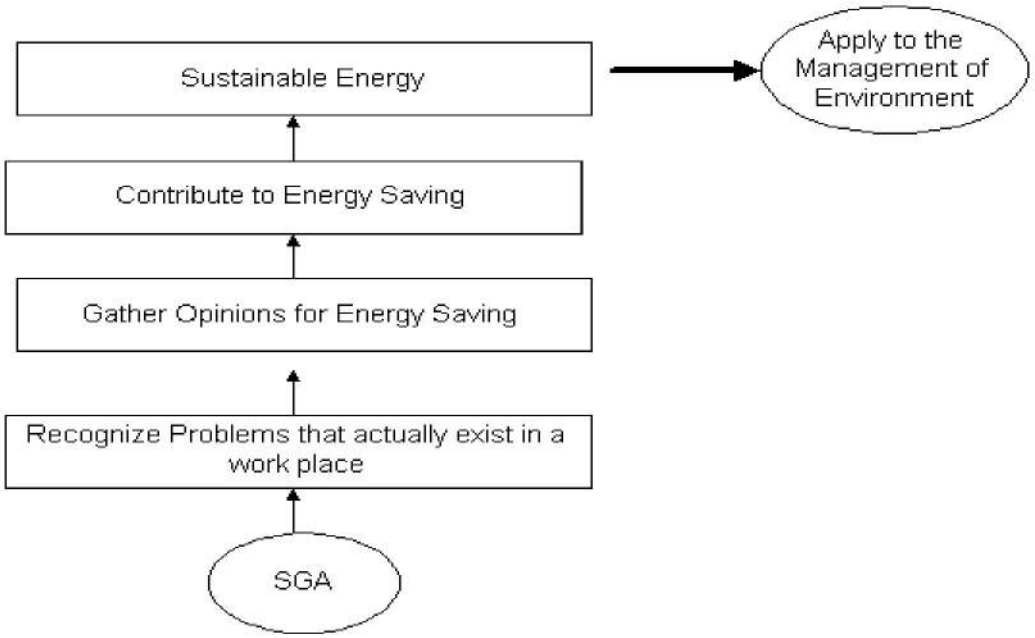
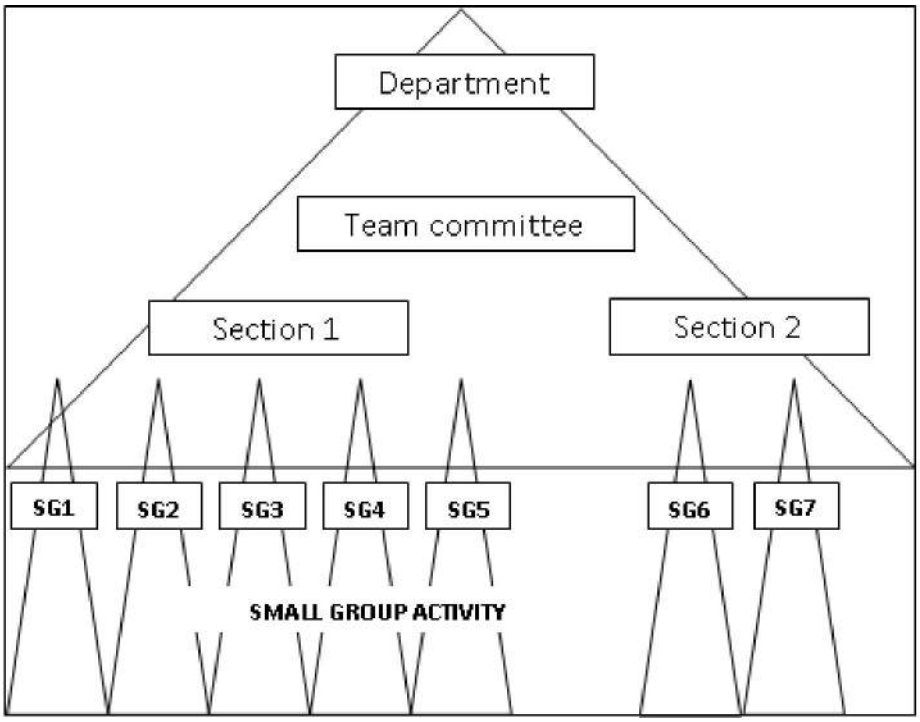


Figure 7 : Relationship of SGA and energy saving

Small group activities for total energy management (TEM) are the activities in which employees of all levels in production or management, starting from the top to the bottom, participate in order to reduce loss related to their own job by improving their job. In order for the activities to succeed, management of all levels must provide support in necessary training and equipment, communication of policies, and the setting of problems to solve.

Small group activities for TEM can be divided into 4 or 5 levels depending on the scale of the organization. This division is in order to emphasize the fact that everyone must improve in their job under the responsibility to each other. It also enables us to make improvement without overlapping. The following example shows utilizing the existing job-related organization as much as possible, as already mentioned in Part 2, 2."Strategy

for Improving the Efficiency of Energy Usage further", Step 2 Proper EC Organization including Assignment of Energy Manager (page 12).



Positioning of SGA in Main Job Structure

4.4.1.3 Executives level

- Ü Define the policy and target for Total Energy Management
- Ü Follow-up and manage activities to make sure that activities are implemented according to the policy
- Ü Consider opinions and suggestions from the promotion office
- Ü Consider reports from promotion committee from various levels

4.4.1.4 Level of Total Energy Management promotion office

- Ü Make sure that whole activities are done in the correct direction, without delay and smoothly
- Ü Find a suitable method that makes it possible to implement activities continuously and without slowdown
- Ü Listen to opinions and suggestions from small groups in order to use for improving
- Ü Provide advice for Total Energy Management to various groups
- Ü Persons in charge of the office must be those with good personal relationship, friendly, and with spirit of good service

4.4.1.5 Medium level

- Ü Define the policies of each department that are consistent with the policy of the Total Energy Management and the target of the company

- Ü Define numerical targets to sub-groups apart from the target of the company as a whole
- Ü Follow-up the progress in order to provide to sub-groups
- Ü Report the progress along with suggestions and opinions to upper level committee periodically

4.4.1.6 Workers/Operators level

- Ü Implement small group activities with various themes and achieve target
- Ü Report progress and problems encountered during implementation to upper level committee periodically
- Ü Ask for support, suggestions, and opinions from upper level committee

4.4.1.7 Responsibility of Energy Conservation committee

- Ü Gather and analyze information on costs related to energy every month
- Ü Analyze and solve problems related to energy
- Ü Find a method for energy conservation
- Ü Prepare energy conservation plan
- Ü Follow-up the result of implementing the plan
- Ü Perform activities such as public relationship for encouraging employees to participate
- Ü Offer training to small group in each department

4.5 STEPS OF SMALL GROUP ACTIVITIES FOR ENERGY CONSERVATION

Small group activities for Energy Conservation can be done by using "10 Stages for Success", based on "PDCA Management Cycle", as shown below and in pictorial forms

Plan: Make an efficient plan in order to improve operation

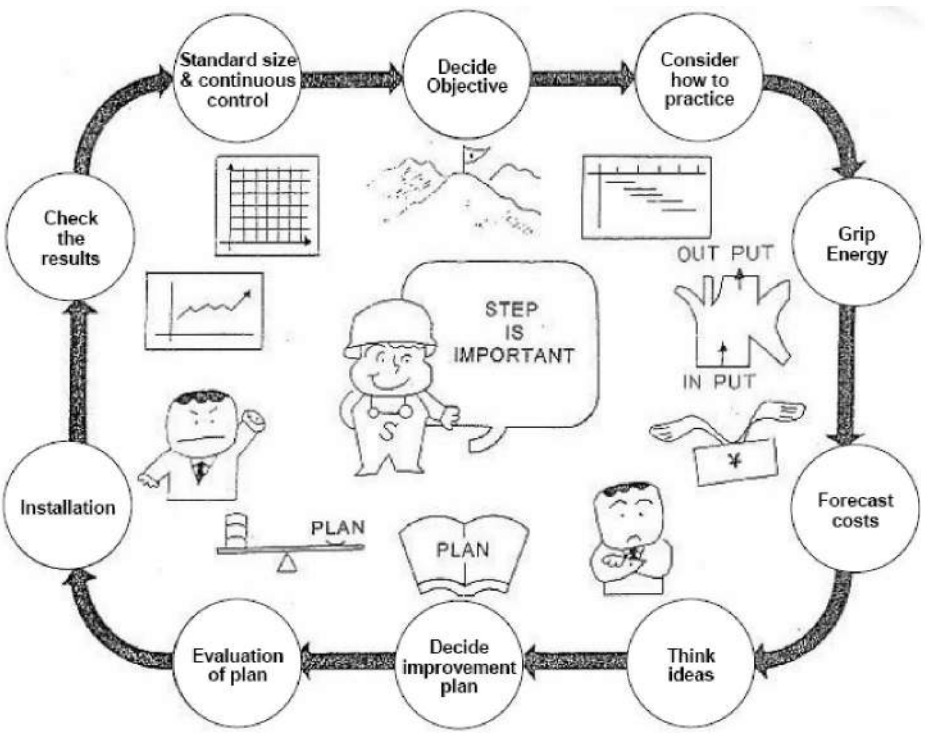
Do: Implement according to the plan

Check: Check if implementation was according to the plan

Act: Judge what to improve, what to learn and what to do from what we have checked

Please note that these stages are substantially the same as "Key Steps" explained earlier, but put more stress on utilization of SGA. So readers could read and use either method up to their preference.

SGA circle



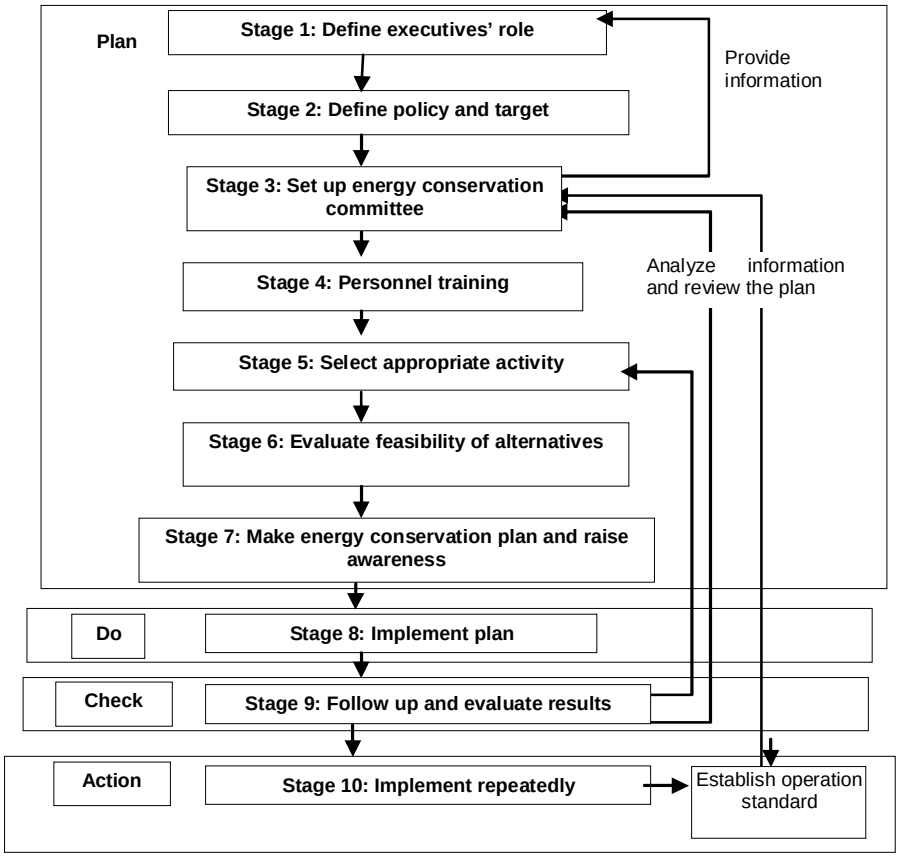


Figure 8 : 10 Stages for Success

4.5.1.1 Stage 1: Define Executive's Role

In promoting small group activities, support must be provided such as basic environmental support. Therefore, executives must provide follow up support to employees of their companies.

- Ü Establish a special unit that provides support to small group activities
- Ü Prepare a system for managing small group activities in the company
- Ü Prepare annual plan for small group activities
- Ü Prepare a venue for meeting, consultation, advice or suggestion
- Ü Establish a system for giving rewards to high achieving employees
- Ü Establish a reporting system starting from informing what to do until reporting of the results
- Ü Establish a fair system for evaluating results
- Ü Establish a system for providing support and training to employees

4.5.1.2 Stage 2: Define Policy and Target

- Ü Executives must announce a policy of supporting small group activities.
- Ü Energy conservation committee must act as an advisor in order to set a numerical target that is consistent with total energy management (TEM) policy and the target of the organization. Specific targets must be set for each group.

We can see that responsibilities in stages 1 and 2 are mainly those of executives and committee. Responsibility of employees will become clearer from stage 3 and afterwards.

4.5.1.3 Stage 3: Set up Energy Conservation Committee

The principle of small group activities (SGA) is to divide into groups based on the scope of responsibility. The size of the group will depend on the size of organization. However, size of the group should not be too large. Usually a size of 5 to 10 persons is considered appropriate. It is important to define responsibilities clearly so that every member of the group can have their responsibility and participate in the activities.

4.5.1.4 Stage 4: Personnel Training

This stage will help employees to have more knowledge and understanding, have new ideas, and have more belief in their own responsibility.

4.5.1.5 Stage 5: Select Appropriate Activity

In doing small group activities, each member must be able to think, express their own ideas, and make decisions based on reality and by investigating electrical equipment, machines, and office equipment that exist in the area of their responsibility. Items to consider include size, number, where to use, situation of usage, current situation, and the number of hour's usage per day. By this we can evaluate the current situation of energy usage. Also by judging if there are more machines than needed, we can choose suitable activities and real problems for the organization.

4.5.1.6 Stage 6: Evaluate feasibility of alternatives (Analyze problems and decide on the measures and activities in each point)

Each group will gather ideas on the reasons for the problems, obstacles, and how to solve problems in order to decide on the problems, measures, and importance of activities and thus evaluate on the feasibility of activities to do based on advice from department manager. Basically, the following activities are not suitable for small group activities.

- Ü Highly technical issues
- Ü Issues that require a long time or many people to implement

We have identified the following problems through small group activities.

- Ü Issues on material quality or production that influence energy usage
- Ü Behavior on energy usage
- Ü Efficiency of machines or equipment that uses energy
- Ü Awareness toward environment and energy usage
- Ü Safety costs for energy conservation

4.5.1.7 Stage 7: Make Energy Conservation Plan and Raise Awareness

Each group must prepare its activity plan. Generally, implementation for small group activities takes 6 months to 1 year. Activities to be implemented should correspond to the objectives of each group. Besides, it might help to listen to opinions of all organizations in order to receive support from all other organizations.

4.5.1.8 Stage 8: Implement Plan

Implement according to the plan of each group.

4.5.1.9 Stage 9: Follow Up and Evaluate Results

After implementing the plan, each member of small groups will follow up and evaluate the result by analyzing result, search for strong and weak points of activities, find a way to improve the activities and report on general achievement.

4.5.1.10 Stage 10: Implement Repeatedly

Energy conservation is an activity that must be implemented repeatedly. Therefore, it is necessary to implement each activity repeated and make improvement to each activity. If we are satisfied with the results, by achieving the objectives of activities, we should provide rewards in order to give motivation for continuing the small group activities and implement creative activities.

Dos and Don'ts in Energy Conservation

- Ü Don't emphasize the mistakes in the past. It is better to talk about the present.
- Ü Don't be worried about the theory or principles. Don't spend too much time in discussion or analysis of problems in meeting rooms.

- Ü Don't think that an activity can be done perfectly from the beginning. It is necessary to do the job continuously by having experiences and judging by ourselves.
- Ü Do start with an activity that requires small amount of investment.
- Ü Do Raise awareness so that all employees understand the necessity and importance of energy conservation and participate in it.
- Ü Do start the activity now without postponing to tomorrow.

4.5.1.11 Tools that are Used Often for Small Group Activities for Energy Conservation

4.5.1.12 5S

5S is a contraction derived from the Japanese words **Seiri, Seito, Seiso, Seiketsu,** and **Shitsuke**. It is simple methodology that is also extremely useful in practical and realistic life. 5S is a set of actions to be followed through every day activities to advance the operational surroundings and circumstances. 5S is made in order to provide fortification to every personage in diverse profitable and industrialized fields. 5S is an extremely practical contrivance and skill set for anyone who wants to generate a more prolific environment within the workplace or who wants to make it their profession to make other people's businesses more proficient and productive. 5S occupy a list of products including eyewear, ear protectors and safety gears. Look into these different products that make up the significance of an industrialized security supply. Lean Six Sigma experts promise or guarantee for the efficiency of 5S as an enlightening enhancement to better working surroundings in an association. If you dig up Six Sigma guidance that is paid for by your company, you will be in a position to work for your company and make things better for you as well as for everyone. 5S is very useful in lots of industries and job markets, but can often fail simply because of the lack of recognition concerning changes in the office.

5S consists of five steps that are crucial for the completion of 5S. The 5S steps are described as follows-

1.Seiri / Sort- This is very logical term in, which identification of the contents take place, data base of the products have been created and, then any kind of sorting take place just to arrange the products and removal of unwanted items. Classification of the products is necessary, which is called Red Tagging. It is important just to identify factors, right from whether it is needed, existing amount obligatory amount, occurrence of necessity, and so on.

2.Seito / Systemize- This step in 5S process consists of removal of unwanted items permanently and one more task that to be take place is decision that means you have to decide that what is required to be in what place. Place the items in such manner that you could retrieve them within 30 seconds of requirement.

3.Seiso / Brush away/ Sweep- Examine all the items on the daily basis. The process is not that much time consuming, but essential to clean up your workplace and most required in 5S. The conscientiousness to keep the office clean should be circulated between everyone in the group.

4.Seiketsu / Homogenize- This important step of 5S involves the visual control, which is important to keep your organization well-organized and clean. It is a complete evaluation to improve the working conditions.

5.Shitsuke / Self Control- This step is quite essential, but critical because it involves all the discipline to ensure the 5S standards, it also takes charge of dedication and commitment.

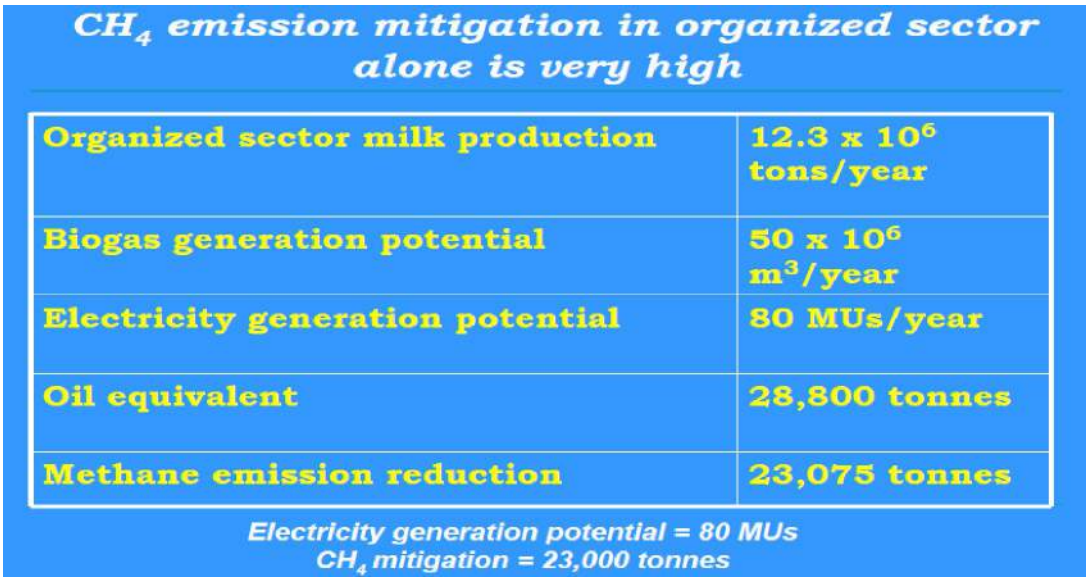
4.5.1.13 QCC (Quality control circle)

QCC (Quality control circle) means controlling quality through group activities. For this, it is necessary to work hand in hand and achieve objective quality or customers' request. With this, we can find weak points, find the cause of problems, gather ideas for problem solving and systematically prepare quality and thus, solve problems such as material loss, production costs, working hours, or productivity. This is also a very useful tool to tackle with Energy Conservation problem. So many factories or institutions are encouraged to utilize this tool.

5 CHAPTER 5

5.1 ENVIRONMENTAL BENEFITS

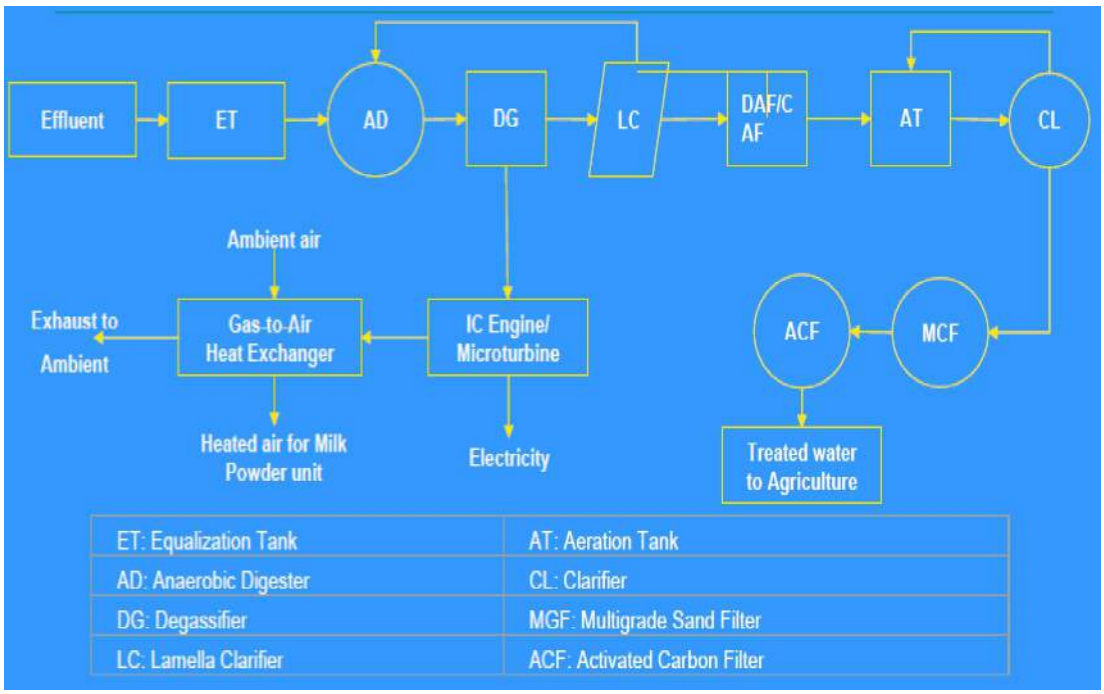
One of the measure for capture of methane from effluent & its productive use as fuel, recommended in the cluster development has CDM potential. The methane capture from Effluent by anaerobic digestion results in methane generation which is used as fuel for boiler. Methane is one of the undesirable gases from effluent. Along with direct hazard to human health, methane is potent green house gas. While the contribution from dairy effluent ponds is relatively small, increasing concern about climate change means that reducing emissions of greenhouse gas is a priority wherever feasible. The opportunity to capture methane and recover energy is becoming increasingly attractive. Every cubic meter of methane captured and burnt reduces its global warming potential and yields approximately 36 MJ or 10 kWh of energy. Around one-third of the typical dairy's energy consumption results from producing hot water. Biogas fired boilers are commercially available and can convert 80 to 90% of the energy in the methane into thermal energy. Natural gas boilers may be modified to run on biogas. As per recent data published by International Institute for Energy Conservation, the opportunity of methane capture & its productive use potentials are good.



The above figures are self explanatory regarding the potential of methane capture & its productive use in dairy industry in India. Considerable amount of energy can be recovered from methane & above all the hazardous methane emission can be reduced. The existing aerobic type effluent treatment consumes electricity which is also saved in anaerobic methane capture method. Recent data published by International Institute for Energy Conservation suggest few following facts.

- **Potential assessment for a typical dairy in Maharashtra**
  - **Waste water generation** — **1000 m³/day**
  - **COD** — **2000-3000 mg/lit**
  - **Biogas generation potential** — **823 m³/day**
  - **Electricity generation** — **1317 units/day**
- **Initial investment (considering ETP exists)** — **Rs. 5 Mio (approx.) ($ 125,000)**
- **Net saving potential** — **up to Rs. 16.5 lacs/yr ($ 41,250)**
- **Simple payback (with waste heat capture)** — **3.03 years**

Though the methane captured can be utilized directly for boilers with some modifications, other option such as electricity generation cannot be ruled out. For a typical methane capture scheme, offering combination of electricity & process heat option for a typical dairy can be explained by a schematic diagram given below-



India being largest producer of milk in the world with annual milk production of approximately 98.3 million tons (Yr.2006), with annual growth rate of 4% has tremendous potential in methane capture for productive use. The methane capture & productive use have positive impact on environment & have currently CDM potential.

5.2 GHG REDUCTION

The result of the cluster development is saving of 1176 per annum. The figure itself indicates the effect of this on GHG emission, environmental impact and thus reduction in pollution related issue. Various measures directly & many time indirectly results in reduction GHG gases. All proposed energy conservation measures will have less energy consumption or fuel consumption compared to conventional/existing technology/equipment consumption, these automatically leads to reduction of GHGs emissions. Reduction of GHGs emissions leads to improved environment and better compliance with environmental regulations

After implementation of proposed energy conservation measures will reduce the grid electricity consumption, natural gas and non renewable wood. Major GHGs emission reduction due to saving of grid electricity and fuels is CO2, reduction of other GHGs are negligible.

5.3 IMPROVED WORKING ENVIRONMENT

Due to energy saving, utilization of renewable sources of energy, methane capture, use of energy efficient products will have very good & positive impact on environment. Indirectly it reduces Burdon on environment & helps in reducing Green House effect & thus global warming. Before the Industrial Revolution, human activities released very few gases into the atmosphere and all climate changes happened naturally. After the Industrial Revolution, through fossil fuel combustion, changing agricultural practices and deforestation, the natural composition of gases in the atmosphere is getting affected and climate and environment began to alter significantly. By reducing energy consumption we can reduce the effect of global warming.

6 CHAPTER 6

6.1 CONCLUSION

6.2 SUMMARY

In this section summary of energy use and technology studies conducted in Gujarat (Dairy) SME Cluster is discussed, which include identified energy conservation measures, its energy & monetary benefits, payback period, issues in implementation are discussed. Details of the same are furnished in table below:

Table 10 : Summary of Maintenance/General House keeping proposals in Gujarat (Dairy) SME Cluster

S. No	Housekeeping practices/No cost energy conservation measures	Issues in implementation
1	Proper tightening/tensioning of belts in various drives	Ü Lack of awareness EC measure
2	lubrications of gear systems	Ü Lack of awareness EC measure
3	Cleaning of compressor filters regularly	Ü Lack of awareness EC measure
4	Switch off the lights after completion of work	Ü Lack of awareness EC measure
5.	Continuous monitoring of Compressed air leakage	Ü Lack of awareness EC measure

Table 11 : Summary of energy saving proposals in Gujarat (Dairy) SME Cluster

SN	Name of Measure	Annual Energy Saving in kwh/annum	Annual Fuel Saving in kgs/annum	Annual Monetary saving (Rs. lakh)	Implementation Cost (Rs. lakh)	Simple payback period (years)	Applicable to number of units in cluster (Nos.)	Annual Cluster Saving Potential of particular EC Measure (Rs. lakh)
1)	Waste heat recovery by providing De-super heater in ammonia vapor compression based refrigeration system.	1050782.4	--	64.41	55	0.85	14	128.82
2)	Improvement in steam & Hot water pipe line insulation to prevent thermal energy loss.	--	186764.22	25.64	5	0.2	22	80.58
3)	Improvement in chilled water pipe line insulation to prevent the heat ingress and thus energy loss.	263376	--	16.13	8	0.5	22	50.69

4)	Energy saving by improving transmission efficiency in chiller compressor and other machines by providing cogged belt in place of conventional V-belt (For Reciprocating Chiller Compressors).	154512	--	9.62	3	0.31	21	33.67
5)	Replacing reciprocating compressor (with higher specific power consumption) by screw compressor with VFD to save energy.	91332	--	5.42	25	4.61	5	9.03
6)	Reducing operating pressure of compressed air system by providing properly size compressed air pipe line along with ring mains, primary and secondary vessels.	17510.4	--	1.06	4	3.77	5	1.77
7)	Energy saving by condensate recovery for boiler.	--	25444.8	7.37	9	1.22	4	14.74