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SAMEEEKSHA NEWSLETTER

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Promoting Energy Efficiency in SMEs
SAMEEEKSHA

VISION

SAMEEEKSHA envisages a robust and competitive SME sector built on strong foundations of knowledge and capabilities in the development, application, and promotion of energy-efficient and environment-friendly technologies.

Bureau of Energy Efficiency
SHAKTI SUSTAINABLE ENERGY FOUNDATION
The Energy and Resources Institute
MSME MICRO, SMALL & MEDIUM ENTERPRISES

A PLATFORM FOR PROMOTING ENERGY EFFICIENCY IN SMEs

IN THIS ISSUE...

The theme of this issue is the chemical industry, one of the energy intensive sectors that have been studied by TERI under the BEE project titled 'Energy and resource mapping of MSME clusters in India'.

The first article presents a broad picture of the chemical industry, which includes a large number of MSMEs and plays a key role in in the overall economic development of the country, providing employment to over 20 lakh people and manufacturing over 80,000 chemical products that either find direct applications by end-users, or serve as raw materials for a range of downstream industries ranging from detergents and fertilisers to pharmaceuticals and textiles. The article highlights the diversity of the chemical sector in terms of product categories as well as its commonalities in terms of the basic equipment and systems used by chemical units in different categories. It underlines the need and potential for promoting energy efficiency (EE) and reducing emissions among MSMEs in the chemical sector, which generally face the same broad and overlapping challenges—in the domains of awareness, technology, finance and skills—that characterize the Indian MSME sector as a whole and make it a challenging task to introduce and scale up EE technologies and practices. The article summarizes a number of EE options that have been identified for chemical units in all categories, as well as some of the key strategies by which these EE options could be promoted for large-scale adoption across MSME chemical clusters.

The second article presents brief profiles of the Ahmedabad and Vapi chemical clusters that were studied under the project, including the cluster-level energy consumption patterns and a set of low-cost energy efficiency measures that could be implemented by the chemical units in these clusters.

SAMEEEKSHA Secretariat

ENERGY AND RESOURCE MAPPING OF INDIAN CHEMICAL INDUSTRY

The chemical industry is one of the energy intensive MSME sub-sectors in the country. During the period 2020-2022 TERI conducted an assessment study of the MSME chemical industry under the BEE project 'Energy and resource mapping of MSME clusters in India'. This article presents an overview of the chemical industries in the MSME sector including the broad findings of the assessment study. The next article presents brief profiles of the Ahmedabad and Vapi chemical clusters located in the state of Gujarat.

Overview

The Indian chemical industry plays a crucial role in the overall economic development of the country, manufacturing over 80,000 chemical products that either find direct applications by end-users, or serve as raw materials for a range of downstream industries such as detergents and soaps; fertilisers; paints, pigments and dyes; paper; pharmaceuticals; pesticides; perfumes and toiletries; plastics; rubber; synthetic fibres; solvents; and textiles. The total production of major chemicals and petrochemicals was estimated at 29.18 million tonnes (2021–22). Chemical sector exports accounted for nearly 12% of India's total exports (Rs 14,65,742 crores).

The chemical industry provides employment to about 20 lakh people and is greatly diverse in terms of unit sizes, technologies and processes. It includes a large number of MSMEs, which may broadly be grouped under four categories: (1) dyes and pigments; (2) active pharmaceutical intermediates and other pharmaceutical products (API/pharma); (3) pesticides; and (4) other chemicals. The total production of MSMEs in the chemical sector is estimated at 4.7 million tonnes per year.

In general, the MSME chemical units face the same broad and overlapping challenges that characterize the Indian MSME sector as a whole and make it a challenging task to introduce and scale up clean and energy-efficient (EE) technologies and practices. The major challenges include:

- continued dependence on inefficient technologies, attributed to low awareness levels;
- inability to access clean fuels at affordable costs;
- difficulties in raising adequate, affordable and timely finance for better technological options; and
- dearth of skilled workers.

Most of the major chemical clusters in India are located in Gujarat, where the required raw materials, good infrastructure, access to reliable energy, and skilled manpower are readily available at competitive prices. Gujarat is also the largest producer of chemicals in India, accounting for 51% of the nation's chemicals production and 35% of pharmaceuticals production. The important chemical clusters in Gujarat include Ahmedabad, Ankleshwar, Nandaseri, Valsad and Vapi. Other important chemical clusters in India are located in Ernakulam (Kerala), Ghaziabad (Uttar Pradesh), Jamshedpur (Jharkhand), Karnal (Haryana) and Thane (Maharashtra).

Growth drivers

The demand for chemical products in India is expected to grow at 9% during 2020–25. The major drivers of growth are directly linked to the increasing demands for input chemical products from sectors such as

Some prominent chemical clusters in India

automobile, buildings, infrastructure (including ports, roads, railways, telecom, etc.), textile, etc. Further, the growth in India's middle-class population and increasing urbanization continue to boost the demand for personal care products, processed and packaged food, paints and coatings, and other products that are manufactured by industries using diverse chemical products and additives as input materials. Also, progressive modernization of agriculture practices is expected to increase the demands for fertilisers, pesticides and other agro chemicals. Other growth drivers of the Indian chemical sector include the emergence of new manufacturing hubs and end-user industries, increased foreign investments in the chemicals sector, abundant raw materials, and the comparatively low costs of workforce.

Key stakeholders

The important stakeholders in the chemicals sector comprise industry associations and federations; research and development (R&D) institutions such as National Chemical Laboratory (NCL) and National Institute of Pharmaceutical Education and Research (NIPER); and governmental bodies such as MSME Development and Facilitation Offices (MSME-DFOs), the state designated agencies (SDAs) of BEE, and state and central pollution control boards.

The national-level chemical industry associations and federations include Chemical Industries Association; Dyestuffs Manufacturers Association of India; Federation of Pesticides Manufacturers Association (SSI); Indian Chemical Council; Indian Chemical Manufacturers Association; Indian Specialty Chemical Manufacturers Association; Indian Small Scale Paint Association; and Pesticides Manufacturers & Formulators Association of India. Table I lists the main cluster-level industry associations across India.

Technology and processes

The process steps followed by chemical units vary widely, depending on the category of chemicals being manufactured. However, MSME chemical units across all categories generally use the same basic kinds of process equipment and auxiliary utility systems. A few examples are provided in the following sections.

Reaction vessels

Chemical reactions are carried out in reaction vessels, made of stainless steel or rubber-lined ceramic material. The reaction vessels vary in capacities, from 1–20 kilo litres. The capacities and number of reaction vessels in a chemical unit depend on the type of manufacturing process, production capacity and batch size. Reaction vessels are typically equipped to provide the conditions necessary to achieve the desired chemical reactions, such as direct/indirect jacket heating systems using steam or thermic fluid, cooling systems where required, electrically driven mechanical agitators, and so on.

Table 1. Prominent cluster-level chemical industry associations

Cluster	Name of industry association/ federation
Ahmedabad	• Vatva Industries Association • Naroda Industries Association • Gujarat Dyestuffs Manufacturers Association
Ankleshwar	• Ankleshwar Industry Association • Panoli Industry Association
Ernakulam	• Indian Small-Scale Paint Association (Kerala Region)
Ghaziabad	• Industrial Area Manufacturers Association
Jharkhand	• Jharkhand Small Industries Association • Adityapur Small Industries Association • Singhbhum Chamber of Commerce & Industry (Jamshedpur)
Karnal	• Haryana Chamber of Commerce & Industries • Karnal Paint and Chemicals Association
Nandesari	• Nandesari Industries Association (Vadodara)
Thane	• Thane Small Scale Industries Association • Chamber of Small Industry Association • Indian Small Scale Paint Association
Vapi	• Vapi Industrial Association
Valsad	• Valsad Industries Association • Sarigram Industries Association

Reaction vessels

Boilers

A large number of chemical units use boilers to meet process heat requirements. The low-pressure steam from the boiler is used for jacket heating of the reaction vessels or for direct injection based on process needs. The boilers are usually of low and medium pressure types (3.5–10.5 kg/cm^2), with capacities in the range of 1–5 tonnes per hour (tph). Chemical units that require intermittent process steam for specific products may also use smaller capacity boilers (up to 750 kg per hour evaporation rate). These boilers use a variety of fuels like natural gas (NG), biomass, coal, etc. depending on availability and economics.

Boiler

Thermic fluid heaters

Thermic fluid heaters (TFHs) are used to meet the indirect heating requirements in the chemical manufacturing processes: e.g., jacket heating in reaction vessels, product drying using heat exchanger, etc., wherein finer control is required over process temperatures and product quality. The TFHs are custom-designed, and their heating capacities may vary from 100,000–600,000 kcal per hour. The TFHs can be fuel-fired or electrically heated, and the temperature of thermic fluid is usually about 180–200 °C.

Thermic fluid heater

Dryers

Dryers are used to remove the last traces of moisture from the end-products of chemical reactions. A wide range of dryers are used by chemical units, depending upon the product chemistry. Commonly used dryers include tray dryer, fluidized bed dryer, rotary vacuum dryer, and spin flash dryer. The heating requirements in the dryer are met through a TFH or hot air generator (HAG).

Other common equipment/systems

Other equipment/systems commonly used by chemical units in all categories include centrifuges, filter presses, chillers, cooling towers, ball mills, mixer drums, air compressors, pumps, fans and blowers.

Energy use

Thermal energy accounts for about 75–80% of total energy consumption by chemical manufacturing units, and is mainly used in equipment such as boilers, thermic fluid heaters, hot air generators, dryers, etc. Electricity accounts for the remaining 20–25% of energy consumption.

The total energy consumption in the MSME chemical sector is estimated to be 493,277 tonnes of oil equivalent (toe), and the corresponding CO_2 emissions are about 1.83 million tonnes (table 2). The dyes & pigments category accounts for the largest share in total energy consumption (≈52%). However, the API/pharma category has the highest average specific energy consumption (SEC) value.

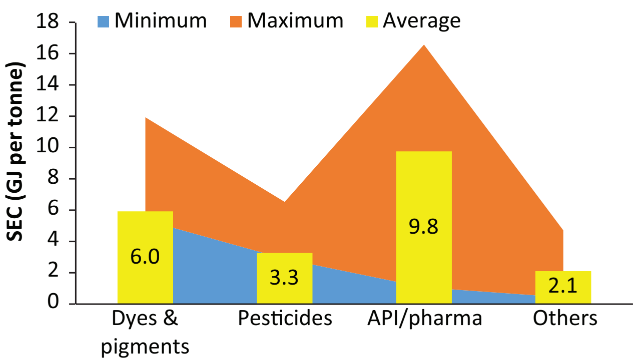
Table 2. Category-wise energy consumption and emissions in MSME chemical sector

Category	Energy consumption (toe/year)	CO_2 emissions (t CO_2/year)
Dyes & pigments	259,188	860,603
Pesticides	28,791	198,486
API/pharma	83,982	455,956
Other chemicals	121,316	313,065
Total	**493,277**	**18,28,110**

Energy saving opportunities

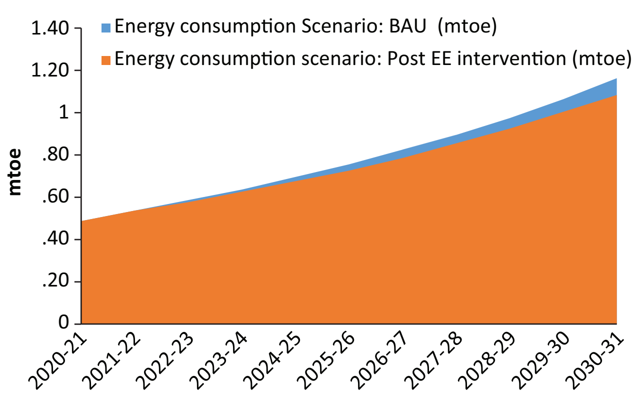
The studies and analyses under the project indicate significant scope for achieving energy and resources saving as well as emissions reduction in the MSME chemical sector. Some of the key EE options that can be adopted by all categories of chemical units are listed below.

- Optimization of steam generation and distribution system
- Performance improvement of thermic fluid heater
- Replacement of tray dryer with fluidized bed dryer
- Fuel switch over in thermic fluid heater from Light diesel oil (LDO) to natural gas (NG)
- Electrification of thermic fluid heater
- Replacement of standard efficiency motors with IE3 motors
- Installation of rooftop solar systems
- Best operating practices (BOP) and good housekeeping measures



Category-wise SEC values of MSME chemical units

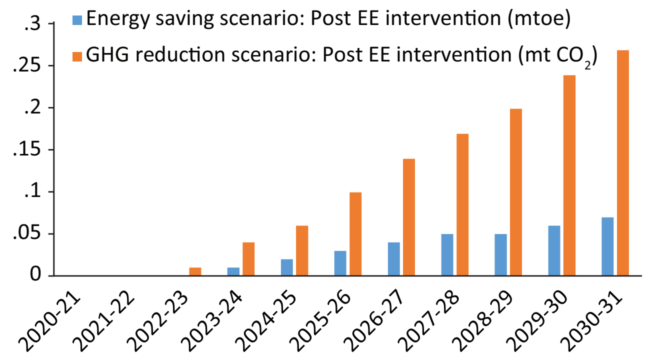
Overall, the large-scale adoption of the identified EE options by MSME chemical units can save about 70,000 toe of energy and reduce about 270,000 tonnes of CO_2 emissions against a 'business-as-usual' (BAU) scenario by 2030–31.



Potential for reducing energy consumption through EE measures up to 2030–31 [mtoe—million tonnes of oil equivalent]

Looking ahead

Energy efficiency can be promoted among MSME chemical units through a mix of policy-level strategies



Year-wise energy saving and emissions reduction potential up to 2030–31

and cluster-level strategies under an appropriate implementation plan. A few key strategies are outlined below:

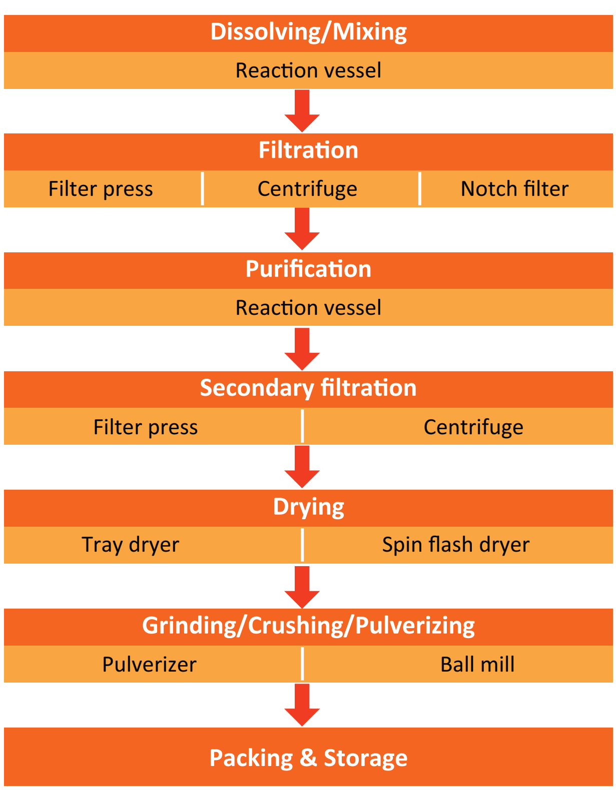
- **Energy management cells.** Several low-cost technology-specific EE measures can be implemented by cluster-level energy management cell (EMCs), which could be established and operated directly by the local industry associations, development institutes, and other cluster-level stakeholders through special purpose vehicles for cluster development programs (SPV-CDP). The EMCs can set and implement quality and EE benchmarks for various technologies/equipment, establish linkages with the appropriate technology/ equipment suppliers, facilitate the adoption of EE technologies/equipment by individual chemical units through a self-sustaining business model, and ensure that each chemical cluster achieves its benchmark EE level at minimal cost.
- **Technology upgradation fund:** A technology upgradation fund (TUF) could be established by BEE in association with SDAs, Ministry of MSME, SIDBI and other banks/financial institutions so that MSME chemical units can access the capital finance needed for adopting EE technologies and/or upgrading their existing technologies.
- **Skill development centres.** Cluster-level skill development centres may be set up with support from Ministry of MSME, Ministry of Skill Development and Entrepreneurship, Office of DC-MSME, and other relevant agencies and institutions to help in creating and sustaining a cadre of workers with updated skillsets on EE technologies and practices.
- **Common facility centres.** To address common needs such as accessing good-quality raw materials, testing facilities, etc., Common Facility Centres (CFCs) could be set up in select chemical clusters by the local industry associations with support from the state government, Ministry of MSME, MSME-DIs, etc.

ENERGY EFFICIENCY OPTIONS IN AHMEDABAD AND VAPI CHEMICAL CLUSTERS

Under the BEE-sponsored project titled 'Energy and resource mapping of MSME clusters in India', TERI has conducted energy audit studies in a number of MSME chemical clusters across India including the Ahmedabad and Vapi chemical clusters in Gujarat. This article presents brief profiles of both these clusters, including energy consumption patterns and a set of low-cost energy efficiency measures that could be implemented by all units.

Ahmedabad chemical cluster

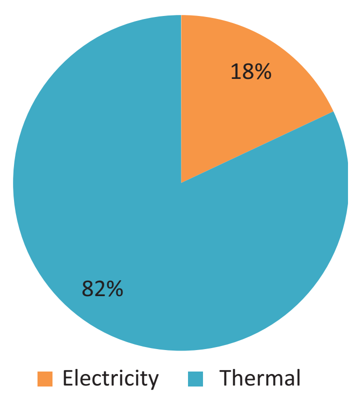
The Ahmedabad chemical cluster has about 585 operating chemical units, located in three broad areas: Vatva (600 units), Naroda (100 units) and Odhav (50 units). The cluster primarily produces a range of dyes & pigments including intermediates. The total annual production of the cluster is estimated at 956,520 tonnes.



Dyes & pigments manufacture—process steps and equipment used

Energy consumption and emissions

A majority of units use natural gas (NG) to meet their thermal energy requirements; a few units also consume small quantities of coal and biomass. Grid electricity is used for lighting and to drive motors, air compressors, pumps, etc. Thermal energy is mainly used in boilers, thermic fluid heaters (TFHs) and hot air generators (HAGs).The total annual energy consumption of the Ahmedabad chemical cluster is about 144,600 toe, of which thermal energy accounts for 82% (≈ 118,100 toe) and electricity the remaining 18% (≈ 26,500 toe). The average specific energy consumption (SEC) of the chemical units in the cluster is about 0.15 toe per tonne product (6.3 GJ/tonne). The total annual CO_2 emissions are estimated at 485,000 tonnes. Table 1 summarizes the cluster-level energy consumption and emissions.



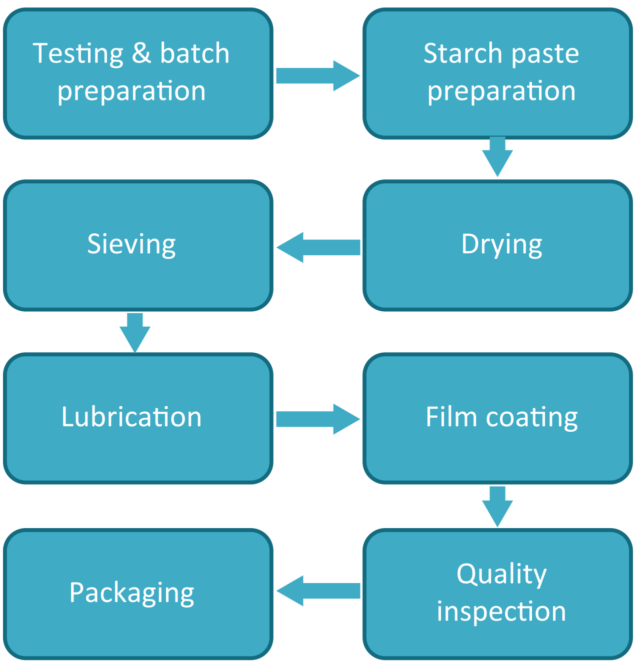
Energy consumption pattern in Ahmedabad chemical cluster

Table 1. Annual energy consumption and emissions in Ahmedabad chemical cluster

Energy form	Energy consumption ('000 toe/yr)	Emissions ('000 tonnes CO_2/yr)
Natural gas (NG)	105.9	208.6
Coal and biomass	12.2	32.7
Electricity	26.5	243.7
Total	**144.6**	**485.0**

Vapi chemical cluster (Gujarat)

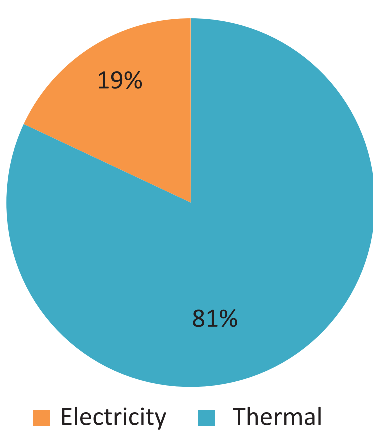
The Vapi chemical cluster has around 277 operating units. The cluster produces pharmaceuticals including active pharmaceutical intermediates (API), as well as a range of other organic and inorganic chemicals like aluminium phosphide, zinc phosphide, tanning agents, plastic additives, etc. The total annual production of the cluster is estimated at 728,908 tonnes.



API/pharmaceuticals production process

Energy consumption and emissions

A majority of units use natural gas (NG) to meet their thermal energy requirements; a few units also consume small quantities light diesel oil (LDO) and furnace oil (FO). Grid electricity is used for lighting and to drive motors, air compressors, pumps, etc. The total annual energy consumption of the Vapi chemical cluster is estimated at 100,120 toe, of which thermal energy accounts for 81% (≈ 82,330 toe) and electricity the remaining 19% (≈ 17,790 toe). The average specific energy consumption (SEC) of the chemical units in the Vapi cluster is about 0.14 toe/tonne product (5.9 GJ/tonne). The total annual CO_2 emissions are estimated at 327,100 tonnes. Table 3 summarizes the cluster-level energy consumption and emissions.



Energy consumption pattern in Vapi chemical cluster

Table 3. Annual energy consumption and emissions in Vapi chemical cluster

Energy form	Energy consumption ('000 toe/yr)	Emissions ('000 tonnes CO_2/yr)
Natural gas (NG)	81.0	159.6
LDO, FO	1.3	4.0
Electricity	17.8	163.5
Total	**100.1**	**327.1**

Energy efficiency options

As mentioned in the previous article, the studies under the BEE project have helped identify a number of energy-efficient (EE) technological options that could be adopted by all categories of chemical units to achieve significant savings in consumption of energy and resources. These EE options could be promoted for large-scale adoption among the MSME units in both Ahmedabad and Vapi clusters.

The studies have also helped identify a number of best operating practices (BOPs) that can be implemented by chemical units in all categories and clusters to achieve significant energy savings at little or no cost. Some of these BOPs are listed below.

Boiler, thermic fluid heater (TFH) and hot air generator (HAG)

- Maintain correct excess air levels based on fuel type.
- Use suitable O_2 analyser (on-line or portable type) to monitor excess air level. Adjust and control air ratio to avoid high excess air while ensuring complete combustion of fuel. Use automatic air-fuel ratio control system in the combustion system and integrate with control loop.
- Install blower having suitable capacity and correct air pressure. Avoid over-sized or under-sized blower. Install blower close to the combustion equipment to avoid transmission loss.

- Maintain proper draft in combustion system using proper damper in flue gas path.
- Recover useful heat from flue gas by installing a suitable waste heat recovery (WHR) system.
- Monitor and maintain quality of feedwater in boiler according to set standards. Ensure that the level of total dissolved solids (TDS) in boiler water is within recommended limits.
- Improve boiler efficiency with proper insulation, and by recovery and reuse of waste heat available in condensate return.
- Use dry steam from boiler for process heating to enhance heat transfer. Use appropriate steam separator or steam trap to ensure supply of dry steam
- Provide suitable insulation for steam and condensate pipes, ducts, etc. to reduce heat losses

Reaction vessel

- Maintain suitable material-to-liquor ratio to optimize water and energy consumption levels in the reaction vessel.
- Use control system to monitor the temperature of reaction vessel, and ensure that the system is switched off on completion of the reaction.

ABOUT **SAMEEEKSHA**

SAMEEEKSHA is a collaborative platform aimed at pooling the knowledge and synergizing the efforts of various organizations and institutions—Indian and international, public and private—that are working towards the common goal of facilitating the development of the Small and Medium Enterprise (SME) sector in India, through the promotion and adoption of clean, energy-efficient technologies and practices.

SAMEEEKSHA provides a unique forum where industry may interface with funding agencies, research and development (R&D) institutions, technology development specialists, government bodies, training institutes, and academia to facilitate this process.

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