Energy Mapping of MSME Clusters - Pharma Sector

Submitted To:

Bureau of Energy Efficiency
Ministry of Power, Government of India

Submitted by:

National Productivity Council

National Productivity Council
New Delhi

February 2022

Acknowledgement

National Productivity Council (NPC) wishes to place on record its deep gratitude to the progressive management of Bureau of Energy Efficiency (BEE), Ministry of Power, Government of India for vesting its confidence in National Productivity Council to conduct the "Energy and Resource Mapping of MSME Clusters in India – Pharma Sector".

We express our gratitude to the following BEE officials for their valuable guidance and encouragement throughout the study.

Shri Abhay Bakre, Director General, Bureau of Energy Efficiency

Shri Dr. Ashok Kumar, Deputy Director General, Bureau of Energy Efficiency

Shri R.K. Rai, Secretary, Bureau of Energy Efficiency

Shri Milind Deore, Director, Bureau of Energy Efficiency

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Shri Bibek Ranjan, Project Engineer, Bureau of Energy Efficiency

We take this opportunity to express our appreciation for the excellent support provided by various MSME unit owners and the cluster Associations for their active involvement and valuable inputs in making the study successful.

We are thankful to all the executives, non-executives, and other staff, who have rendered co-operation and assistance to NPC team during the entire period of the study.

NPC Team

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Abbreviations

AHUs	Air Handling Units
AOD	Air Operated Diaphragm
APH	Air Pre heater
BDMA	Bulk Drugs Manufacturers Association
BEE	Bureau of Energy Efficiency
BLDC	Brushless DC Motor
CFM	Cubic feet per minute
CII	Confederation Indian industry
CMD	Contract Maximum Demand
deg C	degrees Centigrade
DIC	District Industries Centre
DISCOMs	Distribution Company
DPCO	Drug Price Control Order
EC	Electronic Commutation
ECM	Electronically Commutated Motor
EDQM	European Directorate of Quality Medicines
EER	Energy Efficiency Ratio
EESL	Energy Efficiency Services Limited
EET	Energy Efficient Technologies
ESCO	Energy Service Company
FBC	Fluidized Bed Combustion
FICCI	Federation of Indian Chambers of Commerce & Industry
FIs	Financial Institutions
GMP	Good manufacturing practice
GWh	Giga Watt hour
HRE	Heat Recovery
HSD	High speed Diesel
HVAC	Heating, Ventilation and Air conditioning
ICP	ISHRAE Certified Professional
IFC	Institutions for Collaboration
IPLV	Integrated Part Load value
IREDA	Indian Renewable Energy Development Agency Limited
ISHRAE	Indian Society of Heating, Refrigeration and Air Conditioning Engineers
ISHRAE	Indian Society of Heating, Refrigerating and Air Conditioning Engineers
kcal	kilo calories
KPIs	Key Performance Index
kW	Kilo Watt
LDO	Light Diesel Oil
M&V	Measurement and Verification
mm WC	millimetre of Water Column

MNRE	Ministry of New and Renewable Energy
MSME	Ministry of Micro, Small and Medium Enterprises
MW	Mega Watt
NBFCs	Non-Banking Financial Companies
NIPER	National Institute of Pharmaceutical Education and Research
NMRP	National Motors Replacement Program
NPC	National Productivity Council
O&M	Operation and Maintenance
OEM	Original Equipment Manufacturer
OPPI	Organisation of Pharmaceutical Producers of India
PAT	Perform, Achieve and Trade
PFIs	Participating Financial Institutions
Pharmexcil	Pharmaceutical Export Promotion Council of India
PM	Permanent Magnet Motor
PMC	Project Management Cell
PRSF	Partial Risk Sharing Facility
R&D	Research and Development
RBI	Reserve Bank of India
RMD	Recorded Maximum Demand
RT	Room Temperature
SDA	State Designated Agency
SEC	Specific Energy Consumption
SIDBI	Small Industrial Development Bank of India
T kcal	Tera kilo calories
TFH	Tonnes per hour
TOE	Tonne of oil Equivalent
UNNATEE	Unlocking National Energy Efficiency Potential
UOM	Units of Measurement
UTs	Union Territories
VFD	Variable Frequency Drive
VVR	Variable Volume Ratio
WHO	World Health Organization

Executive Summary

The industries in the MSME sector contribute to about 33% of India's manufacturing output and around 28% to the GDP. There are around 63 million MSMEs in India.

It is presumed that majority of the MSME units either has not adopted or lacks in awareness of energy efficiency and technology up-gradation measures since they have started operations and continues to depend on obsolete, low efficiency technologies resulting in excess energy consumption and wastages, and this further leads to reduced profitability and competitiveness of MSMEs.

Therefore, the MSME sector holds immense potential of adopting energy efficiency technology in routine processes. Nevertheless, there is still plenty of room for improvement in terms of concrete measures, most of the unit entrepreneurs claim not to have been able to identify any potential savings in their businesses.

Considering the important of energy conservation and urgent need to develop, demonstrate and disseminate energy efficient technologies at the cluster level, Bureau of Energy Efficiency (BEE) has evolved a comprehensive programme namely "National Programme on Energy Efficiency and Technology Up-gradation in SMEs" to address the various challenges faced by MSMEs in India.

For maximum effectiveness and widespread adoption of the energy efficient technologies in SME sector, BEE has introduced cluster-specific approach for technology deployment as demonstration projects towards creation of an enabling environment at the cluster level to aid in replications.

BEE has implemented various energy efficient technologies in various MSME clusters. Cluster level entities have also been strengthened by the means of empanelment of local service providers, dissemination workshops, capacity building of unit owners etc. In order to bringing behavioural changes towards energy efficiency, documents like Best Operating Practices, Common Monitor able Parameters, and Case Studies were developed and circulated among SMEs. BEE has also developed six audio-video tutorials covering the techno-economic analysis to showcase the success to other SME entrepreneurs.

This project focuses on mapping the Energy & Resource utilisation in the Pharmaceutical Sector by covering some of the SME Clusters in this sector. National Productivity Council has been assigned a project by the Bureau of Energy Efficiency, New Delhi, on "**Energy and Resource Mapping of MSME Clusters in India – Pharma Sector**". Under the above project, BEE desires to implement the road map with the policy recommendations and EE technologies in MSME Pharma sector. The study would primarily focus on Status of MSME Pharma sector, Technology status and EE improvements along with energy savings potentials in the sector. This report details the Policy recommendations and Road map of MSME clusters for Pharma sector in India.

The key observations of the study are summarised in the tables below:

Energy Benchmarks and Energy Efficiency potentials for MSME Pharma Sector

S. No	Description	UOM	Present EE level	Benchmarked EE Level	Percentage EE potential
1	Chiller	kWh/TR	1.27	0.60	52.69 %
2	AHU	kW/CFM	0.00102	0.00022	78.43 %
3	Air Compressor	kW/CFM	0.18	0.14	25.53 %
4	Pump	%	50.00	70.00	40.00 %
5	Vacuum Pump	kWh/m3	0.044	0.0264	40.60 %
6	Boiler & TFH	%	61.68	75.00	13.82 %

Summary of Electrical Energy Saving Potential in MSME Pharma-Units

SUMMARY OF ELECTRICITY SAVINGS IN PHARMA-UNITS			
S. No	**Energy System/Utility**	**Energy Savings**	**Ranking**
		GWh/year	**-**
1	Chillers	2926	1
2	AHUs	553	3
3	Air compressors	263	4
4	Pumps	1612	2
5	Vacuum Pumps	167	5
Total Annual Electrical Energy Savings potential in Pharma Sector		**5521**	
Total Annual GHG Emission reduction potential in Pharma Sector		**4520 x 10^6 (Tonnes of CO_2)**	
Total Baseline electricity consumption of the proposed EE		**14060**	
Total electricity consumption for the Pharma sector		**22873**	
Percentage electricity savings compared to baseline consumption (considering consumption of utilities upgraded)		**34%**	
Percentage electricity savings compared to total electricity consumption (considering consumption of utilities upgraded)		**24%**	

Summary of Thermal Energy Saving Potential in MSME Pharma Sector

SUMMARY OF THERMAL ENERGY SAVINGS IN MSME PHARMA SECTOR		
Parameters	**UOM**	**Value**
Number of Boilers proposed for energy efficiency upgrade	Nos	3578
Annual Thermal energy savings for Pharma Sector	T kcal/year	12
	TOE	12,37,340
Total Annual GHG Emission reduction potential in Pharma Sector	**38,35,754 (Tonnes of CO_2)**	

Baseline thermal energy consumption for the proposed EE	**T kcal/year**	**54**
Total Thermal energy consumption for the Pharma sector	**T kcal/year**	**80**
Percentage thermal savings compared to baseline consumption (considering consumption of utilities upgraded)	**%**	**22.88%**
Percentage thermal energy savings compared to total thermal energy consumption (considering consumption of utilities upgraded)	**%**	**15.56%**

Implementation Plan for MSME Pharma Sector

Technological Aspect:

I. There are about 8000 to 9000 MSME Pharma-Units operating in India. The total energy consumption is estimated to be 22,873 GWh (1.9millionTOE) of electricity and 128 million TOE of thermal energy consumption for the MSME pharma sector.

II. HVAC systems (Chillers, Package units and AHUs), Air compressors, pumping system and vacuum pumps constitute 92% of electricity consumption in MSME Pharma-Units and shall be the focus areas for energy efficiency programs.

III. Boilers and thermic heaters are the consumers of thermal energy in the form of solid fuels and liquid/gaseous fuels. Solid fuels constitute 62% of boilers/thermic heaters and balance 38% is consumed by that of liquid fuel fired.

IV. The key pointers for a business case energy efficiency improvement in pharma sector are:

- 70-80 % of chiller plants are operating with specific energy consumption more than the benchmark SEC.
- 91% of AHUs in MSME Pharma-Units are operating with SEC more than benchmark/best available technology.
- 63% of Air compressors are having SEC more than industry benchmark/OEM.
- 93% of Pumps in MSME Pharma-Units are operating with efficiencies less than benchmark efficiency for the industry or sector.
- All existing vacuum pumps can be replaced with new technology for vacuum pumps (e.g., Oil sealed screw compressors with VFD) offer upto 50% energy savings vis-à-vis the existing centrifugal vacuum pumps with fixed speed motor.
- At least 70% of boilers are operating with thermal efficiency less than the industry/OEM benchmark.

V. The EE technologies and interventions identified for MSME pharma sector are readily available in India through multiple OEMs and system integrators and sufficient experience has been gained by industry in other sectors as well as large Pharma-Units. These technologies include:

- Chillers- Chillers with Screw and Scroll compressors with VFD with Advanced micro pressor load scheduling, Variable volume ratio and precise magnetic levitation for shaft bearing.
- Air handling unit- Electronically Commutated motors (EC Motors) with inbuilt variable speed capability, light-weight materials for blades with aerodynamic shaping.
- Air compressor- Rotary Screw compressor with VFD option.
- Pumps- Energy efficient pumps with IE-3 motors and inbuilt VFD.
- Vacuum pumps- Oil sealed screw type vacuum pump directly coupled motor with inbuilt VFD
- Boilers & Thermic fluid heaters- Mechanised fuel feeding system with combustion control heat recovery (APH & Economizer) retrofit/replacement with FBC technology.

VI. The identified EE technologies for MSME pharma would result in 24% of existing electricity consumption and around 16% of existing fuel consumption. This corresponds to 5,521 GWh electricity savings and 12, 37,340 TOE fuel savings annually for MSME pharma sector.

Financial Aspect:

i. The energy efficiency program for MSME pharma sector would require financial resources toward workshops, seminars for creating awareness among key stake holders, capacity building of MSME workforce to adapt to and sustain the energy efficiency practices and systems, Pre and Post implementation assessment of energy consumption and energy savings accrued through measurement and verification, program management besides the major component of technology procurement. The following table summarizes the financial requirement to cover the entire spectrum of existing MSME Pharma-Units in the sector.

Table- 1: Summary of Budget Resources for EE program in MSME pharma sector

S. No	Parameters	UOM	MSME Pharma Unit	MSME Pharma Sector
1	Technology component	Million. Rs.	6.56	55964
2	Regional/national awareness program cluster level	Million. Rs.	-	20
3	Capacity Building of workforce	Million. Rs.	0.10	853
4	Program Management and M&V budget	Million. Rs.	0.66	5596
Total budget		Million. Rs.	7.32	62434

ii. The investment of the financial resources can be staggered by having the EE program for MSME pharma sector in a phased manner. To kickstart the program a pilot project with 400-500 MSME Pharma-units can be enlisted for

implementation through ESCOs such as EESL that would create enough awareness about the program and also would break the price barriers for many of the EE technologies identified. The phase-II of EE program can be market driven with the financial resources rooted through lending from FIs directly to MSME Pharma-Units, ESCOs, and OEMs through Partial risk sharing facility (PRSF) scheme by SIDBI thus the phasing of EE program for MSME pharma sector and use of PRSF would reduce financial risk for EESL and FIs and MSME Units.

Capacity Building:

i. MSME pharma sector is similar to any other MSME sector in terms of challenges it faces such as market competition, regulatory pressures and funding requirement for capital expenditure. The managements of MSME Pharma-Units are more focused towards meeting the regulatory requirements from the clients or regulatory authorities, Production and marketing and expansion of their business. In the pecking order of priorities expansion of business would take a lion's share in fund allocation as compared to funds available for renovation and modernization projects for improvement in energy efficiency. The business case for production improvement and expansion is much stronger as compared to that of business case for energy efficiency improvement despite the later one is attractive enough. In this context MSME pharma sector requires awareness about the requirement of energy efficiency in the light of climate change, favourable lending for EE projects in MSME sector.

ii. The workforce in MSME Pharma-Units is mostly untrained although qualified. They learn from experience which is just sufficient for routine O&M of the Energy System/Utilities. In most cases such workforce also is through outsourcing, which poses a challenge in-terms of maintaining a reasonable level of competent and improving it through regular training of the workforce. Every time the outsourced agency changes or the outsourced employee changes, the experience gained would be lost. This problem can be addressed by standardizing training and certification of workforce so that a minimum level of competency can be instilled in the entire spectrum of workforce working for MSME pharma sector. Even Pharma-Units can also insist on certification from the employees or outsourcing agencies.

iii. HVAC system which comprises of chiller, AHUs, majority of pumps and cooling towers consumes around 85% of electricity in a typical MSME pharma unit. The certification programs such as ISHRAE certified professional (ICP) from reputed professional bodies like ISHRAE can used to train at-least 2 personals from each pharma unit. The ICP program from ISHRAE is available from different modules of HVAC such as design, commissioning, servicing. It is recommended to develop a separate certification course with the support of ISHRAE for MSME pharma sector to improve and harmonize the technical capacities of workforce in MSME pharma sector that will enable maintaining and sustaining benefits of energy efficiency projects.

Other Recommendations:

i. The BEE shall engage industry associations at National and cluster levels in agreeing to a Charter on Climate Change for MSME Pharma-Units. The charter will elaborate the technology adoption time-lines by the MSME pharma sector. Since, such chatter is by the industries association representing the sector it would be binding on its member Pharma-Units.

ii. Conduct awareness programs about energy efficiency opportunities under the BEE road map as well as the agreed chatter for opinion makers, decision makers and other stake holders in MSME pharma sector such as industry associations, cluster level associations and individual MSME Pharma-Units.

iii. The capacity building program for workforce requires design and development of custom-made certification program by professional bodies like ISHRAE. Such program for capacity building shall also be part of the proposed Charter on Climate Change by MSME Pharma-Units.

iv. Energy Efficiency Services Limited (EESL) may be engaged for phase-I/Pilot phase of energy efficiency program involving technology component for 400-500 MSME Pharma-Units in India. This is expected to pave way for market transformation, market penetration of EE technologies identified for the sector which would result in traction for such technologies in remaining units where in the EE in MSME pharma sector can be implemented by lending directly to individual MSME Pharma-Units or ESCOs. The PRS facility of SIDBI would also play an important role in the Phase-II (market driven EE implementation for MSME sector).

v. The professional bodies and energy auditing companies who would be engaged for pre and post assessment studies, awareness programs shall be trained through workshops and seminars on EE opportunities in MSME pharma sector. This would enable availability of large pool of experts and consultants to work for the sector during the Phase-I and Phase-II implementation periods.

1 Introduction

1.1 Bureau of Energy Efficiency

Government of India has enacted Energy Conservation Act 2001. The Act provides for the legal framework, institutional arrangement and a regulatory mechanism at the Central and State level to embark upon energy efficiency drive in the country. The Government of India has set up Bureau of Energy Efficiency (BEE) on March 01, 2002 under the provision of the Energy Conservation Act, 2001. The mission of Bureau of Energy Efficiency is to assist in developing policies and strategies with a thrust on self-regulation and market principles with the primary objective of reducing energy intensity of the Indian economy within the overall framework of the Energy Conservation Act, 2001. BEE has initiated various Energy Conservation programmes and is implementing National flagship schemes such as Standards and Labelling programme for appliances and equipment, Perform, Achieve and Trade (PAT) for Designated Consumers under NMEEE, Demand Side Management initiatives in Agriculture, Municipalities, MSMEs, Capacity Building of DISCOMs & SDAs, Energy Conservation Building Code for Commercial buildings and ECO-Nivas Samhita for Residential Buildings. By all these schemes, BEE is encouraging to save energy, reduce CO2 emissions.

1.2 Background of the Study

The 'micro, small and medium enterprises' (MSME) sector plays a vital role in the Indian economy. It contributes to about 45% of manufacturing output and 40% of exports. MSMEs generally use inefficient technologies and practices. For maximum effectiveness and widespread adoption of the energy efficient technologies in SME sector, BEE has introduced cluster-specific approach for technology deployment as demonstration projects towards creation of an enabling environment at the cluster level to aid in replications.

National Productivity Council has been assigned a project by the Bureau of Energy Efficiency, New Delhi, on "**Energy and Resource Mapping of MSME Clusters in India – Pharma Sector**". Under the above project, BEE desires to carryout energy mapping of different energy intensive MSME clusters belonging to the Pharma sector.

1.3 Objective of the study

The objective of this assignment is to carryout energy mapping of different energy intensive MSME clusters belonging to the Pharma sector. The study would primarily focus on estimating the energy consumption, production, technology aspects in each of the chosen cluster and assess the energy intensity in the sector. The study would also include conducting techno-economic assessments for energy conservation in each cluster.

1.4 Scope of Work

National Productivity Council (NPC), New Delhi has been entrusted to conduct benchmark study for Pharma Sector and evolving suitable policy recommendations along with implementation roadmap to make the pharmaceutical sector in India Energy & resource efficient. Scope of work of the study includes the following:

1. Evolving suitable policy recommendations along with implementation road map to make the sector energy & resource efficient. The following methodology was adopted to achieve the objectives of the study;
   - Estimate the Production and Energy Consumption patterns in MSME Pharma Clusters
   - Estimate the scale of energy demand and opportunities for energy conservation
   - Evaluate existing technologies and energy saving potential in the clusters through Energy Audits
   - Assess the readiness of the sector for adoption of identified Energy Efficient (EE) technologies
   - Review of the existing institutional arrangements for energy efficiency improvement in the clusters
   - Resource requirement for MSMEs to implement EETs
   - Prepare an implementable road map for technological intervention to promote energy efficiency, including technology, financing and capacity building aspects along with the role of the relevant institutions at the national/state/cluster levels to actively encourage the promotion, adoption and sustained use of new efficient technologies among MSMEs in the sector.
2. Participating as a resource person in the various workshops for improving outreach as well as for dissemination of knowledge, based on the objectives of the study, both at cluster as well as national level.

2 MSME Pharma Sector Overview

2.1 Indian MSME Pharmaceutical Sector

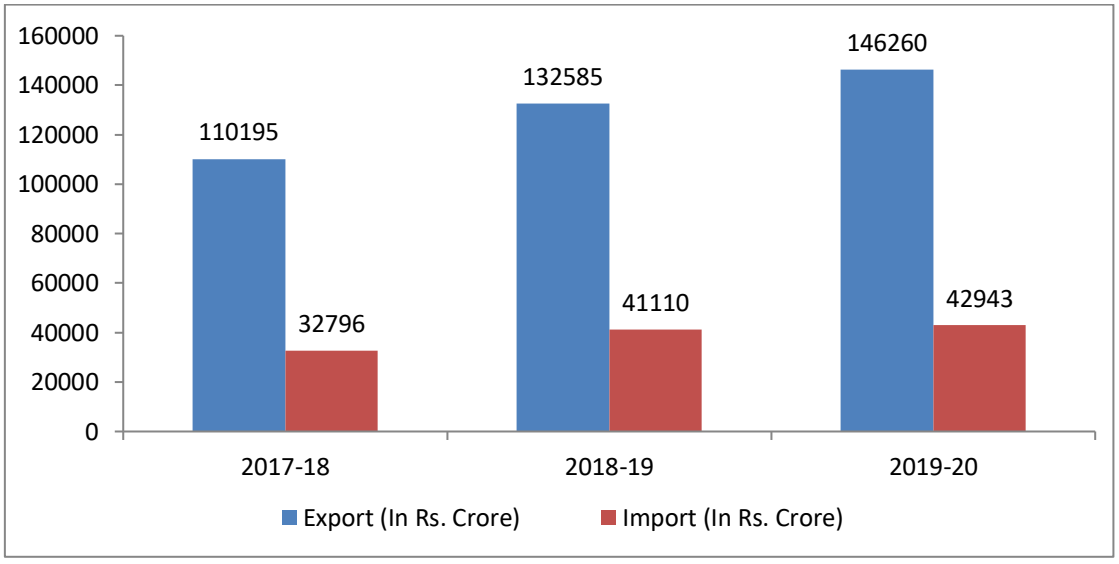
India's pharmaceutical industry is among the leading global producers of cost-effective generic medicines and vaccines, supplying 20 percent of the total global demand by volume and 62 percent of the global demand for vaccines. It is expected to play a key role in meeting the global demand for COVID-19 vaccines, especially for low- and middle-income countries[1].

India ranks third for pharmaceutical production by volume and 14th by value. The country has an established domestic pharmaceutical industry, with a strong network of 3,000 drug companies and about 10,500 manufacturing Units. Out of these, more than 2,000 Units are World Health Organization (WHO) good manufacturing practice (GMP) approved; 253 are European Directorate of Quality Medicines (EDQM)-approved plants; 1,105 have Europe's Certificate of Suitability (CEPs); more than 950 match therapeutic goods administration (TGA) guidelines; and 584 sites are approved by the US Food and Drug Administration (US FDA).

The pharmaceutical industry in India produces a range of bulk drugs, which are the key acting ingredients with medicinal properties that form the basic raw materials for formulations.

Bulk drugs account for roughly one-fifth of the industry output while formulations account for the rest. India also has the expertise for active pharmaceutical ingredients (APIs) and sees significant opportunities for value-creation. India is the source of 60,000 generic brands across 60 therapeutic categories and manufactures more than 500 APIs. According to the Confederation of Indian Industry, India's API industry is ranked the 3rd largest in the world, and the country contributes approximately 57% of APIs to the pre-qualified list of the WHO.

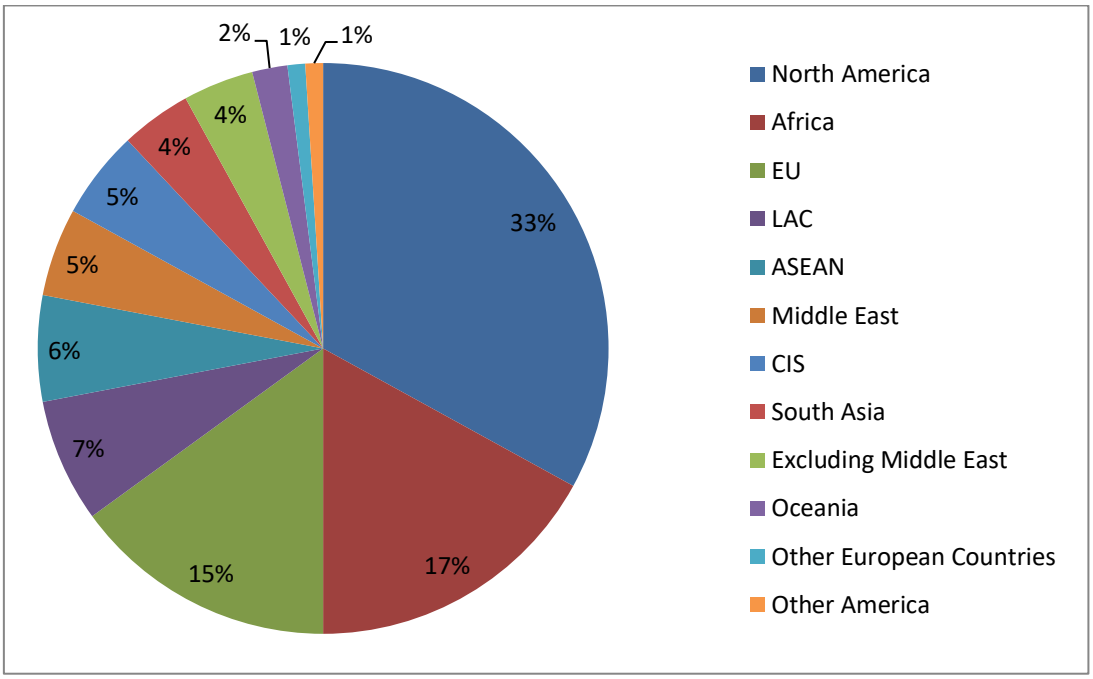
Figure 1: Trade in Pharmaceuticals[2]



[1]India's pharmaceutical industry, Posted by India Briefing and written by Melissa Cyrill, dated: April 13, 2021 https://www.india-briefing.com/news/indias-pharmaceutical-industry-investment-trends-opportunities-incentives-18300.html/

[2]Trade in Pharmaceuticals are taken from Annual Report 2020-2021, Page-4. Government of India, Ministry of chemicals & Fertilizers, Department of Pharmaceuticals

Figure 2: Region wise India's Pharma Exports3 FY 2019-20[4]



2.2 End-User Segment Insights

There are three overall stages in the production of bulk pharmaceutical products: (1) R&D, (2) conversion of natural substances to bulk pharmaceuticals, and (3) formulation of final products. Figure 3 provides an overview of the main process steps in the manufacture of pharmaceuticals. Each of these stages is described in more detail below.

Figure 3: Main process steps in the manufacture of Pharmaceuticals

Research & Development	•Four stages: •Pre-clinical R&D: determine if substance is active and safe (6 years) •Clinical R&D: human testing (6 years) •Review of new drug application (1-2 years) •Post marketing surveillance
Conversion of natural substances to bulk pharmaceutical substances	•Types of conversion: •Chemical Synthesis •Fermentation •Extraction
Formulation of Final products	•Conversion of substances at a much larger scale

[3]Trade in Pharmaceuticals are taken from Annual Report 2020-2021, Page-4. Government of India, Ministry of chemicals & Fertilizers, Department of Pharmaceuticals

[4] Source: Annual Report 2020-2021, Page-4. Government of India, Ministry of chemicals & Fertilizers, Department of Pharmaceuticals

2.2.1 Research & Development

Because it is highly regulated, R&D is the longest stage in pharmaceutical product manufacturing. After identifying several thousands of compounds at the beginning stages of R&D, only one will be introduced as a new pharmaceutical drug. Many resources go into this stage of development.

The four basic stages of R&D are listed above in Figure 3: (1) pre-clinical R&D, (2) clinical R&D, (3) review of new drug application, and (4) post marketing surveillance. In the preclinical R&D stage, compounds are tested on animals to determine biological activity and safety. This testing takes about six years on average to complete.

The next stage, clinical R&D, is typically conducted in three phases, each with progressively more human participants. The first phase of clinical R&D determines the safety of a new drug, the second phase determines a new drug's effectiveness, and the third phase provides further confirmation of safety and effectiveness along with determination of any adverse reactions. The clinical R&D stage altogether takes, on average, about six years to complete.

Finally, after a new drug has been approved for marketing, the CDSCO monitors the ongoing safety of marketed drugs via post marketing surveillance. Also, the pharmaceutical manufacturer will evaluate various ways of formulating the drug on a larger scale for optimum delivery.

2.2.2 Conversion to Bulk Pharmaceutical Substances

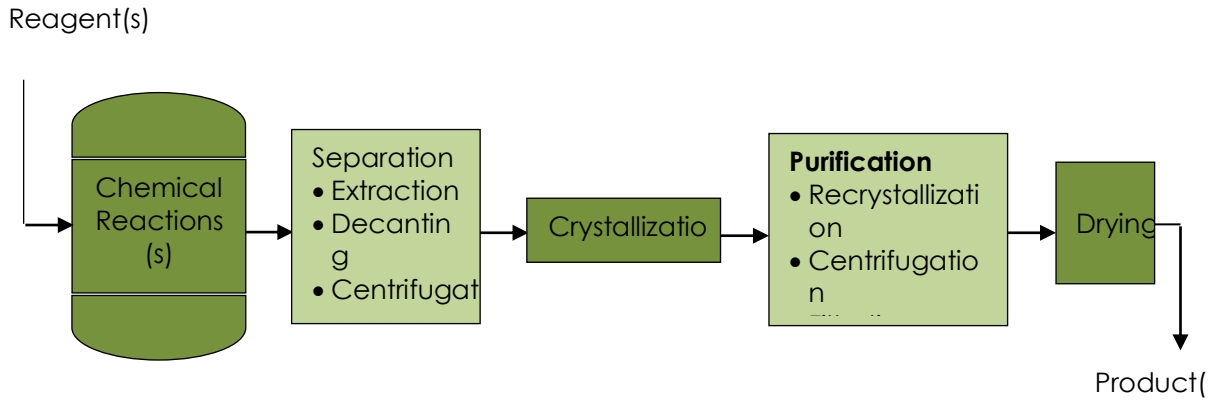
Bulk pharmaceutical substances are produced via chemical synthesis, extraction, fermentation, or a combination of these processes. Antihistamines, cardiovascular agents, central nervous system stimulants, and hormones are produced by chemical synthesis. Enzymes and digestive aids, allergy relief medicines, haematological agents, insulin, anti-cancer drugs, and vaccines are extracted from naturally-occurring substances. Most steroids, antibiotics, and some food additives, like vitamins, are produced by fermentation. Antibiotics, antineoplastic agents, central nervous system depressants, and vitamins are typically produced by more than one of these three processes.

Chemical synthesis, extraction, and fermentation are discussed separately below.

Chemical Synthesis

Figure – 4 shows a simplified diagram of the chemical synthesis process for pharmaceuticals. There are five primary stages in chemical synthesis: (i) reaction, (ii) separation, (iii) crystallization, (iv) purification, and (v) drying. Each of these five stages is described below.

Figure 4: Simplified Chemical Synthesis diagram



(i) **Reaction**: In the reaction process, raw materials are fed into a reactor vessel, where reactions such as alkylations, hydrogenations, or brominations are performed. The most common type of reactor vessel is the kettle-type reactor. These reactors, which are generally made of stainless steel or glass-lined carbon steel, range from 50 to several thousand gallons in capacity. The reactors may be heated or cooled, and reactions may be performed at atmospheric pressure, at elevated pressure, or in a vacuum. Generally, both reaction temperature and pressure are monitored and controlled. Nitrogen may be required for purging the reactor, and some intermediates may be recycled back into the feed. Some reactions are aided via mixing action provided by an agitator. A condenser system may be required to control vent losses. Reactors are often attached to pollution control devices to remove volatile organics or other compounds from vented gases.

(ii) **Separation**: The main types of separation processes are extraction, decanting, centrifugation, filtration, and crystallization. Crystallization is used by many plants and is discussed separately below.

The extraction process is used to separate liquid mixtures. Extraction takes advantage of the differences in the solubility of mixture components. A solvent that preferentially combines with only one of the mixture components is added to the mixture. Two streams result from this process: the extract, which is the solvent-rich solution containing the desired mixture component, and the raffinate, which is the residual feed solution containing the non-desired mixture component(s).

Decanting is a simple process that removes liquids from insoluble solids that have settled to the bottom of a reactor or settling vessel. The liquid is either pumped out of the vessel or poured from the vessel, leaving only the solid and a small amount of liquid in the vessel.

Centrifugation is a process that removes solids from a liquid stream using the principle of centrifugal force. A liquid-solid mixture is added to a rotating vessel - or centrifuge - and an outward force pushes the liquid through a filter that retains the solid phase. The solids are manually scraped off the sides of the vessel or with an internal scraper. To avoid air infiltration, centrifuges are

usually operated under a nitrogen atmosphere and kept sealed during operation.

Filtration separates fluid/solid mixtures by flowing fluid through a porous media, which filters out the solid particulates. Batch filtration systems widely used by the pharmaceutical industry include plate and frame filters, cartridge filters, nutsche filters, and filter/dryer combinations.

(iii) **Crystallization**: Crystallization is a widely used separation technique that is often used alone or in combination with one or more of the separation processes described above. Crystallization refers to the formation of solid crystals from a supersaturated solution. The most common methods of super saturation in practice are cooling, solvent evaporation, and chemical reaction. The solute that has crystallized is subsequently removed from the solution by centrifugation or filtration.

(iv) **Purification**: Purification follows separation, and typically uses the separation methods described above. Several steps are often required to achieve the desired purity level. Recrystallization is a common technique employed in purification. Another common approach is washing with additional solvents, followed by filtration.

(v) **Drying**: The final step in chemical synthesis is drying the product (or intermediates).Drying is done by evaporating solvents from solids. Solvents are then condensed for reuse or disposal. The pharmaceutical industry uses several different types of dryers, including tray dryers, rotary dryers, drum or tumble dryers, or pressure filter dryers. Prior to 1980, the most common type of dryer used by the pharmaceutical industry was the vacuum tray dryer. Today, however, the most common dryers are tumble dryers or combination filter/dryers. In the combination filter/dryer, input slurry is first filtered into a cake, after which a hot gaseous medium is blown up through the filter cake until the desired level of dryness is achieved. Tumble dryers typically range in capacity from 80 to 400 litres. In tumble dryers, a rotating conical shell enhances solvent evaporation while blending the contents of the dryer. Tumble dryers utilize hot air circulation or a vacuum combined with conduction from heated surfaces.

Product Extraction

Active ingredients that are extracted from natural sources are often present in very low concentrations. The volume of finished product is often an order of magnitude smaller than the raw materials, making product extraction an inherently expensive process.

Precipitation, purification, and solvent extraction methods are used to recover active ingredients in the extraction process. Solubility can be changed by pH adjustment, by salt formation, or by the addition of an anti-solvent to isolate desired components in precipitation. Solvents can be used to remove active ingredients from solid components like plant or animal tissues, or to remove fats and oils from the desired product. Ammonia is often used in natural extraction as a means of controlling PH.

Fermentation

In fermentation, microorganisms are typically introduced into a liquid to produce pharmaceuticals as by-products of normal microorganism metabolism. The fermentation process is typically controlled at a particular temperature and pH level under a set of aerobic or anaerobic conditions that are conducive to rapid microorganism growth. The process involves three main steps: (i) seed preparation, (ii) fermentation, and (iii) product recovery.

(I) **Seed preparation**: The fermentation process begins with seed preparation, where inoculum (a medium containing microorganisms) is produced in small batches within seed tanks. Seed tanks are typically 1-10% of the size of production fermentation tanks.

(II) **Fermentation**. After creating the inoculum at the seed preparation stage, the inoculum is introduced into production fermenters. In general, the fermenter is agitated, aerated, and controlled for pH, temperature, and dissolved oxygen levels to optimize the fermentation process. The fermentation process lasts from hours to weeks, depending on the product and process.

(III) **Product Recovery**: When fermentation is complete, the desired pharmaceutical by-products need to be recovered from the fermented liquid mixture. Solvent extraction, direct precipitation, and ion exchange may be used to recover the product. Additionally, if the product is contained within the microorganism used in fermentation, heating or ultra-sound may be required to break the microorganism's cell wall. In solvent extraction, organic solvents are employed to separate the product from the aqueous solution. The product can then be removed from the solvent by crystallization. In direct precipitation, products are precipitated out of solution using precipitating agents like metal salts. In ion exchange, the product adsorbs onto an ion exchange resin and is later recovered from the resin using solvents, acids, or bases.

2.2.3 Formulation of Final Products

The final stage of pharmaceutical manufacturing is the conversion of manufactured bulk substances into final, usable forms. Common forms of pharmaceutical products include tablets, capsules, liquids, creams and ointments, aerosols, patches, and injectable dosages.

To prepare a tablet, the active ingredient is combined with a filler (such as sugar or starch), a binder (such as corn syrup or starch), and sometimes a lubricant (such as magnesium sterate or polyethylene glycol). The filler ensures the proper concentration of the active ingredient; the purpose of the binder is to bond tablet particles together. The lubricant may facilitate equipment operation during tablet manufacture and can also help to slow the disintegration of active ingredients.

Tablets are produced via the compression of powders. Wet granulation or dry granulation processes may be used. In wet granulation, the active ingredient is powdered and mixed with the filler, wetted and blended with the binder in solution,

mixed with lubricants, and finally compressed into tablets. Dry granulation is used when tablet ingredients are sensitive to moisture or drying temperatures. Coatings, if used, are applied to tablets in a rotary drum, into which the coating solution is poured. Once coated, the tablets are dried in the rotary drum; they may also be sent to another drum for polishing.

Capsules are first constructed using a mold to form the outer shell of the capsule, which is typically made of gelatin. Temperature controls during the molding process control the viscosity of the gelatin, which in turn determines the thickness of the capsule walls. The capsule's ingredients are then poured (hard capsules) or injected (soft capsules) into the mold.

For liquid pharmaceutical formulations, the active ingredients are weighed and dissolved into a liquid base. The resulting solutions are then mixed in glass-lined or stainless-steel vessels and tanks. Preservatives may be added to the solution to prevent mold and bacterial growth. If the liquid is to be used orally or for injection, sterilization is required.

Ointments are made by blending active ingredients with a petroleum derivative or wax base. The mixture is cooled, rolled out, poured into tubes, and packaged.

Creams are semisolid emulsions of oil-in-water or water-in-oil; each phase is heated separately and then mixed together to form the final product.

2.3 Key Challenges

Strengths:

- Large untapped domestic market
- Low-cost manufacturing
- Availability of Trained Scientific Personnel
- Raw material available in sufficient quantity
- Existence of Technical Institutes
- Well-developed Infrastructural facilities
- Presence of number of Financial Institutions, Banks etc.

Weakness:

- Low margins
- Low investment in R & D
- Easier imports
- Finance available at high rate of interest
- Low Trust level
- Poor testing facilities
- Poor coordination with Govt. bodies and other related Organisations

Opportunities:

- Possibility of establishing Common Testing Laboratories
- Globalisation can ensure tremendous market potential
- Enterprises can join hands together for overseas market, brand building and participation in trade fairs.

- New Drug Price Control Order – exempting drugs from falling under DPCO for a period of 15 years, provided the drug is developed through indigenous R & D and is patented under the Indian Patent Act, 1970.

Threats:

- China threat – capacity to deliver huge quantity at low price
- Increasing competition
- Investment in Plant & Machinery will increase in order to fulfil the norms of 'Schedule M' of Drugs and Cosmetic Act irrespective of assured market
- Burden of Taxes increasing
- Product Patent Law will be made compulsory

2.4 Geographical Coverage

2.4.1 Pharmaceutical Clusters in India

There are several pharmaceutical clusters in India. Andhra Pradesh, Gujarat, Maharashtra, and Goa are the major pharmaceutical manufacturing clusters in the country. The bulk drug clusters are located primarily in Ahmedabad, Vadodara, Mumbai, Aurangabad, Pune, Hyderabad, Chennai, Mysore, Bangalore, and Visakhapatnam (Vizag).

The number of pharmaceutical Units by state/UT in India are presented below:

Table- 2: Pharmaceutical Units by State and Union Territory in India[5]

S. No	State/UTs	Cluster Names	No. of Pharma Units
1	Andhra Pradesh	Visakhapatnam, Parwada	261
2	Arunachal Pradesh	NIL	NIL
3	Assam	Kuruwa	25
4	Bihar	Patna & Hajipur	89
5	Chhattisgarh	Raipur	31
6	Goa	Margaon	51
7	Gujarat	Ahmedabad, Pune, Ankleshwar, Vapi & Baroda	3332
8	Haryana	Gurgaon	31
9	Himachal Pradesh	Baddi	555
10	Jammu & Kashmir	Jammu/Srinagar	55
11	Jharkhand	Ranchi	44
12	Karnataka	Bidar& Bengaluru	376
13	Kerala	Palakkad, Thiruvananthapuram & Thrissur	100
14	Madhya Pradesh	Indore, Dhar & Ujjain	267
15	Maharashtra	Aurangabad, Pune, Mumbai & Thane	929

[5] The pharmaceutical Units by state and Union Territory wise are taken from the Article- India Briefing and written by Melissa Cyrill, dated: April 13, 2021 https://www.india-briefing.com/news/indias-pharmaceutical-industry-investment-trends-opportunities-incentives-18300.html/

S. No	State/UTs	Cluster Names	No. of Pharma Units
16	Manipur	NIL	NIL
17	Meghalaya	NIL	NIL
18	Mizoram	NIL	NIL
19	Nagaland	NIL	NIL
20	Odisha	Cuttack & Bhubaneswar	18
21	Punjab	Amritsar, Bathinda, Nawanshahar & Derabassi	156
22	Rajasthan	Jaipur	128
23	Sikkim	Sikkim	45
24	Tamil Nadu	Chennai, Mical& Tiruvallur	514
25	Telangana	Hyderabad & Medak	523
26	Tripura	Agartala	6
27	Uttarakhand	Hardwar	220
28	Uttar Pradesh	Kanpur	408
29	West Bengal	Kolkata	180
30	Pondicherry	-	86
31	Andaman & Nicobar Island	NIL	NIL
32	Chandigarh	-	5
33	Delhi	NCR	63
34	Dadra & Nagar Haveli and Daman & Diu	Silvassa	34
35	Lakshadweep	NIL	NIL
Total no of Units			**8532**

2.4.2 MSME Pharmaceutical Associations in India

The MSME Pharmaceutical Associations[6] in India are as follows.

Table- 3: Pharmaceutical Associations in India

S. No	Name of the Association
1	Gujarat Chemical Association, Ahmedabad
2	Gujarat Dyestuff Manufacturers Association, Ahmedabad
3	Indian Drug Manufacturers Association
4	Naroda Industries Association, Naroda (Ahmedabad)
5	Pardi Industrial Association, Ahmedabad
6	Vapi Industries Association
7	Vatva Industrial Estate
8	Visnagar Industries Association

[6]Pharmaceutical Associations are taken from "Status Paper – Pharmaceuticals Clusters in India by Amar Singh, Foundation for MSME Cluster"

S. No	Name of the Association
9	Drug Manufacturers Association (DMA)
10	Pharma Manufacturers Association (PMA)
11	Association of Pharma Manufacturers (APM)
12	Bulk Drugs Manufacturers Association (BDMA), Ahmedabad
13	Organization of Pharmaceutical Manufacturers (OPM)
14	Nalgonda Drugs Manufacturers Association (NDMA)
15	Pashamylaram Industrial Services Society (PISS)
16	Madhya Pradesh Pharmaceutical Manufacturers Organization(MPPMO)
17	Madhya Pradesh Small Scale Drugs Manufacturers Association(MPSSDMA)
18	Madhya Pradesh Ayurvedic Manufacturing Association (MPAMA)
19	Indian Drug Manufacturers Association (IDMA)
20	Indian Pharmaceutical Association (IPA)
21	Organisation of Pharmaceutical Producers of India (OPPI)
22	All India Manufacturers Organisation (AIMO)
23	All India Organisation for Chemists and Druggists (AIOCD)
24	Goa Pharmaceutical manufacturers' Association (GPMA)
25	Goa State Association of Chemists & Druggists
26	Goa Small Industries Association (GSIA)
27	Goa Chamber of Commerce & Industry (GCCI)
28	Confederation of Indian Industries (CII)
29	Chemists & Druggists Association of Goa (CDAG)
30	Retail Druggists and Chemists Association
31	Chemexil, Ahmedabad
32	Vatva Industrial Association
33	Medical Disposable Manufacturers Association (MDMA)
34	Utkal Pharmaceutical Manufacturers Association (UPMA)
35	Orissa Small Scale Industries Association (OSSIA)
36	Orissa Assembly of Small & Medium Enterprises (OASME)
37	Orissa & Orissa Industries Federation (OIF)
38	Orissa Young Entrepreneurs Association (OYEA)
39	Utakal Chamber of Commerce & Industry (UCCI)
40	Thane Belapur Industries Association (TBIA)

Central Public Sector Units, Govt of India[7]

1. Hindustan Organic Chemicals Ltd HOCL), Rasayani, Maharashtra.
2. Hindustan Insecticides Ltd, New Delhi.
3. Indian Drugs & Pharmaceuticals Ltd (IDPL), Dundahera (Haryana).
4. Hindustan Antibiotics Ltd (HAL), Pimpri, Pune, Maharashtra.
5. Smith Stanistreet Pharmaceuticals Ltd. (SSPL), Kolkata.

[7] Central Public sector Units and Joint sector undertakings are taken from "Status Paper – Pharmaceuticals Clusters in India by Amar Singh, Foundation for MSME Cluster"

6. Bengal Chemicals & Pharmaceuticals Ltd (BCPL), Kolkata.
7. Bengal Immunity Limited (BIL), Kolkata, West Bengal.

Joint Sector Undertakings:

1. Rajasthan Drugs & Pharmaceuticals Limited (RDPL)
2. Orissa Drugs & Chemicals Limited (ODCL)
3. Karnataka Antibiotics & Pharmaceuticals Limited (KAPL)
4. Maharashtra Antibiotics & Pharmaceuticals Ltd. (MAPL)
5. Manipur State Drugs & Pharmaceuticals Limited (MSDPL)

Wholly Owned Subsidiaries:

1. IDPL (Tamil Nadu) Limited, Chennai
2. Bihar Drugs & Organic chemicals Limited, Muzaffarpur

Other Organisations:

1. Petrofils Cooperative Ltd, PO Petrofils, District-Vadodara, Gujarat.
2. Central Institute of Plastics Engineering & Technology, Guindy, Chennai.
3. Institute of Pesticides Formulation Technology, Gurgaon, Haryana.
4. National Institute of Pharmaceuticals Education and Research, Mohali, Punjab.

2.4.3 MSME Pharmaceutical Clusters[8] in India

The concentration of pharmaceutical small and medium scale Units are spread over the following regions:

Table- 4: MSME Pharmaceutical Regions in India.

S. No	Region	Production Value Per Annum (Rs. In Crores)	Estimated Employment
1	Maharashtra (Mumbai-Pune and Aurangabad)	12000-15000	65000
2	Gujarat (Ahmedabad-Vadodara)	10000-12000	55000
3	Delhi-UP and Haryana	5000	25000
4	Madhya Pradesh (Indore)	2500	15000
5	Uttarakhand (Dehradun)	2000	20000
6	Andhra Pradesh (Hyderabad-Medak)	8186	20000
7	Cuttack-Bhubaneswar		1400

The MSME Pharmaceutical Clusters in India are presented below.

[8] MSME Pharmaceutical Clusters are taken from "Status Paper – Pharmaceuticals Clusters in India by Amar Singh, Foundation for MSME Cluster"

Table- 5: MSME Pharmaceutical Clusters in India

S. No	Name of the Cluster	State	Estimated No. of Units	Estimated Turnover of the Cluster	Estimated No. of Employment
1	Hyderabad	Andhra Pradesh	391	8187	20000
2	Medak	Andhra Pradesh	136		
3	Ahmedabad	Gujarat	1290	10250	41000
4	Vapi	Gujarat			
5	Margao	Goa	50	1600	1500
6	Aurangabad	Maharashtra			
7	Pune	Maharashtra			
8	Thane	Maharashtra	37	130	1700
9	Indore	Madhya Pradesh	350	2034	20000
10	Bhubaneswar	Orissa	54	20	1400
11	Tiruvallur	Tamil Nadu			
12	Dehradun	Uttarakhand	290	1748	16074

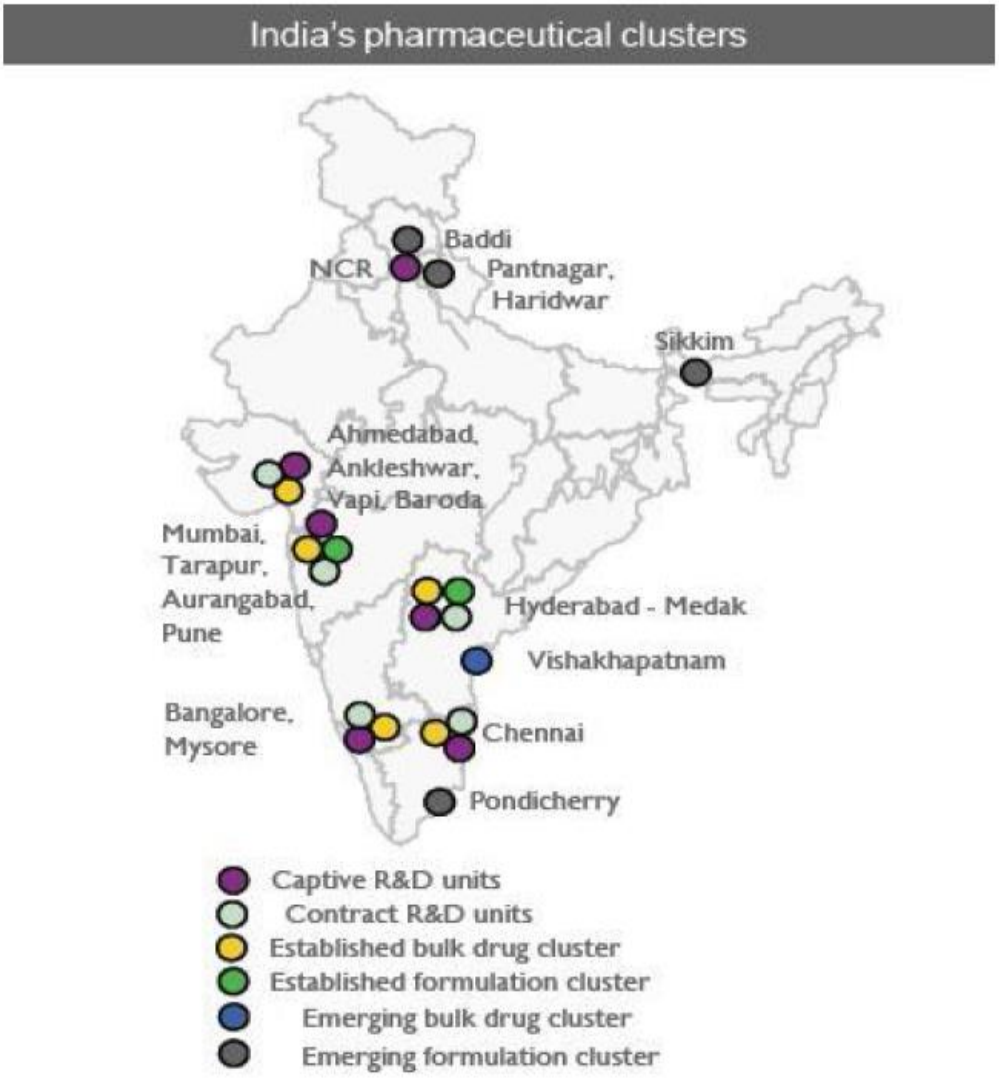


Figure 5: Map of India's Pharmaceutical Clusters in MSME

2.5 Sector Level Stake Holders

2.5.1 Institutions Supporting MSME Pharma Sector

The following institutions have been identified as the key institutions that are actively supporting are potential to support MSME Pharma sector especially in energy efficiency improvements.

Table - 6: Details of Institutions supporting MSME Pharma sector

S. No	Name of the Institution	Category
1	District Industries Centre (DIC)	Government (facilitator)
2	Pharmaceutical Export Promotion Council of India (Pharmexcil)	Government (Pharmaceutical Exporter)
3	National Institute of Pharmaceutical Education and Research (NIPER)	Government (Pharmaceutical R&D)
4	Organisation of Pharmaceutical Producers of India (OPPI)	It represents the research-based pharmaceutical companies in India
5	Bulk Drugs Manufacturers Association (BDMA)	It serves as a coordinator and catalyst between the government and the industry.
6	Energy Efficiency Services Limited (EESL)	Energy Servicing company
7	Small Industrial Development Bank of India (SIDBI)	Financial institution and anchor institution for partial risk sharing facility
8	Indian Renewable Energy Development Agency Limited (IREDA)	Financial institution for renewable and energy efficiency
9	Indian Society of Heating, Refrigeration and Air Conditioning Engineers (ISHRAE)	Professional body for heating ventilation and refrigeration
10	State Designated Agency (SDA)	Government (facilitator)

The detailed Roles and Responsibilities of the institutions supporting MSME Pharma sector are as follows.

1. Institutions for Collaboration (IFCs)

Several IFCs exist in the pharmaceutical cluster in AP. They exist at both the national and state level and provide support to the industry. However, little data exists demonstrating the effectiveness of these IFCs and there seems to be a lack of coordination among the public sector supported IFCs and the private sector associations. Some of the key public sector-led IFCs include:

a) **State Designated Agency (SDA)** - State level agency for implementing energy conservation act. Supports MSME Units with technical assistance for assessment energy audits and conducts training programs and awareness programs on energy efficiency

b) **District Industries Centre (DIC)** - Provides single window service to units in getting approvals. Most cluster firms utilize DIC services including registration, approvals, and incentives.

c) **Pharmexcil - Pharmaceutical Export Promotion Council (Pharmexcil)** has been set up for the purpose of export promotion in the pharmaceutical industry. Pharmaceutical Export Promotion Council of India (Pharmexcil) is the authorized agency of the government of India for promotion of pharmaceutical exports from India. It was set up under the provisions of Foreign Trade Policy by the Ministry of Commerce and Industry in May 2004. Various pharmaceutical products, namely, bulk drugs, formulations, Biotech Products, Indian Systems of medicines, herbal products, diagnostics, clinical research, etc. are covered under its purview. Pharmexcil takes up several external trade promotion activities by organizing trade delegations outside India, arranging buyer-seller meetings, international seminars, etc.

d) **National Institute of Pharmaceutical Education and Research (NIPER)** - Imparts training to entrepreneurs. NIPERis the first national level institute in pharmaceutical sciences with a proclaimed objective of becoming a centre of excellence for advanced studies and research in pharmaceuticals sciences. The Government of India has declared NIPER as an 'Institute of National Importance'. It is an autonomous body set up under the aegis of Department of Pharmaceuticals, Ministry of Chemicals and Fertilizers, Government of India. The Institute is conceived to provide leadership in pharmaceutical sciences and related areas not only within the country, but also to the countries in South East Asia, South Asia and Africa. NIPER is a member of Association of Indian Universities and Association of Common wealth Universities.

e) **Research Centres** - Scientific & research institutions such as the Centre for Cellular and Molecular Biology, Indian Institute of Chemical Technology, Centre for DNA Fingerprinting and Diagnostics, and National Institute of Nutrition are working with the pharmaceutical industry. In the private sector, several industry associations exist. The main objective of these associations is to lobby for favourable government policies. Leading associations include the Organization of Pharmaceutical Producers of India (OPPI) and Bulk Drugs Manufacturers Association (BDMA).

❖ **OPPI - Organisation of Pharmaceutical Producers of India:**

The Organisation of Pharmaceutical Producers of India (OPPI) was established in 1965 and represents the research-based pharmaceutical companies in India. OPPI remains committed to supporting the nation's healthcare objectives and collaborating with all stakeholders to find sustainable solutions. OPPI believes the need for innovation must be balanced with the necessity for more accessible medicines, within a robust IP environment. A holistic approach is needed to expand healthcare in India and OPPI believes the pharmaceutical industry can form part of the solution.

OPPI's stringent Code of Pharmaceuticals Practices binds all our member companies. OPPI has constituted an Ethics & Business Integrity Work Group. N.Rajaram, Managing Director, Sanofi India Ltd & Sanjay Murdeshwar, Managing Director, Novartis India Ltd are the Chairs of this Work Group for 2020.

❖ **Bulk Drugs Manufactures Association:**

The Bulk Drug Manufacturers Association (India) was formed in 1991 with Hyderabad as its Head Quarters. This is an all-India body representing most of the Bulk Drug Manufacturers of India. The Association works for the consolidation of gains of the

industry and serves as a coordinator and catalyst between the government and the industry for the growth of the industry.

The Association works for consolidation of the gains of the industry and serves as a catalyst between Government and the Industry on the various issues for the growth of the industry. To build on India's existing strength in manufacturing and Distribution and substantial enhance the beginnings made in R&D in order to become one of the leading players in the global pharmaceutical market.

To promote the consideration and discussion of all the questions affecting the Bulk Drug Industry in India among all members and serve as a common forum for formulating their views on all matters including national, economic, financial, commercial and related policies concerning the growth of the Bulk Drug Industry.

2.6 Overview of Energy Efficiency Opportunities for MSMEs Pharmaceuticals

A variety of opportunities exist within Indian pharmaceutical laboratories, manufacturing facilities, and other buildings to reduce energy consumption while maintaining or enhancing productivity. Table 6 categorizes available energy efficiency opportunities by the six major activity areas listed: (1) R&D, (2) bulk manufacturing, (3) formulation, packaging and filling, (4) warehouses, (5) offices, and (6) miscellaneous. For each major activity area, Table 6 also provides references to the sections in this Energy Guide that describe relevant energy efficiency measures. Measure descriptions include case studies for Indian pharmaceutical plants with specific energy and cost savings data, when such case study data are available. For measures where data are not available for Indian pharmaceutical plants, this Energy Guide includes case study data from non-Indian pharmaceutical facilities or case study data from similar industries (for example, chemical manufacturing). For individual pharmaceutical facilities, the actual payback period and savings associated with a given measure will vary depending on facility activities, configuration, size, location, and operating characteristics. Hence, the values presented in the Energy Guide are offered as guidelines. Wherever possible, this Energy Guide will provide a typical range of savings and payback periods for each measure found under varying conditions. Although technological changes in equipment conserve energy, changes in staff behaviour and attitude can also have a great impact. Energy efficiency training programs can help a company's staff incorporate energy efficiency practices into their day-to-day work routines. Personnel at all levels should be aware of energy use and company objectives for energy efficiency improvement. Often such information is acquired by lower-level managers but neither passed up to higher-level management nor passed down to staff (Caffal 1995). Energy efficiency programs with regular feedback on staff behaviour, such as reward systems, have had the best results. Though changes in staff behaviour (such as switching off lights or closing windows and doors) often save only small amounts of energy at one time, taken continuously over longer periods they can have a much greater effect than more costly technological improvements. Other staff actions such as the closing of fume hood sashes could result in significant and immediate improvement.

Table- 7: Energy efficiency opportunities[9] for the pharmaceutical industry, categorized by major activity area.

RESEARCH AND DEVELOPMENT	BULK MANUFACTURING
Energy Management HVAC Fume Hoods Cleanrooms Lighting	Energy Management HVAC Cleanrooms Motor Systems Compressed Air Systems Pumps Refrigeration Heat and Steam Distribution
FORMULATION, PACKAGING AND FILLING	**OFFICES**
Energy Management HVAC Cleanrooms Motor Systems Compressed Air Systems Pumps Refrigeration Lighting	Energy Management HVAC Lighting Miscellaneous
WAREHOUSES	**MISCELLANEOUS**
Energy Management HVAC Motor Systems Refrigeration Lighting	Energy Management HVAC Motor Systems Lighting Heat and Steam Distribution Cogeneration Miscellaneous

[9] Energy Efficiency opportunities for the Pharmaceutical Industry are taken from "Energy efficiency improvement and cost saving opportunities for the pharmaceutical industry by Energy Star, march 2008"

3 Energy Consumption and Benchmarking

3.1 Energy Consumption and Demand of MSME Pharma Sector

3.1.1 Production and Energy Linkages

MSME Pharma-Units widely vary in terms of products they manufacture, production capacities and product mix. The products manufactured by MSME Pharma-Units would also change from year to year based on market conditions as well as number of products produced in a single unit can be as high as 13observed from Cluster level studies. The following table indicates typical products manufacture by MSME Pharma-Units.

Table- 8: List of Representative Products Manufactured by MSME Pharma-Units

S. No	Plant Name	Cluster	Manufactured Products	No. of Products
1	Benova Labs Private Limited	Medak	Telmisartan, Olmisartan, Linezolid, Levoslpiride	4
2	Hitesh Chemicals & Drugs	Medak	Methyl Isothiocyanate (MITC), 4-Methyl Thiosemicarbazide, Ethyl Isothiocyanate and n-Propyl Isothiocyanate	4
3	KRS Pharmaceuticals	Medak	Anti Ulceratives, Anti-Fungal, Anti-Depressant, Anti-Histamine, Anti Emetic, Benigan Prostatic Hyperplasia, Anti-Convulsant, Central Nervous System, Cardiac, Cardiovascular, Coronary Artery, Iron-Chelator.	12
4	Pellets Pharma Limited	Medak	Extended/Sustained Release Pellets, Delayed Release Pellets, Immediate Release Pellets, Blended Pellets.	4
5	Sigachi Industries Limited	Medak	1. Coprocessed Excepients. - BARETab™ 2. Thickeners/Stabilizers - HiCel™ MCG. 3. Binders. - HiCelTM, AceCel® 4. Superdisintegrants - HiLoseTM 5. Functional Fillers. - GloCelTM, FillerLacTM 6. Carriers. - HiCel™ MCC Spheres	6
6	SMS Life Sciences India Limited	Medak	Ranitidine HCL (Form-2) USP/ Ph. Eur, Famotidine USP/ Ph. Eur/ JP, Lanoconazole USP/JP, Sildenafil Citrate USP/Ph. Eur.	4
7	Sri Chaitanya Chlorides	Medak	Trichloro Acetyl Chloride, Chloro Acetyl Chloride, Hydro Chloric Acid, Cis Bromo Benzoate, DFTA, Sodium Hypochloride, 2,4-Diflurophenyl-Alpha-(1H-1,2,4-Triazole Acetophenone, IT7, IT9 and Formamidine Acetate.	9
8	Synthokem Labs	Medak	**a) APIS:** Guaifenesin, Mephenesin, Chlorphenesin, Methocarbamol, Potassium Guaiacol Sulfonate, Chlorphenesin Carbamate, Drotaverine Hydrochloride, Mebeverine Hydrochloride, Terazosin Hydrochloride, Prazosin Hydrochloride **b) INTERMEDIATES/FINE CHEMICALS:** 2-Amino-5-Chloro Pyridine, 2,3-Dichloro Benzoyl Cyanide, 1,2-Diethoxy Benzene, 3,4-Diethoxy Phenyl	13
9	Veer Chemie&	Medak	Benzyl Nicotinate, Myristyl Nicotinate,	7

S. No	Plant Name	Cluster	Manufactured Products	No. of Products
	Aromatics Private Limited		Niacinamide, Niacinamide Ascorbate, Niacinamide (Extrapure), Sodium Ascorbyl Phosphate, Tocopheryl Nicotinate.	
10	Vega Life Sciences	Medak	DCC, IPA, Methanol, AEAE and O-Xylane.	5
11	Chiral Bio sciences	Bidar	ARVs [Anti Retro Virals], Anti-Hypertensive [SARTANS], Anti Diabetic etc.	3
12	Chorus Labs	Bidar	Diclofenac Sodium, Etodoloc, Terbinafine Hcl, Nevirapine, Efavirenz & Rivastigmine Hydrogen Tartrate	5
13	R Chem Private Limited	Bidar	Cipro Acrylate, Daftmen base, Sodium Methyl Thionate solution, Sodium Sulphate & Dimethyl Sulphoxide.	5
14	Sri Lakshi Chemicals Limited	Bidar	5 Cyanopthalide, ribofuranose, ethenone, fluconazole, gabapentin, and other etc.	5
15	Sreeven Pharma Pvt Ltd	Bidar	Aceclofenac Paracetamol Tablets, Antiseptic Medicine, Bulk Drugs, and syrups.	4
16	Vani Organics	Bidar	Sodium Bi Sulphite, Pentaprazole, and Bendimidazole 2-Phenyl Methyl Pyrazolone.	3
17	Fortschritt Healthcare Limited	Baddi	Soft Gelatin Capsules, Liquid Orals, Oral Dry Powder, Medicinal Soap, Hair Care Shampoo, Nutrition Supplements, Oncology Medicines and Pharmaceutical Medicines.	6
18	Ayurvet Limited	Baddi	Herbal Veterinary Medicines and Feed Supplements range comprising of Powders, Liquids, Bolus, Capsules & Ointment / Gel	5
19	Hanucham Laboratories	Baddi	Tablets, Liquid Orals, Capsules, Ointment & External Prepration, Dry Powder Injection & Veterinary Division	6
20	Cipla Limited	Goa	Teicoplanin, Pantoprazole, Omeprazole, Azithromycim, Remidsivir etc	5
21	Medizest Pharmaceuticals Pvt Ltd.	Goa	1. Tablets – Uncoated, Sugarcoated,Film coated, Dispersible& Chewable 2. Liquid Orals – Syrups, Suspensions &Emulsions 3. Derma Products – Ointments, Creams & Gels	3

The multitude and variety of products manufactured in MSME Pharma-Units makes the establishing products and energy linkages an impossible task especially with know discretion data or system available for monitoring energy consumption for individual product. The overall Specific Energy Consumption is also observed to be varying widely from 190-14000 kWh/ton of product on account of product type, product mix and scale of operation. Accordingly, the energy consumption has to be linked to the energy consuming utilities and systems with their respective outputs to analyse energy consumption patterns and bring out energy efficiency improvements in pharma sector. The major energy consuming systems/utilities are discussed in the following.

3.1.2 Energy Consuming Systems

Based on Cluster level studies the major energy consuming systems/utilities in MSME Pharma sector are detailed below with respective measures/KPIs for energy efficiency levels.

Table- 9: Energy consuming systems/utilities in MSME Pharma sector

S. No	Energy Utility/System	KPI for Measurement of Energy Efficiency Levels
1	HVAC system - Chiller plant	The Chiller plant performance primarily depends on capacity (TR), Technology (Reciprocating/Screw), Capacity control (with or with-out VFD). The performance of chiller is reported in kW/TR and the same is used as energy KPI. The chiller energy KPI of MSME Units is also compared with that of chillers from large Pharma-Units. The gap between chiller performance of MSME unit and large Units would provide a clue regarding effect of better O&M practice that large pharma unit may have deploy. Further the energy KPI data from OEMs has been collected to estimate the performance gap between existing chillers in MSME unit's vis-a-vis performance possible with latest technology/best available technology
2	HVAC system – Air Handling Unit	The energy consumption of Air handling unit depends on capacity (CFM), the static pressure and technology (Ac induction motor coupled with belt drive, EC motor direct coupled). The energy KPI for air handling unit is W/CFM.
3	Compressed Air system – Air compressors	The Energy KPI of kW/CFM is used for compressed air system. The energy performance of compressed air system depends on capacity (CFM), technology (Reciprocating/Screw), O&M practices and pressure settings.
4	Pumps	The pump efficiency (in percentage) is the energy KPI for pumping system covering flow, head requirements. The pump efficiency also depends on O&M practices, vintage of the pump. The operating pump efficiency is benchmarked with pump efficiency that is generally possible and available in the market.
5	Vacuum Pumps	Vacuum pumps are used to create vacuum in production reactors, solvent recovery Units and vacuum requirement ranges between 600-720 mm hg. The energy consumption of vacuum pumps depends on capacity (m^3/hr), vacuum requirement, technology (centrifugal/screw). The energy KPI for vacuum pumps is kWh/m^3.
6	Boilers & Thermic Fluid Heaters	The thermal efficiency (%) is the energy KPI for Boilers and Thermic fluid heaters that would encapsulate various influencing factors such as output capacity (TPH steam, M kcal/hr for thermic heaters) fuel used (solid fuel/Liquid fuel/Gaseous fuel), presence of heat recovery systems (APH and economizer), combustion control.

3.1.3 Energy Consumption Pattern of MSME Pharma Units

3.1.3.1 Electrical Energy Consumption Analysis

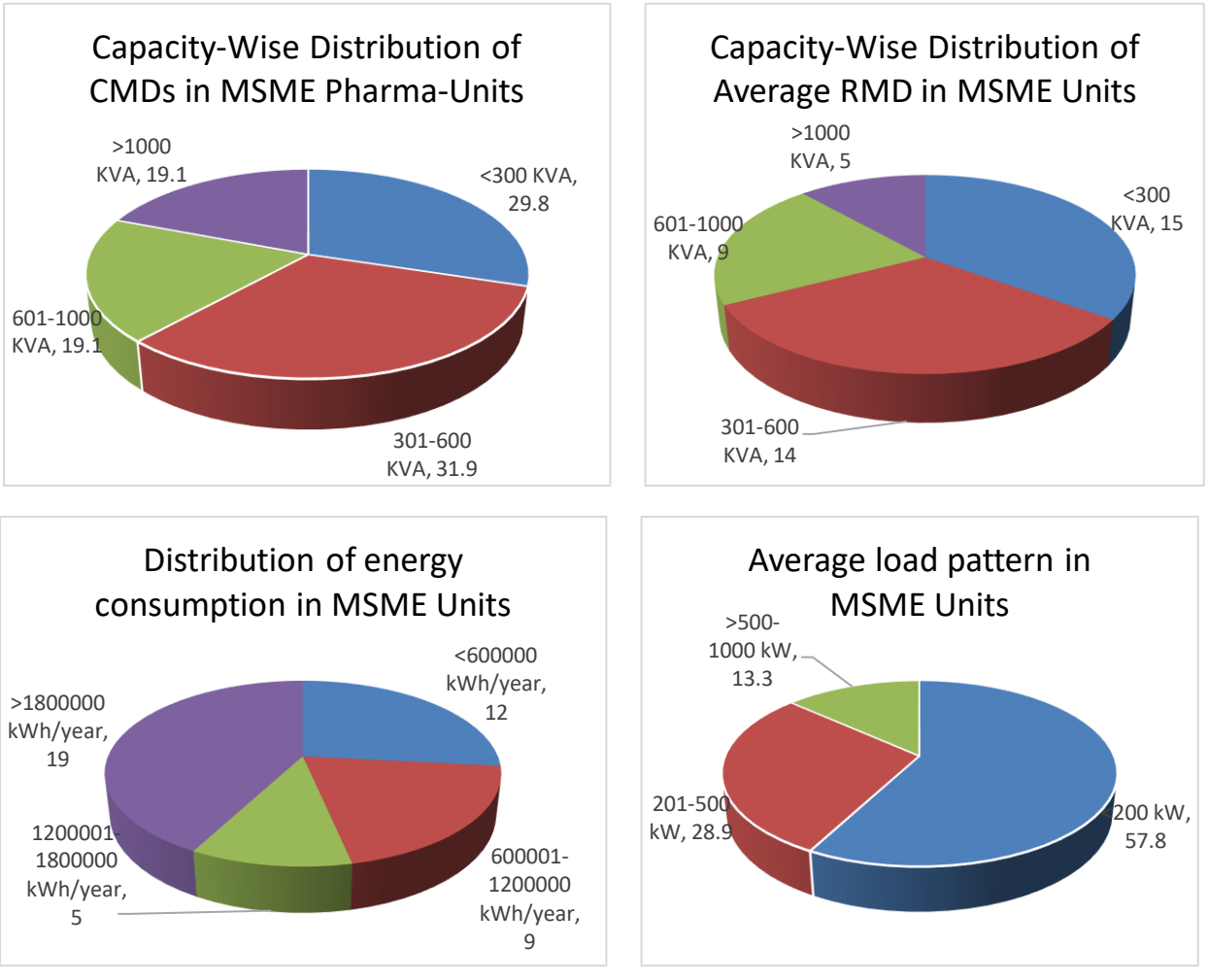
Based on cluster level studies the key features of electrical energy consumption have been analysed.

The MSME Pharma-Units widely vary with respect to its Contract maximum demand (CMD), Recorded Maximum demand, and Average demand. Distribution pattern in terms of percentage of Units falling under a particular band has been depicted in the following charts.

Table - 10: Overall Electrical parameters in MSME Pharma-Units

S. No	Parameter	UOM	Minimum	Maximum	Average
1	Contract Maximum Demand	KVA	100	3900	784
2	Recorded Maximum Demand	KVA	110	3315	607
3	Average Load	kW	18	1863	313
4	Energy Consumption	kWh/year	1,59,120	1,63,19,664	27,40,497

Figure 6:Capacity-wise distribution of CMD, RMD and Average load Pattern in MSME Pharma-Units



3.1.3.2 Thermal Energy Consumption Analysis

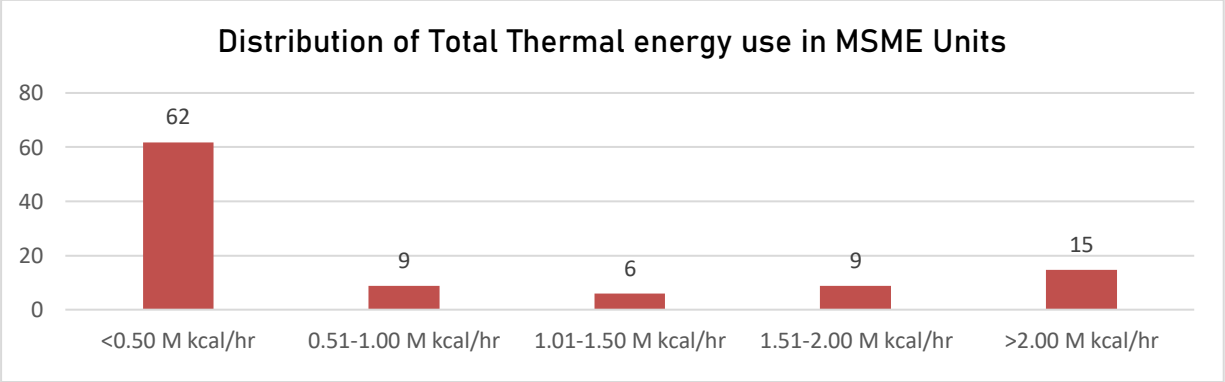
Solid fuels (Coal & bio mass), Liquid fuels (HSD & LDO) and gaseous fuels (Natural gas) are been used in MSME Pharma-Units to produce heat in the form of hot water, steam and thermic fluid for high temperature applications. Hot water & steam are used in production process in the reactors as one of the utilities. Steam and thermic fluid are used in solvent recovery plants depending on the solvent to be recovered.

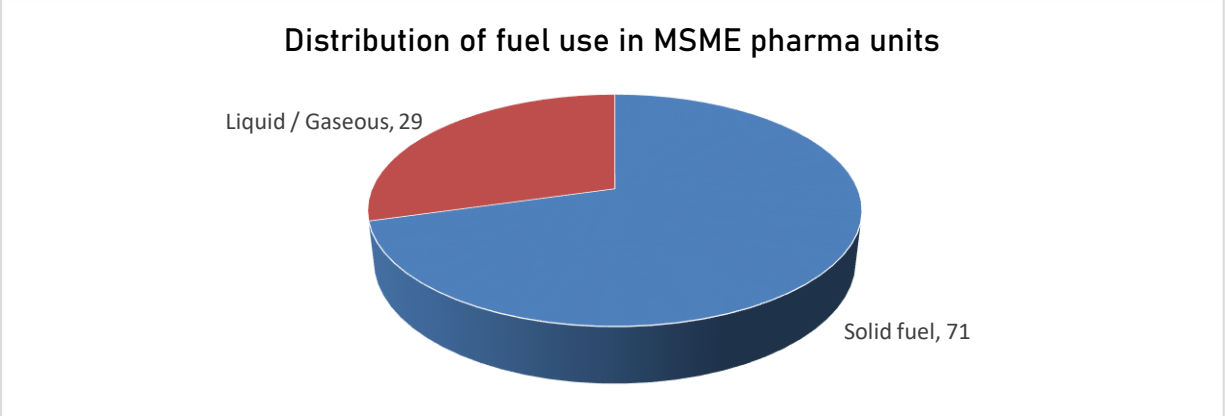
The cluster level studies indicate about 72% of the plants use solid fuels in the form of coal and bio-mass. Balance 28% of the plants are using either liquid fuels or gaseous fuels. The total thermal energy demand from all fuels and distribution of plants in terms of fuel usage are depicted in the following charts.

Table - 11: Thermal Energy Consumption in MSME Pharma-Units

S. No	Parameter	UOM	Minimum	Maximum	Average
1	Annual Thermal energy consumption	M kcal/year	126	1,86,438	15118
2	Thermal energy consumption	M kcal/hr	0.01	21.28	1.73

Figure 7: Distribution of Total Thermal Energy & Fuel use in MSME Pharma-Units





Evidently, solid fuels constitute the major share in thermal energy consumption of MSME Pharma-Units.

3.1.4 Details of Clusters at National Level

As on 2020 there are about 8532 Pharma-Units in India located in different clusters. The details are following in the table.

Table - 12: Details of Clusters at National Level

S. No	State/UTs	Cluster Names	No of Pharma-Units
1	Andhra Pradesh	Visakhapatnam, Parwada	261
2	Assam	Kuruwa	25
3	Bihar	Patna &Hajipur	89
4	Chhattisgarh	Raipur	31
5	Goa	Margaon	51
6	Gujarat	Ahmedabad, Pune, Ankleshwar, Vapi & Baroda	3332
7	Haryana	Gurgaon	31
8	Himachal Pradesh	Baddi	555
9	Jammu & Kashmir	Jammu/Srinagar	55
10	Jharkhand	Ranchi	44
11	Karnataka	Bidar & Bengaluru	376
12	Kerala	Palakkad, Thiruvananthapuram & Thrissur	100
13	Madhya Pradesh	Indore, Dhar & Ujjain	267
14	Maharashtra	Aurangabad, Pune, Mumbai & Thane	929
15	Odisha	Cuttack & Bhubaneswar	18
16	Punjab	Amritsar, Bathinda, Nawanshahar&Derabassi	156
17	Rajasthan	Jaipur	128
18	Sikkim	Sikkim	45
19	Tamil Nadu	Chennai, Mical& Tiruvallur	514
20	Telangana	Hyderabad & Medak	523
21	Tripura	Agartala	6
22	Uttarakhand	Hardwar	220
23	Uttar Pradesh	Kanpur	408
24	West Bengal	Kolkata	180
25	Pondicherry	-	86
26	Chandigarh	-	5
27	Delhi	NCR	63
28	Dadra & Nagar Haveli and Daman & Diu	Silvassa	34
Total No. of Units			**8532**

3.2 Energy Demand for MSME Pharma Sector

3.2.1 Electrical Energy Demand for MSME Pharma Sector

Based on information obtained from cluster level studies. The electricity demand in terms of average load, Maximum demand and electricity consumption for individual clusters is estimated and presented in the following table.

Table - 13: Electrical Energy Demand for MSME Pharma Sector

S. No	State/UTs	No of Pharma-Units	Average load for the cluster	Peak load for the cluster	Estimated electricity consumption per year	Consumption in TOE
	UOM	Nos	MW	MW	GWh/year	
1	Andhra Pradesh	261	80	155	700	60176
2	Assam	25	8	15	67	5764
3	Bihar	89	27	53	239	20520
4	Chhattisgarh	31	9	18	83	7147
5	Goa	51	16	30	137	11758
6	Gujarat	3332	1020	1978	8933	768219
7	Haryana	31	9	18	83	7147
8	Himachal Pradesh	555	170	330	1488	127960
9	Jammu & Kashmir	55	17	33	147	12681
10	Jharkhand	44	13	26	118	10145
11	Karnataka	376	115	223	1008	86690
12	Kerala	100	31	59	268	23056
13	Madhya Pradesh	267	82	159	716	61559
14	Maharashtra	929	284	552	2491	214188
15	Odisha	18	6	11	48	4150
16	Punjab	156	48	93	418	35967
17	Rajasthan	128	39	76	343	29511
18	Sikkim	45	14	27	121	10375
19	Tamil Nadu	514	157	305	1378	118507
20	Telangana	523	160	311	1402	120582
21	Tripura	6	2	4	16	1383
22	Uttarakhand	220	67	131	590	50723
23	Uttar Pradesh	408	125	242	1094	94068
24	West Bengal	180	55	107	483	41500
25	Pondicherry	86	26	51	231	19828
26	Chandigarh	5	2	3	13	1153
27	Delhi	63	19	37	169	14525
28	Dadra & Nagar Haveli and Daman & Diu	34	10	20	91	7839
Total No. of Units		**8532**	**2611**	**5066**	**22873**	**1967120**

3.2.2 Thermal Energy Demand for MSME Pharma Sector

The thermal energy consumption in terms of solid fuels, liquid/gaseous fuels and total thermal energy consumption for Pharma sector at national scale has been worked out and presented in the following table.

Table- 14: Thermal Energy demand for MSME Pharma Sector

S.No	State/UTs	No of Pharma-Units	Estimated Thermal energy consumption for the cluster		Consumption in TOE for the cluster	Estimated thermal consumption for solid fuels		Estimated thermal consumption for liquid fuels		Estimated fuel consumption for solid fuels	Estimated fuel consumption for liquid/gaseous fuels	Consumption in TOE for solid fuels	Consumption in TOE for liquid/gaseous fuels
	UOM	Nos	T kcal / year	T Joules/ year		T kcal / year	T Joules/ year	T kcal / year	T Joules / year	M Tonnes/ year	M litres/ year		
1	Andhra Pradesh	261	3.9	16517	394578	2.43	10185.52	1.51	6331.54	0.60	0.14	243323	151255
2	Assam	25	0.4	1582	37795	0.23	975.62	0.14	606.47	0.06	0.01	23307	14488
3	Bihar	89	1.3	5632	134550	0.83	3473.22	0.52	2159.03	0.20	0.05	82972	51577
4	Chhattisgarh	31	0.5	1962	46866	0.29	1209.77	0.18	752.02	0.07	0.02	28900	17965
5	Goa	51	0.8	3227	77102	0.48	1990.27	0.30	1237.20	0.12	0.03	47546	29556
6	Gujarat	3332	50.4	210861	5037300	31.0	130031	19.3	80830.2	7.61	1.78	3106335	1930965
7	Haryana	31	0.5	1962	46866	0.29	1209.77	0.18	752.02	0.07	0.02	28900	17965
8	Himachal Pradesh	555	8.4	35122	839046	5.17	21658.8	3.22	13463.6	1.27	0.30	517412	321634
9	Jammu & Kashmir	55	0.8	3481	83149	0.51	2146.37	0.32	1334.23	0.13	0.03	51275	31874
10	Jharkhand	44	0.7	2784	66519	0.41	1717.10	0.25	1067.39	0.10	0.02	41020	25499

S.No	State/UTs	No of Pharma-Units	Estimated Thermal energy consumption for the cluster		Consumption in TOE for the cluster	Estimated thermal consumption for solid fuels		Estimated thermal consumption for liquid fuels		Estimated fuel consumption for solid fuels	Estimated fuel consumption for liquid/gaseous fuels	Consumption in TOE for solid fuels	Consumption in TOE for liquid/gaseous fuels
	UOM	Nos	T kcal / year	T Joules/ year		T kcal / year	T Joules/ year	T kcal / year	T Joules / year	M Tonnes/ year	M litres/ year		
11	Karnataka	376	5.7	23795	568435	3.51	14673.3	2.18	9121.29	0.00	0.20	350535	217900
12	Kerala	100	1.5	6328	151179	0.93	3902.50	0.58	2425.88	0.23	0.05	93227	57952
13	Madhya Pradesh	267	4.0	16897	403649	2.49	10419.6	1.55	6477.09	0.61	0.14	248917	154732
14	Maharashtra	929	14.0	58791	1404457	8.66	36254.1	5.38	22536.3	2.12	0.50	866082	538375
15	Odisha	18	0.3	1139	27212	0.17	702.45	0.10	436.66	0.04	0.01	16781	10431
16	Punjab	156	2.4	9872	235840	1.45	6087.89	0.90	3784.37	0.36	0.08	145435	90405
17	Rajasthan	128	1.9	8100	193510	1.19	4995.20	0.74	3105.12	0.29	0.07	119331	74179
18	Sikkim	45	0.7	2848	68031	0.42	1756.12	0.26	1091.64	0.10	0.02	41952	26078
19	Tamil Nadu	514	7.8	32528	777062	4.79	20058.8	2.98	12469.0	1.17	0.27	479189	297874
20	Telangana	523	7.9	33097	790669	4.88	20410.06	3.03	12687.3	1.19	0.28	487579	303090
21	Tripura	6	0.1	380	9071	0.06	234.15	0.03	145.55	0.01	0.00	5594	3477
22	Uttarakhand	220	3.3	13922	332595	2.05	8585.49	1.27	5336.93	0.50	0.12	205100	127495
23	Uttar Pradesh	408	6.2	25820	616812	3.80	15922.19	2.36	9897.58	0.93	0.22	380368	236445
24	West Bengal	180	2.7	11391	272123	1.68	7024.49	1.04	4366.58	0.41	0.10	167809	104314

S.No	State/UTs	No of Pharma-Units	Estimated Thermal energy consumption for the cluster		Consumption in TOE for the cluster	Estimated thermal consumption for solid fuels		Estimated thermal consumption for liquid fuels		Estimated fuel consumption for solid fuels	Estimated fuel consumption for liquid/gaseous fuels	Consumption in TOE for solid fuels	Consumption in TOE for liquid/gaseous fuels
	UOM	Nos	T kcal / year	T Joules/ year		T kcal / year	T Joules/ year	T kcal / year	T Joules / year	M Tonnes/ year	M litres/ year		
25	Pondicherry	86	1.3	5442	130014	0.80	3356.15	0.50	2086.25	0.20	0.05	80176	49839
26	Chandigarh	5	0.1	316	7559	0.05	195.12	0.03	121.29	0.01	0.00	4661	2898
27	Delhi	63	1.0	3987	95243	0.59	2458.57	0.37	1528.30	0.14	0.03	58733	36510
28	Dadra & Nagar Haveli and Daman & Diu	34	0.5	2152	51401	0.32	1326.85	0.20	824.80	0.08	0.02	31697	19704
Total		**8532**	**129**	**539937**	**12898633**	**80**	**332961**	**49**	**206976**	**19**	**5**	**7954157**	**4944476**

3.2.3 Summary of Energy Consumption for MSME Pharma Sector

3.2.3.1 Summary of Source Wise Energy Consumption in Pharma Sector

Table- 15: Summary of source wise energy consumption in Pharma sector

S. No	Parameters	UOM	Value
1.0 Electrical Energy Consumption			
1	Electricity consumption (annual)	GWh/year	**22,873**
		TOE	**19,67,120**
2.1 Thermal energy consumption (Solid fuel)			
1	Thermal energy consumption solid fuels (annual)	T kcal/year	**80**
		T kJ/year	**3,32,961**
		TOE	**79,54,157**
2.2 Thermal energy consumption (liquid/gaseous fuel)			
1	Thermal energy consumption liquid/gaseous fuels (annual)	T kcal/year	**49**
		T kJ/year	**2,06,976**
		TOE	**49,44,476**
2.3 Total Thermal energy consumption for the Pharma Sector			
1	Total Thermal Energy consumption for the Pharma sector	T kcal/year	**129**
		TOE	**1,28,98,633**
3.0 Total Energy consumption in TOE (Electrical & Thermal)			
1	Total Energy consumption for the Pharma sector	TOE	**1,48,65,752**
4.0 Total GHG Emission from MSME Pharma Sector			
1	Total GHG Emission from MSME Pharma Sector	Tonnes of CO_2	**18795 x 10^6**

Table- 16: Source wise distribution of energy consumption in MSME Pharma-Units

Parameters	Electricity Consumption	Thermal Energy Consumption For Solid And Liquid/Gaseous Fuels
Percentage of TOE	13%	87%

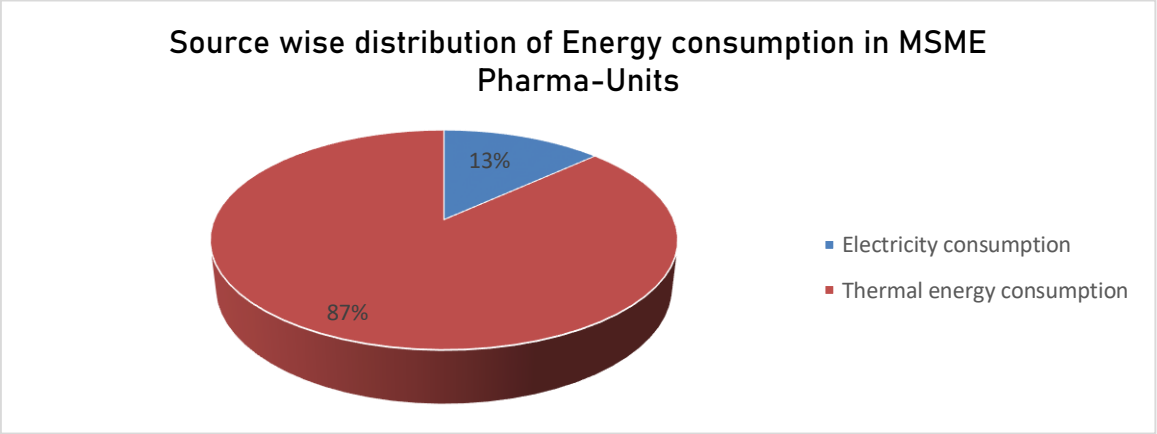


Figure 8: Source-wise distribution of Energy consumption in MSME Pharma-Units

3.2.3.2 Summary of End Use Energy Consumption for MSME Pharma Sector

The cluster level data in terms of type of utility, size, specific energy consumption and number of equipment for Pharma units has been used to extrapolate energy consumption as per end use in MSME Pharma cluster at national level. The following table provides details of energy consumption for each utility in MSME Pharma clusters.

Table- 17: Summary of end use energy consumption in Pharma-Units

Summary of End Use Energy Consumption in Pharma-Units			
S. No	**Energy System/Utility**	**Annual Energy Consumption**	**Percentage**
		GWh	**%**
1	Chillers	11322	50%
2	AHUs	833	4%
3	Air compressors	2537	11%
4	Pumps	5896	26%
5	Vacuum Pumps	417	2%
6	Others	1868	8%
Total		**22873**	

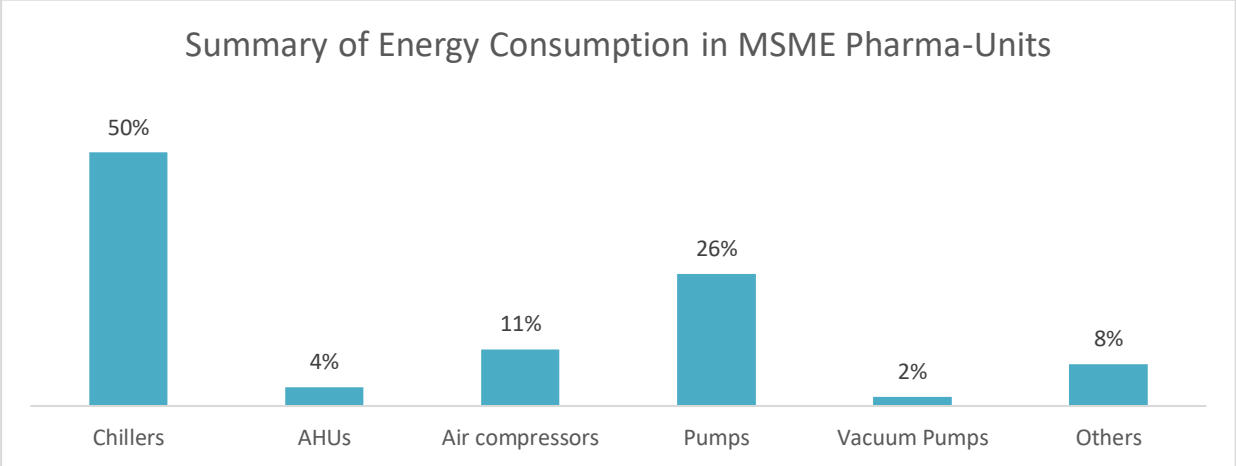


Figure 9: Summary of Energy consumption in MSME Pharma-Units

3.3 Comparison of Specific Energy Consumption (SEC) and Benchmarking

3.3.1 Comparison of SEC and Benchmarking for HVAC System

3.3.1.1 Comparison of SEC of Chillers in MSME Clusters

Chiller plants are a major energy consuming utility of around 50% of electricity consumption for MSME Pharma-Units which is also critical for the production process. Each Pharma plant is equipped with 1 to 2 Chillers Units on average.

MSME Pharma-Units deployed chillers as per temperature requirement of the process ranging between +5 °C to -30 °C. The following chart depicts the distribution of percentage of chillers installed as per Application Temperature.

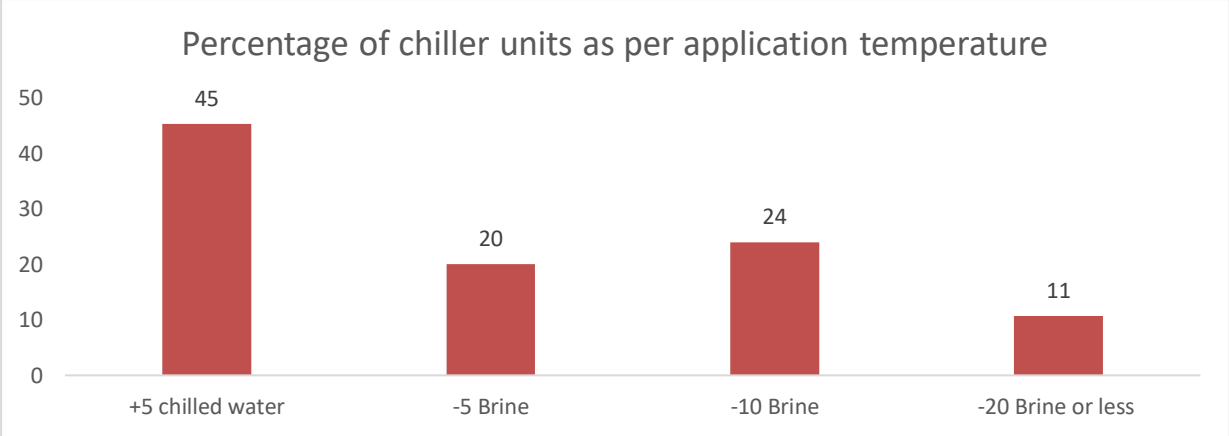


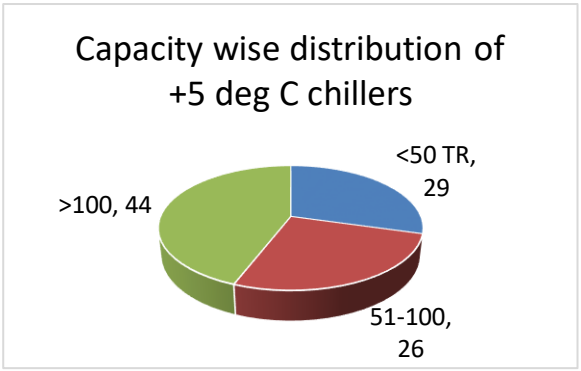
Figure 10: Percentage of Chiller Units as per Application Temperature in MSME Units

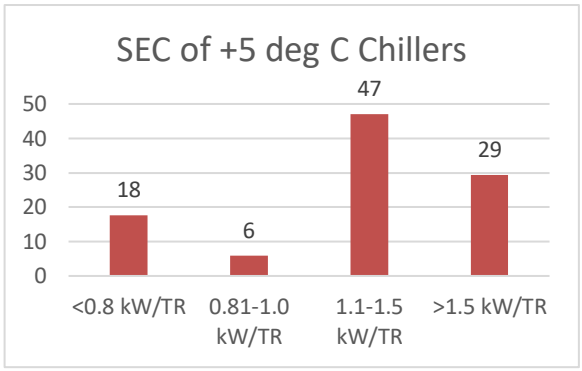
The specific energy consumption (kW/TR) depends on mostly on Application Temperature. The key parameters pertaining to chiller plants in MSME Pharma-Units are presented in the following table.

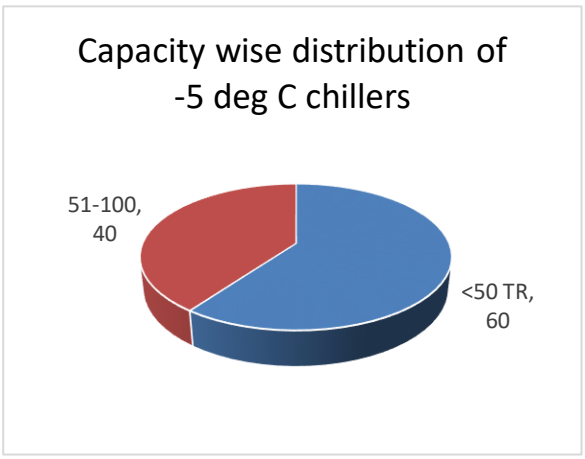
Table- 18: Key Parameters of Chiller Plants in MSME Pharma-Units

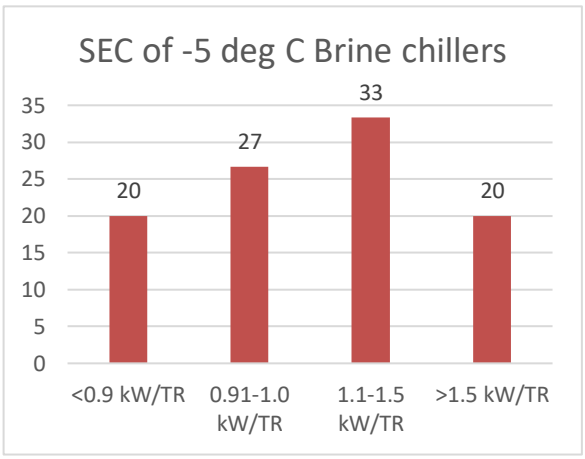
S.No	Parameters	UOM	Minimum	Maximum	Average
1	Capacity of individual +5deg C chillers	TR	22	400	135
2	Specific Energy Consumption of +5deg C chillers	kW/TR	0.63	2.41	1.27
3	Capacity of individual -5deg C Brine chillers	TR	28	100	48
4	Specific Energy Consumption of -5deg C Brine chillers	kW/TR	0.72	4.09	1.34
5	Capacity of individual -10deg C Brine chillers	TR	20	126	60
6	Specific Energy Consumption of -10deg C Brine chillers	kW/TR	1.46	2.94	1.81
7	Capacity of individual -20deg C Brine chillers	TR	20	150	52
8	Specific Energy Consumption of -20deg C Brine chillers	kW/TR	1.80	2.94	2.37
9	Capacity of individual -30deg C Brine chillers	TR	150		
10	Specific Energy Consumption of -30deg C Brine chillers	kW/TR	2.19		
11	Overall Capacity of individual chillers	TR	20	400	94
12	Overall Specific Energy Consumption of chillers	kW/TR	0.63	4.09	1.54

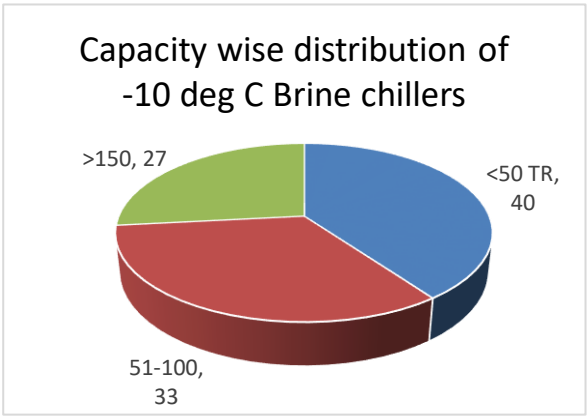
The capacity wise distribution and specific energy consumption of individual chiller plants are presented in the following charts.

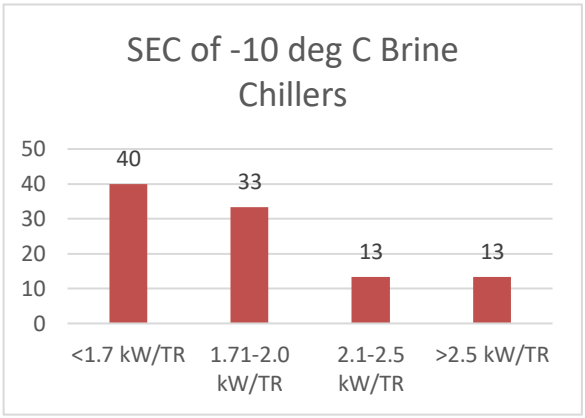


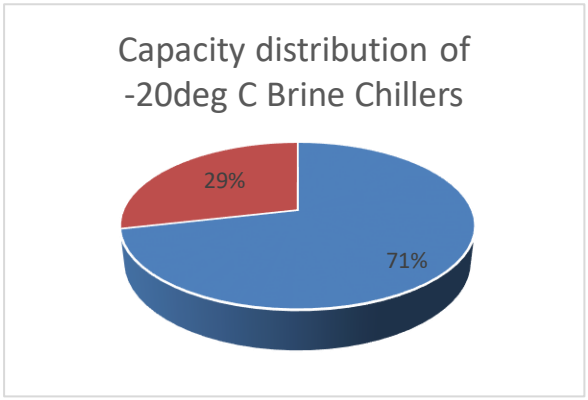












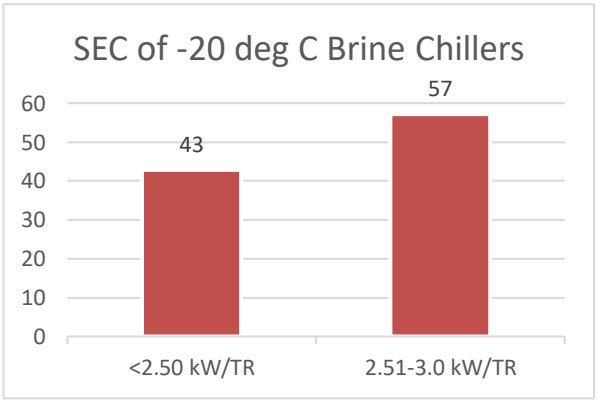


Figure 11: Capacity-wise distribution & SEC of +5deg C, -5deg C, -10deg C& -20deg C Chilling Plants in MSME Units

As seen from the above, about 20-30% of chiller plants are operating with SEC close to values declared by OEMs. Balance 70-80% of the chiller plants in all Temperature Applications may be considered as inefficient which may be on account of poor O&M practices, vintage of the chiller.

3.3.1.2 Energy Efficient Technologies for Chillers

1. Variable Volume Ratio Technology (VVR)

The power consumption of chiller compressor is directly depending on compression ratio. In all types of chiller compressors this ratio is fixed although the discharge pressure varies as per the condenser performance and ambient conditions. This is so even with compressors equipped with VFD where the refrigerant flow is controlled as per the load with regulation of compressor speed.

VVR Technology +5 deg C Chiller by Daikin, Model: WWV with IPLV as low as 0.36 kW/TR

Variable Volume Ratio (VVR) compression technology senses the precise amount of lift needed and adjusts the compression ratio on the fly to deliver optimal efficiency, regardless of ambient temperature or time of day. With VVR technology the over-compression is avoided when load demand is low and get exactly the lift needed.

One of the OEM (e.g., Daikin) is offering chiller compressors based on VVR technology with Integrated Part load value (IPLV) specific energy consumption as low as 0.36kW/TR both VVR chillers are available both with Water cooled and Air cooled condensers.

Comfort links controls Chiller by Carrier, Model: 30HXA, HXC076-271with IPLV as low as 0.51kW/TR

2. Microprocessor based Occupancy/load Scheduling

Chillers with advanced microprocessor-based controls with facility to schedule chiller operation as per occupancy/load are available that can be configured remotely to meet the varying load requirements over the time. Such chillers are available from OEM (e.g., Carrier, Model 30HXA comfort link with SEC of 0.51 kW/TR).

3. Scroll compressor-based Chiller

Chillers based on Scroll compressor with low sound levels in operation are available that offers SEC of around 0.56 kW/TR.

Scroll compressor-based chiller by Daikin, Model: WGZ with IPLV as low as 0.56 kW/TR

4. Precise Magnetic Levitation Technology

Chillers with two stage centrifugal compressors

with magnetic bearings and in-built VFD with state-of-the-art automatic control system are marketed by OEMs (e.g., Bluestar). Two stage centrifugal compressor ensure good part load and full load efficiency resulting in lower IPLV SEC.

The compressor shaft levitates in air while running thereby ensuring no mechanical contact with other parts, completely eliminating wear & tear and frictional losses.

Precise Magnetic Levitation technology Chiller by Bluestar with IPLV as low as 0.59 kW/TR

The VFD precisely controls the compressor speed to match the varying capacity required and operating conditions, thus providing maximum chiller efficiency.

In the event of power failure, the compressor motor acts as a generator, providing power for the bearing control system ensuring smooth de-levitation of the shaft.

The SEC declared by OEM is 0.59 kW/TR.

3.3.1.3 Comparison of Energy KPI for Chillers and Benchmarking

Various technological developments and upgrades are incorporated by OEMs to make chillers more energy efficient. Screw compressors with VFDs, screw compressors with Precise Magnetic levitation technology, Screw compressors with variable volume ratio (VVR) technology are being introduced in the market with specific energy consumption as low as 0.36 kW/TR. The following tables provide details of SEC of chillers offered by various OEMs for both water-cooled and Air-cooled chillers for +5-degree centigrade application.

Similarly, Large Pharma-Units which focus on good O&M practices also achieve better SEC for various Temperature Applications.

Table- 19: Details of Water-Cooled Chillers offered by OEMs

S. No	Chiller Make	Model	Technology/ Controls	Capacity Range	SEC
				Tons	kW/Ton
1	Daikin	Navigator-WWV Water cooled Screw chiller	Variable volume ratio technology	120-300	0.36
2	Daikin	WGZ-Water cooled Scroll chiller	Ultra-quiet operation technology	30-200	0.56
3	Johnson controls	YCWL-Water cooled Scroll chiller	NA	50-200	0.65
4	Carrier	AquaForce-30HXC Water-cooled Screw chiller	Comfort link controls	75-265	0.51
5	Blue star	Water-cooled Screw chiller	Precise Magnetic levitation technology	75-150	0.59

Table - 20: Details of Air-Cooled Chillers offered by OEMs

S. No	Chiller Make	Model	Technology/ Controls	Capacity Range	Sec
				TONS	EER KW/TON
1	Daikin	Pathfinder Air cooled Screw chiller	Variable volume ratio technology	100-565	22 0.56
2	Daikin	Trailblazer, AGZ-E Air Cooled scroll chillers	Variable Speed condenser fan technology	30-240	Full load: 11.2 1.10 Part load: 16.7 0.73
3	Johnson controls	YORK, YVAA-Air cooled Screw chiller	Variable Speed drive technology	150-575	21.35 0.57
4	Carrier	Aquaforce-30XV, Air cooled screw chillers	Variable Speed condenser fan technology	140-500	22 0.54
5	Blue star	NA	Precise Magnetic levitation technology	75 and above	0.95

Performance Benchmarks for chiller plants can be fixed based on minimum or average performance of the plants studied, minimum achieved in the plants studied or elsewhere are based on best available technologies from OEMs. Accordingly, the following table provides the recommended benchmarks for various Temperature Applications of chiller plants in MSME Pharma-Units.

Table- 21: Recommended Benchmark data of Chillers in MSME Pharma-Units

S. No	Parameters	SEC (KW/TR)			
		+5deg C CHILLER	-5deg C CHILLER	-10deg C CHILLER	-20deg C CHILLER
1	Minimum from the cluster	0.63	0.72	1.5	1.8
2	Minimum from other cluster/large Units	0.57	NA	NA	1.41
3	Best available technology	0.36-0.51	NA	NA	NA
4	Recommended benchmark Range	0.40-0.60	0.72-1.34	1.50-1.90	1.40-2.40
5	Recommended benchmark	0.60	1.00	1.75	2.00

It is to be noted that although best available technologies offer the lowest SEC but it is not always possible for all MSME Units to adopt such technologies. The performance also depends on weather conditions at MSME location. Considering that benchmarks are recommended both as a range that provides the guidance as well as absolute value for setting the targets.

3.3.2 Comparison of SEC and Benchmarking for Air Handling Units

3.3.2.1 Comparison of SEC of AHUs in MSME Clusters

Air handling Units (AHUs) primarily used to transfer cooling effect from chilled water/Dx type Ac units into the conditioned space such as production houses, labs, cleanrooms of Pharma-Units.

Air handling units constitute around 4% electricity consumption of a pharma unit. These are generally driven by AC induction motor with belt coupled. The Pharma-Units studied have capacities ranging from 700 CFM to 18000 CFM.

The specific energy consumption of AHU in terms of W/CFM depends on capacity and static pressure requirement. Among the AHUs studied from the clusters, the SEC of AHUs is ranging between 0.13-2.47 W/CFM with an average SEC of 1.02 W/CFM.

The key parameters such as capacity range and SEC range and their respective distribution patterns are presented in the following tables or charts. Air handling parameters have been analysed and presented in the following table.

Table- 22: Key Parameters of AHUs in MSME Pharma-Units

S. No	Parameters	UOM	Minimum	Maximum	Average
1	Capacity of AHU	CFM	700	18000	4555
2	SEC	W/CFM	0.13	2.47	1.02

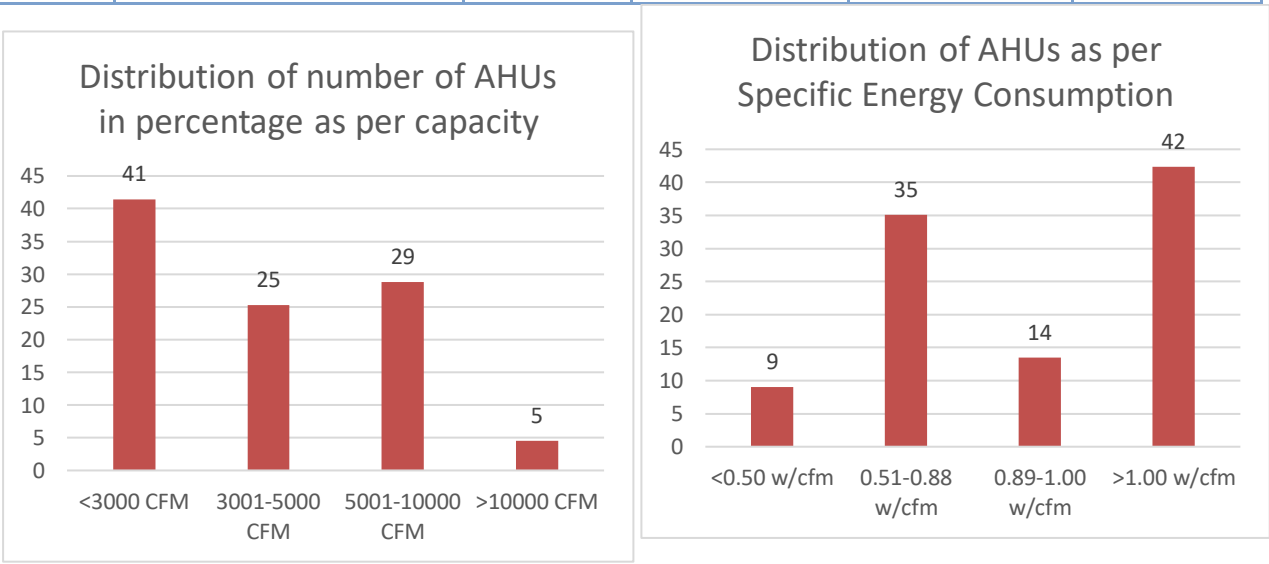


Figure 12: Capacity-wise distribution & SEC of AHUs in MSME Units

There are 2 to 3 AHUs installed for each MSME pharma unit with an average capacity of 4555 CFM. The static pressure ratings of AHUs range between 15-150 mm WC with an average static pressure rating of 111 mm WC. About 66% of AHUs are of capacity <5000 CFM. Only 5% of AHUs are of higher capacity, i.e., more than 10000 CFM. With regard to SEC only around 9% of AHUs are having SEC <0.50 W/CFM. The balance 91% of AHUs can be considered as operated inefficiently.

3.3.2.2 Energy Efficient Technologies for AHUs

1. AHUs with EC motors

Electronic Commutation (EC technology) refers to variety of drive concepts such as PM (permanent magnet motor), ECM (electronically commutated motor) and BLDC (brushless DC motor). AHUs equipped with EC technology are available for various applications including HVAC all kinds of fan such as axial fan and centrifugal fan can be driven by EC motors. Other technology improvement includes material of construction and aerodynamic shape to reduce energy consumption and increase intervals between the maintenance.

EC blowers by ebm-papst

Electronically Commutated motors (EC Motors) with inbuilt variable speed capability are available that offers an average specific energy consumption of 0.22 W/CFM. These motors EC motors coupled AHUs are availed up to 40000 CFM and have advantage of low maintenance, time and cost due to lack of belt coupling and have advantage of VFDs inbuilt. These also comes with additional benefit of having no loose belt that generally affects flow delivery and performance of conventional AHUs

3.3.2.3 Comparison of Energy KPI for AHUs and Benchmarking

The Performance data of AHUs from other clusters/large Units have been collected. The capacity range of such AHUs range between 4200 CFM to 30000 CFM with SEC ranging between 0.14 W/CFM to 0.76 W/CFM with an average SEC 0.37 W/CFM.

Based on the above discussion the following table presents comparison of AHU performance benchmarks and recommended benchmarks for MSME pharma sector.

Table- 23: Recommended Benchmark data of AHUs in MSME Pharma-Units

S. No	Parameters	Sec (W/Cfm)
		AIR HANDLING UNITS
1	Average from the cluster	1.02
2	Average from other cluster/large Units	0.37
3	Best available technology (EC Motors)	0.22
4	Recommended benchmark Range	0.14-0.50
5	Recommended benchmark for long term	0.25

3.3.3 Comparison of SEC and Benchmarking For Compressed Air System

3.3.3.1 Comparison of SEC of Air Compressors in MSME Clusters

Compressed air system is one of the key utilities and constitutes around 11% of electricity consumption of a Pharma unit and air compressors are used for pneumatic operation, instrumentation as well as transfer of solvents with AOD (Air operated diaphragm pumps).

About 45% of air compressors installed in MSME Pharma-Units are of reciprocating type and balance 55% are of screw type. The capacity of air compressors ranges widely from 6.70 CFM to 1000 CFM. The key parameters relating to capacity and specific energy consumption for air compressors from clusters level studies are presented in the following table.

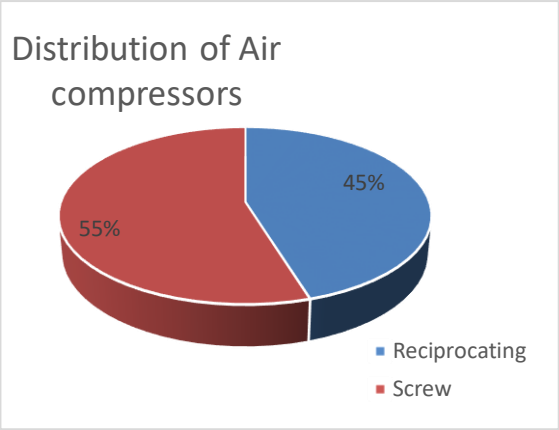


Table- 24: Key Parameters of Air compressors in MSME Pharma-Units

S. No	Parameters	UOM	Minimum	Maximum	Average
a) Reciprocating type Air compressors					
1	Capacity	CFM	7.3	446.0	84.7
2	SEC	kW/CFM	0.11	0.33	0.18
b) Screw type Air compressors					
1	Capacity	CFM	6.7	1000.0	191.0
2	SEC	kW/CFM	0.12	0.26	0.18
c)	Overall Capacity	CFM	6.7	1000	135.6
d)	Overall SEC	kW/CFM	0.11	0.33	0.18
e)	Average number of Air compressors per unit	Nos	2.08 (say 2)		

The distribution of number of compressors as per capacity (CFM) and Specific energy consumption (kW/CFM) are presented in the following charts separately for reciprocating type and screw type air compressors.

3.3.3.2 Energy Efficient Technologies for Air Compressors

1. Rotary screw compressors with Variable speed option

Rotary screw compressors with VFD offer lower specific energy consumption (kW/CFM) compared to reciprocating with fixed speed drive. Several OEMs (e.g., Chicago pneumatic, Atlas Copco, Ingersoll rand) are offering these technology-based air compressors with motor rating between 2.6kW to 300kW that would cover the capacity requirements (in CFM) of MSME Pharma-Units. The typical SEC declared by OEM is 0.14kW/CFM at 7 to 8 bar pressure. The VFD ensures that the compressor operates at good efficiency even in the part load condition.

Rotary screw Air compressor with VFD by Ingersoll Rand

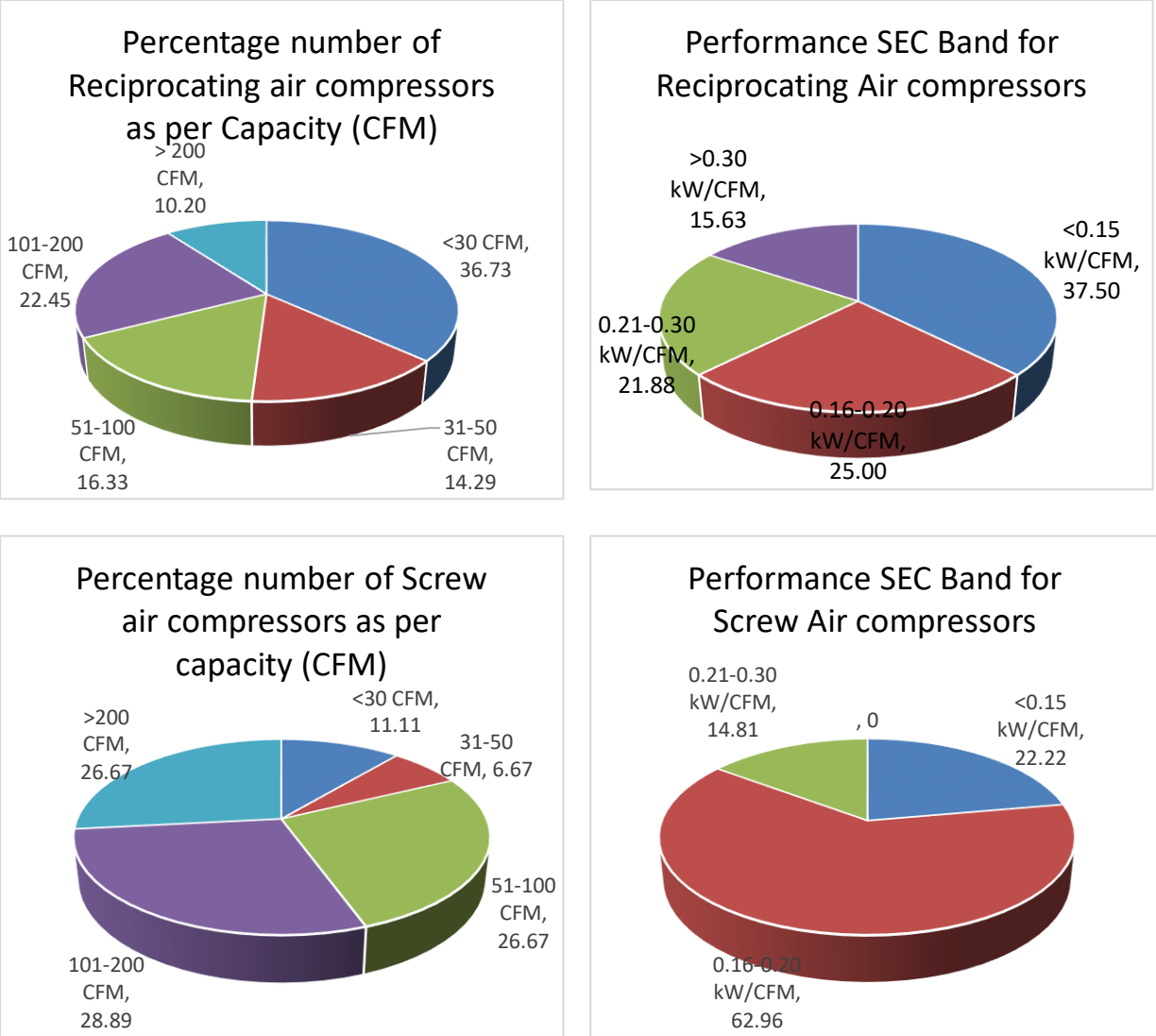


Figure 13: Capacity-wise distribution and SEC of Air compressors.

Reciprocating compressors are generally deployed for smaller capacities with 67% of reciprocating compressors are with capacities less than 100 CFM. The screw type compressors, which are energy efficient, are deployed for higher capacity requirements. About 55% of screw type air compressors are more than 100 CFM. The SEC of reciprocating type air compressors is in the range 0.11-0.33 kW/CFM and that of screw type air compressors is in the range of 0.12-0.26 kW/CFM. It is found that screw type air compressors offer a lower SEC at higher capacities.

3.3.3.3 Comparison of Energy KPI for Air Compressor and Bench Marking

The SEC data for Air compressors from various sources such as intervening sectors such as large Pharma-Units, OEMs, BEE has been collected and presented in the following table. Since the power consumption and SEC of air compressors also depend on discharge pressure, the SEC values indicated below are for 7 to 8 bar discharge pressure.

Table- 25: Recommended Benchmark data of Air compressors in MSME Pharma-Units

S. No	Parameters	Sec (Kw/Cfm)
		Air Compressors
1	Minimum from the cluster	0.11
2	Minimum from other clusters/large pharma	0.22
3	Best available technology / OEM (Ingersoll rand)	0.14 (at 7 to 8 kg/cm^{2}G)
4	By Bureau of Energy Efficiency (Double stage reciprocating compressors)	0.183 (at 7 bar)
5	Recommended benchmark Range	0.11-0.19
6	Recommended benchmark for long-term	0.15

3.3.4 Comparison of SEC and Benchmarking for Pumps

3.3.4.1 Comparison of SEC of Pumps in MSME Clusters

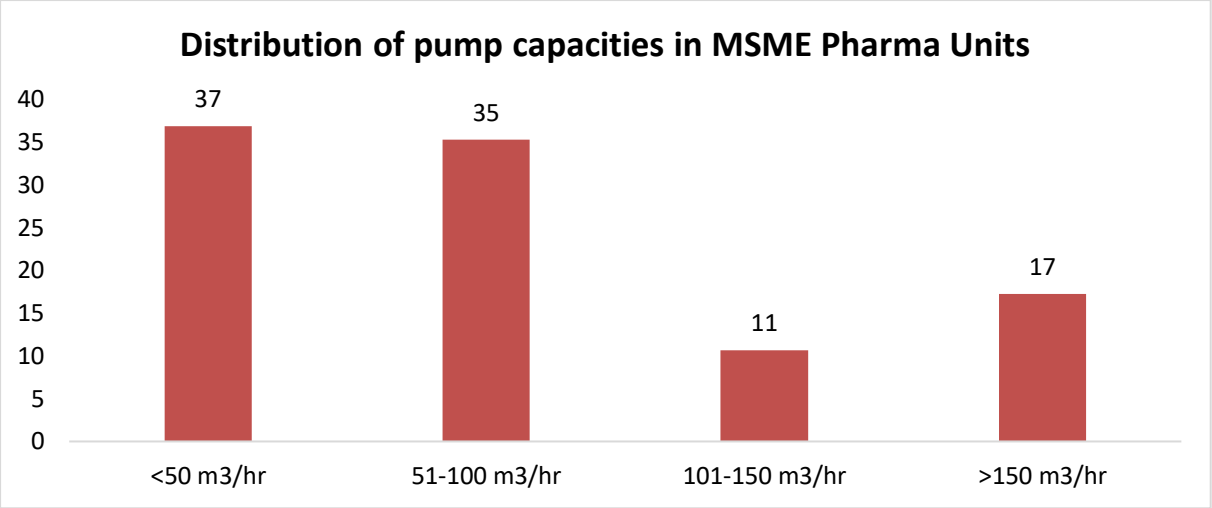
Pumping systems are one of the key utilities of MSME pharma unit providing chilled water/brine for production reactors, Room Temperature (RT) water for production reactors. Other applications of pumps in MSME Pharma-Units include raw water pumps, treated water pumps, fire water pumps, boiler feed water pumps, make-up water pumps, primary pumps of chiller plants, condenser water/circulating water. Typically, 26% of electricity consumes in MSME Pharma-Units is towards pumping system and it is the second highest end use electricity consumer after chiller plants.

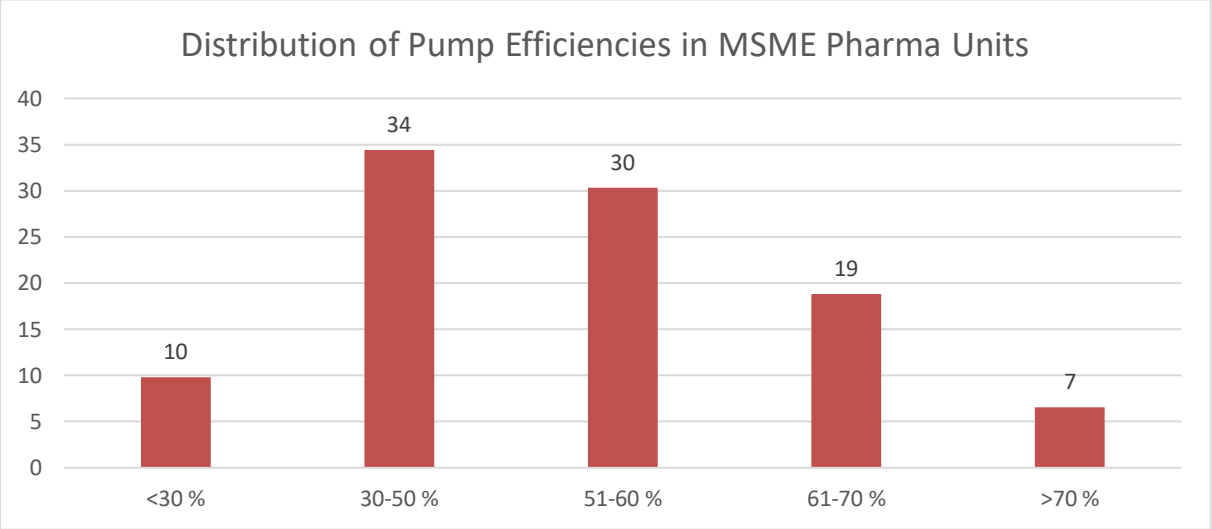
Each pharma unit in MSME sector is found to be having 5 to 6 operating pumps with a capacity ranging from 4 m^3/hr to 450 m^3/hr.

The key features of pumping system of MSME pharma sector are presented in the following table and charts.

Table- 26: Key features of pumping system in MSME Pharm Units.

S. No	Parameters	UOM	Minimum	Maximum	Average
1	Pump Capacity	m^3/hr	4.0	450.0	98.6
2	Pump Efficiency	%	8.8	78.0	49.9
3	SEC	kWh/m^3	0.01	1.85	0.17
4	No. of pumps per plant	Nos.	6		





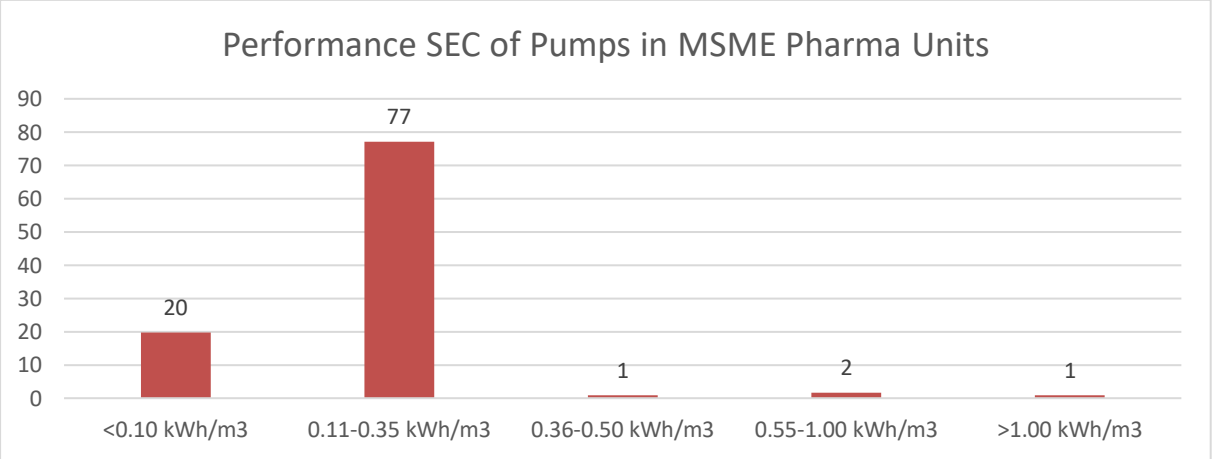


Figure 14: Capacity-wise distribution, Efficiency and SEC of pumps in MSME Pharma-Units

About 72% of the pumps in MSME Pharma-Units are <100 m^3/hr capacity. With regard to pump efficiency, only 7% of the pumps are operating with efficiencies greater than 70% and about 49% of the pumps are operating with efficiency range of 50-70%. Balance 44% of the pumps in MSME Pharma-Units are operating with efficiencies less than 50%.

In head & flow selection and installation of pumps without considering the actual head and flow requirement is found to be a common cause for poor operating efficiency of the pumps. Often MSME Pharma-Units cannot afford an identical pump as standby and in-case of pump failure, any pump that is available as spare would be installed to replace the failed pump. This would create a mismatch between pump design head & flow and system requirement resulting in operation away from Best Efficiency Point of the pump. In such cases a VFD would help to regain the sum of the efficiency which otherwise would be lost with fixed speed operation.

3.3.4.2 Energy Efficient Technologies for Pumps

The latest pumps that are offered by OEM (e.g., Armstrong, Grundfos, Kirloskar, Xylem, KSB) have IE-3 motor with inbuilt VFD that offers efficiencies in excess of 80% over wide range of flow during operation. The measurement of head & flow is the key in selection of suitable pump for various applications in MSME Pharma-Units. The presence of inbuilt VFD would also ensure that there is no efficiency loss over wide range of flow regulation during the operation. The IE-3 motors has compared to IE-2 motors also bringing up to 2% efficiency gain for the pumping system. Many of the OEMs have made their pump selection tools available online which can be a component in capacity building program for MSME Pharma-Units.

Energy Efficient Pump by Grundfos

3.3.4.3 Comparison of Energy KPI for Pumps and Benchmarking

The data from large Pharma-Units reveal that efficiencies as high as 80% can be realized with new age pumps which are generally equipped with IE-3 motors and inbuilt VFDs. The data available from OEMs like Grundfos and Xylem also indicate pumping efficiencies of about 82% are possible for the capacities of pumps installed in MSME Pharma-Units. The following table details the comparison of efficiencies possible and recommended benchmark for MSME pharma sector program.

Table- 27: Recommended Benchmark data of Pumps in MSME Pharma-Units

S. No	Parameters	Efficiencies Of Pumps In Percentage (%)
1	Maximum from the cluster	78.0
2	Maximum from other clusters/large pharma	80.36
3	Best available technology / OEM	82.10
4	Recommended benchmark for long-term	70% and above

3.4 Comparison of SEC and Benchmarking for Vacuum Pumps

3.4.1 Comparison of SEC of vacuum Pumps in MSME Clusters

Vacuum pumps are used to create vacuum in production reactors, solvent recovery Units and vacuum requirement ranges between 600-720 mm hg. The energy consumption of vacuum pumps depends on capacity (m3/hr), vacuum requirement, technology (centrifugal/screw). There are two vacuum pumps on average for each MSME Pharma Unit. It is observed that most MSME Units are using vacuum pumps of capacity 220 m3/hr. Typically about 2% of electricity consumed in MSME Pharma-Units is towards vacuum pumps.

The key features of vacuum pumps from cluster level studies are presented in the following table and chart.

Table- 28: Key features of vacuum pumps from Cluster levels in MSME Pharma-Units

S. No	Parameters	UOM	Minimum	Maximum	Average
1	Capacity of vacuum pumps	m^3/hr	220	220	220
2	Rated Vacuum	mm hg	600	720	640
3	SEC	kWh/1000 m^3	25.00	68.18	44.14
4	Number of vacuum pumps per pharma plant	Nos		1	

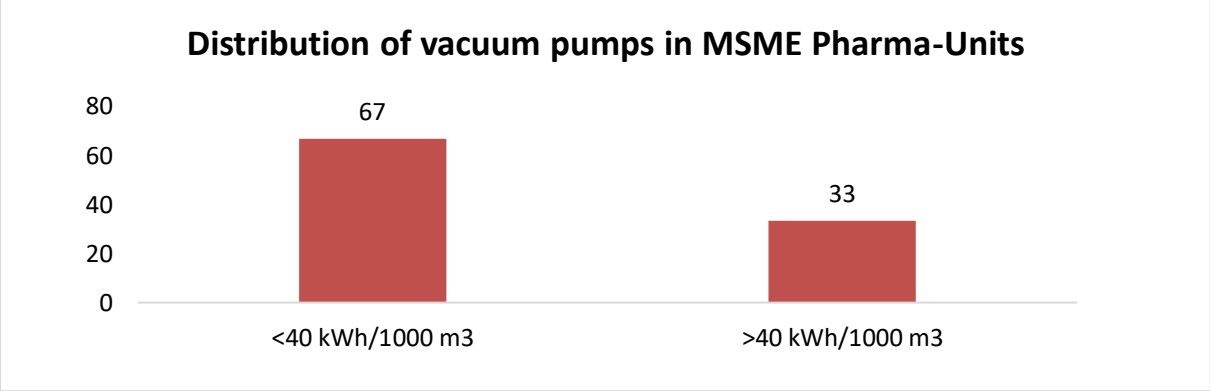


Figure 15: Distribution of Vacuum Pumps in MSME Pharma-Units

3.4.2 Energy Efficient Technology for Vacuum Pumps

1. Oil sealed screw vacuum pump with VFD

A new technology for vacuum pumps is available with screw type compressor directly coupled with motor with VFD that offers up-to 50% energy savings

Oil sealed screw Vacuum Pump by Atlas Copco

as compared to conventional vacuum pumps. These vacuum pumps are introduced in the market and some large Pharma-Units have started installing.

3.4.3 Comparison of Energy KPI for Vacuum Pumps and Benchmarking

The following table provides comparison of average SEC of vacuum pumps from cluster level studies and that of screw type vacuum pump with VFD.

Table- 29: Recommended Benchmark data of Vacuum Pumps in MSME Pharma-Units

S. No	Parameters	SEC of Vacuum Pumps
		kWh/1000 m^3
1	Average from the cluster	44.14
2	Best available technology (screw type vacuum pump with VFD) / OEM	26.00
3	Recommended benchmark for long-term	30.00

3.5 Comparison of SEC and Benchmarking for Boilers & Thermic Fluid Heaters

3.5.1 Comparison of SEC of Boilers & Thermic Fluid Heaters in MSME Clusters

Boiler is the major consumer of thermal energy in the form of solid fuels (Coal/Bio mass), liquid fuels (HSD/LDO) and natural gas. The cluster level studies indicate that each MSME pharma unit is equipped with 1 Boiler. Solid fuel fired boilers constitute 62% and balance 38% are liquid fuel fired in MSME Pharma sector.

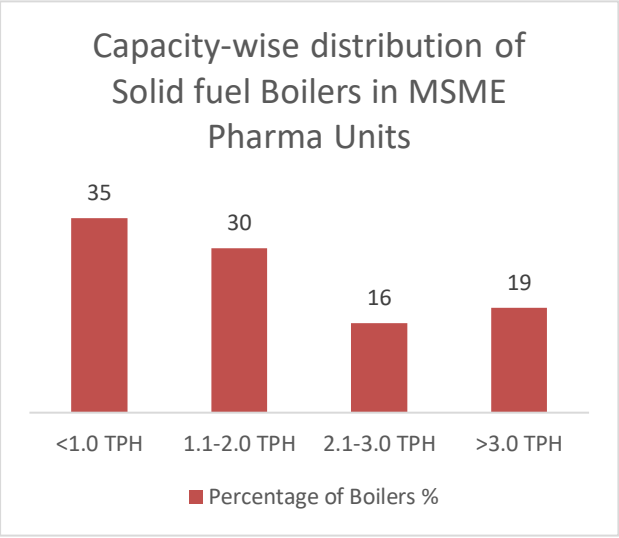
The capacity of the boilers ranges between 0.2-8.0 TPH steam for solid fuel and that for liquid fuel ranges between 0.2-5.0 TPH. Liquid fuel fired boilers are generally installed for low-capacity applications when coal availability and coal management is an issue for the MSME Pharma-Units. The MSME Units are also retrofitting their liquid fuel boilers with natural gas burners when natural gas is available in the vicinity.

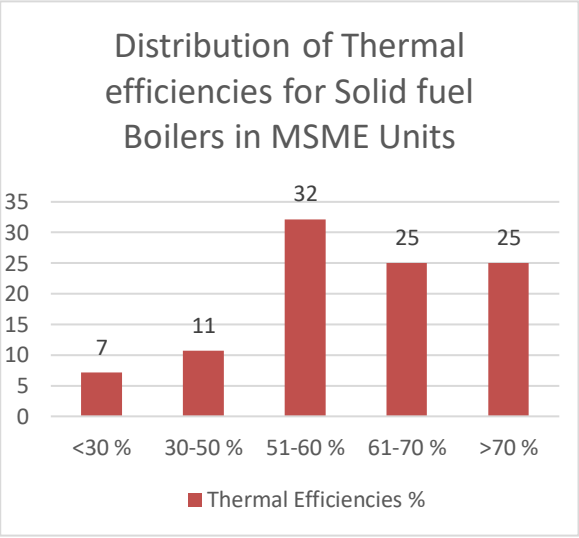
Out of solid fuel boilers only 20% are equipped with Air Pre-Heater (APH) and 40% are equipped with Economizer/HRE for feed water pre heating. Balance 40% of solid fuel fired boilers are without any heat recovery. Accordingly, the thermal efficiency of solid fuel fired boilers is ranging widely between 19.0-83.5% with average efficiency of 61.7%. As seen from the charts below, about 50% of solid fuel boilers are operating with efficiencies less than 60% which can be attributable to lack of heat recovery systems, lack of combustion control as most of solid fuel boilers are manually fed (no mechanized fuel feeding system).

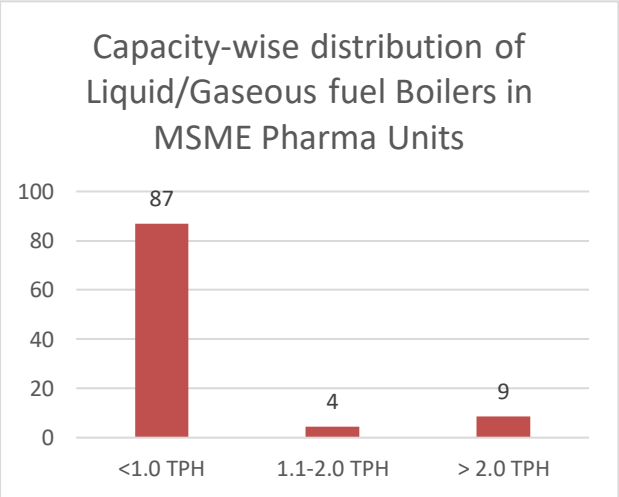
Table- 30: Salient features of Boilers in MSME Pharma-Units

S. No	Parameters	UOM	Minimum	Maximum	Average
1	Capacity of Solid fuel boilers	TPH	0.2	8.0	2.3
2	Thermal efficiency of Solid fuel boilers	%	19.0	83.5	61.7
3	Boilers equipped with Air Pre-Heater	%	20		

S. No	Parameters	UOM	Minimum	Maximum	Average
4	Boilers equipped with Economizer/Heat recovery Unit	%	40		
5	Units without APH and/or Economizer/Heat recovery	%	40		
6	Capacity of liquid/gaseous fuel boilers	TPH	0.2	5.0	0.8
7	Thermal efficiency of liquid/gaseous fuel boilers	%	21.0	87.6	61.1
8	Number of Boilers per Pharma Plant	Nos	1		
9	Percentage of solid fuel boilers	%	62.0		
10	Percentage of liquid/gaseous fuel boilers	%	38.0		







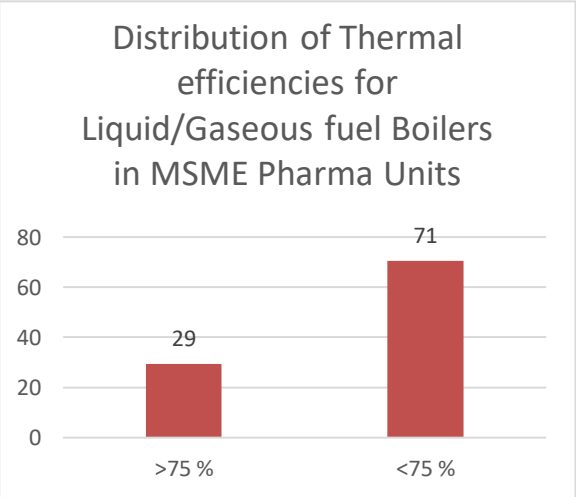


Figure 16: Capacity-wise distribution and Thermal efficiencies of Solid/liquid/gaseous fuel fired boilers in MSME Pharma-Units

The liquid fuel fired boilers are in operated efficiently although cost of steam generation is higher compared to that from solid fuel fired boilers. Some of the solid fuel boilers are based on Fluidized Bed Combustion (FBC) technology and their operating thermal efficiencies are excess of 70%.

It is also seen that small liquid fuel fired thermic fluid heaters are installed with capacity of 0.2 M kcal/hr which are not equipped with any heat recovery systems. Accordingly, such thermic fluid heaters are operating with lower efficiencies range of 34.0-41.0%. Except for such thermic fluid heaters other liquid fuel fired systems which are for steam generation are found to be working efficiently.

3.5.2 Energy Efficient Technologies for Boilers & Thermic Fluid Heaters

The solid fuel boilers which are manually fed, having no combustion control systems and no heat recovery shall be the focus for energy efficiency improvements.

The thermal efficiency of boiler declared by OEMs with heat recovery systems based on FBC technology is around 85.0% for solid fuel boilers. In case of liquid/gaseous fuel fired boilers, the efficiency declared by OEMs is in the range of 94-95%.

Accordingly, the upgrades for energy efficiency improvements for boilers may include the following:

(i) Converting from manual fuel feeding to mechanized fuel feeding with combustion control.
(ii) Installation of APH and/or Economizer for heat recovery from exit flue gases.
(iii) Converting/replacing existing inefficient solid fuel fired boilers to FBC boilers
(iv) Converting/replacing existing inefficient liquid fuel fired boilers to Electric boilers
(v) Capacity building of boilers operators and engineers.
(vi) Other EE upgrades for boiler include automatic blowdown control, thermal insulation upgrade for steam piping.

3.5.3 Comparison of Energy KPI for Boilers & Thermic Fluid Heaters and Benchmarking

A comparison of energy KPI (i.e. thermal efficiency) of boiler from cluster level studies, OEMs and recommended benchmark are tabulated below.

Table- 31: Recommended Benchmark data of Solid fuel boilers in MSME Pharma-Units

S. No	Parameters	Thermal Efficiency (%)
1	Maximum Thermal efficiency for solid fuel boilers from the cluster	83.5
2	Best available technology / OEM for Solid fuel	85.0
3	Recommended benchmark range for Solid fuel boilers	70.0-80.0
4	Recommended benchmark of Solid fuel boilers for long-term	80.0% and above

The Thermal efficiencies of solid fuel fired boilers are supplied by one of the OEM is presented in the following table.

Table- 32: Thermal Efficiencies of COMBLOC Solid fuel fired boiler by Thermax

COMBLOC BY THERMAX (for solid fuels)			
Capacity Range	1.5-6.0 TPH	Standard design pressure	10.54&17.50 kg/cm^2(g)
Thermal efficiencies for Stationary Grate Combustor			
Indian coal 83%	Woodlogs**83%**		Briquettes **82%**
Thermal efficiencies for Bubbling Bed Combustor			
Rice Husk 83%	Imported Coal **85%**	Pellets **84%**	Wood chips **84%**

Table- 33: Recommended Benchmark data of Liquid/Gaseous fuel fired boilers in MSME Units

S. No	Parameters	Thermal Efficiency (%)
1	Maximum Thermal efficiency for liquid/gaseous fuel boilers from the cluster	87.6
2	Best available technology / OEM for liquid/gaseous fuel	94(liquid fuel) – 95(gaseous fuel)
3	Recommended benchmark range for liquid/gaseous fuel boilers	75-90
4	Recommended benchmark of liquid/gaseous fuel boilers for long-term	90% and above

The Thermal efficiencies for liquid/gaseous fuel fired boilers are supplied by one of the OEM is presented in the following table.

Table- 34: Thermal Efficiencies of SHELLMAX global by Thermax for liquid/gaseous fuel

SHELLMAX GLOBAL BY THERMAX (for liquid/gaseous fuels)			
Capacity Range	1.0-16.0 TPH	Standard design pressure	10.54&17.50 kg/cm^2(g)
Thermal efficiencies for Shellmax global			
LO (HSD/LDO)	**94%**	Natural gas	**95%**

3.6 Summary of Energy KPI and Energy Efficiency Potential

The existing energy efficiency levels of various energy systems along with its recommended bench marks and energy efficiency potential in percentage has been estimated and presented in the following table.

Table- 35: Energy Benchmarks and Energy Efficiency potentials for MSME Pharma Sector

S. No	Description	UOM	Present EE level	Benchmarked EE Level	Percentage EE potential
1	Chiller	kWh/TR	1.27	0.60	52.69 %
2	AHU	kW/CFM	0.00102	0.00022	78.43 %

S. No	Description	UOM	Present EE level	Benchmarked EE Level	Percentage EE potential
3	Air Compressor	kW/CFM	0.18	0.14	25.53 %
4	Pump	%	50.00	70.00	40.00 %
5	Vacuum Pump	kWh/m3	0.044	0.0264	40.60 %
6	Boiler & TFH	%	61.68	75.00	17.76 %

The above energy KPI of existing systems and energy efficiency benchmarks are used for estimating energy efficiency potential and investment required for the energy efficiency programs for the sector in the following section.

4 Energy Saving Potential in MSME Pharma Sector

4.1 Energy Saving Potential for Chiller System

The energy saving potential for Chiller system has been estimated and presented in the following table.

Table- 36: Energy Efficiency potential for Chiller System

S. No	Parameters	UOM	+5 °C chillers	-5 °C chillers	-10 °C chillers	-20 °C chillers
1	Number of chillers	Nos	6575	2901	3481	1547
2	number of Chillers proposed for energy efficiency upgrade	Nos	4800	1537	2089	1098
3	Total capacity of chillers for replacement	TR	648439	74208	126232	57434
4	SEC of existing chiller	kW/TR	1.27	1.34	1.81	2.37
5	SEC of Energy efficient chiller	kW/TR	0.60	1.00	1.75	2.00
6	Energy consumption of existing chillers	MU/year	6759	1124	2288	1151
7	Baseline energy consumption for chillers proposed for upgradation	MU/year	4934	596	1373	817
8	Energy consumption after EE upgradation	MU/year	2334	445	1325	689
9	Annual energy savings	MU/year	2600	150	47	128
10	Annual Cost savings	Million Rs./year	18199	1053	331	896
11	Investment for new chillers/EE upgrade	Million Rs.	16211	1855	3156	1660
12	Total number of chillers	Nos	14504			
13	Total number of chillers proposed for energy efficiency upgrade	Nos	9525			
14	Total capacity of chillers for replacement	TR	906313			
15	Total Energy consumption of existing chillers	MU/year	11322			
16	Total Baseline energy consumption for chillers proposed for upgradation	MU/year	7720			
17	Total Energy consumption after EE upgradation	MU/year	4794			
18	Total Annual energy savings	MU/year	2926			
19	Total Annual Cost savings	Million	20480			

S. No	Parameters	UOM	+5 °C chillers	-5 °C chillers	-10 °C chillers	-20 °C chillers
		Rs./year				
20	Total Investment for new chillers/EE upgrade	Million Rs.	22882			

4.2 Energy Efficiency Potential System for AHUs

The Energy Saving potential for AHUs has been estimated and presented in the following table.

Table- 37: Energy Efficiency potential for AHUs

AHUs Up-gradation			
S. No	**Parameters**	**UOM**	**Value**
1	Total number of AHUs for the sector	Nos	25596
2	Total number of AHUs proposed for energy efficiency upgrade	Nos	22524
3	SEC of existing AHUs	kW/CFM	0.00102
4	SEC of Energy efficient AHUs	kW/CFM	0.00025
5	Energy consumption of existing AHUs	MU/year	833
6	Baseline energy consumption for AHUs proposed for up-gradation	MU/year	733
7	Energy consumption after EE up-gradation	MU/year	180
8	Annual energy savings	MU/year	553
9	Annual Cost savings	Million Rs. /Year	3872
10	Investment for new AHUs/EE upgrade	Million Rs.	2052

4.3 Energy Saving Potential for Air Compressors

The Energy Saving potential for Air compressors has been estimated and presented in the following table.

Table- 38: Energy Efficiency potential for Air Compressors

AIR COMPRESSORS UPGRADATION			
S. No	**Parameters**	**UOM**	**Value**
1	Total number of Air compressors for the sector	Nos	17064
2	Total number of Air compressors proposed for energy efficiency upgrade	Nos	10687
3	SEC of existing Air compressors	kW/CFM	0.18
4	SEC of Energy efficient Air compressors	kW/CFM	0.15
5	Energy consumption of existing Air compressors	MU/year	2537

6	Baseline energy consumption for Air compressors proposed for upgradation	MU/year	1589
7	Energy consumption after EE upgradation	MU/year	1326
8	**Annual energy savings**	**MU/year**	**263**
9	**Annual Cost savings**	**Million Rs. /Year**	**1838**
10	**Investment for new Air compressor/EE upgrade**	**Million Rs.**	**7368**

4.4 Energy Saving Potential for Pumps

The Energy Saving potential for Pumps has been estimated and presented in the following table.

Table- 39: Energy Efficiency potential for Pumps

PUMPS UPGRADATION			
S. No	**Parameters**	**UOM**	**Value**
1	Total number of Pumps for the sector	Nos	51192
2	Total number of Pumps proposed for energy efficiency upgrade	Nos	48632
3	SEC of existing Pumps	kWh/m^3	0.17
4	Average Efficiency of existing pumps	%	50%
5	Average Efficiency of Energy efficient pumps	%	70%
6	SEC of Energy efficient Pumps	kWh/m^3	0.12
7	Energy consumption of existing Pumps	MU/year	5896
8	Baseline energy consumption for Pumps proposed for upgradation	MU/year	5601
9	Energy consumption after EE upgradation	MU/year	3989
10	**Annual energy savings**	**MU/year**	**1612**
11	**Annual Cost savings**	**Million Rs. /Year**	**11286**
12	**Investment for new Pumps/EE upgrade**	**Million Rs.**	**12158**

4.5 Energy Saving Potential for Vacuum Pumps

The Energy Saving potential for Vacuum Pumps has been estimated and presented in the following table.

Table- 40: Energy Efficiency potential for Vacuum Pumps

VACUUM PUMPS UPGRADATION			
S. No	**Parameters**	**UOM**	**Value**
1	Total number of Vacuum Pumps for the sector	Nos	8532
2	Total number of Vacuum Pumps proposed for energy efficiency upgrade	Nos	8532
3	SEC of existing Vacuum Pumps	kWh/m^3	0.04

4	SEC of energy efficient Vacuum Pumps	kWh/m^3	0.03
5	Energy consumption of existing vacuum Pumps	MU/year	417
6	Baseline energy consumption for vacuum Pumps proposed for up-gradation	MU/year	417
7	Energy consumption after EE up-gradation	MU/year	250
8	**Annual energy savings**	**MU/year**	**167**
9	**Annual Cost savings**	**Million Rs. /Year**	**1168**
10	**Investment for new vacuum Pumps/EE upgrade**	**Million Rs.**	**2560**

4.6 Energy Saving Potential for Boilers

The thermal energy saving potential for Boilers has been estimated and presented in the following table.

Table- 41: Energy Efficiency potential for Boilers

BOILERS UPGRADATION			
S. No	**Parameters**	**UOM**	**Value**
1	Total number of Boilers for the sector	Nos	8532
2	Number of solid fuel boilers	Nos	5262
3	Total number of Boilers proposed for energy efficiency upgrade	Nos	3578
4	Average Capacity of existing Boilers	TPH	2.33
5	Thermal Energy consumption of existing boilers	T kcal/year	80
6	Baseline energy consumption for boilers proposed for upgradation	T kcal/year	54
7	Energy consumption after EE upgradation	T kcal/year	42
8	**Annual Thermal energy savings**	**T kcal/year**	**12**
		TOE	**1237340**
9	**Annual Cost savings**	**Million Rs. /Year**	**16865.16**
10	**Investment for new boiler /EE upgrade**	**Million Rs.**	**8945**

4.7 Summary of Energy Saving Potential for the Pharma Sector

4.7.1 Summary of Electrical Energy Saving Potential

Table- 42: Summary of Electrical Energy saving potential in MSME Pharma-Units

SUMMARY OF ELECTRICITY SAVINGS IN PHARMA-UNITS			
S. No	Energy System/Utility	Energy Savings	Ranking
		GWh/year	-
1	Chillers	2926	1
2	AHUs	553	3
3	Air compressors	263	4

SUMMARY OF ELECTRICITY SAVINGS IN PHARMA-UNITS			
S. No	Energy System/Utility	Energy Savings	Ranking
		GWh/year	-
4	Pumps	1612	2
5	Vacuum Pumps	167	5
Total Annual Electrical Energy Savings potential in Pharma Sector		**5521**	
Total Annual GHG Emission reduction potential in Pharma Sector		**4520 x 10^6 (Tonnes of CO_2)**	
Total Baseline electricity consumption of the proposed EE		**14060**	
Total electricity consumption for the Pharma sector		**22873**	
Percentage electricity savings compared to baseline consumption (considering consumption of utilities upgraded)		**34%**	
Percentage electricity savings compared to total electricity consumption (considering consumption of utilities upgraded)		**24%**	

4.7.2 Summary of Thermal Energy Saving Potential

Table- 43: Summary of Thermal Energy saving potential in MSME Pharma Sector

SUMMARY OF THERMAL ENERGY SAVINGS IN MSME PHARMA SECTOR		
Parameters	**UOM**	**Value**
Number of Boilers proposed for energy efficiency upgrade	Nos	3578
Annual Thermal energy savings for Pharma Sector	T kcal/year	12
	TOE	12,37,340
Total Annual GHG Emission reduction potential in Pharma Sector	**38,35,754 (Tonnes of CO_2)**	
Baseline thermal energy consumption for the proposed EE	**T kcal/year**	**54**
Total Thermal energy consumption for the Pharma sector	**T kcal/year**	**80**
Percentage thermal savings compared to baseline consumption (considering consumption of utilities upgraded)	**%**	**22.88%**
Percentage thermal energy savings compared to total thermal energy consumption (considering consumption of utilities upgraded)	**%**	**15.56%**

It can be concluded that MSME pharma sector has good potential for EE improvements to the extent of around 24% in electrical utilities and around 16% in thermal utilities as compared to existing energy consumption of pharma unit. The technologies identified for such energy efficient improvements are readily available and a good EE program focusing MSME sector which suitable components for technical assistance, financial assistance, capacity buildings involving various stake holder would enable to realize this potential in an expedited and time bound manner.

5 Recommendations and Implementation Plan

5.1 Existing Institutional Arrangements for Energy Efficiency Improvement

Implementing EE in MSME Pharma sector requires involvement of various institutions and stake holders. The following categories of institutions have been identified as crucial and essential for a successful EE program in MSME Pharma sector.

Table- 44: List of Institutions in MSME Pharma sector

S. No	Name of the Institution	Category
1	Bureau of Energy Efficiency (BEE)	Government (facilitator at national level)
2	Department of Pharmaceuticals (DoP)	Ministry of Chemicals & Fertilizers, Govt. of India
3	Ministry of MSME (MoMSME)	Govt. of India
4	State Designated Agency (SDA)	Government (facilitator at state level)
5	District Industries Centre (DIC)	Government (facilitator at district level)
6	National productivity Council (NPC)	Professional Agencies/Firms
7	Confederation Indian industry (CII)	
8	TERI	
9	Federation of Indian Chambers of Commerce & Industry (FICCI)	
10	Indian Society of Heating, Refrigeration and Air Conditioning Engineers (ISHRAE)	
11	National Institute of Pharmaceutical Education and Research (NIPER)	
12	Energy Efficiency Services Limited (EESL)	Energy Service company
13	Organisation of Pharmaceutical Producers of India (OPPI)	It represents the research-based pharmaceutical companies in India
14	Bulk Drugs Manufacturers Association (BDMA)	It serves as a coordinator and catalyst between the government and the industry.
15	Pharmaceutical Export Promotion Council of India (Pharmexcil)	Government (Pharmaceutical Exporter)
16	Small Industrial Development Bank of India (SIDBI)	Financial institution and anchor institution for partial risk sharing facility
17	Indian Renewable Energy Development Agency Limited (IREDA)	Financial institution for promoting renewable energy systems

A

The key roles and responsibilities envisaged for various institutions for EE program in MSME pharma sector have been presented in the following chart.

Type of Institution	Government	Professional	ESCOs	Industry	Financial Institutions
Role of the Institution	1. Policy formulation 2. Program design 3. Project monitoring 4. Sponsoring training and capacity building program	1.Baseline and post implementation studies 2. Conducting training and capacity building 3. Conducting certification course for MSME workforce (e.g., ICP by ISHRAE) 4. Project management services	1. Funding EE projects 2. Project management 3. Sponsor pre implementation and post implementation studies	1. Participation in training and capacity building programs. 2. Involving all MSME Pharma-Units in EE programs 3. Allocation of financial and resources for EE 4.Encourage the workforce in participating capacity building and certification programs 5. Industry body to prepare a charter on climate change for MSME sector	1. To participate in training and capacity building programs for disseminating information about lending for EE 2. Sponsor pre implementation and post implementation studies
Name of the Institutions	1. BEE 2. SDA 3. DIC	1. NPC 2. CII 3. TERI 4. FICCI 5. ISHRAE 6. Others	1. BEE approved ESCOS 2. EESL 3. OEMs	1. MSME Units 2. Cluster level associations 3. National level associations (e.g., OPPI, BDMA)	1. SIDBI 2. IREDA 3. International funding agencies 4. FI registered under PRSF

Figure 17: Institutions and their Roles & Responsibilities in MSME Pharma sector

Activity Roadmap for Pharma Sector

Activity	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32
Awareness and Capacity Building										
Conducting Cluster Level Awareness Workshops	•	•	•	•						
Conducting Regional/ National Awareness Workshop	•	•	•	•						
Capacity Building and Training of Industry Personnel	•	•	•	•	•	•	•	•	•	•
Vendor and Supplier Development activity for EE (& RE) Projects	•	•	•	•						
Technology Implementation in MSMEs										
Implementation of Energy Efficient Technologies		•		•		•		•		
Implementation of Grid Connected Roof Top Solar Power Systems			•		•		•		•	
Policy related Interventions from Central Government										
Inclusion of identified EE technologies in MoMSME's CLCS Scheme	•		•							
Promotion of Interest subvention scheme provided by DoP, MoC&F, GoI		•		•						
Decarbonization Strategies										
Material Flow Cost Accounting (MFCA) in MSME clusters (No. of Units)		•	•	•						
Promoting Environment Friendly Packaging			•	•	•	•	•	•	•	•

5.2 Awareness and Capacity Building

5.2.1 Conducting Cluster/ Regional/ National Awareness Program

The EE program for MSME pharma sector would kick start with regional workshops with participation of industry leaders, national level associations and cluster level associations and MSME Pharma-Units. This will be followed by awareness workshop for each of the cluster (around 30) covering entire country. The program would be concluded with a national level workshop. The budget/resources for such workshops has been estimated and presented in the following table.

Table- 45: Resource for Regional/National awareness program in MSME pharma sector

RESOURCE FOR REGIONAL/NATIONAL AWARENESS PROGRAM			
S. No	**Parameter**	**UOM**	**Value**
1	Awareness Program at cluster level (30 clusters X 0.5million)	Million Rs.	15
2	Regional/National workshop (5 workshops X 1 million)	Million Rs.	5
Total budget for Regional/National awareness program		Million Rs.	20.00

5.2.2 Capacity Building and Training of Industry Personnel

The workforce in MSME Pharma-Units is mostly untrained although qualified. They learn from experience which is just sufficient for routine O&M of the Energy System/Utilities. In most cases such workforce also is through outsourcing, which poses a challenge in-terms of maintaining a reasonable level of competent and improving it through regular training of the workforce. Every time the outsourced agency changes or the outsourced employee changes, the experience gained would be lost. This problem can be addressed by standardizing training and certification of workforce so that a minimum level of competency can be instilled in the entire spectrum of workforce working for MSME pharma sector. Even Pharma-Units can also insist on certification from the employees or outsourcing agencies.

As can be seen the HVAC system which comprises of chiller, AHUs, majority of pumps and cooling towers consumes around 85% of electricity in a typical MSME pharma unit. The certification programs such as ISHRAE certified professional (ICP) from reputed professional bodies like ISHRAE can used to train at-least 2 personals from each pharma unit. The ICP program from ISHRAE is available from different modules of HVAC such as design, commissioning, servicing where in MSME Pharma-Units can choose the program as per their respective needs.

A separate budget resource is essential for the capacity building of work forced MSME pharma sector which can contribute maintaining and sustaining energy efficiency in the operations of energy system/utility. The budget requirements for such capacity buildings are presented in the following table.

Table- 46: Capacity Building of Workforce in MSME pharma sector

CAPACITY BUILDING OF WORKFORCE			
S. No	Parameter	Uom	Value
1	Number of MSME units to be covered for training	Nos	2000
2	Investment for capacity building (ICP courses by ISHRAE) for 1- person per MSME unit	Million Rs./ Person	0.05
Total budget for capacity building		Million Rs.	100

Capacity building on EE program for MSME Pharma Units may be taken up in phased manner covering at least 2000 MSME units, in different geographies.

5.2.3 Vendor and Supplier Development activity for EE/ RE Projects

The objective of this activity is to develop manufacturers, vendors and supplier of Energy Efficient and Renewable Energy technologies for Pharma Sector. BEE and the respective SDAs should identify, invite and develop the capacity of the local manufacturers and suppliers of the energy efficient and renewable energy technologies.

Awareness workshops, technology showcasing programs, exhibitions and capacity building programs should be conducted to bring the manufacturers and suppliers to build their capacity.

Implementation Strategy:

- Identifying the RE/ EE technology manufacturers and suppliers
- Creating awareness about the need for EE/RE technologies among manufacturers and suppliers, to make the same available to the MSME Units
- Inviting manufacturers and supplier from different regions to set up their local sales office

Budget Requirements:

The estimated budget for this activity is proposed to be Rs. 20.0 Lakhs for conducting about 10 awareness programs.

5.2.4 Implementation Plan

Activity	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32
Awareness and Capacity Building										
Conducting Cluster Level Awareness Workshops (Nos.)	8	8	7	7						
Conducting Regional/ National Awareness Workshop (Nos.)	1	1	1	2						
Capacity Building and Training of Industry Personnel (1 per MSME unit)	250	250	250	200	200	200	200	150	150	150
Vendor and Supplier Development activity for EE (& RE) Projects (Nos.)	3	3	2	2						

BEE shall earmark suitable budget for undertaking the above capacity building activities in preparation for roll out of energy efficiency program for Pharma sector.

5.3 Technology Implementation in MSMEs

5.3.1 Readiness of the Sector for Adoption of Energy Efficient technologies

The EE technologies identified for energy efficiency program in MSME Pharma-Units are available in India and have been installed in various industrial sectors. The following table provides details of technology, its availability and implementation experience of the technology and readiness of MSME sector for such technologies.

Table- 47: Technology & Readiness of MSME pharma sector

EE Up-gradation program	Technologies/EE Interventions	Availability	Implementation Experience	Readiness of MSME Sector	Remarks
HVAC-Chillers	1. Screw/ scroll compressor with VFD 2. Variable volume ratio 3. Precise magnetic levitation 4. Advanced microprocessor controller with load scheduling	Available in India through OEMs such as Daikin, Carrier, Bluestar	Implemented in various sectors including large Pharma	Yes	Work force to be trained for the operation of new technology
HVAC-AHUs	AHUs with EC motors	Available in India through OEMs and their associates such as ebm-papst	Many Pharma-Units including MSME Pharma-Units have implemented on pilot basis	Yes	-
Air compressors	Rotary screw compressor with Variable speed option	Available in market from various OEMs such as Atlas Copco, Chicago pneumatic and Ingersoll rand	Various sectors including large Pharma-Units have implemented	Yes	-
Pumps	Energy efficient pumps with IE-3 motors and inbuilt VFD	Energy efficient pumps are available from most of the pump OEMs such as Grundfos, KSB, Xylem and Kirloskar.	Including large Pharma-Units have installed	Yes	-

Vacuum Pumps	Oil sealed screw type vacuum pump directly coupled motor with inbuilt VFD	Available in India from OEMs such as Atlas copco	Large Pharma-Units have installed with new technology with OEM acting as ESCO with guaranteed savings	Yes	-
Boilers & Thermic fluid Heaters	Mechanised fuel feeding system with combustion control heat recovery (APH & Economizer) retrofit/replacement with FBC technology	Several OEMs and system integrators are available all over India for retrofitting existing boilers as well as supplying new energy efficient boilers with FBC technology	Various sectors have implemented such upgrades for boilers and thermic fluid heaters.	Yes	Downtime and space requirement are key factors and decision making.

5.3.2 Resource Requirement for MSMEs to Implement Energy Efficient Technologies

Table- 48: Technology Component for MSME Pharma sector

S. No	Energy Efficient Program/ Upgrade	UOM	Investment for MSME Pharma Sector	Investment Per MSME Pharma Unit
1	Chillers	Million Rs.	22882	2.68
2	AHUs	Million Rs.	2052	0.24
3	Air compressors	Million Rs.	7368	0.86
4	Pumps	Million Rs.	12158	1.43
5	Vacuum Pumps	Million Rs.	2560	0.30
6	Boilers	Million Rs.	8945	1.05
Total		**Million Rs.**	**55964.4**	**6.56**

Implementation of EE program for MSME Pharma-Units may be taken up in phased manner covering at least 500 MSME units, in different geographies. Such implementation would start with pre implementation assessment as baseline study and would be concluded with post implementation study. The assessments before and after implementation of EE projects would involve actual measurements of energy inputs and outputs from the utility system that would help measurement and verification of actual energy saving from each of the MSME Pharma-Units involved in implementation. Such measurement and verification shall be carried out independently by professional agencies/firms.

Such large programs would also require a project management cell (PMC) at central level (posted by BEE/EESL/SIDBI) to monitor, expedite and coordinate during the implementation. The PMC would also have the responsibility of developing all technical and commercial documents required for procurement of energy efficient products/systems.

The budget for pre and post implementation assessment for measurement and verification of energy savings and PMC have been estimated and presented in the following table.

Table- 49: Resource for Program management and M&V in MSME pharma sector

RESOURCE FOR PROGRAM MANAGEMENT AND MEASUREMENT & VERIFICATION				
S. No	**Parameter**	**UOM**	**Investment Per MSME Pharma Unit**	**Investment For MSME Pharma Sector**
1	Resource for Measuring and verification @ 5%	Million Rs.	0.33	2798
2	Resource for program management @ 5%	Million. Rs.	0.33	2798
Total budget for program management and M&V		Million. Rs.	0.66	5596

5.3.3 Implementation of Grid Connected Roof Top Solar Power Systems in 750 registered MSME Pharma Sector enterprises

The objective of this activity is to encourage and promote the installation of Roof top solar power systems in registered MSME units located in various Pharma clusters in the country.

BEE shall encourage and support the registered MSME industrial units in installing the Grid Connected solar roof top power plants in around 750 units (250 Nos. of 5kW in Micro Units, 250 Nos. of 10kW Small Unit and 250 Nos. of 15kW in Medium Units). The said solar power plants would generate around 15 – 50 units of electricity a day which would meet a substantial part of the energy requirement of a MSME unit and any surplus power could be exported to the grid.

Budget Requirements:

The benchmark cost for grid connected solar roof top system is Rs. 38236 / kW (As per MNRE).

MSME Units	Nos.	Capacity (kWp)	Benchmark Cost (Rs./kWp)	Total Investment Required (Rs. Lakhs)	Electricity Generation (kWh)	Payback in Years
Micro Units	250	5	40991	512	4000	5.1
Small Units	250	10	38236	956	8000	4.8
Medium Units	250	15	38236	1434	12000	4.8

Expected Output:

- Electricity requirement from grid in MSME Industrial units will reduce

- Solar Energy Generation Capacity of 7.5 MW will be established
- Annual Energy Generation Potential of 6.0 MU annually (@ 4kWh/kWp of installation operating for 200 sunny days a year)
- CO_2 emission reduction potential is 4920 Tons/ year

5.3.4 Implementation Plan

Activity	2022 -23	2023 -24	2024 -25	2025 -26	2026 -27	2027 -28	2028 -29	2029 -30	2030 -31	2031 -32
Technology Implementation in MSMEs										
Implementation of Energy Efficient Technologies (No. of projects)		100		100		150		150		
Implementation of Grid Connected Roof Top Solar Power Systems (No. of MSMEs)			200		200		200		150	

The above implementation plan can be executed through ESCO and RESCO route.

5.4 Policy Related Interventions from Central Government

5.4.1 Inclusion of Identified EE technologies in MoMSME's CLCS Scheme

Ministry of MSME provides capital subsidy @ 15% (subject to a maximum of Rs. 15 Lakhs) of the technology cost for several equipments/ technologies in the pharma sector under their Credit Linked Capital Subsidy (CLCS) scheme. In order to catalyse the uptake of energy efficient technologies in the pharma sector, these technologies/ equipments should also be eligible for capital subsidy under the CLCS scheme.

While some of the technologies have already been included in the capital subsidy scheme, the other energy efficient technologies should also be included to make it imperative for the units to adopt such technologies. The technologies already eligible for capital subsidy are listed below:

- Chillers
- AHUs
- Pumps

The scheme details are attached as Annexure – D.

5.4.2 Promotion of Interest subvention scheme (PTUAS) provided by DoP, MoC&F

Department of Pharmaceuticals (DoP) under Ministry of Chemicals and Fertilisers (MoC&F), has a scheme to provide interest subvention under Pharmaceutical Technology Up-gradation Assistance Scheme (PTUAS) for MSMEs. This scheme is aimed at providing interest subvention (up to 6%) to eligible small and medium pharma units having GMP compliant manufacturing facilities both for bulk drugs and pharmaceutical formulations. The scheme also covers up-gradation of HVAC systems (to WHO norms) and therefore provides an incentive to the SMEs to adopt relevant technologies.

BEE shall have to coordinate with DoP to include all EE technologies under the scheme to encourage the SMEs in the pharma sector to adopt these technologies for energy efficiency. The scheme details are attached as Annexure – D.

5.4.3 Implementation Plan

Activity	2022 -23	2023 -24	2024 -25	2025 -26	2026 -27	2027 -28	2028 -29	2029 -30	2030 -31	2031 -32
Policy related Interventions from stake holders										
Inclusion of identified EE technologies in MoMSME' s CLCS Scheme	•		•							
Promotion of Interest subvention scheme provided by DoP, MoC&F		•		•						

5.5 Decarbonisation Strategies

5.5.1 Conducting material flow cost accounting in Pharma MSME clusters

In order to achieve resource efficiency in Pharma Industries, it is desirable to conduct studies on Material Flow Cost Accounting (MFCA), wherein various material and resources being used in the manufacturing process will be suitably accounted for. This will help identify wastages and their associated costs, in a stage-wise manner. This will lead to reduction in raw material consumption, energy savings and reduced procurements; which in turn will lead to reduced carbon emissions.

Implementation Strategy:

- Identifying the 4-5 MSME clusters
- Selection of 5-10 MSME units in each cluster for conducting the MFCA study and implementation of productivity tools
- Conducting the study
- Providing support to MSME units for implementing the productivity improvement measures
- Impact assessment and savings estimations

Budget Requirement:

- The estimated budget required for this activity would be Rs.200 Lakhs.

5.5.2 Promoting Environmental Friendly Packaging

To reduce energy consumption in packaging materials as well as minimise its impact on environment, it would be necessary to mandate the use of environment friendly packaging materials in the Pharma sector.

Implementation Strategy:

- Mandate use of glass containers for capacities above 250 ML
- Increase use of environmentally safe packing materials (blister/paper packing) for tablets and capsules.
- Create awareness on the need for environmental friendly packaging to industry stake holders.

Budget Requirement:

- The estimated budget required for this activity would be Rs.20 Lakhs.

5.5.3 Implementation Plan

Activity	2022-23	2023-24	2024-25	2025-26	2026-27	2027-28	2028-29	2029-30	2030-31	2031-32
Decarburization Strategies										
Material Flow Cost Accounting (MFCA) in MSME clusters (No. of Units)		20	20	10						
Promoting Environment Friendly Packaging			•	•	•	•	•	•	•	•

5.6 Implementation Plan in MSME Pharma Sector

5.6.1 Technological Aspects

VII. There are about 8000 to 9000 MSME Pharma-Units operating in India. The total energy consumption is estimated to be 22,873 GWh (1.9millionTOE) of electricity and 128 million TOE of thermal energy consumption for the MSME pharma sector.

VIII. HVAC systems (Chillers, Package units and AHUs), Air compressors, pumping system and vacuum pumps constitute 92% of electricity consumption in MSME Pharma-Units and shall be the focus areas for energy efficiency programs.

IX. Boilers and thermic heaters are the consumers of thermal energy in the form of solid fuels and liquid/gaseous fuels. Solid fuels constitute 62% of boilers/thermic heaters and balance 38% is consumed by that of liquid fuel fired.

X. The key pointers for a business case energy efficiency improvement in pharma sector are:

- 70-80 % of chiller plants are operating with specific energy consumption more than the benchmark SEC.
- 91% of AHUs in MSME Pharma-Units are operating with SEC more than benchmark/best available technology.
- 63% of Air compressors are having SEC more than industry benchmark/OEM.
- 93% of Pumps in MSME Pharma-Units are operating with efficiencies less than benchmark efficiency for the industry or sector.
- All existing vacuum pumps can be replaced with new technology for vacuum pumps (e.g., Oil sealed screw compressors with VFD) offer upto 50% energy savings vis-à-vis the existing centrifugal vacuum pumps with fixed speed motor.
- At least 70% of boilers are operating with thermal efficiency less than the industry/OEM benchmark.

XI. The EE technologies and interventions identified for MSME pharma sector are readily available in India through multiple OEMs and system integrators and sufficient experience has been gained by industry in other sectors as well as large Pharma-Units. These technologies include:

- Chillers- Chillers with Screw and Scroll compressors with VFD with Advanced micro pressor load scheduling, Variable volume ratio and precise magnetic levitation for shaft bearing.
- Air handling unit- Electronically Commutated motors (EC Motors) with inbuilt variable speed capability, light-weight materials for blades with aerodynamic shaping.
- Air compressor- Rotary Screw compressor with VFD option.
- Pumps- Energy efficient pumps with IE-3 motors and inbuilt VFD.
- Vacuum pumps- Oil sealed screw type vacuum pump directly coupled motor with inbuilt VFD
- Boilers & Thermic fluid heaters- Mechanised fuel feeding system with combustion control heat recovery (APH & Economizer) retrofit/replacement with FBC technology.

XII. The identified EE technologies for MSME pharma would result in 24% of existing electricity consumption and around 16% of existing fuel consumption. This corresponds to 5,521 GWh electricity savings and 12,37,340 TOE fuel savings annually for MSME pharma sector.

5.6.2 Financial Aspects

iii. The energy efficiency program for MSME pharma sector would require financial resources toward workshops, seminars for creating awareness among key stake holders, capacity building of MSME workforce to adapt to and sustain the energy efficiency practices and systems, Pre and Post implementation assessment of energy consumption and energy savings accrued through measurement and verification, program management besides the major component of technology procurement. The following table summarizes the financial requirement to cover the entire spectrum of existing MSME Pharma-Units in the sector.

Table- 50: Summary of Budget Resources for EE program in MSME pharma sector

SUMMARY OF BUDGET RESOURCES FOR EE PROGRAM IN MSME PHARMA SECTOR				
S. No	**Parameters**	**UOM**	**For MSME Pharma Unit**	**For MSME Pharma Sector**
1	Technology component	Million. Rs.	6.56	55964
2	Regional/national awareness program cluster level	Million. Rs.	-	20
3	Capacity Building of workforce	Million. Rs.	0.10	853
4	Program Management and M&V budget	Million. Rs.	0.66	5596
Total budget		Million. Rs.	7.32	62434

iv. The investment of the financial resources can be staggered by having the EE program for MSME pharma sector in a phased manner. To kickstart the program a pilot project with 400-500 MSME Pharma-units can be enlisted for implementation through ESCOs such as EESL that would create enough awareness about the program and also would break the price barriers for many of the EE technologies identified. The phase-II of EE program can be market driven with the financial resources rooted through lending from FIs directly to MSME Pharma-Units, ESCOs, OEMs through Partial risk sharing facility (PRSF) scheme by SIDBI thus the phasing of EE program for MSME pharma sector and use of PRSF would reduce financial risk for EESL and FIs and MSME Units.

5.6.3 Capacity Building

iv. MSME pharma sector is similar to any other MSME sector in terms of challenges it faces such as market competition, regulatory pressures and funding requirement for capital expenditure. The managements of MSME Pharma-Units are more focused towards meeting the regulatory requirements from the clients or regulatory authorities, Production and marketing and expansion of their business. In the pecking order of priorities expansion of business would take a lion's share in fund allocation as compared to funds available for renovation and modernization projects for improvement in energy efficiency. The business case for production improvement and expansion is much stronger as compared to that of business case for energy efficiency improvement despite the later one is attractive enough. In this context MSME pharma sector requires awareness about the requirement of energy efficiency in the light of climate change, favourable lending for EE projects in MSME sector.

v. The workforce in MSME Pharma-Units is mostly untrained although qualified. They learn from experience which is just sufficient for routine O&M of the Energy System/Utilities. In most cases such workforce also is through outsourcing, which poses a challenge in-terms of maintaining a reasonable level of competent and improving it through regular training of the workforce. Every time the outsourced agency changes or the outsourced employee changes, the experience gained would be lost. This problem can be addressed by standardizing training and certification of workforce so that a minimum level of competency can be instilled in the entire spectrum of workforce working for MSME pharma sector. Even Pharma-Units can also insist on certification from the employees or outsourcing agencies.

vi. HVAC system which comprises of chiller, AHUs, majority of pumps and cooling towers consumes around 85% of electricity in a typical MSME pharma unit. The certification programs such as ISHRAE certified professional (ICP) from reputed professional bodies like ISHRAE can used to train at-least 2 personals from each pharma unit. The ICP program from ISHRAE is available from different modules of HVAC such as design, commissioning, servicing. It is recommended to

develop a separate certification course with the support of ISHRAE for MSME pharma sector to improve and harmonize the technical capacities of workforce in MSME pharma sector that will enable maintaining and sustaining benefits of energy efficiency projects.

5.7 Other Recommendations

vi. The BEE shall engage industry associations at National and cluster levels in agreeing to a Charter on Climate Change for MSME Pharma-Units. The charter will elaborate the technology adoption time-lines by the MSME pharma sector. Since, such chatter is by the industries association representing the sector it would be binding on its member Pharma-Units.

vii. Conduct awareness programs about energy efficiency opportunities under the BEE road map as well as the agreed chatter for opinion makers, decision makers and other stake holders in MSME pharma sector such as industry associations, cluster level associations and individual MSME Pharma-Units.

viii. The capacity building program for workforce requires design and development of custom-made certification program by professional bodies like ISHRAE. Such program for capacity building shall also be part of the proposed Charter on Climate Change by MSME Pharma-Units.

ix. Energy Efficiency Services Limited (EESL) may be engaged for phase-I/Pilot phase of energy efficiency program involving technology component for 400-500 MSME Pharma-Units in India. This is expected to pave way for market transformation, market penetration of EE technologies identified for the sector which would result in traction for such technologies in remaining units where in the EE in MSME pharma sector can be implemented by lending directly to individual MSME Pharma-Units or ESCOs. The PRS facility of SIDBI would also play an important role in the Phase-II (market driven EE implementation for MSME sector).

x. The professional bodies and energy auditing companies who would be engaged for pre and post assessment studies, awareness programs shall be trained through workshops and seminars on EE opportunities in MSME pharma sector. This would enable availability of large pool of experts and consultants to work for the sector during the Phase-I and Phase-II implementation periods.

6. STRATEGIES FOR CIRCULAR ECONOMY IN PHARMA SECTOR

The circular economy is an excellent model to implement into any organisation; to be ignorant of the resources used and disposing of 100% of their waste is inefficient and careless. In the pharmaceutical industry, in particular, it is important to look for opportunities to reduce, reuse and recycle wherever possible.

Pharma and biotech companies in India are renowned for their consumption of energy; when investing in new manufacturing sites or retrofitting them, these companies are more willing to investigate eco-driven designs. Whether this is due to cost benefits, reputation, or for a competitive advantage, the result is the same. Moving towards a more circular economy should deliver benefits to not only the organization implementing the model but to the wider community and the overall environment.

Increased emphasis on reusing and recycling relieves pressure on resources and pushes pharmaceutical production in a more sustainable direction.

EECO$_2$ implements the philosophy "reduce, reuse and recycle" when approaching any energy efficiency project. Looking into energy usage and how to expertly reduce it without affecting product quality is the primary objective.

A. Reduce, Reuse and Recycle

Pharmaceutical manufacturing companies should look at reducing its consumption of resources, be that energy, water or materials. When we look at the most significant energy users in pharmaceutical manufacturing and laboratories, we find it is the treatment and movement of the air: HVAC system.

Supported by modern technical knowledge of HVAC systems and unique R&D, as well as the realities of the clients' systems and operations, high-quality energy assessments can lead to the creation of a cost-effective, energy sufficient and carbon-reducing plans for the company to implement. These plans will identify quick changes the company can make to reduce excess consumption, along with longer-term projects to establish a strong foundation for an energy-efficient and environment-conscious corporation.

An energy assessment involves assessing and targeting significant energy-consuming processes associated with the industry to identify opportunities for efficiency improvements. The improvements, whether it be switching lights off,

JIT manufacturing is a process for achieving continuous improvement through the systematic elimination of waste and encompasses not only production control techniques, but also total quality control programs, facility and line design, employee training, etc.

altering airflow rates or re-introducing extracted air or water, will reduce energy consumption and potentially water consumption, too.

B. Circular economy for Drug Making Industry

To achieve true sustainability, a more holistic approach to overall drug development is needed. This should be implemented via processing and operational excellence not just in manufacturing, but also across R&D, materials sourcing, supply chain connectivity and waste management at the later stages of the product life cycle.

Flexibility and agility, alongside six sigma, lean and just-in-time practices, for example, are required across the entire pharma supply chain. This includes raw material, intermediate, drug substance and drug product manufacturing, devices and packaging, extending to the production and utilization of materials and components of manufacturing equipment, and on to warehousing and distribution.

As referenced in the fourth green chemistry principle, implementing a circular economy will support a more holistic greening of the overall drug development process, accelerating the move towards a more sustainable and efficient industry.

Transition towards a more circular economy will dictate changes throughout value chains, from materials and product design, manufacturing and supply, to new business and market models. New ways of minimizing waste and turning waste into resources, prolonging the stability of products and changes to patient behavior, are also important considerations.

C. Waste Management

An example of the circular economy in practice can be seen in closed-loop supply chains, in which suppliers, manufacturers and recyclers collaborate and work closely to increase resource and cost savings.

An increase in patients, prescriptions and overproduction of some medicines, for instance, has contributed to higher volumes of pharmaceutical waste as well as increased disposal costs. It is a growing concern globally that requires a systemic approach to its resolution, and an area where a closed-loop supply chain could be of huge benefit.

Of course, avoiding waste is the ideal scenario, and the growing efficiency of chemical reactions and manufacturing processes continues to impress despite the greater technical challenges that are presented to drug makers tasked with delivering the next generation of therapeutics. Turning waste into secondary raw materials within the pharmaceutical industry could minimize the environmental impact of its activities across the entire value chain while also reducing costs in the long run.

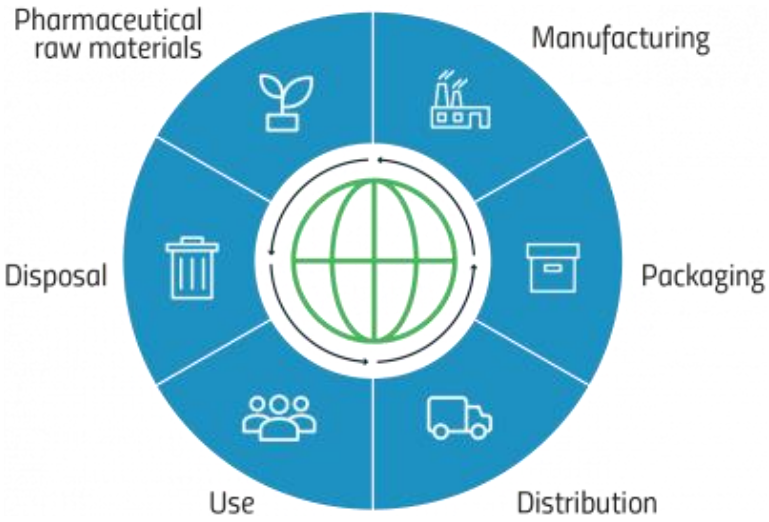
In the truly circular economy, waste from one process would be the input for another. Of course, the stringent regulatory framework makes this a substantial challenge for the pharma industry, but progress here has been made with the judicious use of solvents. Circular systems employ reuse, refurbishment, remanufacturing and recycling to create closed-loop systems by embedding circular principles in the design phase and by minimizing the use of resources and the creation of waste, pollution and carbon emissions.

This approach should be encouraged widely across the industry, especially for solvents, devices and packaging. In the design phase, choosing sustainable, renewable or recycled materials to preserve resources, lessen the environmental impact and maximize product lifetimes should be an integral part of the thinking.

Devices will be replaced with more environmentally friendly alternatives to significantly reduce carbon footprints where possible. For example, a shift to using dry powder inhalers (DPIs) in place of pressurized metered-dose inhalers (pMDIs), which have a carbon footprint 10-37 times higher than DPIs, would reduce carbon dioxide emissions by 58 kilotons in the UK alone.

Although environmental concerns are important to consider for long-term sustainability in the pharmaceutical sector, patient experience must remain the primary objective. A move towards DPIs should be made, but other methods such as life cycle assessments to identify other areas of improvement for DPI production and use, and effective recycling should be considered where direct replacements with pMDIs might not be effective for all patients.

A move towards recyclable packaging will be beneficial and should be at the forefront of the design and manufacture of new packaging solutions. For instance, a recyclable version of the innovative Push Pack — the blister packaging that is the most popular method of medicine storage but often made using non-recyclable PVC — is expected to be on the market by 2022 should the validation process be successful. However, no rules exist that enforce the use of sustainable packaging amongst pharmaceutical companies and the final decision is left with the manufacturers.



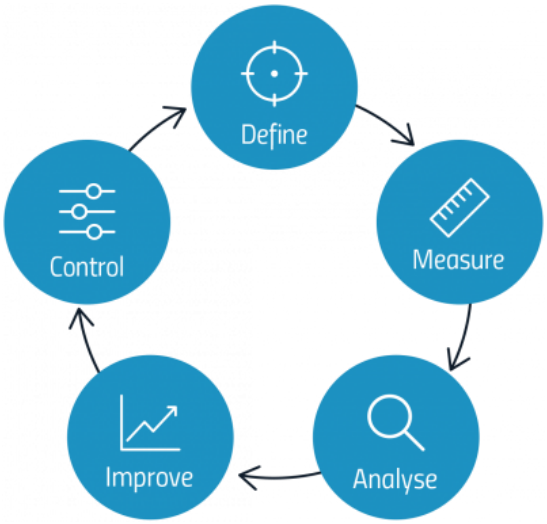
Within the pharmaceutical industry, a circular economy aims to promote waste reduction, maximize medicines' value, and enable sustainability throughout the entire supply chain.

In 2020, industry surveys revealed that 48% of biopharma manufacturers always look for packaging that is recyclable or that can easily enter the waste stream, and 81% are likely to use energy-efficient packaging in the near future.

The key to overcoming the sustainability challenge from a packaging perspective is to take patient needs into consideration from the start. For example, combination products that include a drug and medical device together represent another approach receiving growing attention in terms of improving environmental impact. For drug manufacturers, actively seeking greener ingredients and technologies and communicating this to patients can have a big impact. But patient views should always be considered and will be a key driver of sustainability in this area.

D. Implementing Sustainability

To achieve sustainability across the supply chain, the ability to rapidly integrate innovation and emerging science is key. New environmentally and economically efficient processes and technology that can advance the goals of green chemistry continue to emerge, but replacing existing methods with greener chemicals, materials and process technologies and implementing a more circular model at an industrial scale can be challenging. The complexity of the chemical supply chain requires development and commercialization partnerships for new technologies to become optimized, scaled and driven into products and onto pharmacy shelves.



Six sigma methodology involves the identification, recognition and definition of problems faced in the drug production process, as well as the characterization, measurement and analysis of data to identify weaknesses. This optimizes quality control systems, increasing production and innovation and reducing cycle times.

Integration of greener and more circular processes and technologies can be expedited by partnerships and better collaborations across drug substance and drug product development, as well as suppliers, manufacturers and recyclers. Collaborating with a dedicated innovation partner that specializes in developing economically and environmentally sustainable pharma manufacturing processes, for example, can provide process chemistry solutions to support the delivery of best-in-class small molecule therapeutics while reducing environmental impact. An increase in collaborations amongst pharma companies and across other industries to enable tech transfer and sharing of ideas and new processes or materials will also be beneficial.

Genuine circularity strategies for pharmaceuticals are not routinely explored in many countries, but top-down approaches can also help achieve widespread and effective implementation of more holistic green chemistry technologies and processes. In Europe, for instance, a circular economy is a key policy pursued by the European Commission. One of the four key pillars underlying the European Commission's Pharmaceutical Strategy for Europe details "supporting competitiveness, innovation and sustainability of the EU's pharmaceutical industry and the development of high quality, safe, effective and greener medicines."

New regulations will have a knock-on impact on the driving industry to become more efficient, forcing a transition to green approaches and more streamlined and efficient technologies. Accordingly, if enforced sufficiently, these regulations can drive the discovery and deployment of new and innovative processes for drug development that guarantee the health and safety of employees and patients while also reducing the environmental impact of the industry.

On a more localized level, investing to improve and maintain infrastructures such as modern manufacturing facilities, recycling schemes and effective waste management will also contribute to improved sustainability.

Implementing a holistic approach that integrates green chemistry across all amenable activities within the drug development and manufacturing supply chain and full life cycle of a pharmaceutical product is essential to achieve sustainability.

A circular economy represents a sustainable supply chain proposition. By integrating this approach across several key areas — including raw materials and waste management, drug manufacturing (substance and product), devices and packaging — there is an opportunity to shape the future of the pharmaceutical sector. As well as provoking more efficient use of resources and processes and better sustainability, the implementation of a circular economy could also help to drive innovation and improve long-term economic value.

Furthermore, more agile and flexible manufacturing will also help support a new focus on more localized production solutions, thus reducing the environmental burden of shipping and storage.

Making more responsible choices, increasing expenditure on new, greener technologies, forming strategic partnerships (including cross-industry collaboration) and new regulations that support innovation and environmentally friendly processes while also improving efficiencies will be key to success.

E. Benefits of Circular Economy in Pharma Sector :

To drive true sustainable growth and innovation, pharma units need to embrace circular economy thinking. A circular economy is based on the principles of designing out waste and pollution, keeping products and materials in use and regenerating natural systems. A circular economy seeks to rebuild capital, whether this is financial, manufactured, human, social or natural. This ensures enhanced flows of goods and services.

The benefits of adopting circular economy in the pharma sector are summarised as below:

- Lower costs for raw materials and waste handling
- Improved competitiveness
- Higher robustness against market fluctuations
- Reduced consumption of natural resources
- Lower emission of CO2

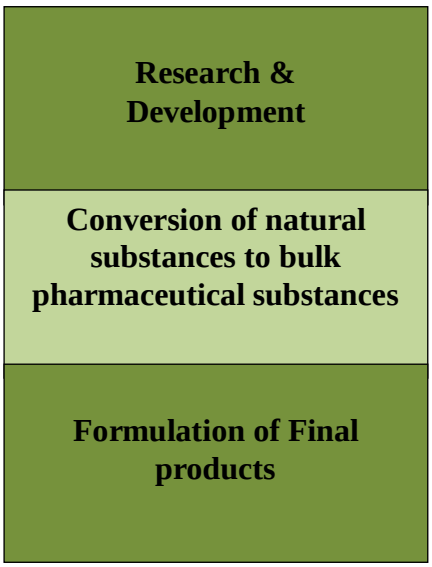
ANNEXURES

ANNEXURE-A: PRODUCTION PROCESS AND TECHNOLOGY ADOPTED

1) TYPE OF PRODUCTION PROCESSES IN MSME PHARMA SECTOR.

There are three overall stages in the production of bulk pharmaceutical products: (1) R&D, (2) conversion of natural substances to bulk pharmaceuticals, and (3) formulation of final products. Figure 18 provides an overview of the main process steps in the manufacture of pharmaceuticals. Each of these stages is described in more detail below.

Figure 18: Main process steps in the manufacture of Pharmaceuticals



Four stages:
1. Pre-clinical R&D: determine if substance is active and safe (6 years)
2. Clinical R&D: human testing (6 years)
3. Review of new drug application (1-2 years)
4. Post marketing surveillance

Types of conversion:
- Chemical Synthesis
- Fermentation
- Extraction

Conversion of substances at a much larger scale

- **RESEARCH&DEVELOPMENT**

Because it is highly regulated, R&D is the longest stage in pharmaceutical product manufacturing. After identifying several thousands of compounds at the beginning stages of R&D, only one will be introduced as a new pharmaceutical drug. Many resources go into this stage of development.

The four basic stages of R&D are listed above in Figure 18: (1) pre-clinical R&D, (2) clinical R&D, (3) review of new drug application, and (4) post marketing surveillance. In the preclinical R&D stage, compounds are tested on animals to determine biological activity and safety. This testing takes about six years on average to complete.

The next stage, clinical R&D, is typically conducted in three phases, each with progressively more human participants. The first phase of clinical R&D determines the safety of a new drug, the second phase determines a new drug's effectiveness, and the third phase provides further confirmation of safety and effectiveness along with determination of any adverse reactions. The clinical R&D stage altogether takes, on average, about six years to complete.

Finally, after a new drug has been approved for marketing, the CDSCO monitors the ongoing safety of marketed drugs via post marketing surveillance. Also, the

pharmaceutical manufacturer will evaluate various ways of formulating the drug on a larger scale for optimum delivery.

- **CONVERSION TO BULK PHARMACEUTICAL SUBSTANCES**

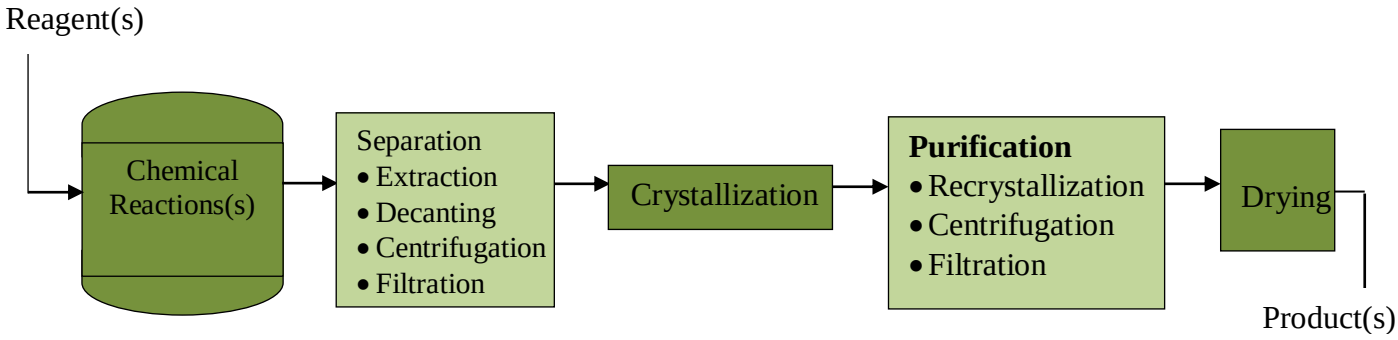
Bulk pharmaceutical substances are produced via chemical synthesis, extraction, fermentation, or a combination of these processes. Antihistamines, cardiovascular agents, central nervous system stimulants, and hormones are produced by chemical synthesis. Enzymes and digestive aids, allergy relief medicines, haematological agents, insulin, anti-cancer drugs, and vaccines are extracted from naturally-occurring substances. Most steroids, antibiotics, and some food additives, like vitamins, are produced by fermentation. Antibiotics, antineoplastic agents, central nervous system depressants, and vitamins are typically produced by more than one of these three processes.

Chemical synthesis, extraction, and fermentation are discussed separately below.

Chemical Synthesis

Figure 19 shows a simplified diagram of the chemical synthesis process for pharmaceuticals. There are five primary stages in chemical synthesis: (i) reaction, (ii) separation, (iii) crystallization, (iv) purification, and (v) drying. Each of these five stages is described below.

Figure 19: Simplified Chemical Synthesis diagram



(i) Reaction. In the reaction process, raw materials are fed into a reactor vessel, where reactions such as alkylations, hydrogenations, or brominations are performed. The most common type of reactor vessel is the kettle-type reactor. These reactors, which are generally made of stainless steel or glass-lined carbon steel, range from 50 to several thousand gallons in capacity. The reactors may be heated or cooled, and reactions may be performed at atmospheric pressure, at elevated pressure, or in a vacuum. Generally, both reaction temperature and pressure are monitored and controlled. Nitrogen may be required for purging the reactor, and some intermediates may be recycled back into the feed. Some reactions are aided via mixing action provided by an agitator. A condenser system may be required to control vent losses. Reactors are often attached to pollution control devices to remove volatile organics or other compounds from vented gases.

(ii) Separation. The main types of separation processes are extraction, decanting, centrifugation, filtration, and crystallization. Crystallization is used by many plants and is discussed separately below.

The extraction process is used to separate liquid mixtures. Extraction takes advantage of the differences in the solubility of mixture components. A solvent that preferentially combines with only one of the mixture components is added to the mixture. Two streams result from this process: the extract, which is the solvent-rich solution containing the desired mixture component, and the raffinate, which is the residual feed solution containing the non-desired mixture component(s).

Decanting is a simple process that removes liquids from insoluble solids that have settled to the bottom of a reactor or settling vessel. The liquid is either pumped out of the vessel or poured from the vessel, leaving only the solid and a small amount of liquid in the vessel.

Centrifugation is a process that removes solids from a liquid stream using the principle of centrifugal force. A liquid-solid mixture is added to a rotating vessel - or centrifuge - and an outward force pushes the liquid through a filter that retains the solid phase. The solids are manually scraped off the sides of the vessel or with an internal scraper. To avoid air infiltration, centrifuges are usually operated under a nitrogen atmosphere and kept sealed during operation.

Filtration separates fluid/solid mixtures by flowing fluid through a porous media, which filters out the solid particulates. Batch filtration systems widely used by the pharmaceutical industry include plate and frame filters, cartridge filters, nutsche filters, and filter/dryer combinations.

(iii) Crystallization. Crystallization is a widely used separation technique that is often usedalone or in combination with one or more of the separation processes described above. Crystallization refers to the formation of solid crystals from a supersaturated solution. The most common methods of super saturation in practice are cooling, solvent evaporation, and chemical reaction. The solute that has crystallized is subsequently removed from the solution by centrifugation or filtration.

(iv) Purification. Purification follows separation, and typically uses the separation methods described above. Several steps are often required to achieve the desired purity level. Re-crystallization is a common technique employed in purification. Another common approach is washing with additional solvents, followed by filtration.

(v) Drying. The final step in chemical synthesis is drying the product (or intermediates).Drying is done by evaporating solvents from solids. Solvents are then condensed for reuse or disposal. The pharmaceutical industry uses several different types of dryers, including traydryers, rotary dryers, drum or tumble dryers, or pressure filter dryers. Prior to 1980, the mostcommon type of dryer used by the pharmaceutical industry was the vacuum tray dryer.Today, however, the most common dryers are tumble dryers or combination filter/dryers. In the combination filter/dryer, input slurry is first filtered into a cake, after which a hot gaseous medium is blown up through the filter

cake until the desired level of dryness is achieved. Tumble dryers typically range in capacity from 80 to 400 litres. In tumble dryers, a rotating conical shell enhances solvent evaporation while blending the contents of the dryer. Tumble dryers utilize hot air circulation or a vacuum combined with conduction from heated surfaces.

Product Extraction

Active ingredients that are extracted from natural sources are often present in very low concentrations. The volume of finished product is often an order of magnitude smaller than the raw materials, making product extraction an inherently expensive process.

Precipitation, purification, and solvent extraction methods are used to recover active ingredients in the extraction process. Solubility can be changed by pH adjustment, by salt formation, or by the addition of an anti-solvent to isolate desired components in precipitation. Solvents can be used to remove active ingredients from solid components like plant or animal tissues, or to remove fats and oils from the desired product. Ammonia is often used in natural extraction as a means of controlling pH.

Fermentation

In fermentation, microorganisms are typically introduced into a liquid to produce pharmaceuticals as by-products of normal microorganism metabolism. The fermentation process is typically controlled at a particular temperature and pH level under a set of aerobic or anaerobic conditions that are conducive to rapid microorganism growth. The process involves three main steps: (i) seed preparation, (ii) fermentation, and (iii) product recovery.

(i) Seed preparation. The fermentation process begins with seed preparation, where inoculums (a medium containing microorganisms) is produced in small batches within seed tanks. Seedtanks are typically 1-10% of the size of production fermentation tanks.

(ii) Fermentation. After creating the inoculum at the seed preparation stage, the inoculum is introduced into production fermenters. In general, the fermenter is agitated, aerated, and controlled for pH, temperature, and dissolved oxygen levels to optimize the fermentation process. The fermentation process lasts from hours to weeks, depending on the product and process.

(iii) Product Recovery. When fermentation is complete, the desired pharmaceutical by-products need to be recovered from the fermented liquid mixture. Solvent extraction, direct precipitation, and ion exchange may be used to recover the product. Additionally, if the product is contained within the microorganism used in fermentation, heating or ultra-sound may be required to break the microorganism's cell wall. In solvent extraction, organic solvents are employed to separate the product from the aqueous solution. The product can then be removed from the solvent by crystallization. In direct precipitation, products are precipitated out of solution using precipitating agents like metal salts. In ion exchange, the product adsorbs onto an ion exchange resin and is later recovered from the resin using solvents, acids, or bases.

- **FORMULATION OF FINAL PRODUCTS**

The final stage of pharmaceutical manufacturing is the conversion of manufactured bulk substances into final, usable forms. Common forms of pharmaceutical products

include tablets, capsules, liquids, creams and ointments, aerosols, patches, and injectable dosages.

To prepare a tablet, the active ingredient is combined with a filler (such as sugar or starch), a binder (such as corn syrup or starch), and sometimes a lubricant (such as magnesium sterate or polyethylene glycol). The filler ensures the proper concentration of the active ingredient; the purpose of the binder is to bond tablet particles together. The lubricant may facilitate equipment operation during tablet manufacture and can also help to slow the disintegration of active ingredients.

Tablets are produced via the compression of powders. Wet granulation or dry granulation processes may be used. In wet granulation, the active ingredient is powdered and mixed with the filler, wetted and blended with the binder in solution, mixed with lubricants, and finally compressed into tablets. Dry granulation is used when tablet ingredients are sensitive to moisture or drying temperatures. Coatings, if used, are applied to tablets in a rotary drum, into which the coating solution is poured. Once coated, the tablets are dried in the rotary drum; they may also be sent to another drum for polishing.

Capsules are first constructed using a mold to form the outer shell of the capsule, which is typically made of gelatin. Temperature controls during the molding process control the viscosity of the gelatin, which in turn determines the thickness of the capsule walls. The capsule's ingredients are then poured (hard capsules) or injected (soft capsules) into the mold.

For liquid pharmaceutical formulations, the active ingredients are weighed and dissolved into a liquid base. The resulting solutions are then mixed in glass-lined or stainless-steel vessels and tanks. Preservatives may be added to the solution to prevent mold and bacterial growth. If the liquid is to be used orally or for injection, sterilization is required.

Ointments are made by blending active ingredients with a petroleum derivative or wax base. The mixture is cooled, rolled out, poured into tubes, and packaged.

Creams are semisolid emulsions of oil-in-water or water-in-oil; each phase is heated separately and then mixed together to form the final product.

2) TECHNOLOGIES USED IN MSME PHARMA SECTOR

I. TECHNOLOGY STATUS FOR CHILLERS IN PHARMA SECTOR

Chiller plants are a major energy consuming utility of around 50% of electricity consumption for MSME Pharma-Units which is also critical for the production process. Each pharma plant is equipped with 1 to 2 Chiller Units on average.

MSME Pharma-Units deployed chillers as per temperature requirement of the process ranging between +5 degree Centigrade to -30 degrees Centigrade.

II. TECHNOLOGY STATUS FOR AIR HANDLING UNITS

Air handling Units (AHUs) primarily used to transfer cooling effect from chilled water/Dx type Ac units into the conditioned space such as production houses, labs, cleanrooms of Pharma-Units.

Air handling units constitute around 4% electricity consumption of a pharma unit. These are generally driven by AC induction motor with belt coupled. The Pharma-Units studied have capacities ranging from 700 CFM to 18000 CFM.

III. TECHNOLOGY STATUS FOR COMPRESSED AIR SYSTEM

Compressed air system is one of the key utilities and constitutes around 11% of electricity consumption of a Pharma unit and air compressors are used for pneumatic operation, instrumentation as well as transfer of solvents with AOD (Air operated diaphragm pumps).

About 45% of air compressors installed in MSME Pharma-Units are of reciprocating type and balance 55% are of screw type. The capacity of air compressors ranges widely from 6.70 CFM to 1000 CFM.

IV. TECHNOLOGY STATUS FOR PUMPS

Pumping systems are one of the key utilities of MSME pharma unit providing chilled water/brine for production reactors, Room Temperature (RT) water for production reactors. Other applications of pumps in MSME Pharma-Units include raw water pumps, treated water pumps, fire water pumps, boiler feed water pumps, make-up water pumps, primary pumps of chiller plants, condenser water/circulating water. Typically, 26% of electricity consume in MSME Pharma-Units is towards pumping system and it is the second highest end use electricity consumer after chiller plants.

Each pharma unit in MSME sector is found to be having 5 to 6 operating pumps with a capacity ranging from 4 m^3/hr to 450 m^3/hr.

V. TECHNOLOGY STATUS FOR VACCUM PUMPS

Vacuum pumps are used to create vacuum in production reactors, solvent recovery Units and vacuum requirement ranges between 600-720 mm hg. The energy consumption of vacuum pumps depends on capacity (m^3/hr), vacuum requirement, technology (centrifugal/screw). There are two vacuum pumps on average for each MSME Pharma Unit. It is observed that most MSME Units are using vacuum pumps of capacity 220 m^3/hr. Typically about 2% of electricity consumed in MSME Pharma-Units is towards vacuum pumps.

VI. TECHNOLOGICAL STATUS FOR BOILERS & THERMIC FLUID HEATERS

Boiler is the major consumer of thermal energy in the form of solid fuels (Coal/Bio mass), liquid fuels (HSD/LDO) and natural gas. The cluster level studies indicate that each MSME pharma unit is equipped with 1 Boiler. Solid fuel fired boilers constitute 62% and balance 38% are liquid fuel fired in MSME Pharma sector.

The capacity of the boilers ranges between 0.2-8.0 TPH steam for solid fuel and that for liquid fuel ranges between 0.2-5.0 TPH. Liquid fuel fired boilers are generally installed for low-capacity applications when coal availability and coal management is an issue for the MSME Pharma-Units. The MSME Units are also retrofitting their liquid fuel boilers with natural gas burners when natural gas is available in the vicinity.

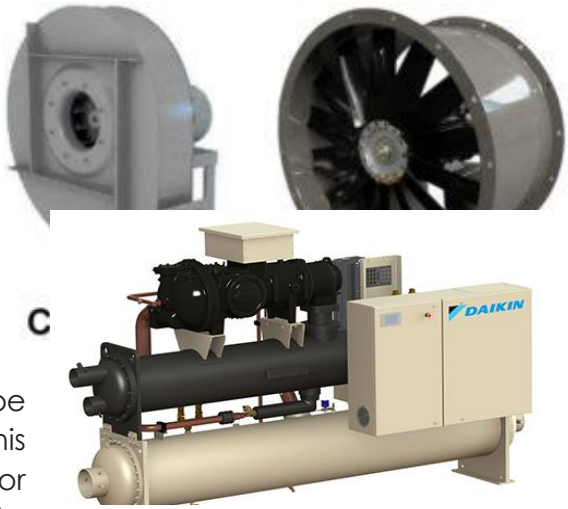
Out of solid fuel boilers only 20% are equipped with Air Pre-Heater (APH) and 40% are equipped with Economizer/HRE for feed water pre heating. Balance 40% of solid fuel fired boilers are without any heat recovery. Accordingly, the thermal efficiency of solid fuel fired boilers is ranging widely between 19.0-83.5% with average efficiency of 61.7%.

ANNEXURE-B: EE TECHNOLOGY COMPENDIUM: Pharma Sector

1) EE TECHNOLOGIES FOR MSME PHARMA SECTOR.

ENERGY EFFICIENT TECHNOLOGIES FOR CHILLERS

a) SCREW COMPRESSOR-BASED CHILLER WITH VFD



Screw compressor-based chiller by Daikin

Screw compressors are used for both Water-Cooled and Air-Cooled chillers. With water cooled type the compressor is on top of the chiller and with air cooled type the compressors are under the chiller. Indoor water-cooled chillers will often be insulated whereas air cooled may not be. This type takes the refrigerant off of the evaporator and passes through into the compressor. Inside the compressor are two interconnecting screws.

The refrigerant will enter into a void between the two screws, but as the screws rotates, they push the socket of refrigerant further into the compressor and squeeze it into a small space. The refrigerant will exit at high pressure, high temperature.

Chillers with Screw compressor (without VFD) as SEC of around 0.54to 0.63 kW/TR.

Screw Chillers with VFD as SEC of around 0.48-0.54 kW/TR and provides uniform SEC irrespective of the load.

Scroll compressor-based chiller by Daikin, Model: WGZ with IPLV as low as 0.56 kW/TR

b) SCROLL COMPRESSOR-BASED CHILLER

Chillers based on Scroll compressor with low

Sound levels in operation are available that offers SEC of around 0.56 kW/TR.

c) MICROPROCESSOR BASED OCCUPANCY/LOAD SCHEDULING

Chillers with advanced microprocessor-based controls with facility to schedule chiller operation as per occupancy/load are available that can be configured remotely to meet the varying load requirements over the time. Such chillers are available from OEM (e.g., Carrier, Model 30HXA comfort link with SEC of 0.51 kW/TR).

Comfort links controls Chiller by Carrier, Model: 30HXA, HXC076-271 with IPLV as low as 0.51 kW/TR

ENERGY EFFICIENT TECHNOLOGIES FOR AHUs

a) **CENTRIFUGAL FAN**

Centrifugal fan efficiencies range from 50 percent to about 70 percent depending upon blade configuration

b) **VANE AXIAL FANS**

Vane-axial fan efficiencies range from 80 percent to over 90 percent

c) **DIRECT DRIVE MECHNISM**

Direct drive fan/motor combinations are the most efficient at 100 percent. Standard V-belt drives are about 93 percent efficient when first installed but drop over time. Synchronous belt systems offer an energy-efficiency increase to about 96 percent for the life of the belt.

ENERGY EFFICIENT TECHNOLOGIES FOR AIR COMPRESSORS

a) Rotary screw compressors with Variable speed option

Rotary screw Air compressor with VFD with SEC 0.14 kW/CFM (at 7 to 8 bar)

Rotary screw compressors with VFD offer a lower specific energy consumption (kW/CFM) compared to reciprocating with fixed speed drive. Several OEMs (e.g., Chicago pneumatic, Atlas Copco, Ingersoll rand) are offering this technology-based air compressors with motor rating between 2.6kW to 300kW that would cover the capacity requirements (in CFM) of MSME Pharma-Units. The typical SEC declared by OEM is 0.14kW/CFM at 7 to 8 bar pressure. The VFD ensures that the compressor operates at good efficiency even in the part load condition.

ENERGY EFFICIENT TECHNOLOGIES FOR PUMPS

a) Energy Efficient Pumps

The latest pumps that are offered by OEM (e.g., Armstrong, Grundfos, Kirloskar, Xylem, KSB) have IE-3 motor with inbuilt VFD that offers efficiencies in excess of 80% over wide range of flow during operation. The measurement of head & flow is the key in selection of suitable pump for various applications in MSME Pharma-Units. The presence of inbuilt VFD would also ensure that there is no efficiency loss over wide range of flow regulation during the operation. The IE-3 motors have compared to IE-2 motors also bringing up to 2% efficiency gain for the pumping system. Many of the OEMs have made their pump selection tools available online which can be a component in capacity building program for MSME Pharma-Units.

Energy Efficient Pump by Grundfos

ENERGY EFFICIENCY TECHNOLOGY FOR MOTORS

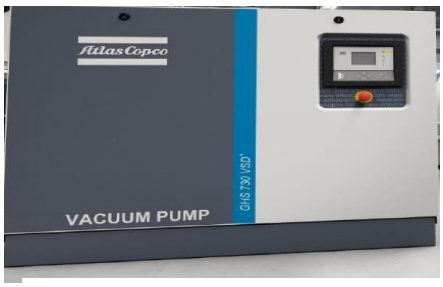
Premium efficiency motors that have full-load efficiencies of greater than 94 percent depending upon horsepower are available. It is also important to consider the part-load motor efficiency and its operation with a VFD in system.

Motor efficiency classification IE-3 and above are recommended for Pumps, fans, Blowers, Compressors and Reactor Stirrers.

ENERGY EFFICIENT TECHNOLOGY FOR VACUUM PUMPS

a) Oil sealed screw vacuum pump with VFD

A new technology for vacuum pumps is available with screw type compressor directly coupled with motor with VFD that offers up-to 50% energy savings as compared to conventional vacuum pumps. These vacuum pumps are introduced in the market and some large Pharma-Units have started installing.



Oil sealed screw Vacuum Pump by Atlas Copco

ENERGY EFFICIENT TECHNOLOGY FOR COOLING TOWERS

a) Mist Cooling System for Cooling Towers

Mist Cooling System (MCS) requires only 70 to 75% of re-circulation water quantity as compared to that required for Cooling Tower (as it won't have any evaporation losses). In MCS system there is no fan used and the water is been sent to patented sprinklers, where it forms mist and there will be slight increase in the head of the circulation pump (depend on the site location). The Mist cooling system will guarantee approach of 2 °C throughout the year. To operate this cooling tower, there is no need of standby required.

Mist Cooling System for Cooling

ENERGY EFFICIENT TECHNOLOGY FOR BOILERS

a) Fluidised Bed Combustion Boiler

Fluidized Bed Combustion (FBC) technology is available for solid fuel fired boilers and their operating thermal efficiencies are more than 80%.

Fluidised Bed Combustion Boiler

2) EE RETROFITS (UTILITIES)

a) ONLINE CHILLER CONDENSER AUTOMATIC TUBE CLEANING SYSTEM.

Chiller Condenser Automatic Tube Cleaning System are available that will continuously clean the condenser tubes and avoid any shut down requirements and manual Labour. By installing online Chiller Condenser Automatic Tube Cleaning System, it is expected to save 10% of energy as per the estimates of ASHARE.

Advantage of Automatic tube cleaning – the benefits:

- **Improved operating efficiency:** the chiller continuously operates at optimum efficiency, leading to lower energy use and consequent cost reduction.
- **Extended chiller life cycle:** increasing return on investment, because the compressor never operates beyond its design limits and because condenser tube corrosion is eliminated.
- **No chiller downtime:** the automatic tube cleaning system keeps the condenser tubes permanently clean while the chiller is operating.
- **Low cleaning system operating costs:** the sponge balls used in the automatic tube cleaning system are the only consumables needing to be replaced.
- **Lower water treatment costs:** water treatment is only required to prevent scaling of ancillary equipment, leading to cost savings of as much as 50% of the cost of chemicals used for water treatment.

Online Chiller Automatic Condenser Tube Cleaning System

- **Environment friendly:** the automatic tube cleaning system uses no chemicals.

b) AHU RETROFITS

Reducing AHU pressure drop

The AHU pressure drop can be reduced by:

Lowering face velocity

Lowering face velocities necessitates larger area coils and filter elements and bigger AHU housings than conventionally used. These larger items increase the AHU's cost, but a resulting decrease in face velocity from 500 fpm to 400 fpm usually makes up for the increased cost over the life of the AHU. Face velocity reductions from 500 fpm to 400 fpm can have a simple payback of about three years. A comparable decrease in face velocity at filters can have a simple payback of one year or less.

Considering filter loading and VFDs

Variable system resistance, primarily resulting from filter loading, can be efficiently corrected for with a VFD on the fan. The energy saved by a VFD will pay for the drive in two to five years, depending upon system capacity.

Adding bypass dampers

Some AHU components are only utilized during a portion of the year; therefore, bypass dampers should be used to reduce parasitic energy losses when these components are not needed.

c) VARIABLE FREQUENCY DRIVES FOR PUMPS

Variable frequency drives are used for adjusting flow or pressure to the actual demand. They control the frequency of the electrical power supplied to pumps. Significant power savings can be achieved when using a VFD pump.

A variable frequency drive is a system for controlling the rotational speed of an alternating current electric motor. It controls the frequency of the electrical power supplied to the motor. A variable frequency drive is a specific type of adjustable-speed drive. Variable frequency drives are also known as adjustable frequency drives (AFD), variable speed drives (VSD), AC drives, or inverter drives.

Automatic frequency control consists of a primary electrical circuit converting the alternating current into a direct current, then converting it back into an alternating current with the required frequency. Internal energy loss in the automatic frequency control is rated ~3.5 %

Variable frequency drives are widely used on pumps and machine tool drives, compressors and in ventilations systems for large buildings. Variable frequency drive motors on fans save energy by allowing the volume of air moved to match the system demand. Reasons for employing automatic frequency control can both be related to the functionality of the application and for saving energy. For example, automatic frequency control is used in pump applications where the flow is matched either to volume or pressure. The pump adjusts its revolutions to a given set point via a regulating loop. Adjusting the flow or pressure to the actual demand reduces power consumption.

d) RETROFITS FOR BOILERS & THERMIC FLUID HEATERS.

The Retrofits for the boilers may include the following:

(i) Converting from manual fuel feeding to mechanized fuel feeding with combustion control.

(ii) Installation of APH and/or Economizer for heat recovery from exit flue gases.

(iii) Converting/replacing existing inefficient boilers to FBC boilers.

3) STATE OF THE ART TECHNOLOGIES

a) VARIABLE VOLUME RATIO TECHNOLOGY (VVR)

The power consumption of chiller compressor is directly depending on compression ratio. In all types of chiller compressors this ratio is fixed although the discharge pressure varies as per the condenser performance and ambient conditions. This is so even with compressors equipped with VFD where the refrigerant flow is controlled as per the load with regulation of compressor speed.

VVR Technology +5 deg C Chiller by Daikin, Model: WWV with IPLV as low as 0.36 kW/TR

Variable Volume Ratio (VVR) compression technology senses the precise amount of lift needed and adjusts the compression ratio on the fly to deliver optimal efficiency, regardless of ambient temperature or time of day. With VVR technology the over-compression is avoided when load demand is low and get exactly the lift needed.

One of the OEM (e.g., Daikin) is offering chiller compressors based on VVR technology with Integrated Part load value (IPLV) specific energy consumption as low as 0.36kW/TR both VVR chillers are available both with Water cooled and Air cooled condensers.

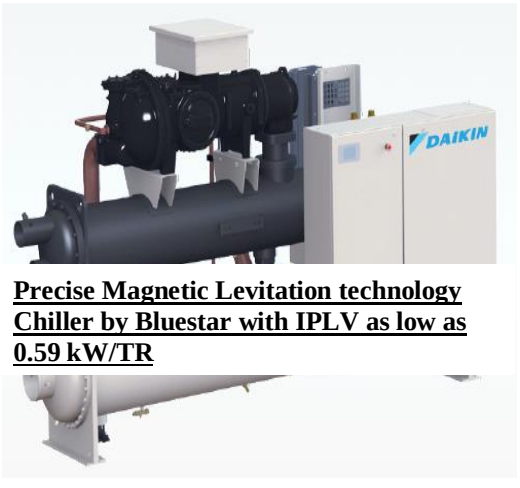
b) PRECISE MAGNETIC LEVITATION TECHNOLOGY

Chillers with two stage centrifugal compressors with magnetic bearings and in-built VFD with state-of-the-art automatic control system are marketed by OEMs (e.g., Bluestar). Two stage centrifugal compressor ensure good part load and full load efficiency resulting in lower IPLV SEC.

The compressor shaft levitates in air while running thereby ensuring no mechanical contact with other parts, completely eliminating wear & tear and frictional losses.

The VFD precisely controls the compressor speed to match the varying capacity required and operating conditions, thus providing maximum chiller efficiency.

In the event of power failure, the compressor motor acts as a generator, providing power for the bearing control system ensuring smooth de-levitation of the shaft. The SEC declared by OEM is 0.59 kW/TR.



Precise Magnetic Levitation technology Chiller by Bluestar with IPLV as low as 0.59 kW/TR

c) AHUs WITH EC MOTORS

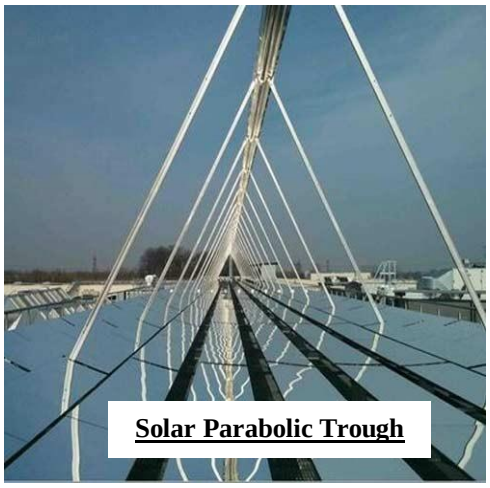
Electronic Commutation (EC technology) refers to variety of drive concepts such as PM (permanent magnet motor), ECM (electronically commutated motor) and BLDC (brushless DC motor). AHUs equipped with EC technology are available for various applications including HVAC all kinds of fan such as axial fan and centrifugal fan can be driven by EC motors. Other technology improvement includes material of construction and aerodynamic shape to reduce energy consumption and increase intervals between the maintenance.

EC blowers by ebm-papst

Electronically Commutated motors (EC Motors) with inbuilt variable speed capability are available that offers an average specific energy consumption of 0.22 W/CFM. These motors EC motors coupled AHUs are availed up to 40000 CFM and have advantage of low maintenance, time and cost due to lack of belt coupling and have advantage of VFDs inbuilt. These also come with additional benefit of having no loose belt that generally affects flow delivery and performance of conventional AHUs.

d) SOLAR STEAM GENERATOR (PARABOLIC TROUGH)

Compact Linear Fresnel Reflector (CLFR) non-tracking parabolic collector for generation of steam using solar energy. Due to its design, it does not need daily tracking of the sun and can produce steam of upto 175 deg C. The steam generator has a compound parabolic reflector that concentrates energy on an evacuated tube that generates steam.



Solar Parabolic Trough

The key Parameters of the system is given below.

- Length: 1.8 m
- Width: 0.9 m
- Aperture Area: 1.6 sq.m
- Steam Temperature: Max. 175 deg C.

Features of the system

- Optimum quality
- Low maintenance
- Weather resistant

4) BEST OPERATING PRACTICES.

a) BEST PRACTICES FOR CHILLING SYTEM

- **Maintain Daily Logs:**

  As basic as this may seem, having a daily record of operating conditions, the pressure and temperatures in the chiller unit, as well as the fluid levels and flow rate, could help quickly predict the likelihood of future damage to the chiller machine. Keeping a chiller log sheet is advantageous as a pre-emptive chiller maintenance schedule can be structured before the onset of actual damages.

- **Keep The Chiller Tubing Clean:**

  The chiller working principle is reliant on heat transfer to exert a cooling effect. In shell and tube and brazed plate heat exchangers, an obstruction to the flow of cooling fluid through condenser tubes will significantly diminish how efficiently a chiller transfers heat.

  Over time, corrosion can accumulate inside the chiller tubing and impede the removal of generated heat. Therefore, it is necessary that regular quarterly or at least yearly cleaning of chiller tubes is scheduled and carried out.

- **Reduce The Temperature of The Condenser Water:**

  Reducing the temperature of the water entering the condenser of an industrial chiller, significantly improves efficiency as it has to work less to exert its overall cooling effect. Although not recommended as standard practice, reducing the temperature of the water passing through the chiller's condenser unit may serve as a measure to temporarily overcome problems with its coil.

- **Inspect The Condenser Water Loops:**

  Chilled water loops should be inspected at least yearly and treated to remove contaminants. Regularly inspect your chiller's "Y" strainer and use an inline cartridge filter for additional protection.

  Light should be visible through the condenser coil for dirt or airborne particle build-up. Check deep into the coils with a flashlight and, if dirty, clean as needed.

  Always disconnect the power before cleaning and protect all electrical components from water and from water entering electrical conduit lines. Remove the covers of the chiller and use water or compressed air to blow back through the coil in the opposite direction of airflow. Avoid any damage to coil fins such as bending fins flat.

- **Monitor for Refrigerant Leaks:**

  The rate of cooling of a chiller is dependent on the amount of refrigerant circulating through its compressor. Valve stems sometimes vibrate loose and will result in refrigerant leaks. Refrigerant leaks from the compressor or the introduction of moisture into the system can also impact the cooling capacity of the chiller.

Checking for leaks and maintaining a proper level of refrigerant in the chiller's compressor unit will ensure optimal performance.

- **Measure The Glycol Concentration:**

  Protection of system components from freezing is critical, as freezing can occur from the external ambient or internal system temperatures.

  The evaporator (or other heat exchanger) is the most susceptible component to freezing, even during normal operation. The fluid entering the evaporator must be capable of passing through without forming ice. Ice formation quickly restricts the flow, causing further freezing and eventual rupture.

  The chilled fluid needs to have a freeze point that is well below any temperature that the chiller is capable of cooling.

- **Maintain an Optimal Chilled Flow:**

  The rate of flow of chilled water must be maintained to ensure satisfactory chiller cooling performance. Chillers need between 9.5to 11.5Litres per minute (LPM) per TR to provide efficient heat exchange.

- **Look out for non-Condensable:**

  Another significant aspect of chiller maintenance is keeping air and moisture out of the chiller system. As these elements can diminish chiller efficiency and increase energy consumption, it is vitally important that they are quickly purged from the condenser circulation.

- **Examine the Compressor Oil:**

  Laboratory analysis of the oil from the compressor unit of a chiller should be done every year and changed according to recommendations from the analysing lab. When oil changes are made, it is necessary for filters to be tested and replaced if faulty. However, oil analysis is limited to only centrifugal chiller operation and maintenance. Newer magnetic bearing frictionless chillers do not utilize oil.

- **Inspect Motors and Starting Mechanism:**

  Routine sensor calibration, microprocessor control inspection, safety checks for electrical connections, wiring, and switchgear, are all recommended. Additionally, regular drive motor checks are required to keep chillers fully functional.

- **Install Variable Speed Drives:**

  Chiller motors consume significant amounts of electricity when in use, which increases operation costs. Installation of variable frequency drives (VFDs) will offer energy savings as varying the motor speed matches motor efficiency to load, minimizing energy waste.

b) BEST PRACTICES FOR AIR HANDLING UNITS

- AHU should be fabricated and installed according to design qualification, and its record should be kept available.

- AHU system should be located at proper, and clean place and space should be adequate for cleaning and maintenance.
- Proper size filters should be fitted in AHU to supply the air quality of the desired class. Separate AHU for different areas.
- Temperature humidity controls should be PLC-based and fully automated. An alarm system in out-of-specification condition shall be installed.
- The material of construction of AHU should be easily cleanable and does not generate any type of contamination.
- The design of AHU should be easily cleanable.
- Return air ducts should have adequate filters, especially in dusty areas, such as tablets, powder, and capsules, etc.
- Training should be given to personnel for good practices for Air handling unit, and records should be maintained.
- SOP should be correctly written, followed, and displayed at proper places near AHU.
- Periodical cleaning, preventive maintenance, and validation should be done, and records should be maintained.
- AHU system for parenteral and other formulation should be designed by considering the proper pressure differentiate airflow pattern, from cleaner to dirtier. Air changes, heat load, occupancy.
- Fabrication quality of AHU and duct, pipelines should be good, no leakage, and properly installed wherever required.
- Systematic drawing, with the type of duct, diffuser, grills, dust size, elbow, branching should be available.
- Manometers should be installed to indicate the room inside pressure.
- AHU filters critical non-sterile areas should be installed at the terminals, for any class filters should be fitted at terminals.
- Filters should be installed properly with proper gaskets to avoid leakages.
- Filter cleaning and preventive maintenance record should be maintained.
- AHU should be 'ON' whenever production is going on.
- Start-up, a time to achieve the desired air quality class, should be established and recorded.
- AHU should be installed in the shed and not in an open space.
- Fire and safety instruments should be fitted to the AHU system.
- Temperature, Humidity, pressure, air velocity measuring instruments shall be made available.
- Pressure drop across the filter should be maintained and recorded for filter integrity.
- AHU surround area should be clean and Area shall be disinfected when there is a longer gap between production activities.

c) BEST PRACTICES FOR AIR COMPRESSORS

- **Air Filter**

The purpose of an air compressor is to produce clean, pure, compressed air that will ultimately power numerous functions. To ensure the quality of air that comes out at the end, the ambient air that goes into the compressor must be filtered of impurities before it leaves the machines. None of that could be possible without a clean air filter. If the air filter is dirty, impurities and particulates could corrupt the compressed air and degrade the quality of end-point applications. Therefore, clean the air filter regularly. Change it out at regular intervals, which vary based on the environment.

- **Oil Filter**

Oil can degrade the quality of compressed air if it passes through the system and gets carried to the end of an application. Some of the worst-affected processes would include pneumatic spray painters, air cleaners and anything else where oil could corrupt the surface in question. Therefore, it is crucial to ensure oil, when present in the system, is removed from the compressed air before the air leaves the machine. Check oil filters weekly, regardless of whether the compressor is lubricated or non-lubricated. Moreover, replace the oil filter entirely at recommended intervals, which can range from 4,000 to 8,000 hours of use depending on the unit. If the oil filter gets heavily covered in oily residue before that time, replace it sooner.

- **Lubricant**

Check the lubricant level daily to ensure the health of the air compressor. Every three to six months, wipe off old lubricant and reapply a fresh coat. Each time you replace the lubricant, be sure you also change out the separator element.

- **Belts**

For an air compressor to go about its internal motions, it is crucial for the belts to have proper tension. The rubber of each belt must also remain firm, yet flexible, to ensure balanced movement between the pulleys of connected parts. Over time, however, the rubber on a belt will inevitably wear down and crack in certain places. Therefore, it is crucial to replace the belts before they lose their tension or, even worse, snap in the middle of an operation.

Inspect each belt once per week to verify they are free of wear. Adjust the tension if necessary and replace each belt once wear takes hold.

- **Intake Vents**

To ensure the incoming air remains as clean as possible and to prevent dirt from getting sucked into the system, inspect the intake vents weekly and clean them when necessary.

- **Other Parts and Things to Check**

In addition to the periodic cleaning, lubrication and replacement of parts, check various points along the air compressor and its attachments at regular intervals.

Inspect the following on a weekly basis: Air dryer performance, Oil level, Temperatures, Vibration, Amps and Voltage.

Inspect the air compressor for signs of oil or air leaks. Also check the pneumatic hoses for air leaks, as leakage severely reduces the efficiency of an air compressor. Furthermore, make sure the coolers are free of dirt.

d) BEST PRACTICES FOR PUMPS

- **Suction piping**

  There should be at least 10 diameters of pipe between the suction of the pump and the first elbow. This is especially critical in double-ended pump designs as the turbulent inlet flow can cause shaft thrusting and subsequent bearing problems. If an elbow must be installed, be sure it is in a plane at right angles to the pump shaft to prevent an uneven flow to both sides of a double suction impeller. Make sure eccentric reducers are not installed upside down at the pump suction. The top of the reducer should go straight into the suction flange.

- **Piping installation**

  Pipe from the pump suction flange to the pipe rack, not the other way around. This reduces the chance of pipe strain.

- **Pump selection**

- For a system that will have variable flow, make sure the system curve and the pump curve intersect each other at a large angle. Having the pump and system curve intersect at an acute angle will result in an unstable system with flow control issues.

- **Pump assembly**

  Ensure the pump rebuild is fully documented, including all bearing fits, shaft runouts and clearances. Make sure that the appropriate oil level (centre line of lowest ball) is marked on the outside of the housing for easy validation of oil levels.

e) BEST PRACTICES FOR VACCUM PUMPS

- **Inspect the Surrounding Environment**

  Vacuum pumps require the right conditions to operate at their best. In the worst conditions, they have a greater chance of breaking down and creating gridlock in your operations.

  The airflow around the pump can be critical to its optimum performance. When the pump was first installed, the airflow might have been excellent. Check this frequently for any changes.

- **Conduct a Visual Vacuum Pump Inspection**

  Visual inspection is not just about the vacuum pump itself, but the area around the Vacuum pump. We have to see oil or water leaking in the area of the Vacuum pump. This could be sign that something bad is on the horizon.

  Beyond a visual inspection, other signs that it's time to perform some maintenance on the Vacuum pump include unusual sounds coming from the unit or a drop in performance.

- **Do Regular Oil & Filter Changes**

  According to Blower and Vacuum Best Practices, dry Vacuum pumps typically require an oil change in the gearbox about once per year. We may need to do this twice annually for heavy usage. In comparison, an oil-sealed vacuum pump could require an oil and filter change up to monthly depending on their usage and application.

- **Perform Leak Testing**

  By leak testing the Vacuum pump system periodically after it's been installed, we can ensure that there is a vacuum-tight seal though the various connections. Eliminating

these leaks can prolong the life of the vacuum pump and improve the quality of the work it produces.

Keeping foreign elements out of the vacuum pump is critical. This includes debris, moisture, and oxygen, which are all contaminants that can compromise the integrity of the unit and reduce its effectiveness.

f) BEST PRACTICES FOR BOILERS & THERMIC FLUID HEATERS

- **Reduce excess air:**

  Excess air means there is more air for combustion than is required. The extra air is heated up and thrown away. The most important parameter affecting combustion efficiency is the air/fuel ratio.

- **Install waste heat recovery**

  The magnitude of the stack loss for boilers without recovery is about 18% on gas-fired and about 12% for oil- and coal-fired boilers. A major problem with heat recovery in flue gas is corrosion. If flue gas is cooled, drops of acid condense at the acid dew temperature. As the temperature of the flue gas is dropped further, the water dew point is reached at which water condenses. The water mixes with the acid and reduces the severity of the corrosion problem.

- **Reduce scale and soot deposits**:

  Scale or deposits serve as an insulator, resulting in more heat from the flame going up the stack rather than to the water due to these deposits. Any scale formation has a tremendous potential to decrease the heat transfer.

- **Reduce blowdown**:

  Blowdown results in the energy in the hot water being lost to the sewer unless energy recovery equipment is used. There are two types of blow-down. Mud blow is designed to remove the heavy sludge that accumulates at the bottom of the boiler. Continuous or skimming blow is designed to remove light solids that are dissolved in the water.

- **Recover waste heat from blowdown**:

  Blowdown Typical uses for waste heat include: contains energy, which can be captured by a waste heat recovery system.

- **Reduce line pressure:** Line pressure sets the steam temperature for saturated steam.

- **Operate boilers at peak efficiency**:

  Plants having two or more boilers can save energy by load management such that each boiler is operated to obtain combined peak efficiency.

- **Preheat combustion air**:

  Since the boiler and stack release heat, which rises to the top of the boiler room, the air ducts can be arranged, so the boiler is able to draw the hot air down back to the boiler.

ANNEXURE-C: EXISTING EE POLICY INITIATIVES AND PROGRAMS FOR THE SECTOR

A) GEE-WB-BEE Project:

The project "Financing of Energy Efficiency at MSMEs" is part of the Global Environmental Facility (GEF) Programmatic Framework for Energy Efficiency in India with an objective to increase demand for energy efficiency investments in target micro, small and medium enterprise clusters and to build their capacity to access commercial finance. The project is being implemented in two phases and more than 20 clusters in India.

B) Funding for Energy Efficiency Program:

SIDBI and Energy Efficiency Services Limited (EESL) are implementing the project.

The project development objective is to assist India in achieving energy savings with mobilization of commercial finance and participation of ESCOs.

The above objective can be accomplished through

1. Leveraging project funds to encourage private sector investment in energy efficiency projects, and
2. Providing complementary technical assistance and capacity building to stakeholders in India's energy efficiency market

C) Promoting Market Transformation for Energy Efficiency in MSME:

The EESL-UNIDO-MSME project titled "Promoting Market Transformation for Energy Efficiency in Micro, Small & Medium Enterprises (MSME)" is being implemented by United Nations Industrial Development Organization (UNIDO) in collaboration with Energy Efficiency Services Ltd (EESL). The project aims to deploy 30-35 technologies in selective MSME clusters in the country which have maximum possibility of replication and potential to improve the energy productivity of fellow MSMEs units, hence competitiveness. The project also aims to adopt various business models of ESCO (Energy Servicing Company) where the MSME unit is expected to pay-back to the investor from the monetized energy saving in a period of time.

D) EESL's National Motor Replacement Program (NMRP):

The National Motors Replacement Programme (NMRP) shall offer appropriate technical specifications (as per IS-12615) keeping in mind key customer pain points viz. high initial costs, high operating and maintenance costs and quality of the products.
EESL is targeting the 3-phase LT induction motors in the capacity range of 0.75 kW to 75 kW preferably directly-coupled with loads like pumps, fans, blowers, air compressors etc.

E) EESL's Energy Efficient Buildings Program:

Under the Energy Efficient Building's programme EESL intends to bring investment to the tune of Rs 1000 crore covering more than 10,000 large government/private buildings. It is estimated that about 1 crore LED lights, 15 lakh energy efficient ceiling fans and 1.5 lakh energy efficient ACs will be retrofitted by EESL in these buildings. Apart from retrofitting, EESL also aims to widen its services in areas like centralized AC system, Energy Audits and New Generation Energy Management System in buildings.

GOVERNMENT OF INDIA
Revised Guidelines on
Credit Linked Capital Subsidy Scheme (CLCSS)
for
Technology Upgradation

of
Small Scale Industries (SSI)
(As on April 20, 2006)

Office of the Development Commissioner (MSME)
Ministry of Small Scale Industries
Government of India
Nirman Bhavan, New Delhi-110011

These guidelines can also be
downloaded from the following Websites :
www.smallindustryindia.gov.in
www.laghu-udyog.gov.in

INDEX

viii) Rubber Processing including Cycle/ Rickshaw Tyres
ix) Food Processing (including Ice Cream manufacturing)
x) Poultry Hatchery & Cattle Feed Industry
xi) Dimensional Stone Industry (excluding Quarrying and Mining)
xii) Glass and Ceramic Items including Tiles
xiii) Leather and Leather Products including Footwear and Garments
xiv) Electronic equipment viz test, measuring and assembly/ manufacturing, Industrial process control; Analytical, Medical, Electronic Consumer & Communication equipment etc.
xv) Fans & Motors Industry
xvi) General Light Service(GLS) Lamps
xvii) Information Technology (Hardware)
xviii) Mineral Filled Sheathed Heating Elements
xxix) Transformer/ Electrical Stampings/ Laminations /Coils/Chokes including Solenoid coils
xx) Wires & Cable Industry
xxi) Auto Parts and Components
xxii) Bicycle Parts
xxiii) Combustion Devices/ Appliances
xxiv) Forging & Hand Tools
xxv) Foundries – Steel and Cast Iron
xxvi) General Engineering Works
xxvii) Gold Plating and Jewellery
xxviii) Locks
xxix) Steel Furniture
xxx) Toys
xxxi) Non-Ferrous Foundry
xxxii) Sport Goods
xxxiii) Cosmetics
xxxiv) Readymade Garments
xxxv) Wooden Furniture
xxxvi) Mineral Water Bottle
xxxvii) Paints, Varnishes, Alkyds and Alkyd products
xxxviii) Agricultural Implements and Post Harvest Equipment
xxxix) Beneficiation of Graphite and Phosphate
xxxx) Khadi and Village Industries
xxxxi) Coir and Coir Products
xxxxii) Steel Re-rolling and /or Pencil Ingot making Industries
xxxxiii) Zinc Sulphate
xxxxiv) Welding Electrodes
xxxxv) Sewing Machine Industry

b) List of Primary Lending Institutions (PLI) (Scheduled Commercial Banks, State Financial Corporation (SFC) & the NSIC Ltd, Cooperative Banks, Regional Rural Banks and North Eastern Development Financial Institution, other nodal banks / agencies participating in the scheme (Appendix II).

c) Agreement for Financial Assistance under the CLCSS (Appendix III)

	d) Application Form for Assistance under the CLCSS (Appendix IV). **e) Addresses of the SIDBI Head Office and its branches.** **f) Addresses of the NABARD Head office and its field offices.**

Credit Linked Capital Subsidy Scheme (CLCSS) for Technology Upgradation of the Small Scale Industries

1. **Background**

1.1 The Ministry of Small Scale Industries (SSI) is operating a scheme for technology upgradation of Small Scale Industries (SSI) called the Credit Linked Capital Subsidy Scheme (CLCSS). The Scheme aims at facilitating technology upgradation by providing upfront capital subsidy to SSI units, including tiny, khadi, village and coir industrial units, on institutional finance (credit) availed of by them for modernisation of their production equipment (plant and machinery) and techniques. The Scheme (pre-revised) provided for 12 per cent capital subsidy to SSI units, including tiny units, on institutional finance availed of by them for induction of well established and improved technology in selected sub-sectors/products approved under the Scheme. The eligible amount of subsidy calculated under the pre-revised scheme was based on the actual loan amount not exceeding Rs.40 lakh.

1.2 Due to insufficient investment and lack of awareness of both the quality standards and access to modern technologies, a large percentage of SSI units continue with outdated technology and plant & machinery. With increasing competition due to liberalisation of the economy, the survival and growth of the SSI units are critically dependent on their modernisation and technological upgradation. Upgradation of both the process of manufacture and corresponding plant and machinery is necessary for the small enterprises to reduce the cost of production and remain price competitive at a time when cheaper products are easily available in the global market.

1.3 It is in this background that the Finance Minister made an announcement in the Budget Speech of 2004-05 to raise the ceiling for loans under the Scheme from Rs. 40 lakh to Rs. 1 crore and rate of subsidy from 12 per cent to 15 per cent. Further, in the light of the experience gathered in implementing the Scheme, certain other modifications were also required to make it more useful to the SSI units, including tiny, khadi, village and coir industrial units, in taking up technology upgradation on a larger scale.

1.4 After considering these issues, the CLCSS has been amended as follows :

(a). the ceiling on loans under the Scheme has been raised from Rs. 40 lakh to Rs. 1 crore;

(b). the rate of subsidy has been enhanced from 12 per cent to 15 per cent;

(c). the admissible capital subsidy is to be calculated with reference to the purchase price of plant and machinery, instead of the term loan disbursed to the beneficiary unit;

(d). the practice of categorisation of SSI units in different slabs on the basis of their present investment for determining the eligible subsidy has been done away with ; and

(e). the operation of the Scheme has been extended upto 31 st March, 2007.

The above amendments are effective from September 29, 2005.

2. **Objective**

2.1 The revised scheme aims at facilitating technology upgradation by providing 15 per cent upfront capital subsidy with effect from the 29 th September, 2005 (12 per cent prior to 29.09.2005) to SSI units, including tiny, khadi, village and coir industrial units (hereinafter referred to as SSI units), on institutional finance availed of by them for induction of well established and improved technologies in the specified sub-sectors / products approved under the scheme.

3. **Scope of the Scheme**

3.1 The scheme would cover the following technology needs / products/sub - sectors:

i) Bio-tech Industry
ii) Common Effluent Treatment Plant
iii) Corrugated Boxes
iv) Drugs and Pharmaceuticals
v) Dyes and Intermediates
vi) Industry based on Medicinal and Aromatic plants
vii) Plastic Moulded/ Extruded Products and Parts/ Components
viii) Rubber Processing including Cycle/ Rickshaw Tyres
ix) Food Processing (including Ice Cream manufacturing)
x) Poultry Hatchery & Cattle Feed Industry
xi) Dimensional Stone Industry (excluding Quarrying and Mining)
xii) Glass and Ceramic Items including Tiles
xiii) Leather and Leather Products including Footwear and Garments
xiv) Electronic equipment viz test, measuring and assembly/ manufacturing, Industrial process control; Analytical, Medical, Electronic Consumer & Communication equipment etc.
xv) Fans & Motors Industry
xvi) General Light Service(GLS) lamps
xvii) Information Technology (Hardware)
xviii) Mineral Filled Sheathed Heating Elements
xix) Transformer/ Electrical Stampings/ Laminations /Coils/Chokes including Solenoid coils
xx) Wires & Cable Industry
xxi) Auto Parts and Components
xxii) Bicycle Parts
xxiii) Combustion Devices/ Appliances
xxiv) Forging & Hand Tools
xxv) Foundries – Steel and Cast Iron
xxvi) General Engineering Works
xxvii) Gold Plating and Jewellery
xxviii) Locks
xxix) Steel Furniture
xxx) Toys
xxxi) Non-Ferrous Foundry

xxxii) Sport Goods
xxxiii) Cosmetics
xxxiv) Readymade Garments
xxxv) Wooden Furniture
xxxvi) Mineral Water Bottle
xxxvii) Paints, Varnishes, Alkyds and Alkyd products
xxxviii) Agricultural Implements and Post Harvest Equipment
xxxix Beneficiation of Graphite and Phosphate
xxxx) Khadi and Village Industries
xxxxi) Coir and Coir Products
xxxxii) Steel Re-rolling and /or Pencil Ingot making Industries
xxxxiii) Zinc Sulphate
xxxxiv) Welding Electrodes
xxxxv) Sewing Machine Industry

A list of Well Established and Improved Technologies is enclosed at Appendix-I. The cost of plant and machinery mentioned in Appendix – I is only indicative. Actual cost may be taken for the purpose of calculation of subsidy

3.2 As the Scheme progresses, the list of products / sub-sectors may be expanded by inducting new technologies / products / sub-sectors with the approval of the Competent Authority, i.e. the Governing and Technology Approval Board (GTAB) / Technical Sub-Committee(TSC) of the CLCSS.

4. **Nodal Agencies**

4.1 The Small Industries Development Bank of India (SIDBI) and the National Bank for Agriculture and Rural Development (NABARD) will continue to act as the Nodal Agencies for the implementation of this scheme.

4.2 As decided in the 5 th meeting of the Governing and Technology Approval Board (GTAB) of the Credit Linked Capital Subsidy Scheme (CLCSS) held on February 17, 2006 the following nine Public Sector Banks/ Government Agencies have also been inducted as nodal banks/agencies for implementation and release of capital subsidy under the CLCSS:

S. No.	Name of Bank/Agencies
1.	State Bank of India
2.	Canara Bank
3.	Bank of Baroda
4.	Punjab National Bank
5.	Bank of India
6.	Andhra Bank
7.	State Bank of Bikaner & Jaipur
8.	Tamil Nadu Industrial Investment Corporation

9.	The National Small Industries Corporation Ltd.

4.3 The inclusion of above-mentioned nodal banks/agencies will be in addition to the existing nodal agencies, namely, the Small Industries Development Bank of India (SIDBI) and the National Bank for Agriculture and Rural Development (NABARD) under the CLCSS. These nodal banks/ agencies would consider proposals only in respect of credit approved by their respective branches, whereas, for other Primary Lending Institutions (PLI), the SIDBI and the NABARD would continue to be the nodal agencies for release of subsidy under this scheme.

4.4 The cut-off date for implementing the above decision is **April 04, 2006** . No proposals after this cut off date will be sent to the SIDBI or the NABARD, as the case may be, by these banks/agencies and the new nodal banks/agencies would start processing proposals directly after this cut-off date for release of subsidy under the CLCSS.

4.5 Other modalities for implementing the above decision will remain the same as are currently in practice in the case of the SIDBI and the NABARD.

5. **Eligible Primary Lending Institutions (PLI)**

5.1 All Scheduled Commercial Banks , Scheduled Cooperative Banks [including the urban cooperative banks co-opted by the SIDBI under the Technological Upgradation Fund Scheme(TUFS) of the Ministry of Textiles], Regional Rural Banks (RRBs), State Financial Corporations (SFCs) and North Eastern Development Financial Institution (NEDFi) are eligible as PLI under this scheme after they execute a General Agreement (GA) with any of the nodal agencies, i.e., the Small Industries Development Bank of India (SIDBI) and National Bank for Agriculture and Rural Development (NABARD).

5.2 Details of eligible Scheduled Commercial Banks, SFC, Cooperative Banks [including urban cooperative banks co-opted by the SIDBI under the Technological Upgradation Fund Scheme(TUFS) of the Ministry of Textiles]/ and RRBs under this scheme are provided at **Appendix II.**

6. **Eligible Beneficiaries**

6.1 The eligible beneficiaries include sole Proprietorships, Partnerships, Co-operative societies, Private and Public limited companies in the SSI sector. Priority shall be given to Women entrepreneurs.

7. **Types of units to be covered under the Scheme**

i). Existing SSI units registered with the State Directorate of Industries, which upgrade their existing plant and machinery with the state- of -the -art technology, with or without expansion.

ii). New SSI units which are registered with the State Directorate of Industries and which have set up their facilities only with the appropriate eligible and proven technology duly approved by the GTAB/TSC.

8. **Eligibility Criteria**

i). Capital subsidy at the revised rate of 15 per cent of the eligible investment in plant and machinery under the Scheme shall be available only for such projects, where terms loans have been sanctioned by the eligible

PLI **on or after September 29, 2005 .** Machinery purchased under Hire Purchase Scheme of the NSIC are also eligible for subsidy under this Scheme .

ii). Industry graduating from small scale to medium scale on account of sanction of additional loan under CLCSS shall be eligible for assistance.

iii). Eligibility for capital subsidy under the Scheme is not linked to any refinance Scheme of the Nodal Agency (ies). Hence, it is not necessary that the PLI will have to seek refinance in respect of the term loans sanctioned by them from any of the refinancing Nodal Agencies.

iv). Labour intensive and/or export oriented new sectors/ activities will be considered for inclusion under the scheme.

9. **Definition of Technology Upgradation**

9.1 Technology upgradation would ordinarily mean induction of state-of-the-art or near state-of-the-art technology. In the varying mosaic of technology obtaining in more than 7500 products in the Indian small scale sector, technology upgradation would mean a significant step up from the present technology level to a substantially higher one involving improved productivity, and/or improvement in the quality of products and/or improved environmental conditions including work environment for the unit. It would also include installation of improved packaging techniques as well as anti-pollution measures and energy conservation machinery. Further, the units in need of introducing facilities for in-house testing and on-line quality control would qualify for assistance, as the same is a case of technology upgradation.

9.2 **Replacement of existing equipment/technology with the same equipment/technology will not qualify for subsidy under this scheme, nor would the scheme be applicable to units upgrading with <u>second hand machinery</u>.**

10. **Duration of the Scheme**

Presently, the scheme is in operation up to March 31, 2007 or till the time sanctions of aggregate capital subsidy disbursed by the Nodal Agencies reaches Rs.600 crore,**<u>whichever is earlier.</u>**

11. **Ceiling on eligible loan amount and capital subsidy**

11.1 The maximum limit of eligible loan under the revised scheme is Rs. 100 lakh. Accordingly, the ceiling on subsidy would be Rs.15 lakh or 15 per cent of the investment in eligible plant and machinery, whichever is lower.

i). In calculating the value of plant & machinery, the following shall be excluded, namely :

- the cost of equipments such as tools, jigs, dies, moulds and spare parts for maintenance and the cost of consumable stores;

- the cost of installation of plant & machinery;

- the cost of research & development equipment and pollution control equipment (except where these have been approved for specific product/sub sector by the GTAB ;

- the cost of generation sets and extra transformer installed by the undertaking as per the regulations of the State Electricity Board; (except where gas based generation sets have been approved for specific product/sub- sector by the GTAB).

- the bank charges and service charges paid to the National Small Industries Corporation Ltd or the State Small Industries Corporation;

- the cost involved in procurement or installation of cables, wiring, bus bars, electrical control panels (not those mounted on individual machines), oil circuit breakers or miniature circuit breakers which are necessarily to be used for providing electrical power to the plant & machinery or for safety measures;

- the cost of gas producer plants (except where these have been approved for specific product/sub sector by the GTAB) ;

- transportation charges (excluding of sales-tax and excise) for indigenous machinery from the place of manufacturing to the site of the factory;

- charges paid for technical know-how for erection of plant & machinery;

- cost of such storage tanks which store raw materials, finished products only and are not linked with the manufacturing process; and

- cost of fire fighting equipment.

ii). The amendments to the existing CLCSS are applicable with effect from 29.9.2005. The revised rates are applicable only in cases where the loans have been sanctioned/ approved **on or after September 29, 2005** . Cases where the loans were sanctioned/ approved prior to September 29, 2005 will be governed by the pre-revised guidelines regarding ceiling on subsidy (Rs.4.80 lakh), method of calculation of subsidy, etc.

iii). Units which have already availed subsidy under the pre-revised CLCSS scheme (before 29.9.2005), cannot claim additional subsidy on account of difference in the rate of subsidy which is now permissible under the revised guidelines.

12. **Working Capital Requirements**

12.1 Since success of the technology upgradation scheme, to a large extent, depends upon the availability of adequate working capital, lending institutions would like to be assured that the borrowing units have made adequate arrangements for meeting the working capital requirements. Commercial banks should also accord priority in providing adequate working capital support to the assisted units.

13. **Other conditions for loans**

i). Promoters' contribution, security, debt-equity ratio, up-front fee, etc. will be determined by the lending agency as per its existing norms.

ii). Units availing subsidy under the CLCSS shall not avail any other subsidy for technology upgradation from the Central/State/UT Government. However, cases covered under National Equity Fund (NEF) Scheme,

which are otherwise eligible under the CLCSS can also be covered under this scheme.

iii). **Units in the North-Eastern Region which are availing financial incentives/subsidy under any other scheme from the Government in the Region would, however, be eligible for subsidy under the CLCSS.**

iv). One of the main requirements for sanction of assistance under the technology upgradation scheme will be availability of competent management in the unit concerned to carry out the upgradation programme and to manage the operation of the unit efficiently. Towards this end, the lending agencies may stipulate conditions as may be considered necessary.

14. **Procedural Aspects**

i). All the eligible PLI (excluding the new nodal banks / agencies) will have to execute a General Agreement (GA) for availing capital subsidy under the scheme, irrespective of the fact whether refinance is availed by them or not.

ii). The PLI may have the flexibility to execute the GA with either of the nodal agencies or with both the nodal agencies for providing subsidy to the eligible beneficiaries under the scheme. However, in the latter case, while claiming the subsidy from one nodal agency, the PLIs will have to give the undertaking to the nodal agency that they have not claimed subsidy under CLCSS in respect of the beneficiary unit from the other nodal agency (as the case may be).

iii). After sanction of the assistance, the eligible PLI will get an agreement executed with the concerned SSI unit on behalf of Government of India (GoI). Format of the agreement to be executed by the eligible PLI with the SSI unit is provided in **Appendix III.**

iv). The eligible PLI would obtain application for assistance under the CLCSS in the prescribed form provided in **Appendix – IV.**

v). The eligible PLI shall furnish subsidy forecast on quarterly basis, through their Head Office (HO), which will act as a nodal office, to the Regional Office (RO)/Branch Office (BO) of the SIDBI or the NABARD (as the case may be) located in the region. The subsidy forecast information for every quarter on or before 1 st March for April-June quarter, on or before 1 st June for July-September quarter, on or before 1 st September for October-December quarter and on or before 1 st December for January-March quarter, may be furnished as per prescribed format.

vi). The eligible PLI would release the subsidy amount with each installment of loan in a manner proportionate to the amount of term loan disbursed (on pro- rata basis), subject to the ceiling of the term loan/ subsidy amount as per applicable guidelines of the CLCSS.

vii). The eligible PLI shall furnish details of release of subsidy to the beneficiary units, together with the request for replenishing advance money placed with PLI for release of subsidy, on quarterly basis on March 1, June 1, September 1 and December 1. The requests of PLI for replenishment of advance money for subsidy, however, would be entertained by the nodal agencies only on receipt of complete details of subsidy released

to the beneficiary units.

viii). The eligible PLI shall be responsible for ensuring eligibility for sanction of subsidy to the SSI units in terms of Government of India guidelines under this scheme and also for disbursal and monitoring of the assisted units.

15. **Other Parameters**

i). The Governmental assistance cannot be utilised for the purposes other than for which it has been sanctioned. The eligible PLI shall have to strictly follow this norm and no deviation would be permitted.

ii). In case, it is found that capital subsidy from the Government has been availed of on the basis of any false information, the industrial unit shall be liable to refund the Government the capital subsidy availed, along with interest to be charged from the date of disbursal to the date of refund. The rate of interest shall be the prime lending rate of the PLIs concerned at the time of invoking this penal clause.

iii). The eligible PLI shall, therefore, incorporate suitable conditions in respect of point at (ii) above in their security documents entered into with the unit, which would give necessary authorisation to proceed legally in such eventualities.

iv). The credit risk under the Scheme will be borne by the eligible PLI and as such, they will have to make their own commercial judgement while appraising the project. The credit decision of the eligible PLI will be final.

v). There shall not be any binding obligation on the part of the nodal banks/ agencies to obtain sanction from GoI for the government assistance in respect of the proposals which are covered under the CLCSS.

vi). Both the SIDBI and the NABARD shall have the right to inspect the books of eligible PLI and the loan accounts irrespective of whether refinance is availed or not from the Nodal Agency (ies) under this Scheme and/ or call for any other information as may be required by GoI from time to time.

vii). Both the SIDBI and the NABARD shall have the right to recall from eligible PLI the entire amount of the capital subsidy in respect of their assisted units irrespective of whether or not the eligible PLI have recovered the said subsidy from their units, if they come to the conclusion that any of the accounts do not conform to the policies, procedures and guidelines laid down under the CLCSS guidelines and as stipulated by the GoI/the Nodal Agencies from time to time.

viii). The beneficiary unit shall remain in commercial production for a period of at least three years after installation of eligible plant and machinery on which subsidy under CLCSS has been availed.

16. **Monitoring of the scheme**

16.1 The scheme is monitored by the Governing and Technology Approval Board (GTAB of the CLCSS. The Secretary (SSI) is the Chairperson of the Board and the Additional Secretary & Development Commissioner (SSI) is its Member-Secretary. The GTAB would also periodically review the functioning of the scheme. There is a Technical Sub-Committee under the GTAB to consider inclusion of new sub-sectors/products and Well Established and Improved Technologies under the Scheme

		Folder gluer - semi-automatic/-automatic.	4 - 10	Rust free pasting suitable for packaging of food
2.	Printing.	Multi colour flexo printer slotter for flexographic printing	7	processed products.Web based coating is echo-friendly, food grade, recyclable and being water based, free from fire hazard.
3.	Testing & Quality Control.	Micro processor based bursting strength tester	2	Equipment for testing strength of the box.
		Micro processor based compression strength tester.	3	Equipment for testing compression strength of the box.
		Micro processor based crust tester.	1.75	Equipment for testing edge crush, flat crush and pin adhesion strength of the box.

iv) Drugs and Pharmaceuticals.

Sl. No.	Activity	Technology Need	Cost (Rs. in lakh)	Advantages
Tablet and capsule section .				
1.	Dispensing.	Reverse laminar flow equipment.	1.50	Safety of personnel.
2.	Weighing.	Automatic electronic balance 300 kg.; 150 kg. and 1 kg.	0.50-2.depending on the model.	Accurate weighing of raw materials; Increased productivity.
3.	Mixing and granulation .	Rapid mixer granulator 200 L capacity.	3 to 4	Increased productivity; better quality product.
4.	Dry granulation.	Roller compactor.	1.50 to 3	Increased productivity.
5.	Drying.	Fluidized bed dryer 200 L capacity.	3 -50	Increased productivity.
6.	Size reduction.	Clitzmill or Cadmill.	0.40	Increased productivity.
		Oscillating granulator.	0.15	Increased productivity.
7.	Sifter.	Vibrating sifter 24 inches diameter		Increased productivity.

8.	Coating suspension.	Colloid mill	0.80	Increased productivity.
10.	Compression.	16 station rotary tablet machine.	2	Increased productivity.
		27 station rotary tablet machine.	3.25	Increased productivity.
11.	De-dusting of tablets.	On-line de-duster.	0.25	Improved product quality.
12	Capsule filling.	Semi-automatic capsule filling machine.	6	Increased productivity.
13.	Capsule polishing.	Automatic polishing machine.	2	Increased productivity.
14.	Printing of packaging cartons.	Semi-automatic.	2	Increased productivity.
Liquid oral section				
15.	Water generation.	RO water plant.	6	
16.	Mixing vessel.	Variable speed stirrer.	0.50	Increased productivity.
17.	Homogenization..	Colloid mill.	0.75	Increased productivity; Better product quality.
18.	Bottle washing.	Automatic rotary line.	4	Increased productivity, better product quality.
19.	Liquid transfer.	Transfer pump.	0.20	Increased productivity.
20.	Filling machine.	4- head automatic filling machine.	2	Accurate fill volumes.
Injectable Section				
21.	Filtration.	Filter cartridges.	0.50 to 1	Increased productivity.
22.	Integrity of the membrane filter.	Bubble point apparatus.	0.75	Better product quality.
23.	Vial filling machine.	Automated filling machine with sealing facility.	5	Increased productivity; better control on product sterility.
24	Equipment for	S.S. Horizontal Autoclaves (Steam,	1.70	Increased

	Sterilisation by Moist Heat.	Sterilizers), Double Door with automated control and monitoring systems as electronic timer with Digital indicator, automatic Low Water cut off device, temperature recorder (Thermograph) and pressure gauges.		productivity better control on the product quality and sterility.
25	Equipment for Sterilisation by dry Heat.	S.S. Dry Heat Sterilizer (Class 100 with HEPA filter, Fully automatic S.S. Control Panel with Printer memory circuit, fixed probes and Thermo-graph for recording each sterilization cycle S.S. Cooling system, sealed Dampers, motorized internal Baffles, S.S. Loading trolley, S.S. Carriage.	10 -11	Increased productivity better control on the product quality and sterility.
Dry Syrup Section				
26.	Filling machine.	Automated auger filling machine.	2	Increased productivity.
27.	Labeling.	Automated labeling machine.	2	Increased productivity.
Lactum Tab/Cap Machine .				
28.	Acetum Tab/Cap Machine.	1)Blister Pack Machine. 2) Strip Packing Machine.	3.80 2	These machines are required to avoid contamination with other non-B-Lactum group products.
Quality Control Department				
29.	Drug assay.	High performance liquid chromatograph.	12	Accurate drug analysis.
30	Pollution control.	Effluent Treatment Pollution Control machinery.	10 – 15	Biochemical treatment of effluent removes 90 to 95% of soluble organic matter in the waste.
31.	Microbiological Lab in Quality Control Department.	1) B.O.D. Incubators. 2) Incubators. 3) Laminar Air Flow.	1 0.45 0.75	These machines are required to improve the quality of the finished products by way of testing.
Environment Control Devices.				

32	Air conditioning and humidity control of all types of areas.	Air conditioning. Humidity control equipment (Dehumidifier).	0.20 –0.30 per ton 0.10 -0.25 per ton for Desiccant based; 0.06 to 0. 10 per ton for Chiller based.	Improve product stability, enhance personal comfort.
	Air handling for parenteral (Sterile)area.	Air handling unit with HEPA filters, Ducting with insulation; Chilled water piping; electrical cabling and panels; chilled water pump; chilled water control.	0.20 per ton 0. 30 - 0.35 per ton.	Improves product quality, enhanced personal safety.
	Air handling other for parenteral area.	Air handling unit with 5 micron filters.	0.15 per ton	Improves product quality, enhanced personal safety.
	Miscellaneous fittings.	Ducting with insulation; chilled water piping electrical cabling and panels; chilled water pump; chilled water control.	0.20 - 0.25 per ton.	
.	General	1) Reverse Laminar Air Flow. 2) Dust Extractors. 3) Non A.C.-A.H.U. in Terms of C.F.M.	0.60 1 0.50 per unit.	To avoid contamination during dispensing of raw materials. To control environment at manufacturing section where dust is generated. To control environment at manufacturing section where dust is generated and Air conditioning is not required, only filtered air is required.
N 2 O Gas for Hospital use.				
33.	Testing and quality control.	Gas Chromatograph and Moisture Meter for On-line Quality Control for Purity of N 2 O Gas used for anesthetic purpose.	Variable as per actual.	For controlling the purity of N 2 O gas.

b).**Antacid Bulk Drugs like Aluminum Hydroxide Gel, Magnesium Hydroxide, Magnesium Trisilicate etc .**

Sl. No.	Activity	Technology Need	Cost (Rs. in lakh)	Advantages
1	Reaction.	S.S. Reactor.	4 for capacity of 15000 litre.	1.Tremendous improvement in the quality. 2. Teak wood trees are saved resulting in better environment & atmosphere.
2	Reaction.	Glass lined Reactor.	40 for capacity of 10000 litre.	1.Tremendous improvement in the quality. 2. Teak wood trees are saved resulting in better environment.
3	Filtration.	P.P. Filter Press.	8 for 60 pairs.	1. Quality improvement. 2. Time saving Device. 3.Saving of water consumption. 4.Quantitative improvement.
4.	Drying.	S.S. Dryer with modern facilities Spray/Flash.	40	1. Anti Air pollution device. 2. Improves the quality of the product. 3.Free from foreign contamination.
5.	Centrifugation.	Centrifuge (S.S. or Rubber Lined).	10	1. Quality of the product improves. 2. No corrosion. 3. Saving of time. 4. Saving of labour.
6.	Raw material and finished product weighing.	Electronic Weighing Machine.	0.15	1. Saving of time. 2. Saving of labour. 3. No loss of material. 4.Increase in the profitability.
7.	Quality control.	Laboratory Equipment of latest technology, spectrophotometer, Gas Chromatograph & others.	10	1. To get the best possible precise results. 2. Less time consuming & immediate results display.
8.	Pulverisation.	Latest technology pulverisers Impact Type.	4	1.Quality of products improves due to finest particles. 2.Physical loss of material

E. Pharmaceutical Technology Upgradation Assistance Scheme (PTUAS)

1. Background/Rationale

The sub-scheme is aimed at providing interest subvention to the eligible Small and Medium Scale Pharma Units having GMP compliant manufacturing facilities both for Bulk Drugs and Pharmaceutical Formulations. The eligible units intending to upgrade their manufacturing infrastructure to attain WHO-GMP norms, have to secure loan from any Financial Institution for upgrading their infrastructure and technology.

2. Goal of the Scheme

To facilitate Small and Medium Pharma Enterprises (SMEs) of proven track record to migrate from Schedule M to World Health Organization (WHO)/Good Manufacturing Practices (GMP) norms to enable them to participate and compete in global markets and earn foreign exchange.

2.1 ***Coverage:*** With the budgetary allocation of Rs. 144 crores for 2018-2020, it is possible to extend benefit of interest subvention to around 250 Pharma SMEs.

3. Scheme: Objective and details

3.1. Objective: The Scheme aims at providing assistance as **interest subvention** against sanctioned loan by any scheduled commercial bank/financial institution, both in Public and Private Sector.

3.2. Scheme details:

a) ***Implementation Agency***: The Scheme is implemented through a Public Sector Financial Institution (PSFI) to be identified by the Government. The Financial Institution will be selected through a process of open Competitive Bidding amongst the eligible Public Sector Financial Institution (PSFI). The framework for selection of the operating PSFI will be based upon competitive bidding in line with Expression of Interest (EoI) to be invited through adequate publicity as mandated for such activities.

b) The upper limit of interest subvention on loans for technology/infrastructure upgradation shall be restricted to 6% per annum for a period of three years on reducing balance basis. The maximum loan eligible for this purpose will be Rs. 4 crore, availed by the concerned SME for purpose of Upgradation to WHO-GMP norms.

c) Performance condition: The scheduled commercial bank/financial institution extending loan for assistance under this scheme shall ensure that:-

(i) All beneficiary Pharma SMEs, to whom benefit of interest subvention is to be extended, must obtain WHO-GMP certification within 2½ years from the date of first disbursement of loan.

(ii) Pharma SMEs which availed the benefit under the Scheme must achieve incremental export revenue in excess of the sanctioned loan amount, within 36 months of the last drawl of the loan, failing which loan will be converted into a normal loan by the Financial Institution. The interest subvention amount credited to the loan account with the

sanctioning commercial bank/financial institution will stand withdrawn along with penalty to be decided by the SSC.

4. **Eligible activity:** The scheduled Commercial Banks extending loan for Pharma SMEs to be eligible for interest subvention under the scheme need to consider the following infrastructure as eligible for approaching PSFI for assistance under the scheme:-

a) Only machinery and electronic Management Information System (MIS) required for upgrading a schedule M plant into a WHO-GMP i.e., machinery to meet the gap only are to be considered.
b) An indicative list of such equipment categories as provided by the Office of the DCGI is attached (**Appendix**). This list would be updated from time to time, based on the recommendations of DCGI (CDSCO), depending on the requirement of the Pharma industry under the WHO-GMP norms.
c) Under the Scheme, procurement of only new machinery will be permitted.

5. Publicity Campaign & source of funds:-

The identified and selected Financial Institution will be responsible for undertaking awareness campaign in the Pharma SME clusters in partnership with Indian Drugs Manufacturers Association (IDMA), Bulk Drugs Manufacturers Association (BDMA) and Pharmexcil and respective State Governments / Drug Controllers. The objective is to create both awareness and to identify eligible and interested Pharma SMEs, besides creating demand for successful implementation of Scheme.

6. Performance Management/ Monitoring and Evaluation:-

6.1. Monitoring:-

a) The operating PSFI will provide full access to Scheme monitoring portal to the Department of Pharmaceuticals for monitoring purpose.
b) The Financial Institution will also furnish monthly information in respect of sanction and disbursement of interest subvention to the lending banks/financial institution towards the loans account of beneficiary Pharma SMEs and other related information to DoP.
c) The operating PSFI will submit a quarterly progress report / statement indicating all Key Performance Parameters including the following:-

(i) Number of awareness events organized in Pharma clusters in partnership with IDMA, BDMA and Pharmexcil.
(ii) Number of applications pending sanction of interest subvention amount for more than 20 days.
(iii)No. of days taken to decide sanction/ no sanction
(iv)No. of days taken to disburse the sanctioned interest subvention against loans extended by the commercial banks/financial institution to eligible Pharma SMEs for technology/infrastructure upgradation under this scheme.

d) The annual account pertaining to funds allocated to PSFI by DoP would be got audited by the operating Financial Institution by a Chartered Accountant and the report would be submitted to D/o Pharmaceuticals for review by the Scheme Steering Committee(SSC).

6.2. Management by Scheme Steering Committee (SSC)

A Scheme Steering Committee would be constituted to lay down norms for monitoring and for effective implementation of the Scheme.

The composition of the Steering Committee will be as follows:-

(i) Secretary, DoP - Chairperson
(ii) Financial Adviser, DoP-Member
(iii) Joint Secretary, MSME- Member
(iv) Joint Secretary, DIPP- Member
(v) DCGI, CDSCO- Member
(vi) CMD of identified Public Sector Financial Institution- Member
(vii) DG, Pharmexcil- Member
(viii) President, IDMA- Member
(ix) President, BDMA- Member
(x) Joint Secretary(Policy), DoP- Convenor

The SSC may co-opt representatives of any Pharma Industry Associations, lending Financial Institutions, R&D Institutions and Other Government/ Private sector expert organizations as members or special invitees as may be necessary from time to time.

Functions:-

1. To review the Scheme quarterly and give a direction to the Scheme.
2. To take all decisions required for successful implementation of the Scheme, including modifications if any required.
3. It shall hold meeting once in 3 months.
4. Joint Secretary (Policy), Nodal officer of the Scheme and Secretary (Pharma) are jointly empowered to resolve issues in the implementation of Scheme in the interest of the Scheme mandate, where organizing the meeting of SSC may cause delay and affect its implementation.

7. Mid-term review of the Scheme

A mid-term review of the Scheme would be conducted immediately after completion of 1 year of the launch of the Scheme. For this purpose, D/o Pharmaceuticals will engage the services of institutes of repute such as National Council for Applied Economic Research or any other independent agency for conducting the said review. The review report would be submitted to the Scheme Steering Committee for taking a view on continuation/ amendment of the Scheme.

8. The Primary Lending Institutions (PLIs) can register with the operating financial institution by signing MOU.

9. The selected PSFI to operate the scheme shall be responsible for ensuring proper implementation and monitoring of the scheme and will put in place appropriate mechanisms for the purpose. The PSFI will provide periodic monitoring inputs to Department of Pharmaceuticals through regular monthly and quarterly reports.

10. Miscellaneous Provisions

10.1 Monitoring and Management Expenses: Project monitoring and management expenditure will be limited to maximum 1% of the total budget outlay of the sanctioned funds will be utilised. The main activities for which these funds will be utilized include, mainly in DoP:-

(i) Preparation of panels of Pharma Regulatory Affair Experts/Agencies for preparation of Detailed Project Report for upgradation of technology and infrastructure relevant for attaining WHO-GMP norms.
(ii) Expenditure involved in site visits of the beneficiary of Pharma SMEs for monitoring of progress and evaluation of the scheme.
(iii) Development of customized software for data management, specialized reports, monitoring and evaluation.
(iv) PTUAS related publicity material and awareness generation.
(v) Organization of meeting of various Committees including the Scheme Steering Committee(SSC).
(vi) Purchase of office automation equipment like photocopier, maintenance etc.
(vii) Outsourcing of Data management services.

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Appendix

EQUIPMENT CATEGORIES REQUIRED FOR UPGRADATION A PHARMA PLANT FROM SCHEDULE M TO WHO-GMP NORMS*

Eligible activity	Formulation Plant	API/ Intermediate/ Bulk Drug Plant
1. Up gradation of HVAC (*Heating, Ventilation, and Air Conditioning*) system to WHO norms i.e. HEPA (High-Efficiency Particulate Air filters) etc	√	√
2. Stability testing chambers.	√	√
3. All equipment & instruments for operating a Microbiology laboratory including autoclaves, incubators, biosafety cabinets, colony counters, HVAC systems	√	√
4. All lab scale and pilot scale manufacturing equipment required for R&D development - formulation/bulk	√	√
5. State-of- art lab equipment for testing as per Pharmacopeia other than IP not limiting to NMR, HPLC, HPTLC, IR Spectrophotometer, Atomic Absorption Photometers, GC, Electrophoresis and Dissolution apparatus	√	√
6. Water management and purification systems including Steam systems.	√	√
7. Automatic particle counters for sterile areas	√	√
8. Laboratory information management system	√	√

* The list is subject to requirements/changes in WHO-GMP regulatory compliance to be informed/ provided by DCGI from time to time.

Note: The required renovation of factory building is not included in the project cost to be financed.

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