Working Technical Group Meeting Agenda Note

Subject: ***1st Working Technical Group (WTG) Meeting of UNIDO GEF Project "Promoting Market Transformation for Energy Efficiency in MSMEs.***

Following are a agenda note prepared for the 1st WTG meeting of UNIDO GEF Project "Promoting Market Transformation for Energy Efficiency in MSMEs" which is scheduled on 10th October 2018 at UNIDO Office, India International Centre (IIC), Lodi Estate.

Proposed agenda for the meeting are as under:

Time	Details
11:00 – 11:10 hrs.	Introduction of the members
11:10 – 11:20 hrs.	Project over view (UNIDO)
11:30 – 11:45 hrs.	Project update (EESL)
11:45 – 12:00 hrs.	Tea Break
12:00 – 12:15 hrs.	Presentation and discussion on technology – 1 (EESL)
12:15 – 12:30 hrs.	Presentation and discussion on technology – 2 (EESL)
12:30 – 12:45 hrs.	Presentation and discussion on technology – 3 (EESL)
12:45 – 13:00 hrs.	Presentation and discussion on technology – 4 (EESL)
13:00 –13:15 hrs.	Presentation and discussion on technology – 5 (EESL)
13:15 – 13:30 hrs.	Presentation and discussion on business model (EESL)
13:30 – 13:45 hrs.	Way forward
13:45 – 14:15 hrs.	Lunch

Agenda Item No. 1 PROJECT BACKGROUND / OVERVIEW:

i. GEF- 5 Project: Brief Snapshot:

The objective of the project is to promote the implementation of energy efficiency in the MSME sector; to create and sustain a revolving fund mechanism to ensure replication of energy efficiency measures in the sector; and to address the identified barriers for scaling-up energy efficiency measures and consequently promote a cleaner and more competitive MSME industry in India. This will be achieved through four components:

Component 1: Programme to identify energy intensive clusters and replicable technologies – Expected Outcome: (i) 10 energy intensive clusters identified based on objective criteria; and (ii) Identification of technologies that have the maximum impact on the cluster as a whole.

Component 2: Demonstration projects and aggregation of demand for demonstrated technologies in the clusters – Expected Outcome: (i) Capacity built and awareness raised

as a result of the demonstration projects; (ii) Demonstration of energy consumption reduction at the cluster level; and (iii) Scaling up of investment activities for EE in industry.

Component 3: Financing models to support replication of energy efficiency projects in MSMEs – Expected Outcome: Establishment of sustainable and effective financial mechanisms.

Component 4: Monitoring and Evaluation – Expected Outcome: Monitoring and evaluation mechanisms and indicators established to facilitate successful project implementation and sound impact assessment.

ii. Budget Overview and Expected Impact

a. Project Value: 4.46 million USD
b. Co-financing: 26.86 million USD
c. Project closing date: July 2020
d. Project Partners: GEF, UNIDO, MOMSME, EESL, SIDBI and BEE
e. Target: A total reduction of 9,561,838 GJ (0.228 MToE) /806,000 tonnes CO2eq in 10-year

iii. Stakeholders in GEF-5

MSME: Ministry of MSME is the Lead Executing Agency (EA) of the Project. The Ministry of MSME will chair the PSC meeting and would play an advisory role.

UNIDO: UNIDO is the Implementing Agency (IA) of the proposed project and a member of the Project Steering Committee (PSC)

BEE: BEE is the guiding agency in the Project and will be part of the PSC.

EESL: EESL under the Ministry of Power, Government of India, is the Executive Partner of the project, as well as a member of the PSC and will provide project guidance to the PMU hosted in the Ministry of MSME.

SIDBI: SIDBI is the lead bank for the provision of financial assistance towards energy efficiency investments during the project for EESL/ESCO/MSME Units.

MSME Industry: MSME Industrial enterprises are the main beneficiaries under the project.

Industrial Association: Major associations role is to facilitate workshops, create outreach and sensitize industries on relevant training programs and workshops.

Business Chambers of Commerce: The Chamber of Commerce facilitates and creates outreach for the project's activities using their existing communication channels.

iv. Road Map

- Scoping study
- Video graphic baseline study

- Brainstorming workshop
- Finalization of technologies
- Pilot (35*2) demonstration
- Tool-kit preparation
- Dissemination and training
- Evolving innovative financial mechanism
- Up-scaling

v. Cluster Selection

EESL conducted thorough secondary research and data analysis of 32 clusters. The secondary researches were done by referring the data from various sources like:

- ✓ Industrial Profiles from the office of DC MSME
- ✓ BEE MSME Study Reports, AFD MSME Document, CMIE Reports,
- ✓ TERI SAMEEKSHA Web portal
- ✓ Energy audit reports of NPC/TERI/FICCI/CII
- ✓ Focused group discussions / Brainstorming workshops with cluster associations
- ✓ Selective field visits /baseline survey / energy audits

Following factors and weightages were considered while analysis of the clusters.

Criteria	Maximum Weightage
No. of MSMEs	5
Absolute Energy Consumption (ToE)	10
Energy Density (ToE/MSME unit)	10
SEC Bandwidth (times)	10
Contribution to Industrial GDP (%)	5
Energy Cost (% of Manf. Cost)	10
Potential Improvement Through GEF-5 (ToE)	30
Investment Potential (mn $)	20
Total	100

Following 10 clusters (mentioned in the below table) were shortlisted and notified by the 3rd Project Steering Committee meeting held on 21st February 2018.

Sl.	Clusters	As per CEO Endorsement Document	Decision in 2nd PSC Meeting	Proposed in 3rd PSC Meeting	Remarks
1	Surat (Textile)	Yes	Yes	Yes	
2	Orissa (Sponge Iron)	Yes	Yes	Yes	
3	Vellore (Rice Mill)	Yes	Yes	Yes	

Sl.	Clusters	As per CEO Endorsement Document	Decision in 2nd PSC Meeting	Proposed in 3rd PSC Meeting	Remarks
4	Jorhat (Tea)	Yes	Yes	Yes	
5	Batala, Jalandhar & Ludhiana (Forging)	Yes	Yes	Yes	
6	Ankleshwar (Chemical)	No	No	Yes	Replacement for Vapi (Chemical)
7	Muzaffarnagar (Paper)	No	No	Yes	Replacement for Jodhpur (Lime)
8	Varanasi (Textile)	No	No	Yes	Replacement for Pali (Textile)
9	East and West Godavari (Ceramics)	No	No	Yes	Replacement for Morbi (Ceramics)
10	Howrah (Galvanizing & Wire Drawing)	No	No	Yes	Replacement for Varanasi (Bricks)

The estimated potential investment in the above 10 clusters is about US$ 150 million and may result in 110,000 TOE of energy saving at the end of GEF-5 project.

Agenda Item No. 2 PROJECT STATUS / PROGRESS:

i. Past Activities
- Short scoping study and data validation activities carried in 8 clusters.
- Video graphic baseline study in 5 clusters.
- Outreach to cluster association and industries completed in all the clusters
- Energy Audit carried out in Vellore and Jorhat
- Focussed Group Discussion in six clusters

ii. Recent Activities
- Awareness workshop conducted at Muzaffarnagar Paper cluster and Vellore Rice mill cluster
- Conducted brainstorming meeting with DESL on finalization of technologies and its technical specifications for Surat Cluster
- Format for Submitting Expression of Interest (EOI) has been prepared and circulated to PMCs
- Draft Business models shared with PMCs
- Conducted meeting with technology suppliers for identified technologies
- 6 No of technologies were identified in Surat, Vellore & Muzaffarnagar clusters.

iii. Hiring of Project Management Consultants (PMC):

EESL has issued the Letter of Award (LOA) to the following agencies after completing the necessary technical and financial evaluation process. The LOA were issued on 10th August 2018.

1. M/s Development Environergy Services Ltd (DESL):
   - Textiles (Surat)
   - Chemical (Ankleshwar)

- Tea (Jorhat)
- Galvanizing and Wire drawing (Howrah)

2. M/s Deloitte Touche Tohmatsu India LLP (Deloitte):
   - Paper (Muzaffarnagar)
   - Forging (Batala, Jalandhar and Ludhiana)
   - Textiles (Varanasi)
3. M/s National Productivity Council (NPC):
   - Sponge Iron (Sundargarh)
   - Rice (Vellore)
   - Ceramic (East and West Godavari)

iv. Hiring of Cluster Co-Ordinators

The advertisement for hiring of Cluster Coordinators was published on 24th of May 2018 in leading newspapers of respective clusters as well as in EESL's website, wherein 60 applications were received for different clusters out of which 40 were shortlisted for the interview. The interview of the short-listed candidates was conducted on 17th August 2018 at EESL office. Six candidates have been selected for six clusters in the first week of September 2018.

v. Development of GEF-5 Project Web Portal:
A dedicated GEF-5 portal has developed after incorporating the suggestions received from UNIDO. The link of the demo version of the web portal is: http://csdcin.esspl.com/GEF5/.

vi. Vision Document Preparation:
A comprehensive vision document has been developed by the experts. This document will define the high-level scope of the GEF-5 project.

Agenda Item No. 3 APPROVAL FOR SELECTION OF TECHNOLOGY CRITERIA:

Following is a table reflecting technology selection criteria

Criteria	Sub Criteria	Minimum Qualifying Criteria	Description
Energy Efficiency	% of Energy Saving from Baseline	10% or above	The identified technology shall have the energy saving potential to the tune of 10% or above to meet the overall project saving objective. In the identified clusters the energy saving potential is around 1,10,000 TOE against the baseline energy consumption of around 2.8 mTOE i.e. 4%

Replicability	No. of MSME to accept	20 MSME or 30% of total MSME in cluster whichever is higher	The identified technology shall have replication potential of minimum 20 or 30% of the total number of MSME in cluster.
Financial Viability	(a) Payback Period (PBP)	(b) PBP should be less than 1.5 years	As per industry practices the typical payback period is less than 2 years for any energy efficiency project and
Availability	(a) Indigenous (b) At least 3 technology providers	(c) Yes/No (d) Yes/No	The identified technology should be available locally.
Ease of Implementation	(a) Easy (b) Medium (c) Hard	Medium	Out of Easy, medium and Hard, to fulfill the project requirements, implementation of technology shall be medium to reduce the cost and time for implementation

Agenda Item No. 4 PRESENTATION AND DISCUSSION ON IDENITIFIED TECHNOLOGIES

i. Identification of Cluster Technology through the Audits Conducted in Vellore and Jorhat Cluster

Jorhat Tea Cluster: In Jorhat cluster there are about 150 tea factories in and around Jorhat, Golaghat and some part of Sibsagar also. Major factories include APPL, Williamson Magor, Jaishree Tea et. Field studies conducted in few units of the cluster and audit report provides an overview of the cluster, the Energy consumption profile, motor load survey information and recommendations regarding adoption of EE measure. This cluster is predominantly Thermal energy intensive with about - 80 % of the total consumption contributed by gas. Technologies like energy efficient LED lighting, EE motors, VFD applications and use of APFC could be replicable technologies to attract the investments.

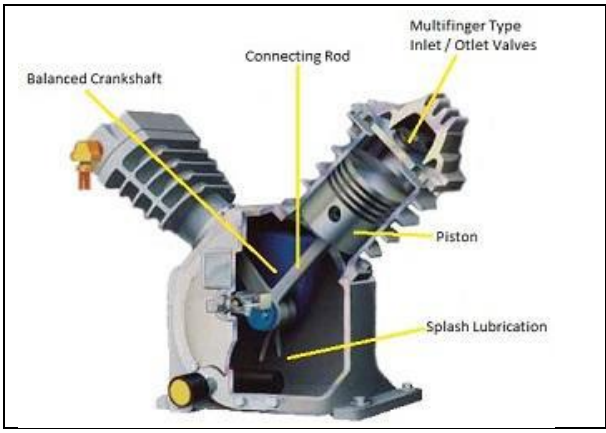
Vellore Rice Cluster: In Vellore Rice Mills Cluster, there are about 340 units out of which 5 units are under assessment. Field studies have been completed and the report is under-development. This report will highlight the cluster brief, the energy scenario and recommendation for EE measures. It is expected that, in both clusters, about 2-3 common technologies like energy efficient motors, air-compressors, VFDs, efficient boiler/combustion system will be selected. Apart from this, one/two process specific technologies would be explored for demonstration in due discussion with cluster associations.

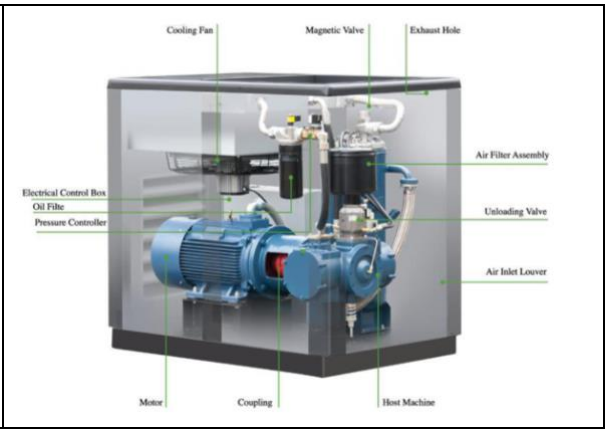
The studies conducted are aimed to track the status of the technologies installed, energy use pattern and its cost, operating practices, identification

of the technologies and measures for improving energy efficiency etc Summary of outcomes for both the clusters submitted to UNIDO for their review.

ii. Technology Demonstration: Baseline Study at Surat Cluster on Compressed Air System: EESL team conducted a baseline study at one of interested units in Surat on 3rd July 2018 for replacement of existing reciprocating compressed air system with VFD enabled screw compressor with PM motor. Free air delivery test of the existing compressors was carried out and air demand was recorded for the exiting process. The data was shared with the technology suppliers in order to finalizing the specification of the Screw compressor.

Technology – 1: Replacement of reciprocating compressor with screw compressor with VFD





Details of Existing	Details of Proposed
• Compressor type: Reciprocating (Piston type) • Type of Motor drive: – IE1 motors (Belt drive) – Non-Inverter – Fan cooled • Operating pressure: 7 Bars • Tank: bottom fitted • Dryer system: NA • Monitoring system: NA	• Compressor type: Screw • Type of Motor drive: – PM motors (direct drive) – Inverter Duty – Oil cooled • Operating pressure: 7 Bars • Tank: separate • Dryer system: Yes • VFD Enable: Yes

Baseline study:

- Energy Saving potential: 40% to 55% in compressed air system.
- Reduction in compressed air generation cost: 50%
- The overall specific power consumption of the system is 0.29 kW/CFM
- The specific power consumption of the facility will be reduced of 0.15 kW/CFM.
- Proposed annual energy saving of about 1,85,640 kWh
- This project will be resulting in an annual CO_2 reduction of 174 Tonnes
- Life time CO_2 reduction of 2617 Tonnes.

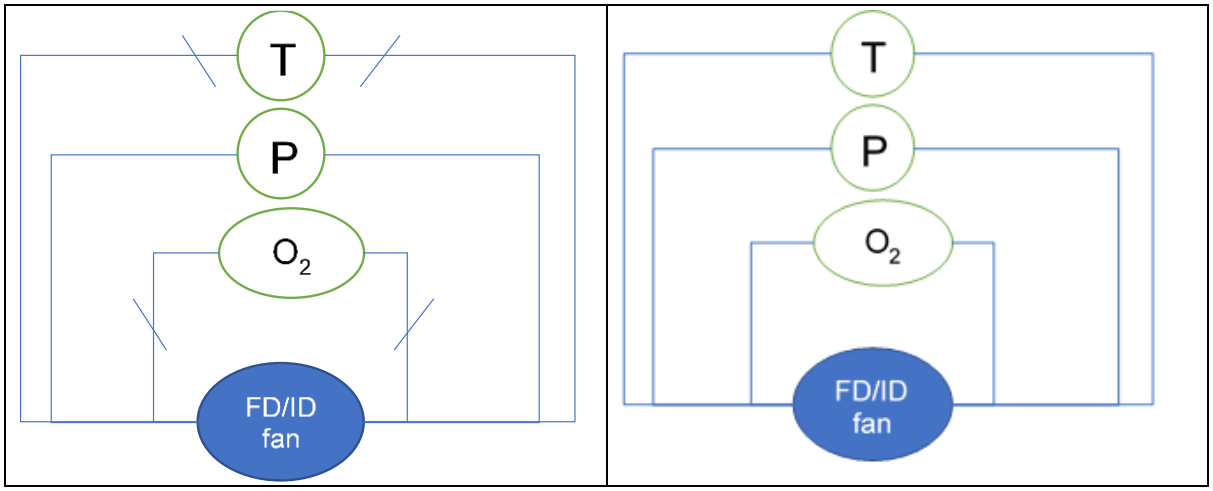
Qualifying Criteria:

Criteria	Sub Criteria	Minimum Qualifying Criteria	Description
Energy Efficiency	% of Energy Saving from Baseline	10% or above	✓ Electrical energy saving : >= 40%
Replicability	No. of MSME to accept	20 MSME or 30% of total MSME in cluster whichever is higher	• Replication potential of minimum 120 units • About 40% of the total number of MSME in cluster.
Financial Viability	(a) Payback Period (PBP)	(b) PBP should be less than 1.5 years	• Simple Pay Back is less than 1.6 years
Availability	(a) Indigenous (b) At least 3 technology provider	(c) Yes/No (d) Yes/No	• Yes • Yes
Ease of Implementation	(a) Easy (b) Medium (c) Hard	Easy	• Very less customization is required • Very less civil work is required. • Existing piping may be used many cases

Impact of Bulk Investments: (Anticipated):

- As there are about 400 processing units dueling in the cluster which are having compressed air system
- Most of the units are operating reciprocating compressed air system and are operated for 24 hours basis.
- The projection is made for considering 126 units among 314 units
- Annual energy saving of about 24.5 million units
- Annual monitory saving to Rs. 18.37 cores.
- Reduction of annual CO_2 emission from the cluster by 23,030 tonnes.

Technology – 2: Online combustion efficiency monitoring & control (Oxygen trimming & Excess air control)



Details of Existing System	Details of Proposed System
• Control mechanism: Steam pressure based cut off system • Combustion control: NA • Operating pressure: 9 to 10 bars • Monitoring system: only temperature • Oxygen % : 13 to 17 % • Dry Flue gas loss: High	• Control mechanism: % Oxygen and temperature • Combustion control: close loop control system • Operating pressure: 9 to 10 bars • Monitoring system: temperature, Oxygen % and pressure • Oxygen %: 5 to 7 % • Dry Flue gas loss: Low

Sample Case Study:

- Energy Saving potential: Electrical: 10% to 15% Thermal: 12% to 18%
- Increase in boiler efficiency: 3 – 5%
- 10,000 tones of coal saved (considering 5% saving in energy)
- 20,000 t CO_2 savings per year (Emission factor of coal = 99.7 tCO_2/TJ)

Qualifying Criteria:

Criteria	Sub Criteria	Minimum Qualifying Criteria	Description
Energy Efficiency	% of Energy Saving from Baseline	10% or above	✓ Electrical energy saving : <= 10% ✓ Fuel saving : >= 15%
Replicability	No. of MSME to accept	20 MSME or 30% of total MSME in cluster whichever is higher	• Replication potential of minimum 130 units • About 43% of the total number of MSME in cluster.

Financial Viability	(a) Payback Period (PBP) (b) Internal Rate of Return (IRR)	***(a)*** PBP should be less than 1.5 years	• Simple Pay Back is less than 0.5 years • IRR of the project is
Availability	(a) Indigenous (b) At least 3 technology providers	***(b)*** Yes/No ***(c)*** Yes/No	• Yes • Yes
Ease of Implementation	(a) Easy (b) Medium (c) Hard	Medium	• Customization is required • Re tuning of system parameters required.

Impact of Bulk Investments (Anticipated):

- As there are more than 300 processing units.
- Boilers are used continuously for 24 hours.
- The projection is made for considering 130 units among 314 units
- Annual energy saving of about 2.2 million units
- 10,000 tons of coal saved (considering 5% saving in energy)
- 20,000 t CO2 savings per year (Emission factor of coal = 99.7 tCO2/TJ)

Technology – 3: Condensate and Flash steam Recovery

Details of Existing	Details of Proposed
• Type: Electrical pump based • Boiler feed water temperature: 45^{o}C • Boiler operating pressure: 9 Bars • Tank insulation: Average • Flash Steam utilized: No • Monitoring system: NA	• Type: Pressure power pump based • Boiler feed water temperature: 90^{o}C • Boiler operating pressure: 9 Bars • Tank insulation: Good • Flash Steam utilized: Yes • Monitoring system: No

Sample Case Study:

- % Rise in feed water temperature: 50%
- % Rise in boiler efficiency: 3 to 4%
- % Reduction in fuel consumption 10%

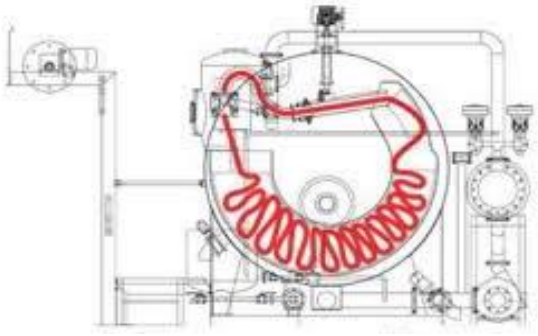
Qualifying Criteria:

Criteria	Sub Criteria	Minimum Qualifying Criteria	Description
Energy Efficiency	% of Energy Saving from Baseline	10% or above	✓ Fuel saving : >= 10%
Replicability	No. of MSME to accept	30% of total MSME in cluster whichever is higher	✓ Replication potential of minimum 115 units ✓ About 38% of the total number of MSME in cluster.
Financial Viability	(a) Payback Period (PBP) (b) Internal Rate of Return (IRR)	(a) PBP should be less than 1.5 years	• Simple Pay Back is less than 1.4 years
Availability	(a) Indigenous (b) At least 3 technology provider	(a) Yes/No (b) Yes/No	• Yes • Yes
Ease of Implementation	(a) Easy (b) Medium (c) Hard	Medium	• Customization is required • Resizing of condensate piping is required. • Replacement of existing steam traps

Impact of Bulk Investments (Anticipated):

- As there are more than 300 processing units.
- Boilers are used continuously for 24 hours.
- The projection is made for considering 115 units
- Annual Fuel saving: 5000 MT
- 10,000 t CO_2 savings per year (Emission factor of coal = 99.7 tCO2/TJ)

Technology – 4: PLC control Jet dying machines

Details of Existing	Details of Proposed
• Type: Manual control • Longer batch time • Higher water consumption • Monitoring system: No	• Type: Auto control • 20% less batch time • Lower water consumption • Monitoring system: Yes

Sample Case Study:

- % reduction in Steam consumption: 8%
- % reduction in Electrical power consumption: 15%
- % Reduction water consumption: 5%

Qualifying Criteria:

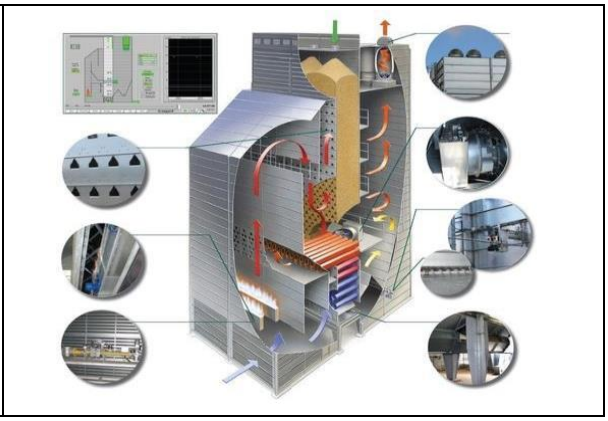
Criteria	Sub Criteria	Minimum Qualifying Criteria	Description
Energy Efficiency	% of Energy Saving from Baseline	10% or above	✓ Fuel saving: ~ 10%
Replicability	No. of MSME to accept	20 units or 30% of total MSME in cluster whichever is higher	✓ Replication potential of minimum 200 units ✓ About 66% of the total number of MSME in cluster.
Financial Viability	(a) Payback Period (PBP)	(a) PBP should be less than 1.5 years	• Simple Pay Back is greater than 2 years
Availability	(a) Indigenous (b) At least 3 technology providers	(a) Yes/No (b) Yes/No	• Yes • Yes

Ease of Implementation	(a) Easy (b) Medium (c) Hard	Medium	• Customization is required • Retrofitting PLC based control in existing system.

Impact of Bulk Investments (Anticipated):

- As there are more than 200 processing units.
- Jet dying machines are used continuously for 18hours.
- Annual Fuel saving: 25000 MT
- 48,000 t CO_2 savings per year

Technology – 5: Replacing existing dryer with LSU dryers



Details of Existing System	Details of Proposed System
• Hot air direction: bottom • Electrical power for 24 TPD: 22kW • Operating Steam pressure: 5 bars	• Hot air direction: bottom • Electrical power for 24 TPD: 22kW • Operating Steam pressure: 5 bars

Sample Case Study:
- Electrical Energy saving: 80%
- Thermal Energy saving: 15%
- Reduction of batch time: 20%
- Better quality products

Qualifying Criteria:

Criteria	Sub Criteria	Minimum Qualifying Criteria	Description
Energy Efficiency	% of Energy Saving from Baseline	10% or above	✓ Electrical Energy saving = 80% ✓ Thermal energy saving = 15%

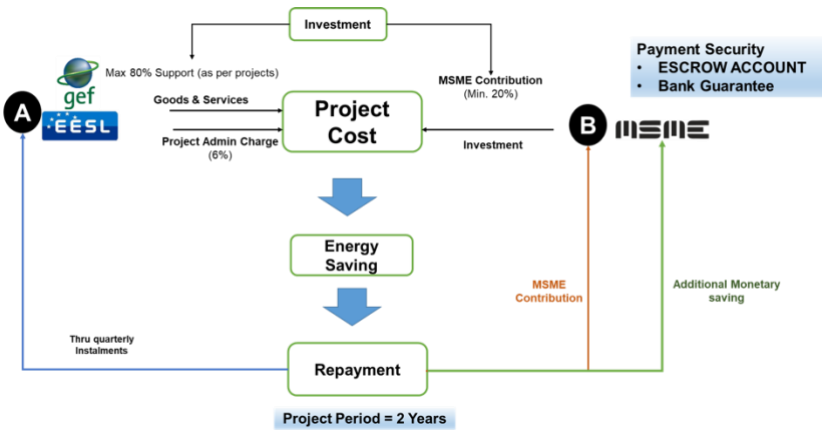
Replicability	No. of MSME to accept	20 MSME or 30% of total MSME in cluster whichever is higher	✓ Replication potential of minimum 50 units ✓ About 35% of the total number of MSME in cluster.
Financial Viability	(a) Payback Period (PBP)	(b) PBP should be less than 1.5 years	• Simple Pay Back is less than 1.45 years
Availability	(a) Indigenous (b) At least 3 technology provider	(c) Yes/No (d) Yes/No	• Yes • Yes
Ease of Implementation	(a) Easy (b) Medium (c) Hard	Medium	• Customization is required are per units requirement • Complete reconstruction of dryer system.

Impact of Bulk Investments (Anticipated):

- The projection is made for considering 50 units among 130 units of Arni rice mill cluster
- Annual energy saving of about 40000 million units
- Annual fuel saving of about 114570 MT

<u>Agenda Item No. 5 BUSINESS MODEL:</u>

EESL has developed business models for the identified technologies, the broad scheme of which is illustrated in below-given schematic.



Annexure- 1: Technology Details for Technical Working Group (TWG) meeting: 10th October 2018

1. Installation of Automation and Control System in Boiler (For Surat Textile Cluster)

i. Cluster Brief:

Surat, known as the synthetic capital of India, is house to about 400 textile processing units, involved in processing of synthetic sarees and dress materials. The textile processing units can be broadly classified into 'Dyeing' units and 'Printing' units. Most of the units have the facilities of both dyeing and printing. The sarees and dress materials produced in Surat cluster are not only marketed in India but also exported to various countries. The textile processing units in Surat, are mainly micro, small and medium enterprises (MSMEs) and are spread over various location like Palsana, Sachin, Pandesara and Surat city industrial areas. The main raw material for the cluster is polyester grey cloth which is sourced from local polyester producers in and around Surat. Majority of the industries located in Surat are wet processing units which requires high amounts of thermal energy in the form of steam and thermic-fluid, leading to a high share of energy cost. The sector is unorganized in nature, mostly using old and inefficient technologies. There is a significant potential to make these units energy efficient and cost competitive, through accelerated adoption of energy efficient technologies in the cluster.

ii. Existing practice:

Textile processing units at Surat are equipped with boilers in the range of 6 TPH to 12 TPH which are typically fired using solid fuel i.e. coal. Most of these boilers are equipped with waste heat recovery system. Although, there are VFDs installed in the FD / ID Fans, the air flow control is manually done in most of the units. Studies suggest that most of the units fail to maintain the correct amount of air in the combustion chamber, required for optimum combustion. This leads to incomplete combustion with a significant percentage of the heat loss through dry flue gas loss. The excess air flow can be determined by the free oxygen percentage in the flue gas which automatically leads to higher excess air percentage. Also, the draft pressure is not monitored and controlled to the desire level. The blow-down control in the boiler is also manual which leads to a lower boiler efficiency.

iii. Proposed technology:

Based on the detailed analysis of the existing boiler, it is proposed to install "Automation and control system in the boiler". The key parameters which requires monitoring and control are as follows:

- ✓ Optimum boiler combustion efficiency through effective monitoring and control of Forced Draft (FD), Induced Draft (ID) and Fuel feeder.
- ✓ Monitoring and synchronizing fuel feeder control with respect to instantaneous steam pressure.

- ✓ Excess Air monitoring and control based on the fuel feeding rate with the help of feedback from the stack oxygen sensor.
- ✓ Furnace draft pressure monitoring and controlling the furnace at slightly negative draft pressure.
- ✓ Automatic boiler blow-down based on TDS level monitoring

iv. Justification of technology selection:

The proposed technology of automation and control system in boiler not only helps to monitor and analyze various boiler parameters but also can improve the efficiency of boiler through effective monitoring and control of air-fuel ratio; controlling furnace draft; maintain optimum fuel feed based on steam pressure in boiler and automatic blow-down. The improvement envisaged through the installation of the system has been summarized in the table below:

Parameter	Current Operation	Ideal Operating Scenario	Effect on Boiler Performance	Post Implementation of ideal scenario
Stack Oxygen %	Oxygen measurement not available	Excess air will be maintained within requirement based on the fuel used for optimized combustion	Higher stack oxygen will result higher heat loss as excess air carrying heat	FD fan and feeder auto control based on steam pressure, which maintains the stack oxygen within standard limits.
Draft Pressure	Not measured online	-0.25 to -0.75 mmWC (Auto control)	Positive draft pressure causes back-fire and more negative draft pressure results in fuel unburnt	Based furnace pressure feedback ID fan auto-controlled which help to maintain the pressure within limits
Unburnt Loss	3.0%	2.5%	Unbalance of draft and excess air resulting in higher un-burnt in Bottom and Fly Ash	Optimized draft will provide higher residence time in combustion and Excess air trimmed within band as per load will improve combustion
CO	< 150	< 300 ppm	High excess air resulting in incomplete combustion and higher un-burnt	By having synchronized combustion and proper FD and ID balance will yield better combustion
Stack Temp	140-143 ^{0}C	150 - 153 ^{0}C	Higher stack temperature	Synchronized combustion with

			indicating better combustion in the furnace	result precise air to fuel ratio due to trimming and balanced draft will lower stack oxygen and a small increase in the temperature.
Blow Down Control	Manual	Automatic based on TDS and hardness	Due to manual blow-down and dependent on spot check analysis (2880 ppm) resulting in loss of heat and quality in steam	Auto Blow down based on TDS will maintain IBD TDS at 3500 ppm

v. Energy & monitoring saving:
For calculating the energy and monetary benefits, a typical case of boiler of 8 tph capacity has been considered. The benefits envisaged through installation of boiler automation and control system has been summarized in the table below:

Particular	Unit	Existing	Proposed
Percentage O_2 in flue gas	%	13.50	11
Excess air	%	180.00	110.00
Dry flue gas loss	%	17.45	13.31
Air flow rate	T/h	11.55	8.19
Reduction in power consumption	kW	22.81	20.45
Fuel consumption per hour	kg/hour	625.0	591.1
Saving in fuel consumption	kg/hour	33.9	
Annual operating days	days	7320.00	
Reduction in fuel consumption	MT/Year	248	
Reduction in power consumption	kWh	17260	
Monetary saving	Rs (in lakhs)/year	16	
Estimated investment	Rs.	12	
Simple payback period (Years)	Years	0.73	

* extracts of calculation provided

The benefits can be summarized as:

- ✓ 3-8 % reduction in specific fuel consumption
- ✓ 1-3 % reduction in specific power consumption
- ✓ Improvement in boiler indirect efficiency by 2-5%
- ✓ Improvement in boiler blow-down loss
- ✓ Improvement in boiler draft pressure

Parameter	UoM	Value
Annual thermal energy saving (one unit)	t/y	248
Annual thermal energy saving (one unit)	MJ/y	4989752.768
Annual electrical energy saving (one unit)	kWh/y	17260
Annual electrical energy saving (one unit)	MJ/y	62136
Annual total energy savings	MJ/y	5051889
Annual coal saving (considering 20% replication)	t/y	15893
Annual electricity saving (considering 20% replication)	kWh/y	1104649.98
Annual energy saving (considering 20% replication)	MJ/y	323320872.9
Annual CO_2 emission saving (one unit)	tCO_2/yr	16
Annual CO_2 emission saving (considering 20% replication)	tCO_2/yr	994
Estimated investment in technology (one unit)	Rs in Lakh	12
Estimated investment in technology considering 20% replication (assuming price down due to demand aggregation)	Rs in Lakh	704
Total Investment	in million USD	1
Total energy savings (in 10 years)	TJ	3233
Annual CO_2 emission saving (in 10 years)	tCO_2/yr	9942

vi. Replication Potential:

Based on the discussion with associations, units, sample survey and energy audits, it is estimated that the technology has a replication potential of 20% in the cluster. Based on 20% replication, the overall project benefits will be as follows:

vii. Availability of the technology

There are good many technology providers available in India and many of them have their base in Surat. The following are the technology providers available in the cluster.

1. Forbes marshall
2. Thermax India Limited
3. Masibus instruments
4. Yokogawa India Limited

viii. Effect on the process

This technology has no effect on the existing production process, it will only enhance the existing boiler performance by improving the combustion efficiency.

ix. Reasons for unpopularity:

This technology has yet not penetrated the cluster because of the following reason:

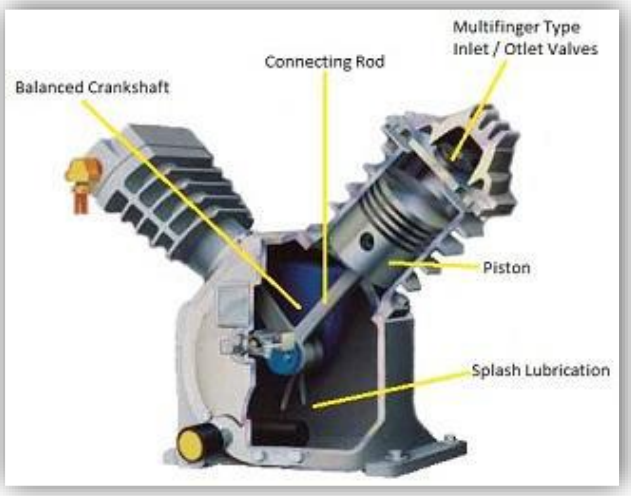
- ✓ Less knowledge on combustion efficiency and its impact.
- ✓ Higher capital cost of the technology.
- ✓ Less availability of skilled person for operating the same.
- ✓ No one has yet demonstrated the results of the technology to all unit owners in the cluster.
- ✓ Risk of failure.

2. Replacement of Reciprocating Compressor with VFD Enabled Permanent Magnet Motor Based Screw Air Compressor (For Surat Textile Cluster)

i. Cluster Brief:

Surat, known as the synthetic capital of India, is house to about 400 textile processing units, involved in processing of synthetic sarees and dress materials. The textile processing units can be broadly classified into 'Dyeing' units and 'Printing' units. Most of the units have the facilities of both dyeing and printing. The sarees and dress materials produced in Surat cluster are not only marketed in India but also exported to various countries. The textile processing units in Surat, are mainly micro, small and medium enterprises (MSMEs) and are spread over various location like Palsana, Sachin, Pandesara and Surat city industrial areas. The main raw material for the cluster is polyester grey cloth which is sourced from local polyester producers in and around Surat. Majority of the industries located in Surat are wet processing units which requires high amounts of thermal energy in the form of steam and thermic-fluid, leading to a high share of energy cost. The sector is unorganized in nature, mostly using old and inefficient technologies. There is a significant potential to make these units energy efficient and cost competitive, through accelerated adoption of energy efficient technologies in the cluster.

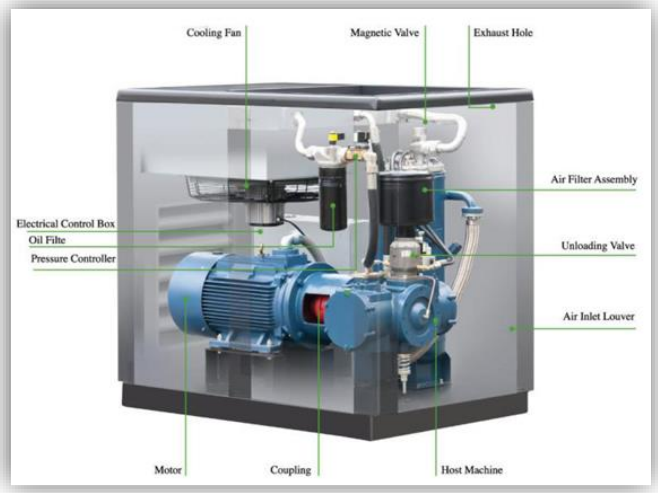
ii. Existing practice:



In the textile manufacturing process, there is a continuous demand of compressed air in order to cater various pneumatic operations throughout the manufacturing process. In the exiting manufacturing process the compressed air system is distributed in nature and most of the compressed air demand is catered by multiple reciprocating air compressor installed at various location of the plant. In most of the cases separate reciprocating air compressors are installed for individual processes. Generally, these single stage reciprocating compressors work with higher noise and have a relatively high cost of compression. The operational efficiency varies from 22 to 35 kW/100 cfm, based on the age of the equipment.

iii. Proposed technology:

Based on the detailed analysis of the existing compressed air system, it is proposed to replace the low performing reciprocating compressor with VFD enabled permanent motor-based screw air compressor. The key parameters to be included in the technology are:



- ✓ High efficient rotary screw compressor with VFD which can cater to fluctuating compressed air requirement.
- ✓ Equipped with high efficiency permanent magnet motor
- ✓ Motor is directly coupled to the screw arrangement of the compressor which actually nullifies the transmission loss of a belt driven system.
- ✓ Lubricating oil-based cooling system

iv. Justification of technology selection:

In a typical 24 hour operating textile processing process where the compressed air demand is continuous and fluctuating in nature with an air pressure requirement of up to 7 bars, a screw air compressor with variable operation mode is more suitable as compared to the reciprocating compressed system. Moreover, a screw compressor is able to compress higher volume of compressed air as compared to a reciprocating compressed air system at same pressure.

A comparison is drawn between the two type of compressor air technologies on different aspects for having clear understanding. To start with, a screw air compressor uses two meshing helical screws, known as rotors for compressing the air whereas a reciprocating (Piston Type) air compressors use pistons driven by a crankshaft to compress the air. In the following aspects, the two technologies are differentiated from each other.

- ✓ Number of Moving part:
  There are a lot of moving parts like piston, piston ring, crankshaft, connecting rod, valves, etc. in reciprocating causing wear & tear. Hence lesser reliability & more chances of breakdown where as a screw compressor has only two moving parts which are not in contact with each other so no wear & tear, hence there is less possibility of breakdown.

- ✓ Internal air temperature:
  In case of reciprocating air compressor, the internal temperature at which the pistons operate is around 150 to 200 ^{o}C, it is due to the friction generated by the

contact of piston rings against the cylinder walls. Whereas in case of screw air compressor the internal air-end (screw component) operating temperature is around 80 to 100°C. This is possible because of no friction between the screws and oil / lubricant which forms a non-wearing seal between rotors and casing thereby removing heat through a thermostatically controlled fluid circuit.

- ✓ Operational point
  There are around 8 or more valves in total & hence will require frequent cleaning due to high carbonation thus higher maintenance in case of reciprocating compressor where as there is only one piston type inlet valve, so there is a less chance of carbonation hence minimum shutdown is not required for maintenance.

- ✓ Space requirement
  Reciprocating compressors require foundation as well as grouting because of high unbalanced forces & vibration. Here the pistons rise and fall (vertical machine) or move back and forth in the cylinder thereby causing too much vibration. Hence it involves additional foundation cost. Whereas in case of screw as it rotates in one direction thereby causing less noise, heat and vibration. Furthermore, Screw Compressor is skid mounted therefore foundation is not required. No additional cost of foundation. More over the space requirement is also less as compared to the reciprocating compressor of same capacity.

- ✓ Noise generation
  In case of reciprocating compressed air system the noise levels could go as high as 100 dB where in the noise levels are within 75 dB in case of screw air compressor. Also, most of the screw air compressor comes in a sound isolation box.

- ✓ Transmission losses
  In case of reciprocating compressed air system, v-belt is used for transmitting power from motor shaft to compressor which accounts for a loss of 5% whereas in case of the screw compressor either direct drive or poly cogged belt are used which decreases the transmission loss and increases the overall efficiency of the system.

v. Energy & monitoring saving:
For calculating the energy and monetary benefits, a typical case of compressor of 250 cfm requirement has been considered where in 8 number of reciprocating compressed air system were operating in order to cater the compressed air demand of the system. The benefits envisaged through replication of reciprocating compressor with screw compressor have been summarized in the table below:

Parameters	Unit	Values
Required CFM	CFM	250
Existing kW/CFM	kW/CFM	0.29

Proposed kW/CFM	kW/CFM	0.15
kWh per hour	kW	35
Annual Operating hours	Hours/annum	5304
Annual energy saved (kWh/year)	kWh/years	185640
Annual monetary saving (Rs/Year)	Rs/Years	1392300
Project cost Rs.	Rs	1652000
Simple pay back	Year	1.19

The benefits can be summarized as:

- ✓ 30-50 % reduction in specific power consumption of the compressor
- ✓ Noise free operation
- ✓ Longer compressor life

vi. Replication Potential:

Based on the discussion with associations, units, sample survey and energy audits, it is estimated that the technology has a replication potential of 40% in the cluster. Based on 40% replication, the overall project benefits will be as follows:

Parameters	Units	Values
Annual electrical energy saving (one unit)	kWh/y	185640
Annual electrical energy saving (one unit)	MJ/y	668297
Annual electricity saving (considering 40% replication)	kWh/y	16633344
Annual CO_2 emission saving (one unit)	tCO_2/yr	167
Annual CO2 emission saving (considering 40% replication)	tCO_2/yr	14970
Estimated investment in technology (one unit)	Rs in Lakh	16.52
Estimated investment in technology considering 40% replication (assuming price down due to demand aggregation)	Rs in Lakh	1480
Total Investment	Rs in Lakhs	2.11
Lifetime energy savings (in 10 years)	TJ	34222
Lifetime CO_2 emission saving (in 10 years)	tCO_2	149700

vii. Availability of the technology

There are good many technology providers available in India and many of them have their base in Surat. The following are the technology providers available in the cluster.

1. Atlas Copco
2. Venus air compressors
3. Kaeser air compressor
4. Hitachi compressed air system

viii. Effect on the process

This technology has no effect on the existing production process, it will only reduce the power consumption required for generating compressed air.

ix. Reasons for unpopularity:

This technology has yet not penetrated the cluster because of the following reason:

- ✓ Less knowledge on use of VFD in compressed air system.
- ✓ Higher capital cost of the technology as compared with the existing.
- ✓ No one has yet demonstrated the results of the technology to all unit owners in the cluster.

3. Steam Trapping and Condensate Recovery System for Jet Dyeing Machines (For Surat Textile Cluster)

i. Cluster Brief:

Surat, known as the synthetic capital of India, is house to about 400 textile processing units, involved in processing of synthetic sarees and dress materials. The textile processing units can be broadly classified into 'Dyeing' units and 'Printing' units. Most of the units have the facilities of both dyeing and printing. The sarees and dress materials produced in Surat cluster are not only marketed in India but also exported to various countries. The textile processing units in Surat, are mainly micro, small and medium enterprises (MSMEs) and are spread over various location like Palsana, Sachin, Pandesara and Surat city industrial areas. The main raw material for the cluster is polyester grey cloth which is sourced from local polyester producers in and around Surat. Majority of the industries located in Surat are wet processing units which requires high amounts of thermal energy in the form of steam and thermic-fluid, leading to a high share of energy cost. The sector is unorganized in nature, mostly using old and inefficient technologies. There is a significant potential to make these units energy efficient and cost competitive, through accelerated adoption of energy efficient technologies in the cluster.

ii. Existing practice:

Steam at a working pressure of 3-4 kg/cm^2 is used in the textile processing units in a number of machines. For e.g. zero-zero machines are used for finishing operations wherein the fabric is rotated in circular rubber drum with blanket of steam rotating around it. Similarly, jet dyeing machines are used for pressurized dyeing (colouring) process, used mainly for polyester based fabric. A significant amount of steam is lost during the heating operation of the jet dyeing process, as the portion of the latent heat is transferred to the equipment line resulting in condensate formation. Also, a significant amount of steam is transformed to condensate during the cooling cycle of

the jet dyeing process. In addition to these, heat available in exit water generated during the process is wasted during the water recycling process. Not wasting, but rather recovering and reusing as much of this sensible heat is possible through installation of condensate recovery system. Also in typical units, no traps or thermodynamics traps are used in these pressurized steam machines. Thermodynamic traps work on the difference in dynamic response to velocity change in the flow of compressible and incompressible fluids. As steam enters, static pressure above the disk forces the disk against the valve seat. The static pressure over a large area overcomes the high inlet pressure of the steam. As the steam starts to condense, the pressure against the disk lessens and the trap cycles. This essentially makes a TD trap a "time cycle" device: It will open even if there is only steam present, this can cause premature wear. If non-condensable gas is trapped on top of the disc, it can cause the trap to be locked shut. In the current process, it was observed that the TD traps are not being able to remove condensate properly.

iii. Proposed technology:

In order to recover heat lost through condensate, it is proposed to install a condensate recovery system in the jet dyeing machines. Condensate recovery is a process to reuse the water and sensible heat contained in the discharged condensate. The system includes a positive displacement condensate pump which can recover (suck) hot condensate and flash steam from the steam pipeline and feed the same into the boiler feed water tank. The pump may also be equipped with an in-built receiver for condensate which eliminates the need for a separate storage tank. The installation of the system will allow 80-100% recovery of condensate formed during the jet dyeing and the zero-zero process. The technology can be suitably modified for mechanical or sensor based control.

In addition to the condensate recovery system, it is suggested to install pneumatically operated float traps in steam unit of jet dyeing machine in place of TD traps. These float traps will be able to filter out condensate in the machine exit and allow steam to pass through the line. The amount of steam being discharged along with the condensate can be saved in the process.

iv. Justification of technology selection:

Recovering condensate instead of throwing it away can lead to significant savings of energy, chemical treatment and make-up water. Condensate can be reused in many different ways, for example:

- ✓ As heated feed water, by sending hot condensate back to the boiler's deaerator
- ✓ As pre-heat, for any applicable heating system
- ✓ As steam, by reusing flash steam
- ✓ As hot water, for cleaning equipment or other cleaning applications

In addition, the installation of the float-traps in the steam utilizing units will lead to following benefits:

- ✓ Higher capacity turndown trap
- ✓ Complete Space Optimization – Area required for installation is less
- ✓ No welding required
- ✓ No Inline leakages
- ✓ Lesser Radiation losses
- ✓ Reduced transportation costs

Steam generated by a boiler contains heat energy which is used to heat the product. When steam loses it energy by heating the product, condensate is formed. Also, a part of energy contained by steam is lost through radiation losses from pipes and fittings. After losing this heat, steam gets converted into condensate. If this condensate is not drained immediately as soon as it forms, it can reduce the operating efficiency of the system by slowing the heat transfer to the process. Presence of condensate in a steam system can also cause physical damage due to water hammer or corrosion. A Steam trap is an automatic drain valve which distinguishes between steam and condensate. A steam trap holds back steam & discharges condensate under varying pressures or loads. The steam traps should have good capacity to vent out air and other non-condensable gases quickly while holding back the live steam.

v. Energy & monitoring saving:

For calculating the energy and monetary benefits, a typical case of a textile processing unit using 8 tph steams is considered. The benefits envisaged through installation of condensate recovery and steam traps have been summarized in the table below:

Parameters	Unit	Existing	proposed
Steam generation	kg/h	8000	
Steam consumption in Jet dyeing	%	25	
Condensate recovery	%	0	80
Recovered condensate	kg/h	1600	
Heat saving	kcal/h	44800	
Fuel saving	kg/h	11.7	
Annual fuel saving	t/y	43	
Monetary saving annually by fuel	Rs Lakh/y	1.8	
Annual RO water saving	t/y	5856	
RO water price	Rs./KL	45	
Monetary saving through condensate recovery	Rs Lakh/y	2.6	
Total Estimated investment	Rs Lakh	6	
Total Monetary saving	Rs Lakh	4.4	
Simple payback period	years	1.37	

The benefits can be summarized as:

- ✓ 2-3 % reduction in specific fuel consumption
- ✓ 15 – 20 % saving in annual RO water consumption

- ✓ Reuse of sensible heat which would have lost in condensate

vi. Replication Potential:

Based on the discussion with associations, units, sample survey and energy audits, it is estimated that the technology has a replication potential of 20% in the cluster. Based on 20% replication, the overall project benefits will be as follows:

Parameter	Units	Value
Annual fuel saving (one unit)	t/y	43
Annual thermal energy saving (one unit)	MJ/y	863789
Annual fuel saving (considering 20% replication)	t/y	2751
Annual CO_2 emission saving (one unit)	tCO_2/yr	86
Annual CO2 emission saving (considering 20% replication)	tCO_2/yr	5506
Estimated investment in technology (one unit)	Rs in Lakh	6
Estimated investment in technology considering 20% replication (assuming price down due to demand aggregation)	Rs in Lakh	704
Total Investment	in million USD	1
Life time energy saving	TJ	9
Life time CO_2 saving	tCO_2/yr	55061

4. Replacing Existing Dryers with LSU Dryers (For Vellore Rice Mill Cluster)

i. Cluster Brief:

Paddy is the principal crop extensively cultivated in Tamilnadu and accounts for the third of total gross cropped area and nearly 60% of irrigated area in Tamilnadu. Rice is a product of milling of paddy hence rice milling is an important activity in Tamilnadu. In 2015-16, the State produced 8.7 million tons of rice accounting for about two- thirds of the total production of the food grains6. Yield-wise, Tamilnadu ranked first in rice production.

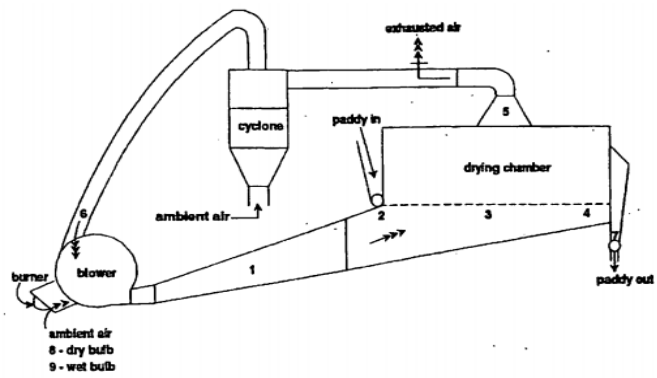
The Vellore cluster rice mills are concentrated in areas Arni (Tiruvannamalai District), Arcot and Vellore (Vellore District). Vellore is an old cluster as the mills have been operating since 1950's and a majority of these old mills are still in operation today. Periodically, new rice mills have been added in the cluster.

The Vellore cluster has about 340 rice mills spread across the areas of Arni (Tiruvannamalai District) and Arcot & Vellore (Vellore District). Out of this, about 150 rice mills are located in Arni and nearby villages Arunagiri Road, Sevoor, Rathanamangalam, and Vandhavasri within a radius of five km. The remaining 190 mills are concentrated in Arcot, Vellore, Gudiatham, Arakkonam, and Walajpet. The rice mills of the cluster have been in operation for the past five decades.

The Arni Paddy and Rice Merchants Association is the representing Association of the rice mills, which was established in the year 1974.

ii. Existing practice:

A skeleton sketch of the existing dryer system is provided below, here the paddy is placed in a drying chamber and hot air is forced through the stationary grain mass until the desired moisture level is reached. This is a batch drying process where in the grain layer thickness is of 2.5-3.0 meters. The recommended airflow rates for this type of dryers range from 3 to 4 m^3 /min per ton of paddy. The grain is cooled in the same unit for 2 to 4 hours using ambient air.



Existing flat-bed dryer

Here in fluidization takes place in the drying chamber where in the hot air is blown from the bottom of the bed. The steam based heat exchangers are in place at the blower suction which are used to raise the inlet ambient air temperature to desired levels. For the heat exchanger, a steam pressure is required of about 5kg/cm^2 (gauge). The main constrain of this type of drying system is that higher capacity blower is required, as such process required a sufficient air pressure for creating bubbling/fluidization effect at paddy bed in the drying chamber.

iii. Proposed technology:

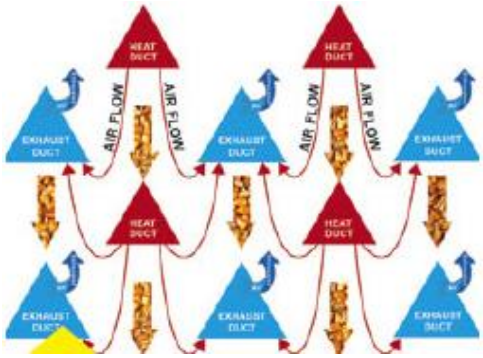
The proposed drying system is known as LSU dryers, these types of dryer consumes less energy as compared to the flat bed dryers. It has lower specific power consumption as well as lower steam consumption. The design increases the surface heat exchange area of the grains and hot air and reduces the time required for drying. More over as the blower is used for circulating hot air instead of generating sufficient pressure for fluidization. Thus, reduce the power consumption of the blower.

Cut section diagram of the LSU dryer

iv. Justification of technology selection:

As shown in figure the rectangular drying chambers are having multiple air ports where from the hot air is passed, these air ports are designed in such a way that it increases the surface of contact between the paddy and hot air. More over the design also enhances the heat utilization factor of the system. The figure 4 shown how the system magnifies the heat utilization factor in the dryer.

Layers of inverted V-shaped channels (called inverted V ports) are installed in the drying chamber. Heated air is introduced at many points through the descending grain bulk through these channels. One end of each air channel has an opening and the other end is sealed. Alternate layers are air inlet and air outlet channels are places as shown in figure. The inlet and outlet ports are arranged one below the other in an offset pattern.



Efficient heat Utilization system

v. Energy & monitoring saving:

As per the existing dryer system, the air inflows in upward direction and the moisture content moves from the bottom to the upward direction due to which the moisture content of the of the paddy increase from bottom to top, which requires high heat and more time to dry.

But with the new type dryer, i.e. V Port type dryer, we have a large cross-sectional area which is diffused to paddy and flow of air is from left to right or right to left. Due to which the drying time of paddy decreases which results in the reduce consumption of the electricity and fuel.

The efficiency of the V-port dryer is more than existing type dryers.

Parameters	Existing System	New System
Capacity	24	24
Motor Wattage	22.35	11.18
Fuel		
Operating Hours	24	8
No. of Days	300	300
Electricity Consumption (per batch)	160920	26820
Fuel Consumption (per batch)	2546	2164.1
Electricity Cost	8.7	8.7
Fuel cost (per Kg)	10	10
Total Electricity Cost	1400004	233334
Total Fuel Cost	25460	21641
Reduction in energy cost		1170489
Capital cost for the project		2124000
Payback Period		1.81

* extracts of calculation provided

The benefits can be summarized as:

- ✓ 15 - 25 % reduction in fuel consumption
- ✓ 65- 80% reduction in power consumption
- ✓ Uniformly dried product can be obtained if the dryer is designed properly.
- ✓ The dryer can be used for different types of grains.

- ✓ Increases the production capacity.

Parameters	Units	Values
Annual thermal energy saving (one unit)	t/y	153
Annual thermal energy saving (one unit)	MJ/y	3069376
Annual electrical energy saving (one unit)	kWh/y	134100
Annual electrical energy saving (one unit)	MJ/y	482755
Annual total energy savings	MJ/y	3552131
Annual coal saving (considering 20% replication)	t/y	7638
Annual electricity saving (considering 20% replication)	kWh/y	6705000
Annual energy saving (considering 20% replication)	MJ/y	177606538.2
Annual CO_2 emission saving (one unit)	tCO_2/yr	121
Annual CO_2 emission saving (considering 20% replication)	tCO_2/yr	6035
Estimated investment in technology (one unit)	Rs in Lakh	12
Estimated investment in technology considering 20% replication (assuming price down due to demand aggregation)	Rs in Lakh	550
Total Investment	in million USD	0.79
Life time energy saving	TJ	1776
Life time CO_2 saving	tCO_2/yr	60345

vi. Replication Potential:

Based on the discussion with associations, units, sample survey and energy audits, it is estimated that the technology has a replication potential of 16% in the cluster. Based on 16% replication, the overall project benefits will be as follows:

vii. Availability of the technology:

There are good many technology providers available in India and many of them have their base in Surat. The following are the technology providers available in the cluster.

1. Sri Vinayaka Engineering works.
2. APIT Pvt. Ltd.
3. Sri Amman Engineering works.
4. Shankar Engineering corporation.

viii. Effect on the process:

This technology will increase the quality of the rice production and will increase the existing production capacity.

ix. Reasons for unpopularity:

This technology has yet not penetrated the cluster because of the following reason:

- ✓ Less knowledge on the dryer technology.
- ✓ Higher capital cost of the technology.
- ✓ No one has yet demonstrated the results of the technology to all unit owners in the cluster.

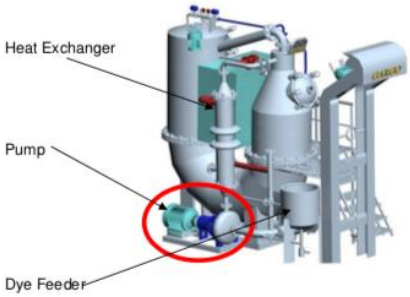
5. PLC Controlled Jet Dyeing Machine (For Surat Textile Cluster)

i. Cluster Brief:

Surat, known as the synthetic capital of India, is house to about 400 textile processing units, involved in processing of synthetic sarees and dress materials. The textile processing units can be broadly classified into 'Dyeing' units and 'Printing' units. Most of the units have the facilities of both dyeing and printing. The sarees and dress materials produced in Surat cluster are not only marketed in India but also exported to various countries. The textile processing units in Surat, are mainly micro, small and medium enterprises (MSMEs) and are spread over various location like Palsana, Sachin, Pandesara and Surat city industrial areas. The main raw material for the cluster is polyester grey cloth which is sourced from local polyester producers in and around Surat. Majority of the industries located in Surat are wet processing units which requires high amounts of thermal energy in the form of steam and thermic-fluid, leading to a high share of energy cost. The sector is unorganized in nature, mostly using old and inefficient technologies. There is a significant potential to make these units energy efficient and cost competitive, through accelerated adoption of energy efficient technologies in the cluster.

ii. Existing practice:

Textile processing units at Surat are equipped with multiple jet dyeing machine and most of them are operated manually. It is used for dyeing the cloth by forcibly contacting the jet flow of dyestuff chemical. It is done in such way that the cloth gets dyed evenly with a relatively less quantity of chemical without applying much tension on the cloth in order to keep the quality of the cloth intact. Other than that, the steam is used to raise the temperature of the dyeing solution through the heat exchanger this process under goes both heating and cooling cycle. In the present system, this operation is done manually where in the batch time depends on the skill of the person. More over the amount of water and chemical required for completing the process also depend of the individual operator's skill set.

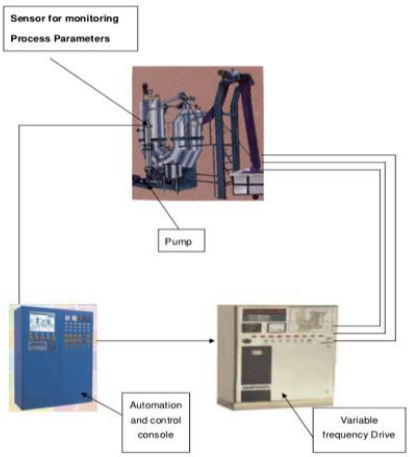


Existing jet dying machine

iii. Proposed technology:

Based on the detailed analysis of the jet dyeing process, it is proposed to install "Automation and control system in the machine". This system will be providing the following added advantages in the system.

- ✓ The automation system will optimize and reduce the batch time of the existing process.
- ✓ In enhances the overall production capacity.
- ✓ It automatically selects the heating and cooling cycle as per the process requirement and it also optimize the temperature as per the system requirement.



Proposed system

iv. Justification of technology selection:

This PLC based automation system optimizes the chemical, energy and time requirement of the batch:

- ✓ Less man power needed.
- ✓ Less time required for completing the batch.
- ✓ Less energy requirement for batch completion.
- ✓ Amount of water and chemical required is less.
- ✓ Reduction in steam consumption.

v. Energy & monitoring saving:

For calculating the energy and monetary benefits, a typical case of boiler of 8 tph capacity has been considered. The benefits envisaged through installation of boiler automation and control system has been summarized in the table below:

Parameters	Units	Values
Number of batches per day	Nos.	80
Mass of fabric per batch	kg/batch	250
Steam requirement	t/h	1.18
Initial water requirement	kg/d	200000
Steam Saving due to installation of PLC in Jet Dyeing	t/h	0.094
Water saving due to PLC system	kl/y	2745
Total monetary saving	Rs Lakh/y	7.3
Estimated investment	Rs. Lakh	26.4
Simple payback period	years	3.6

* extracts of calculation provided

The benefits can be summarized as:

- ✓ 3-8 % reduction in specific steam consumption
- ✓ 1-3 % reduction in specific water consumption
- ✓ Uniformity in colour
- ✓ Optimum process cycle including pressurization de-pressurization and cooling cycles.

Parameters	Units	Values
Annual fuel saving (one unit)	t/y	125
Annual thermal energy saving (one unit)	MJ/y	2508998
Annual fuel saving (considering 20% replication)	t/y	7992
Annual CO_2 emission saving (one unit)	tCO_2/yr	250
Annual CO2 emission saving (considering 20% replication)	tCO_2/yr	15993
Estimated investment in technology (one unit)	Rs in Lakh	10
Estimated investment in technology considering 20% replication (assuming price down due to demand aggregation)	Rs in Lakh	704

Parameters	Units	Values
Total Investment	in million USD	1.01
Life time energy saving	TJ	25.09
Life time CO_2 saving	tCO_2/yr	159934

vi. Replication Potential:

Based on the discussion with associations, units, sample survey and energy audits, it is estimated that the technology has a replication potential of 20% in the cluster. Based on 20% replication, the overall project benefits will be as follows:

vii. Availability of the technology:

There are good many technology providers available in India and many of them have their base in Surat. The following are the technology providers available in the cluster.

1. Semitronics Pvt. Ltd.
2. R. B Electronic and engineering Pvt. Ltd.
3. Sun Instrumentation and control.
4. S K controls Pvt. Ltd.
5. Electrocom technology India LTd.
6. Rekon Industries.

viii. Effect on the process

This technology increases the existing production process without increasing the capacity of the jet dyeing machine. It may also enhance the quality of the product.

ix. Reasons for unpopularity:

This technology has yet not penetrated the cluster because of the following reason:

- ✓ Less knowledge of the automation system.
- ✓ Higher capital cost of the technology.
- ✓ Less availability of skilled person for operating such system.
- ✓ No one has yet demonstrated the results of the technology to all unit owners in the cluster.

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