

1. Policy - is an principle or protocol to guide decisions and achieve rational outcomes.

Framework- 1) Decisions 2) Stakeholders 3)Policies 4)Goals 5)Criteria 6) Analysis

2. Energy Goals -

- Increase Energy Access
- Develop capacities of energy transition
- Enhance energy security
- Manage energy related market power
- Manage energy resource endowments
- Reduce environmental and human health impact
- Accelerate energy related technological changes
- Coordinate and implement international energy related policies

3. India Policy Documents-

1. Five Year Plans- First five year Plan (1951–1956), Twelfth Plan (2012–2017). With the Planning Commission dissolved, no more formal plans are made for the economy, but Five-Year Defence Plans continue to be made. The latest would have been 2017–2022. However, there is no Thirteenth Five-Year Plan.

2. Integrated Energy Policy- The Integrated Energy Policy, released in August 2006, addresses all aspects of energy, including energy security, access and availability, affordability and pricing, efficiency and the environment.

3. National Action Plan on Climate Change- National Action Plan for Climate Change (NAPCC) is a Government of India's programme launched in 2008 to mitigate and adapt to the adverse impact of climate change.

4. Electricity Regulation Commission Act 1998- An Act to provide for the establishment of a Central Electricity Regulatory Commission and State Electricity Regulatory Commissions, rationalization of electricity tariff, transparent policies regarding subsidies, promotion of efficient and environmentally benign policies and matters connected therewith or incidental thereto.

5. Electricity Act 2003- The act covers major issues involving generation, distribution, transmission and trading in power.

6. UMPP(Ultra Mega Power Projects)- are a series of ambitious power stations planned by the Government of India.

7. Rural Electrification Policy 2006

8. INDC 2015- Countries across the globe committed to create a new international climate agreement by the conclusion of the U.N. Framework Convention on Climate Change (UNFCCC) Conference of the Parties (COP21) in Paris in December 2015. In preparation, countries have agreed to publicly outline what post-2020 climate actions they intend to take under a new international agreement, known as their Intended Nationally Determined Contributions (INDCs). The INDCs will largely determine whether the world achieves an ambitious 2015 agreement and is put on a path toward a low-carbon, climate-resilient future.

4. ISO-50001

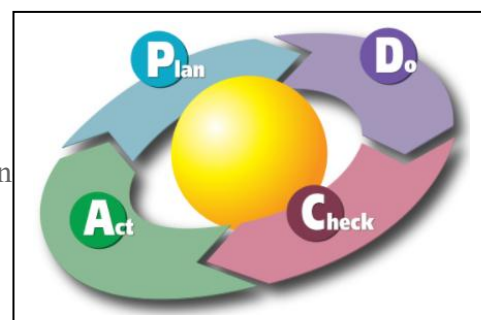
- It is an international standard created by the International Organization for Standardization (ISO). The standard specifies the requirements for establishing, implementing, maintaining and improving an energy management system, whose purpose is to enable an organization to follow a systematic approach in achieving continual improvement of energy performance, including energy efficiency, energy security, energy use and consumption.
- The standard aims to help organizations continually reduce their energy use, and therefore their energy costs and their greenhouse gas emissions.
- ISO 50001 was originally released by ISO in June 2011 and is suitable for any organization, whatever its size, sector or geographical location. The second edition, ISO 50001:2018 was released in August 2018.
- For organizations committed to addressing their impact, conserving resources and improving the bottom line through efficient energy management.
- ISO 50001 provides a framework of requirements for organizations to:

- Develop a policy for more efficient use of energy
- Fix targets and objectives to meet the policy
- Use data to better understand and make decisions about energy use
- Measure the results
- Review how well the policy works, and
- Continually improve energy management.

5. PDCA (plan–do–check–act or plan–do–check–adjust)

- PDCA (plan–do–check–act or plan–do–check–adjust) is an iterative four-step management method.
- used in business for the control and continual improvement of processes and products.
- It is also known as the Deming circle/cycle/wheel, Shewhart cycle, control circle/cycle, or plan–do–study–act (PDSA).
- The ISO 50001 process follows the same PDCA approach as these other ISO standards and provides a framework to:

- ✓ Develop a policy for more efficient use of energy
- ✓ Fix targets and objectives to meet the policy
- ✓ Use data to better understand and make decisions about en
- ✓ Measure the results
- ✓ Review how well the policy works, and
- ✓ Continually improve energy management.



Plan- Establish objectives and processes required to deliver the desired results.

Do- Carry out the objectives from the previous step.

Check- the data and results gathered from the do phase are evaluated. Data is compared to the expected outcomes to see any similarities and differences.

Act- This act phase is where a process is improved. Records from the "do" and "check" phases help identify issues with the process.











6. PAT scheme

Perform Achieve and Trade (PAT) scheme is a flagship programme (**the most important or prioritized concern of the organization**) of Bureau of Energy Efficiency under the National Mission for Enhanced Energy Efficiency (NMEEE). NMEEE is one of the eight national missions under the National Action Plan on Climate Change (NAPCC) launched by the Government of India in the year 2008.

- PAT scheme is a market based compliance mechanism to accelerate improvements in energy efficiency in energy intensive industries.
- The energy savings achieved by notified industries is converted into tradable instruments called Energy Saving Certificates (ESCerts).

PAT Cycles for Implementation of Scheme:

- 1.** PAT Cycle -I (2012-2015)
- 2.** PAT Cycle –II (2016-17 to 2018-19)
- 3.** PAT Cycle –III (2017-18 to 2019-20)
- 4.** PAT Cycle –IV (2018-19 to 2020-21)
- 5.** PAT cycle –V (2019-2020 to 2021-22)
- 6.** PAT cycle –VI (2020-21 to 2022-23)

Achievements of PAT cycle -I:					Achievements of PAT cycle -II:				
									
Energy Saving 8.67 mtoe 5635 MW 1.25% of India's total primary energy supply	Emission Reduction 31 million tonnes of CO ₂ 1.93% of India's emissions	Skill Development Capacity building: 5000+ Engineers and operators 13718 Energy Auditors & Managers 219 Accreditation	Savings Rs. 9,500 Crores from saved energy consumption and avoided generation	Investment Encouraged investments for energy efficient technologies for domestic manufacturing Rs 26,000 Crore invested	Energy Saving 13.28 mtoe 1.46% of India's total final energy consumption (2018-19)	Emission Reduction 61 million tonnes of CO ₂ 2.5% of India's emissions	Capacity building 12000+ Engineers and operators 17000 Energy Auditors & Managers 500 Accreditation	Savings Monetary savings Rs 31,445 Crores	Investment Encouraged investments for energy efficient technologies Rs 43,721 Crore (reported)
Achievements of PAT Cycle -1					Achievement of PAT Cycle -2				

7. BEE and State Development Agencies and EESL Programme

7.1 BEE-

- The Government of India set up Bureau of Energy Efficiency (BEE). on 1st March 2002 under the provisions of the Energy Conservation Act, 2001.
- The mission of **the Bureau of Energy Efficiency** is to assist in developing policies and strategies with a thrust on self-regulation and market principles, within the overall framework of the Energy Conservation Act, 2001 with the primary objective of reducing energy intensity of the Indian economy.

7.2 Role of BEE-

- BEE co-ordinates with designated consumers, designated agencies and other organizations and recognize, identify and utilize the existing resources and infrastructure, in performing the functions assigned to it under the Energy Conservation Act.
- The Energy Conservation Act provides for regulatory and promotional functions.

7.3 Promotional Functions of BEE-

- Create awareness and disseminate information on energy efficiency and conservation.
- Arrange and organize training of personnel and specialists in the techniques for efficient use of energy and its conservation
- Strengthen consultancy services in the field of energy conservation.
- Promote research and development .
- Develop testing and certification procedures and promote testing facilities.
- Formulate and facilitate implementation of pilot projects and demonstration projects
- Promote use of energy efficient processes, equipment, devices and systems
- Take steps to encourage preferential treatment for use of energy efficient equipment or appliances
- Promote innovative financing of energy efficiency projects
- Give financial assistance to institutions for promoting efficient use of energy and its conservation
- Prepare educational curriculum on efficient use of energy and its conservation
- Implement international co-operation programmes relating to efficient use of energy and its conservation

8. State Development Agencies (SDAs)

- In exercise of the powers conferred by section 15(d) of the Energy Conservation (EC) Act 2001, all the State Governments / UT Administrations have designated an agency as State Designated Agency (SDA) to coordinate, regulate and enforce the provisions of this Act within the State, either by assigning additional responsibilities to one of the existing departments of the State Government or by establishing a dedicated Stand-Alone SDA for energy efficiency.
- These agencies differ from State to State with the Renewable Energy Development Agency comprising 44%, Electrical Inspectorate comprising 19%, Distribution Companies comprising 17%, Power Departments comprising 14% and Stand-Alone SDA comprising 6%.

- Some list of SDAs- Maharashtra Energy Development Agency (MEDA), Punjab Energy Development Agency (PEDA), Rajasthan Renewable Energy Corporation Ltd (RRECL), Jharkhand Renewable Energy Development Agency (JREDA), Uttar Pradesh New and Renewable Energy Development Agency (UPNEDA), etc.
- Total 36 SDAs are operating in India.

In order to build and strengthen the institutional, technical and financial capacities and capabilities of the SDAs for undertaking energy efficiency activities at the State level, BEE provides financial assistance to the SDAs under two major components cited as below.

- Providing financial assistance to the State Designated Agencies to coordinate, regulate and enforce efficient use of energy and its conservation.
- Contribution to State Energy Conservation Fund (SECF).

➤ Key Activities-

- 1) Providing financial assistance to the State Designated Agencies to coordinate, regulate and enforce efficient use of energy and its conservation.
- 2) State Partnership for Energy Efficiency Demonstrations (SPEED)
 - Implementation of energy efficiency demonstration projects
 - Implementation of energy efficiency activities in Government schools
- 3) Model Energy Efficient Village Campaign
- 4) Institutionalization of Enforcement Machinery at State level
- 5) Manpower Support to SDAs
- 6) State Energy Efficiency Research & Outreach Programme
- 7) Workshops / Capacity Building of energy professionals
- 8) Maintenance and updation of Internet Platform and other database created on energy efficiency
- 9) Analysis and survey of the impact of energy conservation activities by SDAs

9. Energy Efficiency Services Limited (EESL)

- It is a joint venture of state-run power companies, responsible for implementation of Domestic Efficient Lighting Programme (DELP) or the UJALA scheme.
- It has reduced the prices of LED bulbs by 75%.

10. Municipal and Agricultural DSM (DEMAND SIDE MANAGEMENT)Initiatives

- Demand Side Management (DSM) has been traditionally recognized as one of the major intervention to achieve reduction in energy demands while ensuring continuous development.
- In recent past, DSM has gained unprecedented importance and has become an integral part of almost all the central and state missions on promotion of Energy Efficiency.
- DSM interventions have helped utilities not only to reduce the peak electricity demands and but also to defer high investments in generation, transmission and distribution networks.

10.1 Agricultural demand side management

- ✓ This programme promises energy efficiency through agriculture demand side management by reduction in overall power consumption, improving efficiencies of ground water extraction, reducing subsidy burden on state utilities and also investment in power plants through avoided capacity.
- ✓ Over 70 per cent of the rural households depend on agriculture. Agriculture is an important sector of Indian economy as it contributes about **17%** to the total GDP and provides employment to over **60%** of the population.
- ✓ As per the available data, more than 2.1 crore pump sets are installed in agriculture sector, majority of the pump sets are inefficient. Statistics shows that 2.5 to 5 lakh new pump set connections added every year to the sector.

- ✓ The average capacity of agricultural pumps in India is around 5 HP with efficiency levels hovering around 25-30%.
- ✓ BEE in association with various DISCOMs implemented four pilot AgDSM projects in Maharashtra, Karnataka and Andhra Pradesh.
- ✓ An MoU was signed between Indian Council of Agricultural Research (ICAR) and Bureau of Energy Efficiency (BEE), Ministry of Power, to create awareness for energy efficient pumpsets and operational practices so as to adopt energy and resource efficient approaches with aim to create awareness on energy efficiency and conservation in agricultural practices, particularly in using agriculture pumpsets, tractors and other machines and to improve fuel and water resource use efficiency thereby reducing the cost of cultivation so as to increase farmer's income in harmony with strategies of "Per drop more crop" and "Doubling Farmers' income".

10.2 Municipal demand side management (MuDSM)

- ✓ The growing demand for public utilities due to rising population and improved standards of living of the population has increased the energy demand for the service provided by the urban local bodies. The Municipality sector/urban local bodies (ULBs) consume electricity for various utility services like street lighting, water pumping, sewage treatment, and in various public buildings.
- ✓ Currently around 30% of Indian population lives in urban areas and continuous migration from rural areas is putting additional burden on the urban local bodies.
- ✓ The energy consumption of the municipality sector is characterized by frequent changes and rising peaks in power load curves in the morning hours due to water pumping and evening hours for street lighting.
- ✓ The inefficient use of electricity due to limited diffusion of energy efficiency technology and demand side management (DSM) initiatives, have considerably increased the energy spent of the municipalities.
- ✓ The Municipal Demand Side Management (MuDSM) programme can improve the overall energy efficiency of the Urban Local Bodies (ULBs) which could lead to substantial savings in the electricity consumption, thereby resulting in cost reduction/savings for the ULBs.
- ✓ Identifying the immense energy saving potential in municipal sector, BEE initiated Municipal Demand Side Management (MuDSM) during XI plan.
- ✓ The basic objective of the project is to improve the overall energy efficiency of the ULBs, which could lead to substantial savings in the electricity consumption, thereby resulting in cost reduction/savings for the ULBs. During the XI plan, the situation analysis was carried out in the Municipal sector in 2007 covering 23 States/UTs.
- ✓ Bureau of Energy Efficiency has initiated a programme to cover 175 municipalities in the country by conducting energy audits and preparation of Detailed Project Reports (DPRs) and implementation through ESCO mode.

11. Energy Use and Energy Supply

Energy is essential for a wide range of human activities, both in the United States and around the world, yet its use is the dominant source of emissions of CO₂ and several other important climate forcing agents. In addition to total demand for energy, the type of fuel used and the end-use equipment affect CO₂ emissions. The diversity of ways in which energy is supplied and used provides ample opportunities to reduce energy-related emissions. However, achieving reductions can be very difficult, especially because it involves considerations of human behavior and preferences; economics; multiple time frames for decision making and results; and myriad stakeholders. Questions decision makers are asking, or will be asking, about energy supply and consumption in the context of climate change include the following: What options are currently available for limiting emissions of greenhouse gases (GHGs) and other climate forcing agents in the energy sector, and

- ✓ what are the most promising emerging technologies?
- ✓ What are the major obstacles to widespread adoption of new energy technologies that reduce GHG emissions?

- ✓ What are the best ways to promote or encourage the use of energy-conserving and low-GHG energy options?
- ✓ What impacts will climate change have on energy production, distribution, and consumption systems, and how should possible impacts be accounted for when designing and developing new systems and infrastructure?
- ✓ What are the possible unintended consequences of new energy sources for human and environmental well-being?
- Energy Consumption
- Reduction in Energy Demand
- Energy Efficiency Improvement
- Energy sources which reduces emissions and Green House Gases
- Fuel Switching
- Solar Energy
- Wind Energy
- Bio Energy
- Geothermal Energy
- Hydro power
- Nuclear Power
- Carbon Dioxide Removal Approaches
- Carbon Capture and Storage
- Direct Air Capture
- Energy Carrier Transmission and Storage
- Science to Supply Technology Deployment
- Likely Impact of Climate change on Energy System Operation
- Science to Support Adapting to climate change
- Research Needs

(<https://www.nap.edu/read/12782/chapter/18#375>)

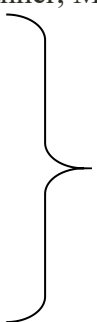
12. Standards & Labeling Programme

- It is one of the major thrust areas of BEE.
- A key objective of this scheme is to provide the consumer an informed choice about the energy saving and thereby the cost saving potential of the relevant marketed product.
- The scheme targets display of energy performance labels on high energy end use equipment & appliances and lays down minimum energy performance standards.

Star Labelled Appliances:-

Presently, S&L program covers star rating for **26 appliances/equipment.** List of the appliances covered under the ambit of Star Labeling is as given below:

- | | | |
|---|---|-----------------------------|
| <ul style="list-style-type: none"> ✓ Room Air Conditioners ✓ Frost Free Refrigerators ✓ Tubular Florescent Lamp ✓ Distribution Transformer ✓ Room Air Conditioner ✓ Direct Cool Refrigerator ✓ Color TV ✓ Electric Geysers ✓ Variable Capacity Inverter Air conditioners | } | Mandatory Appliances |
| <ul style="list-style-type: none"> ✓ LED Lamps ✓ Induction Motors ✓ Pump Sets ✓ Ceiling Fans ✓ LPG -Stoves ✓ Washing Machine ✓ Computer (Notebooks/Laptops) ✓ Ballast (Electronic/ Magnetic) | } | Voluntary Appliances |

- ✓ Office equipment's (Printer, Copier, Scanner, MFD's)
 - ✓ Diesel Engine Driven Mono-set Pumps
 - ✓ Solid State Inverter
 - ✓ DG Sets
 - ✓ Chillers
 - ✓ Microwave Oven
 - ✓ Solar Water Heater
 - ✓ Light Commercial Air Conditioner
 - ✓ Deep freezers
- 
- Voluntary Appliances**

13. Excellence Enhancement Centre (EEC)

- It has been setup in India under Indo-German Energy Forum established by Republic of India and Federal Republic of Germany in 2006 to promote energy efficiency and energy security.
- The Centre aimed to create greater awareness of energy efficiency in the Indian power sector by encouraging the exchange of ideas and experience, providing examples of best practice and facilitating technology transfer.
- The long-term goal was to establish more efficient power and heating plants and to introduce modern plant operation and management methods in the Indian power sector.
- The EEC is structured in accordance with the European model of an industrial association.
- **EEC Membership** is open to power sector companies, manufacturers and research and development organisations.
- Regular professional exchanges, sector events and technical publications and guidelines help to ensure the EEC retains its practical orientation.

Member Benifits:-

- ✓ Free Expert Technical Advices (conditions apply) to receipient members.
- ✓ Generating Business Opportunities for Experts/Donor Member organizaions.
- ✓ Access to discounted purchase of EEC's Technical Studies
- ✓ Preference in the Study/Expert committees of EEC.

Aims and Objectives

- **To become a truly representative voluntary association** of the entire Power Sector including Generation (Coal, Hydro, Nuclear, Renewables), Transmission, Distribution, Manufacturing, EPC Consultants, Testing, R&D, Academic and Regulatory institutions.
- **To promote Peer to Peer cooperation** between Indian Power Sector Stakeholders.
- **To provide a platform for the top Experts in Power Sector** and power plant operators for knowledge exchange and resolving related problems.
- **To share best practices** in all areas of power sector and provide broad based expertise.
- **To identify challenges**, develop common solutions and initiate joint action plans for power sector.
- **To create a "Technical Discussion Forum"** for Indian Power Sector on EEC Website.
- **To promote policy initiatives of MOP, GOI** by taking up suggested studies and giving feedback from stakeholders of Indian Power Sector.
- **To facilitate bilateral cooperation** in the Indian Power Sector.
- **To engage pro-actively with foreign organizations** such as VGB Germany, for Technical knowhow, Expertise, Consultancy, Studies and Reviews.
- **To raise awareness** for the need of excellence in Power Sector.

- **Making EEC more broad based** by catering to the entire Power Sector including Generation (Coal, Hydro, Nuclear, Renewables) , Transmission, Distribution, Manufacturing, EPC Consultants, Testing, R&D, Academic and Regulatory institutions.
- **Promoting Peer to Peer** cooperation by facilitating Expert Technical Advice from leading organizations such as CEA / BEE / NTPC/ PGCIL/ STEAG/ BHEL/ Tata Power etc. to stakeholders of Indian Power Sector who may seek such expertise. While the recipient member organizations will get the service largely free as a benefit of EEC membership, the donor organizations will be compensated by EEC for their services thereby generating business opportunities for the leading Indian Power Sector organizations.
- **Organizing an EEC Conference on annual basis** with Key note address by Ministers & Policy Makers, Economists, Visionaries and Technical Experts from Indian and international Power Sector, followed by presentation and discussion Sessions on key issues and challenges facing the Indian Power Sector.
- **Conducting 4-5 workshops every year** on relevant topics of interest to EEC Members / Power Utilities.
- **Conducting 4-5 training programs every year** on operational & maintenance issues of Indian Power Sector.
- **Facilitating Knowledge Exchange** through "Technical Discussion Forum" on EEC Website.
- **Facilitating Technical Advice / Consultancy services** from VGB Germany or other Foreign Organizations to Indian Power Sector member organizations for which EEC will bear part of the costs as a benefit of EEC membership - subject to conditions.
- **Facilitating Knowledge Exchange** between German/European power Sector and Indian Power Sector.
- **Taking up Technical studies** for the Indian Power Sector with the association of VGB Germany or other foreign organizations.
- **Creating an Archive of Best Practices**, Reference Guidelines, Technical and Operational Studies, Case Studies and Solutions which shall be available for purchase in hard & soft copies. Already EEC has Best Practices for Coal Based Power Plants in Germany and 22 Guidelines in its Library which are available to Member organizations for reference and consultation.

14. Input Output Analysis

- ✓ In economics, an input-output model is a quantitative economic model that represents the interdependencies between different sectors of a national economy or different regional economies.
- ✓ Wassily Leontief (Soviet American Economics) is credited with developing this type of analysis and earned the Nobel Prize in Economics for his development of this model.
- ✓ Related to these models are economic multipliers measuring total (direct plus indirect) changes in sales, income and employment.
- ✓ In general, input-output models depict the monetary flow of goods and services throughout the economy. All sectors in the economy purchase goods from one another and use these goods in the production of a final product.
- ✓ Mathematically, this type of interaction may be expressed as:

where

$$x_{11} + x_{12} + \dots + x_{1n} + y_1 = X_1$$

$$x_{21} + x_{22} + \dots + x_{2n} + y_2 = X_2$$

$$\begin{matrix} \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \end{matrix}$$

$$x_{n1} + x_{n2} + \dots + x_{nn} + y_n = X_n$$

x_{ij} = sales from sector i to sector j ,
 $i, j = 1, 2, \dots, n$

y_i = final demand for products of sector i ,
 $i = 1, 2, \dots, n$

X_i = total output of sector i ,
 $i = 1, 2, \dots, n$