ENERGY EFFICIENCY IN INDUSTRIES, INDIA

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By:
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Alliance for an Energy Efficient Economy (AEEE)

Bundesministerium für Wirtschaft und Energie
MITTELSTAND GLOBAL EXPORTINITIATIVE ENERGIE

AEEE VISION & MISSION

About AEEE

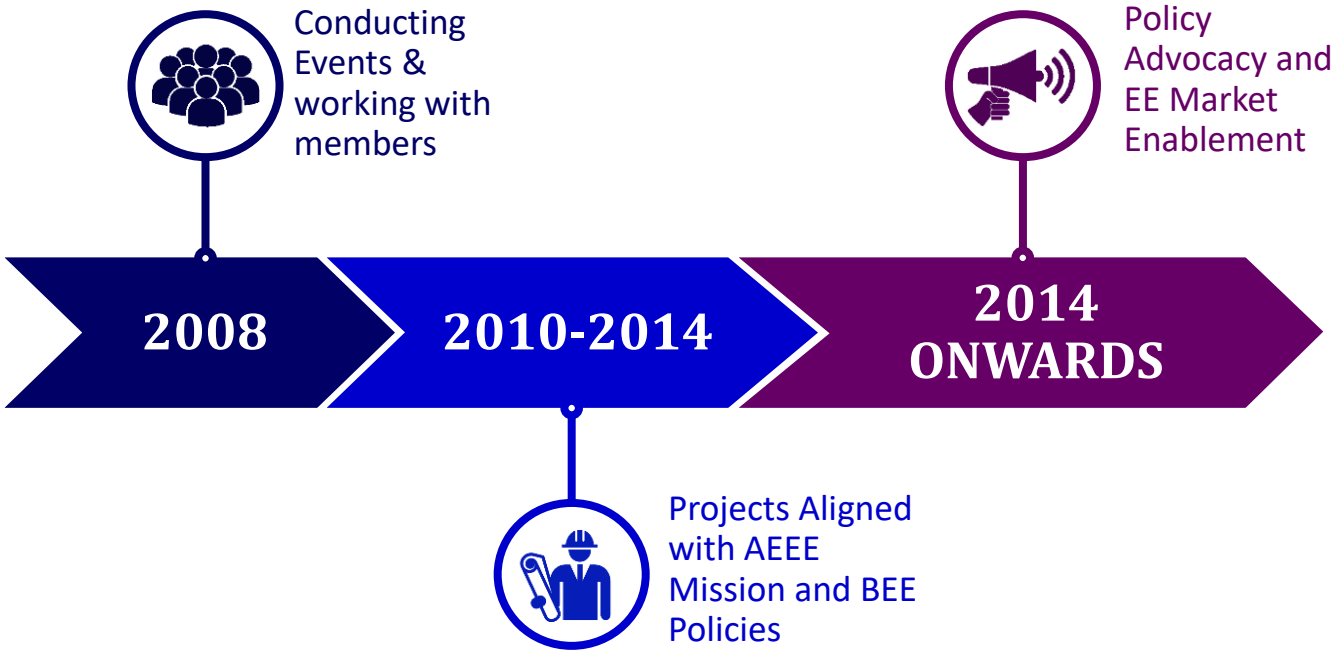
POLICY ADVOCACY - Energy Efficiency as a Resource

Advocates for **data driven and evidence-based policies** to unleash innovation and entrepreneurship to create an energy-efficient Indian economy

ENERGY EFFICIENCY MARKET ENABLER – scale energy efficiency investments

Helps create a **market for best available technologies and solutions** by developing business models for **energy-efficient** products and services

Milestones in AEEE Evolution



AEEE has **grown steadily**, striving to garner the full potential of energy efficiency, **keeping pace with the government's increasing focus on energy efficiency** and becoming a **credible and recognised voice among policy makers and businesses**.

Mission

Enable an Energy Efficient India

Be a partner in the **transformation of India** into a global leader in energy efficiency

Shape India as one of the **most attractive markets for companies** with the best available energy-efficient technologies

Focal Areas

ESCO Market Development and **Energy Efficiency Financing**

Sustainable & Smart Space Cooling

Residential & Commercial Building Energy Efficiency

DSM & Demand Response with Indian DISCOMS

Energy Efficiency Policy & Program Implementation in Indian States

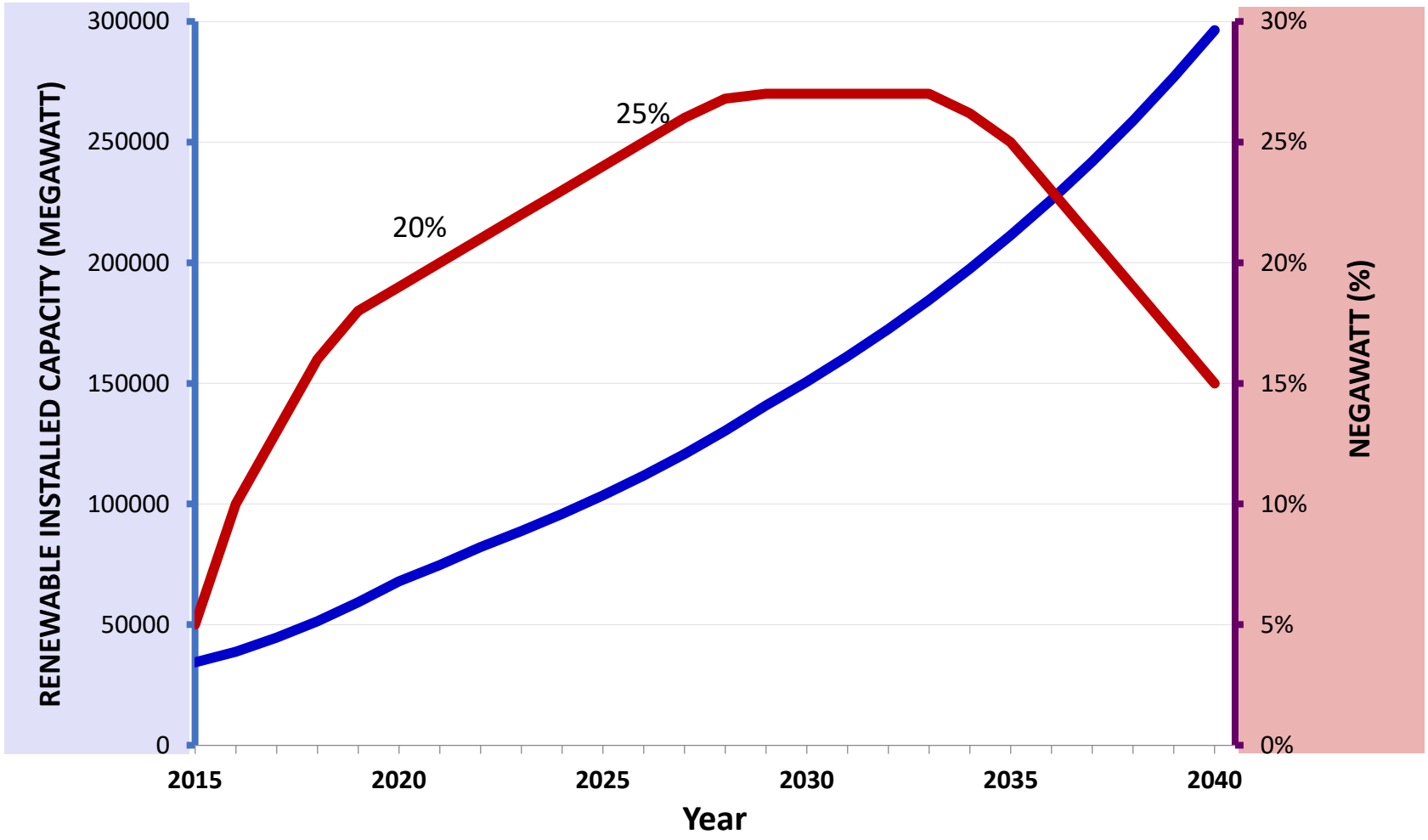
Energy Efficiency: The First Fuel

Leaky Pot Syndrome

Leakage;
Avoidable Fuel and
Resource Requirements

Eliminate Waste;
Reduced Fuel and
Resource Requirements

Dynamic Duo: Energy Efficiency and Renewable Energy



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Target: An Energy Efficient India

ENERGY EFFICIENCY AS A RESOURCE

Can save 100 GW for India by 2030

CHEAPER

- Cost of Conserved Energy significantly lower than Power Generation

FASTER

- EE technology available today
- Shorter lead time than new supply

CLEANER

- "Negawatt" produces no environmental footprint

Advantage AEEE

NETWORK

- Network with different stakeholders of EE ecosystem – Policy Makers, End Users, ESCOs, Technology Providers, Startups and FIs

CAPABILITY and CREDENTIALS

- Core and extended teams, where required, partner network has the right capabilities to work across the spectrum of the EE ecosystem
- Recognised by the industry community to deliver on transforming EE market in India

CAPACITY BUILDING

- Already working on capacity building at different levels – CMVP, workshops, seminars, webinars, trainings, etc.; has the right expertise NEUTRAL BODY

ENERGY EFFICIENCY THROUGH **PAT** INITIATIVE

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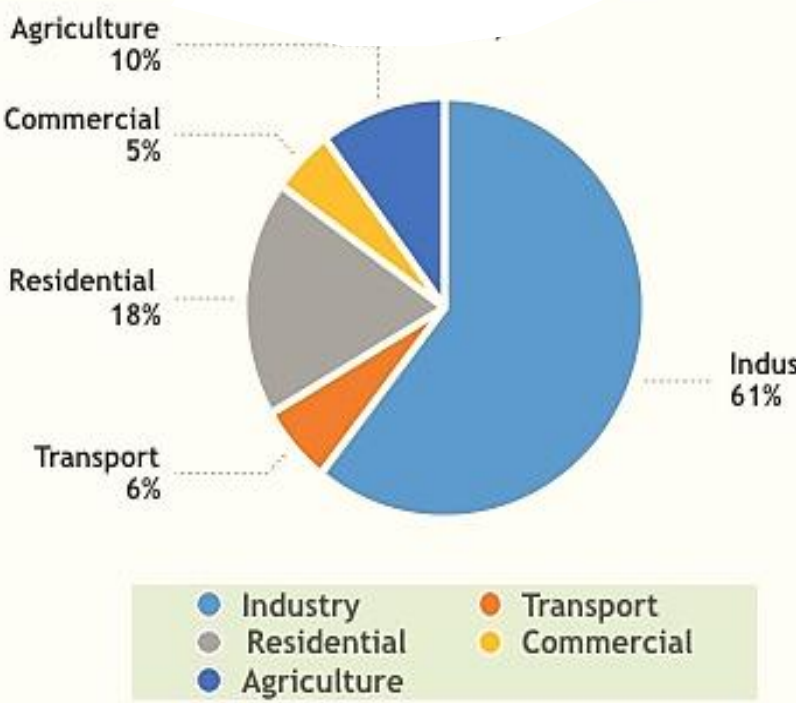
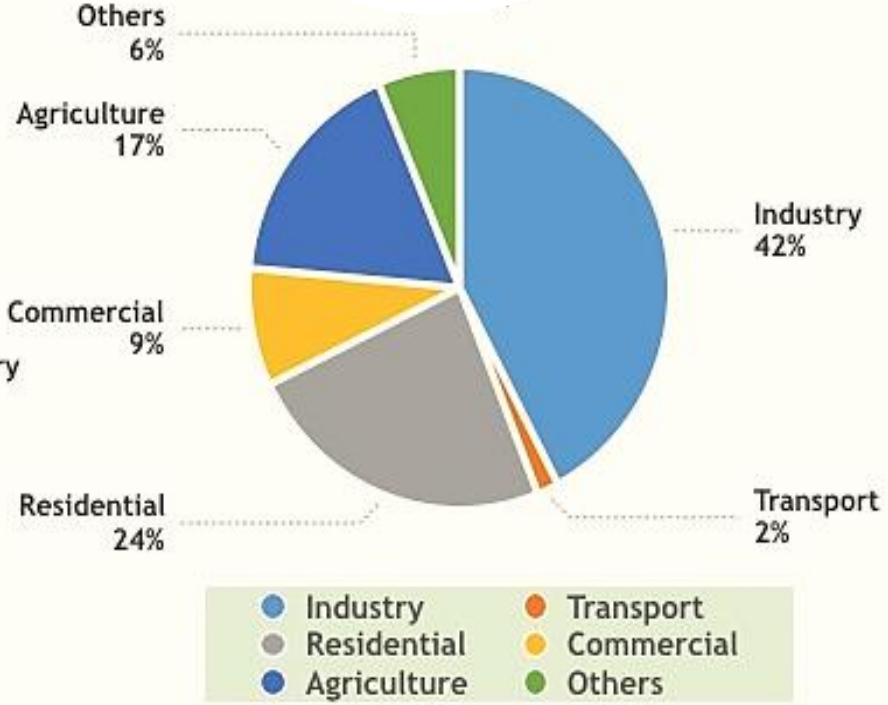
Energy Consumption Pattern in India 2015-2016

Total Primary Energy Consumption (ktoe)

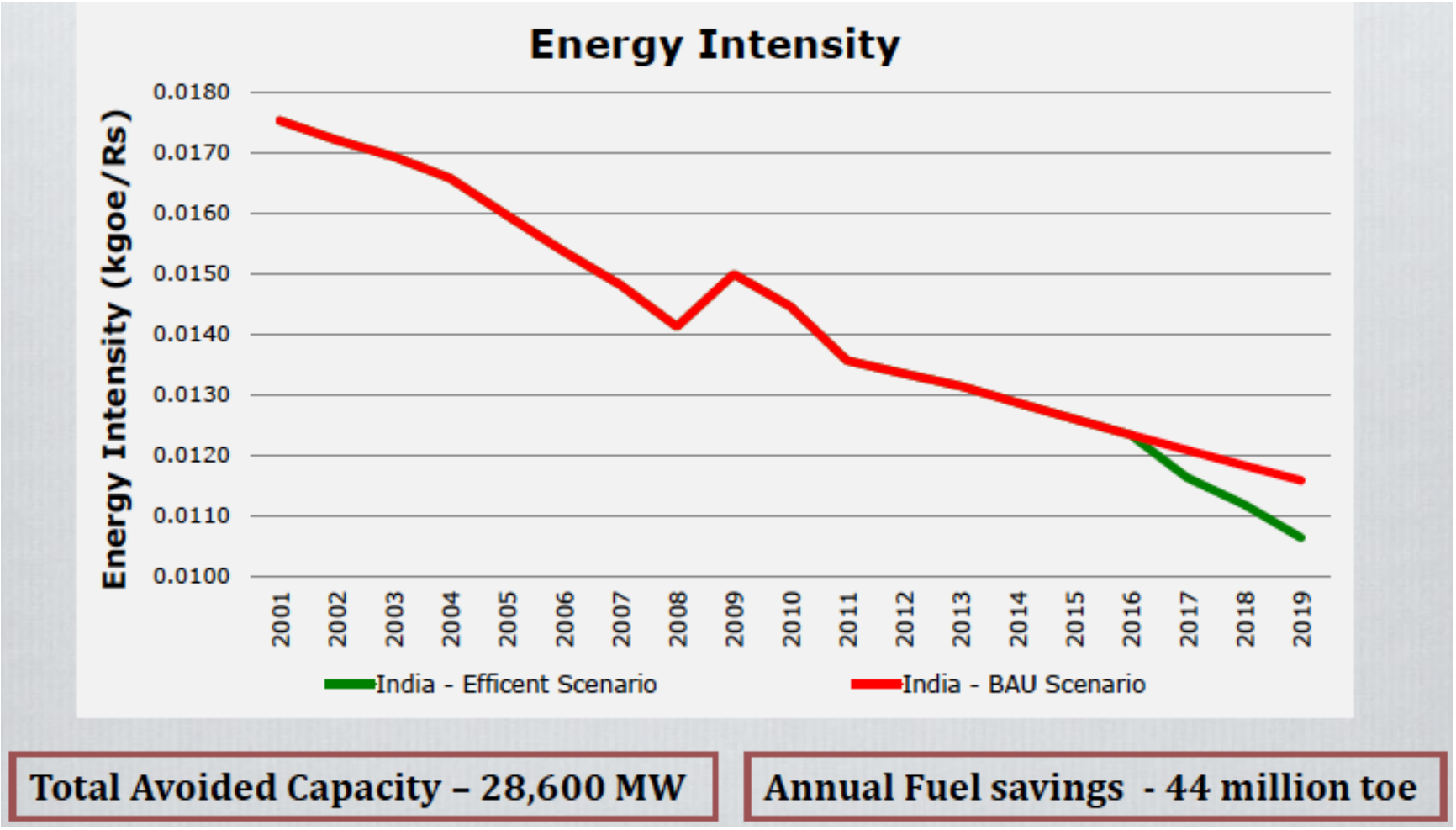


Electricity Consumption (GWh)



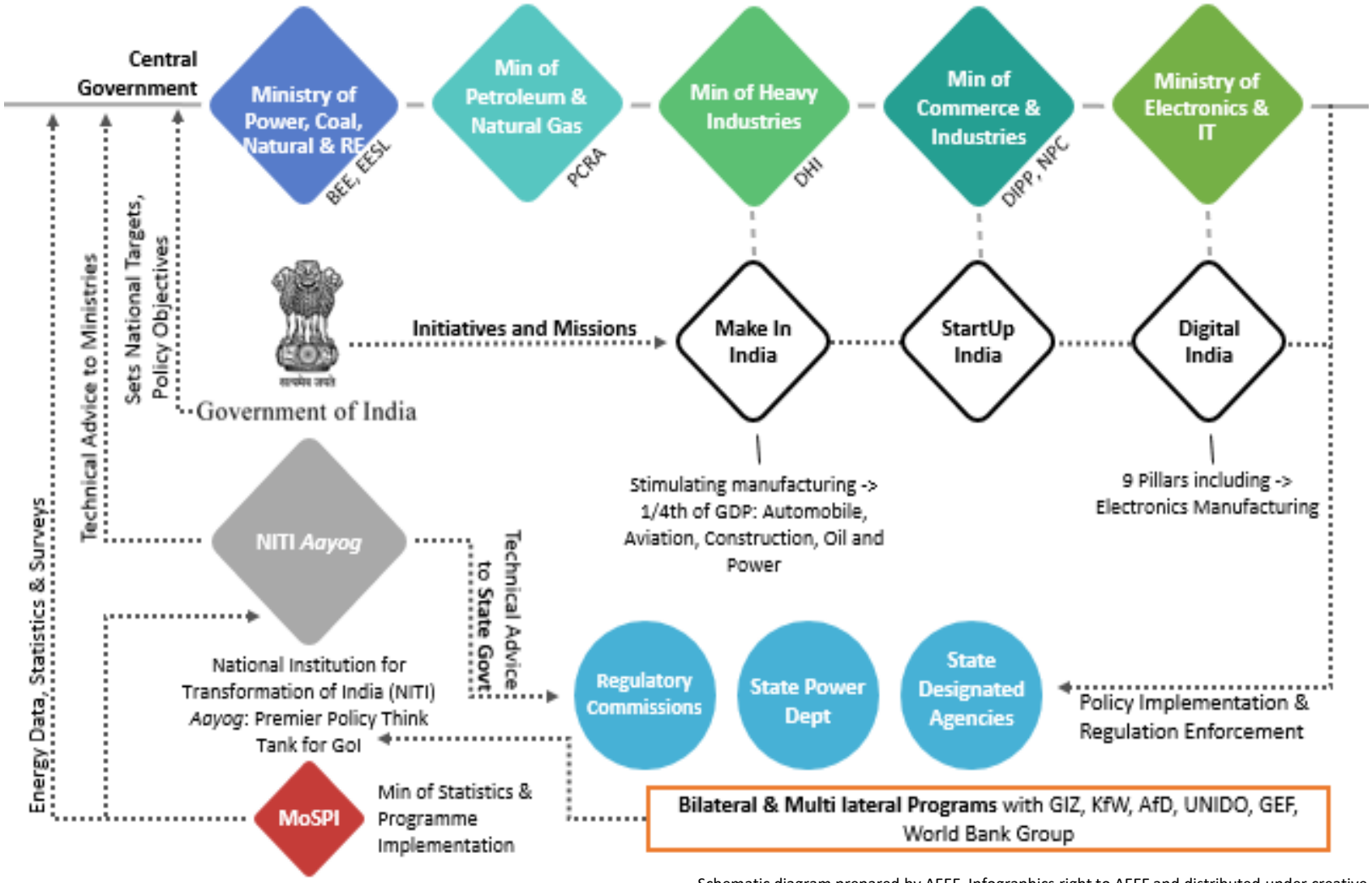
Source: MoSPI

Energy Intensity Declines despite Increase in GDP



Source: BEE

Government of India: Key Institutions for Large Industries



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Large Industries: The Dominant Segment

Trend in Large Industries	•**Move towards privatisation** which **supports both operational and energy efficiency** – PAT Scheme a regulatory mechanism to improve efficiency
Number of Large Industrial Units	•**200+ Large Public Sector Enterprises in Industrial sector** *(includes Energy, steel & infrastructure, manufacturing & mining industry, textiles & agro-based etc.)* •Dynamic Private Sector Industries with major Global presence and partnerships, and wide mix of shareholding patterns
Contribution to Economy	•**30% of GDP** *(leading contributors include Engineering & Machinery, Textiles, Chemicals, Transportation and Electrical equipment)*
Market & Employment	•Accounts for **30 % of Exports**, over 50% of share of inputs for national infrastructure development •**Employs 33% of the national workforce**, as sector is capital intensive

Source: BEE

PAT – Perform - Achieve – Trade Scheme

A Regulatory Instrument

Targets to reduce Specific energy Consumption in Energy Intensive Industries

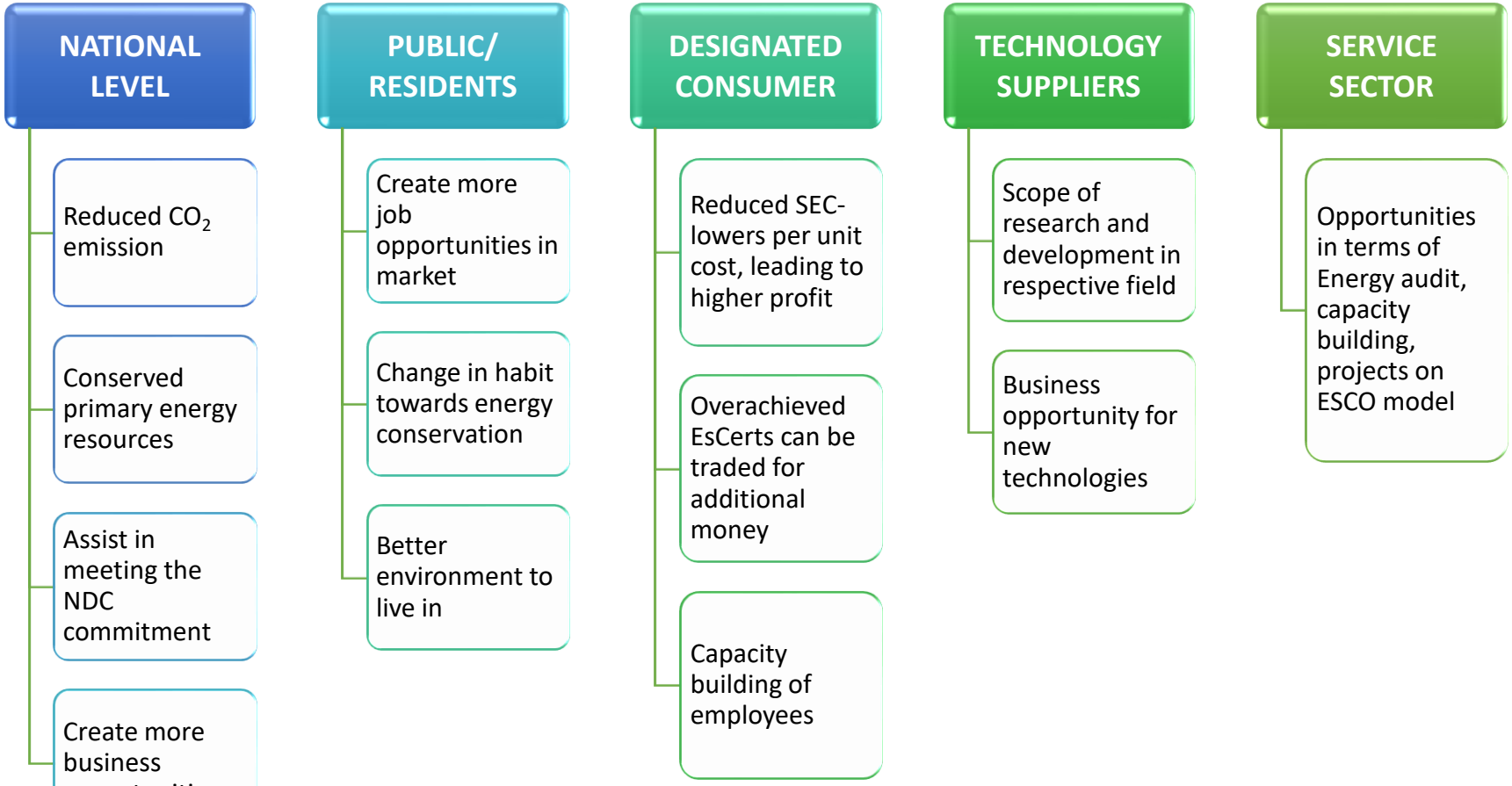
Have an associated market based mechanism

Enhances cost effectiveness through certification of excess energy saving

Certificates can be traded in the power exchange for compliance/monetary purpose.

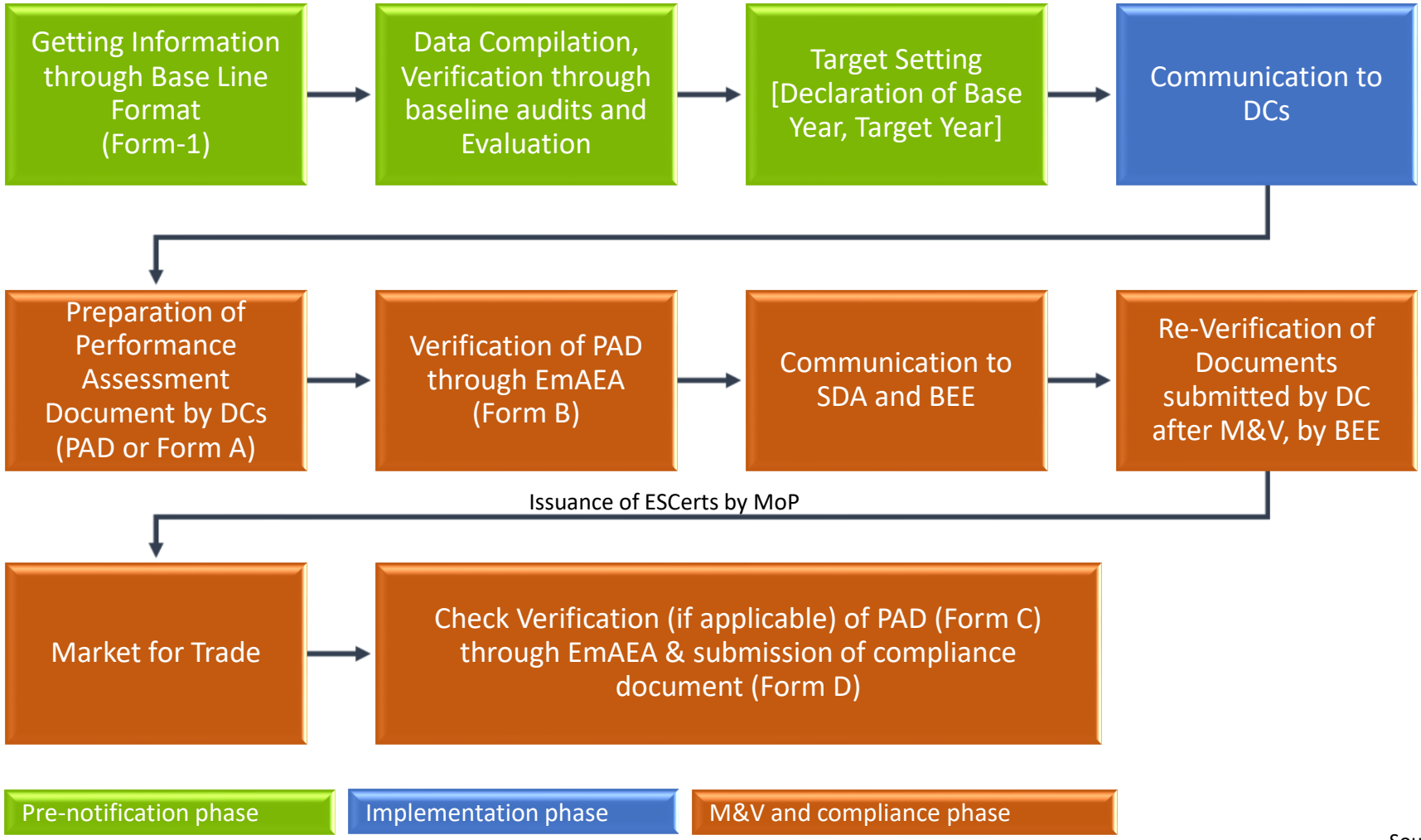
Source: BEE

Relevance of PAT



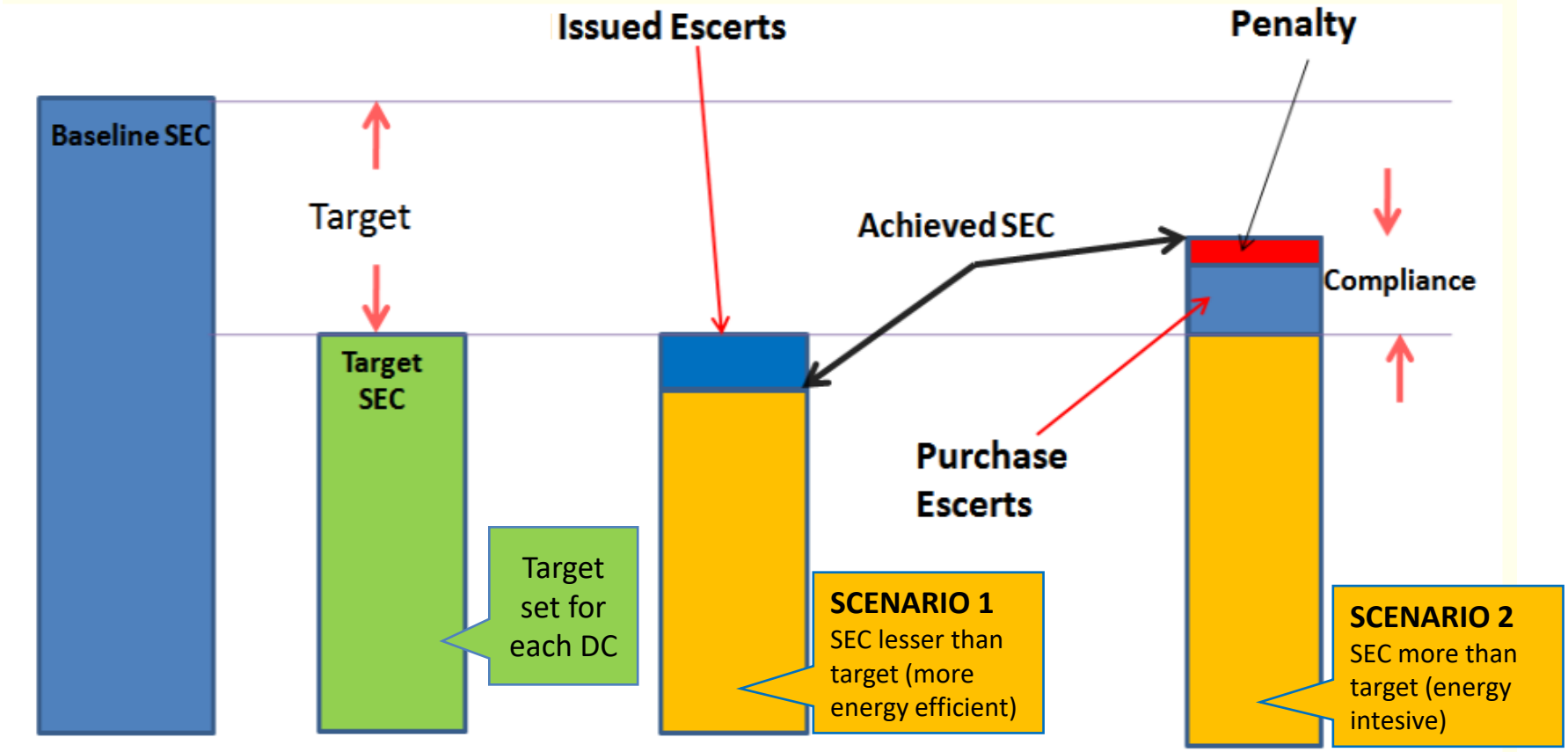
Source: GIZ

PAT Scheme Design Overview



Source: GIZ

PAT Compliance Process



SEC: Specific Energy Consumption

Source: BEE

PAT Cycles

PAT CYCLE 1 2012-2015	PAT CYCLE 2 2016-2019	PAT CYCLE 3 2017-2020
• **478 designated consumers** (DCs) from 8 energy intensive sectors • Cumulative Consumption- 164.79 MTOE • Energy Saving Target- **6.686 MTOE** • Achieved- **8.67 MTOE**	• **681 DCs** and 3 new sectors added • Cumulative consumption- 227 MTOE • **Target – 8.869 MTOE** reduction	• **116 DCs added** • Cumulative consumption – 35 MTOE • Energy Saving Target – **1.06 MTOE**

Source: BEE

Achievements of PAT Cycle I

32 million Tonnes of CO_2
1.93 % of India's Total CO_2 emission

Coal savings of 21 million tonnes
6,600 rakes of coal

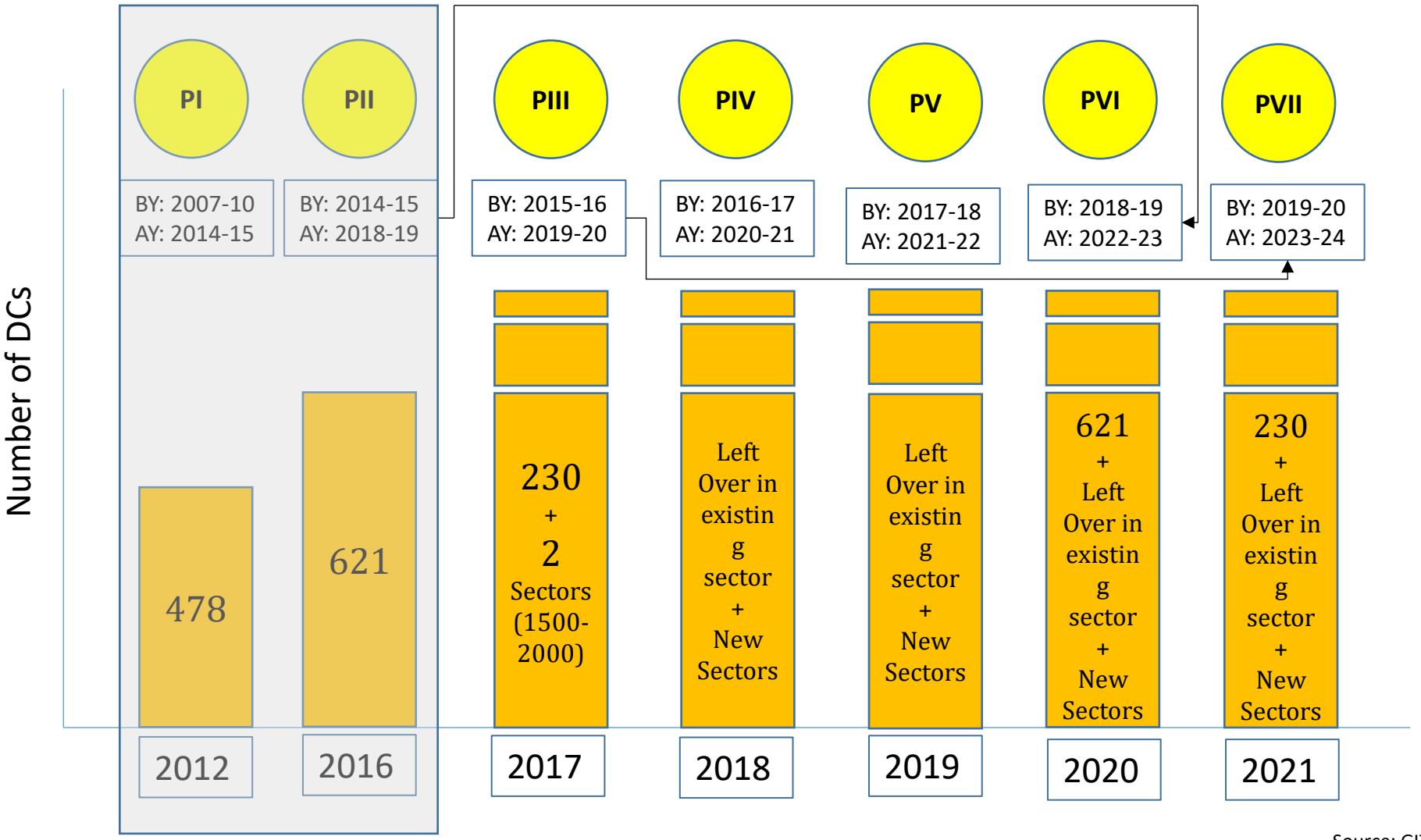
Investment of 348 Million Euro
in energy efficient technologies

Energy savings of 8.67 million toe
1.25 % of India's total primary energy supply
2.38 % of total energy consumed by Indian industries
5.24 % of total energy consumed by Indian industries under PAT

Capacity building
Approx. **13,500 Energy Auditors and Managers certified**
219 Energy Auditors accredited
53 Empanelled Accredited Energy Auditors
Capacity building of over 5000 engineers and operators

Source: BEE

PAT- Way Forward (Rolling Cycles)



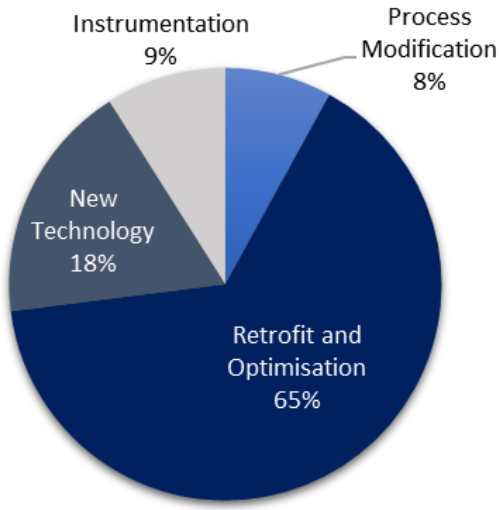
Source: GIZ

Unleashing the Potential from PAT-1 to PAT-2

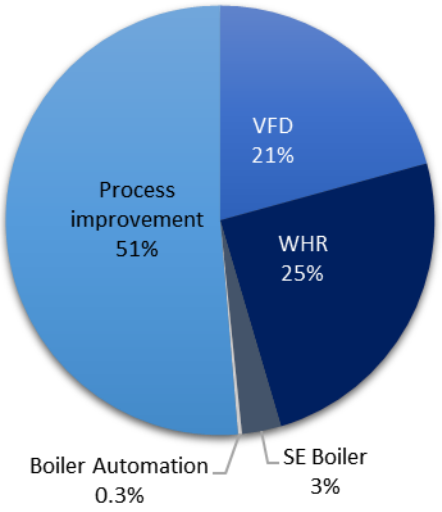
PAT – 1
Limited role of Process Modification
Largely Retrofits & Optimisation

PAT-2
Predominant role of Process Innovation
Estimated market **472 Million Euro** by 2020

Types of Energy Efficiency Projects undertaken in PAT phase -1



Rs 34,000 crore Industrial EE market by 2020
(excluding thermal power sector)



Source: AEEE

ENERGY EFFICIENCY IN **IRON AND STEEL INDUSTRY**

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Overview of Iron and Steel Industry

India is world's third largest producer of crude steel (up from eighth in 2003)

Contributes nearly 2% of country's GDP

Employs over 600,000 people

Present crude steel capacity: 126 Million Tonnes

Production of crude steel during 2016-17: 97.4 Million Tonnes

Source: Shakti

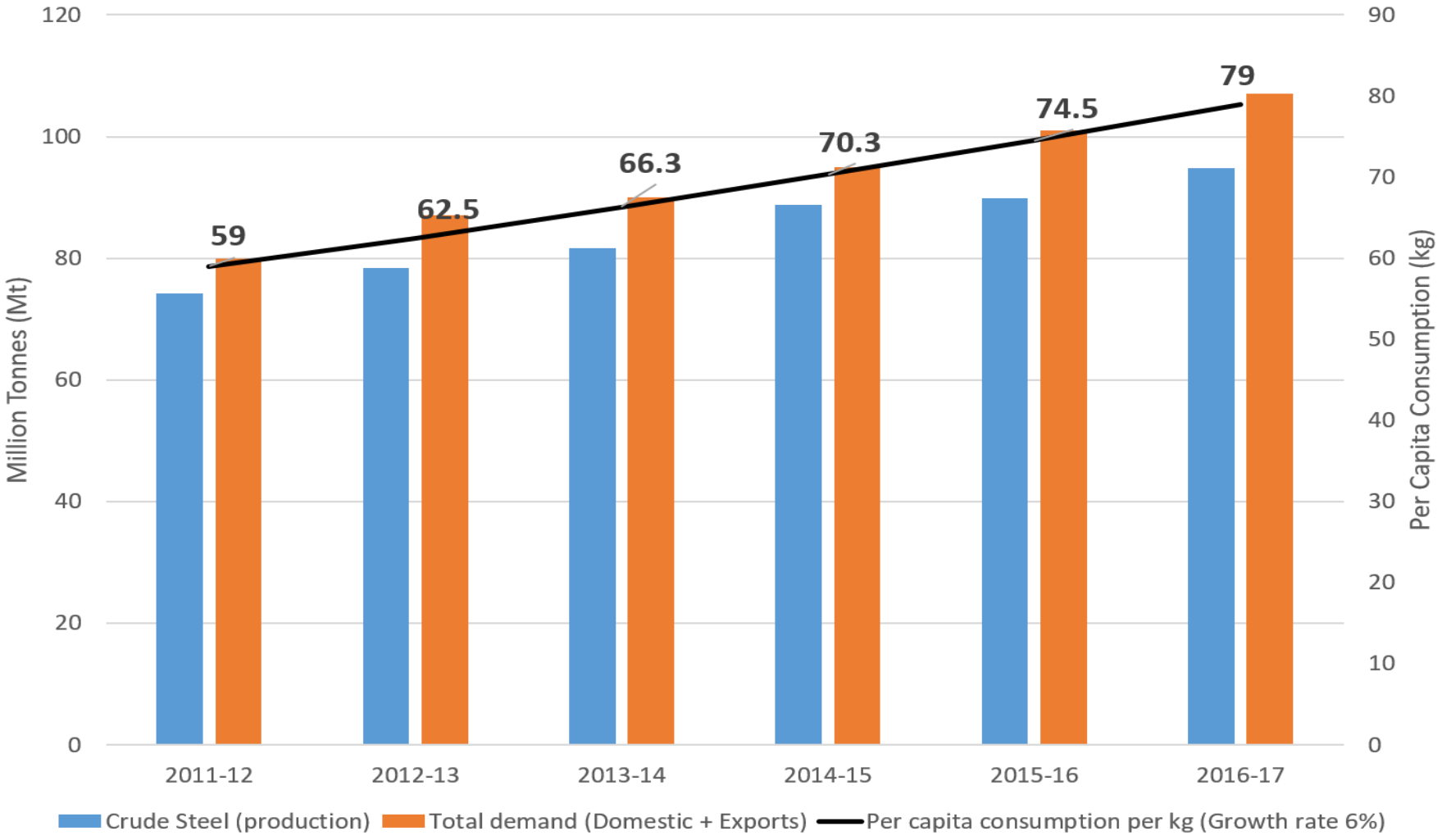
SEC by different process routes- Steel & Iron Industry

Process		BF-BOF (GJ/tcs)	Smelt Reduction-BOF (GJ/tcs)	Coal Based DRI-EAF (GJ/tcs)	Gas Based DRI-EAF (GJ/tcs)
Material Processing	Sintering	2.1	-	-	-
	Pelletizing	-	0.8	0.8	0.8
	Coking	1.0	-	-	-
Iron Making	BF	**11.8**	-	-	-
	Smelt Reduction	-	**17.0**	-	-
	DRI	-	-	**12.6**	**9.5**
Steel Making	BOF	1.0	1.0	-	-
	EAF	-	-	5.6	5.6
	Refining	0.4	0.4	-	-
	Continuous Casting	0.1	0.1	0.1	0.1
Total	**70.6 GJ/tcs**	16.4	19.3	19.0	15.9

Average Energy Consumption in Steel & Iron Industry per tone of cast steel: 71 GJ

Source: Shakti

Crude Steel Production, demand in contrast with Per Capita Energy Consumption



Source: Shakti

Technology Adoption: Based on Investment and Level of Difficulty

LEVEL 1

- Variable Frequency Drive for centrifugal equipment
- Preventive Maintenance
- Sinter Plant Air Leakages
- Energy efficiency improvements in captive power plant

LEVEL 2

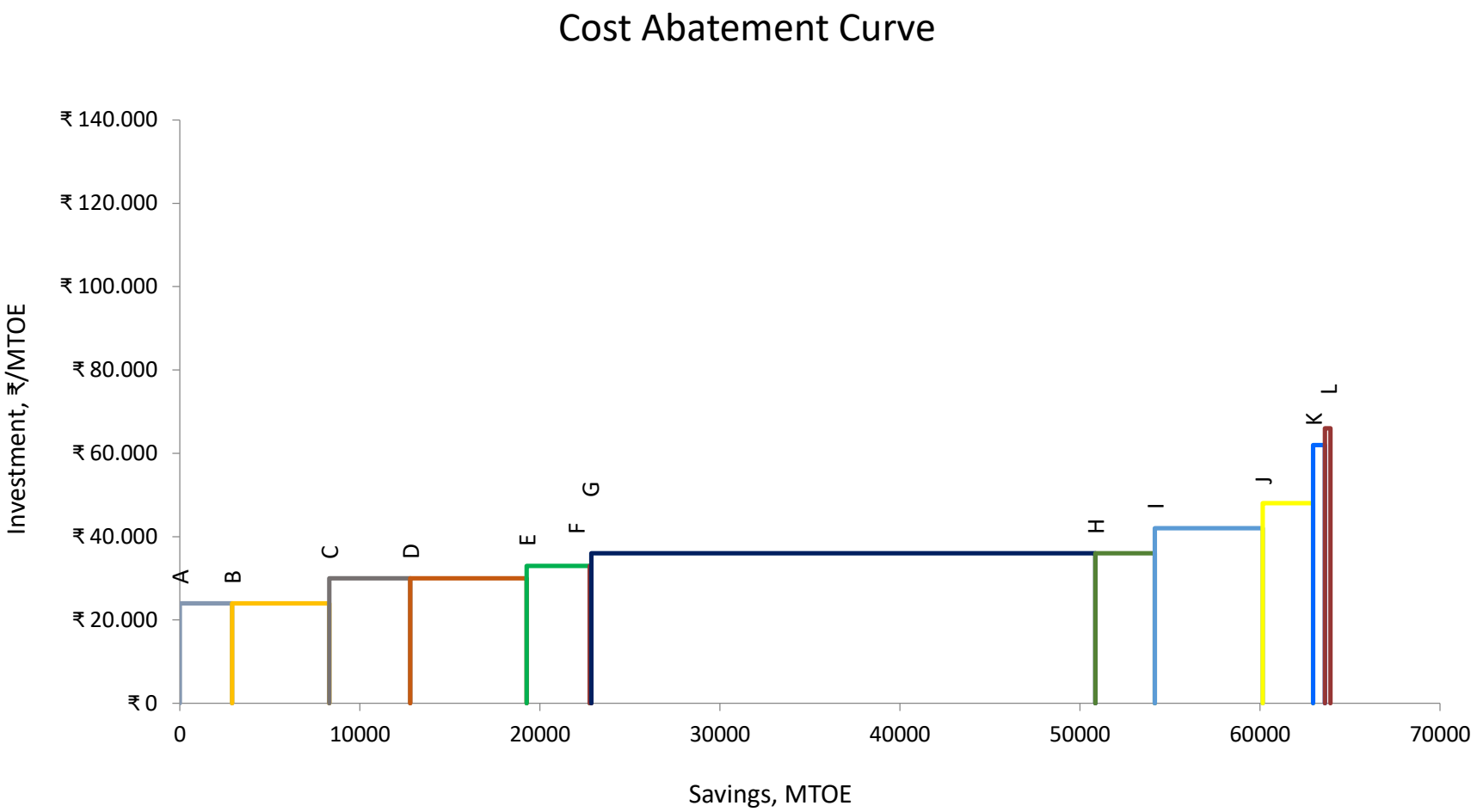
- Multi slit burner-Sintering furnace
- Coal Moisture Control
- Hot stove waste heat recovery
- Blast furnace Gas Sensible Heat Recovery
- Continuous Casting
- Sensible heat recovery from main exhaust gas of sintering machine

LEVEL 3

- Waste heat recovery from sinter bed
- Coke Dry Quenching
- Top Pressure Turbine
- Computerized operation of Coke Ovens
- Pulverized Coke Injection
- Waste heat recovery from sponge iron kiln

Source: Shakti

Cost Abatement Curve for various interventions



Source: Shakti

Future Energy Saving Opportunities

DIRECT REDUCED IRON MAKING (DRI PROCESS)

- Electric Arc Furnace (EAF)
- MIDREX Direct Reduction (DR) Plant, composed of
  - Shaft Furnace
  - Reformer
- Able to use both lump and pellet as raw material and recycles used gas.

PRODUCTION OF LIQUID IRON

- COREX- Doesn't require coking coal
- FINEX- Optimized fine-ore reduction process for direct utilization of the low-cost iron ore fines for iron production

Source: Shakti

ENERGY EFFICIENCY IN **TEXTILE INDUSTRY**

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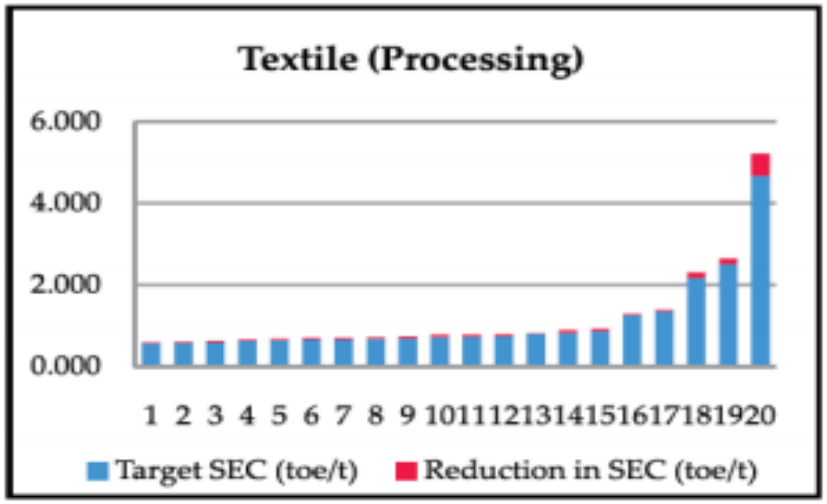
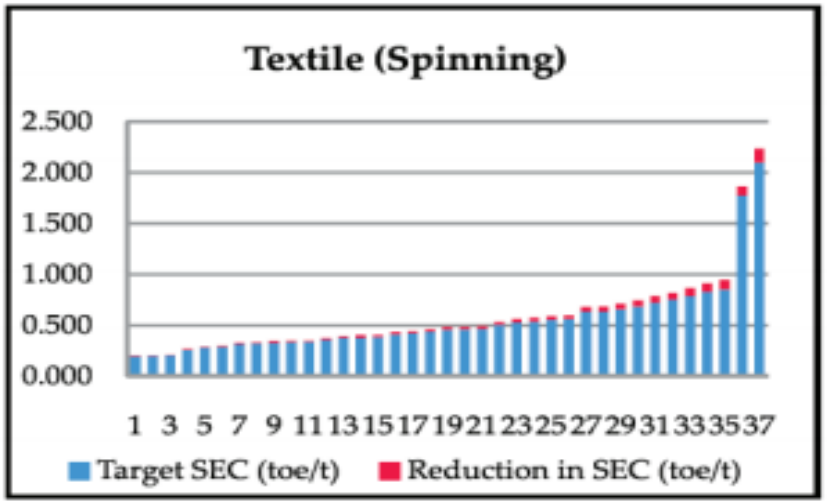
Overview of Textile Industry

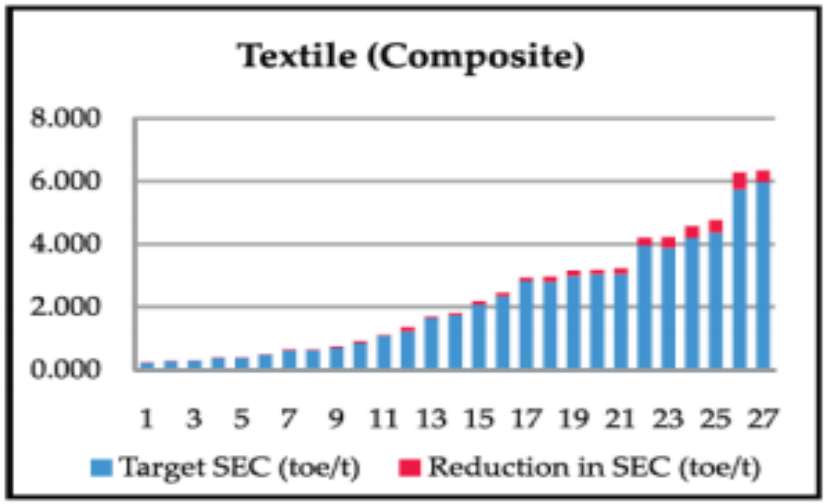
- Contributes 14% to Industrial production and 4% to India's GDP
- Constitutes 15% of country's export earnings
- Second largest employment provider: 51 million people directly and 68 million indirectly in 2015-16
- Textile exports in 2015-16: 36 Billion Euro
- Second largest textile fibre producer in the world (9 million tonnes in 2015-16)
- Largest cotton and jute producer in the world
- Second largest textile manufacturing capacity globally
- India accounts for 18% of world's spindles and 9% of world's rotors (Second highest in the world)
- 5% share in global textiles and apparel trade

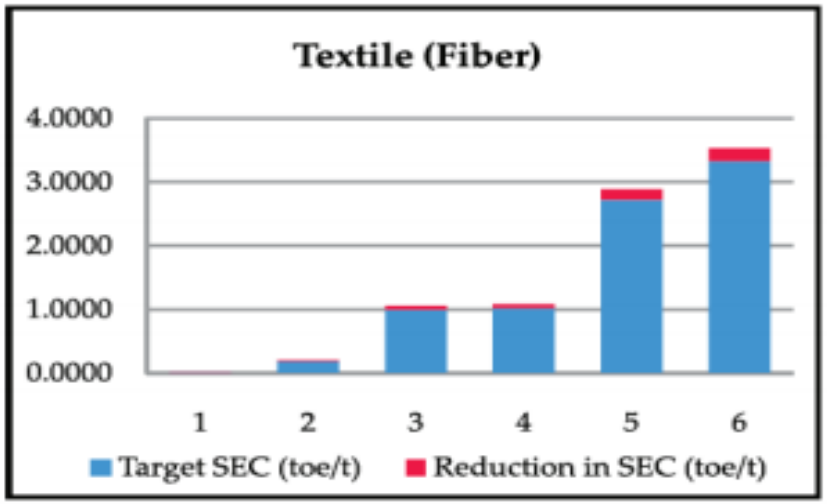
Source: Ministry of Textiles Website

Specific Energy Consumption of DCs of PAT in Textile



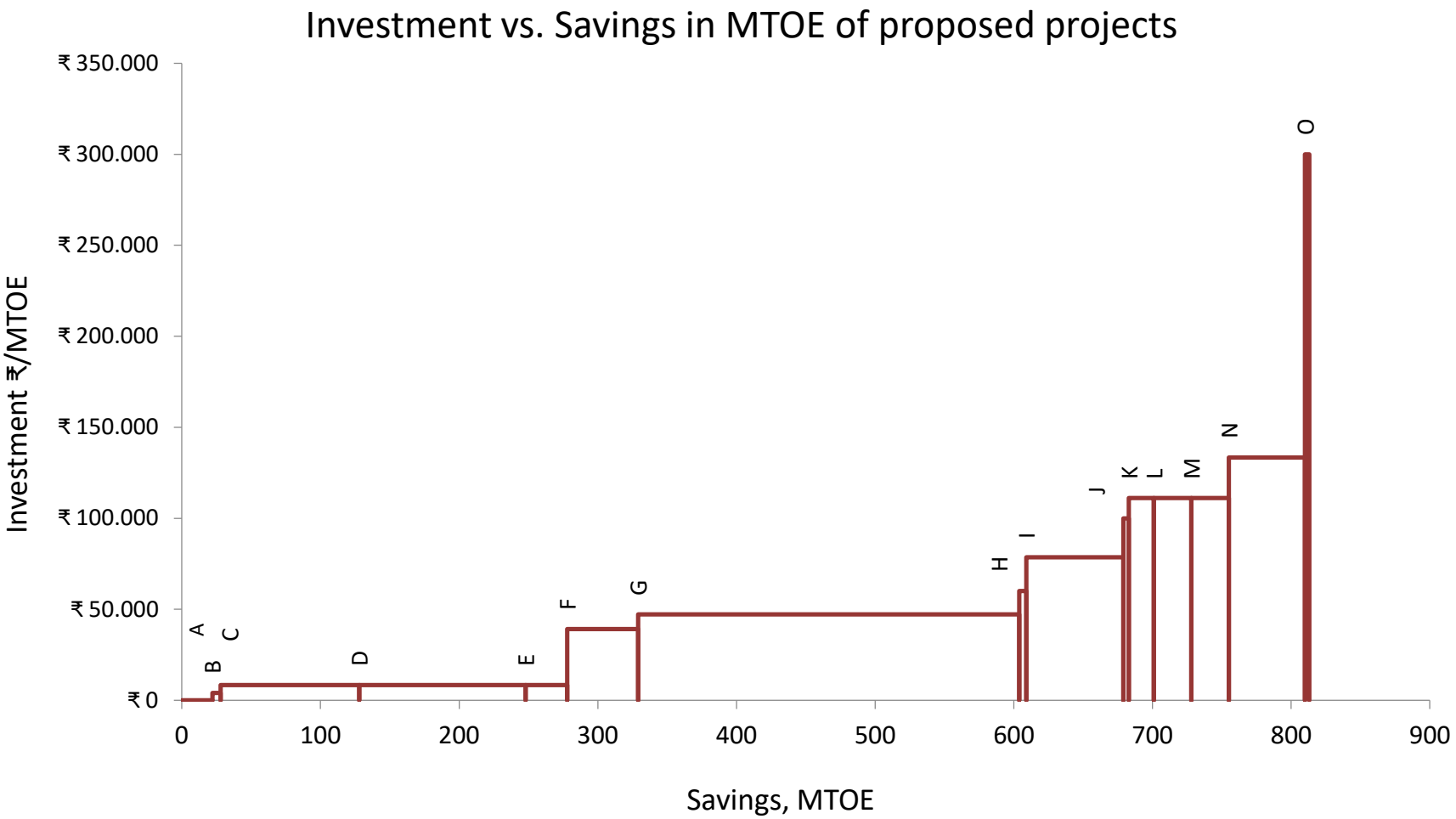






Source: Shakti

Best Practices for EE: Cost Abatement



Source: Shakti

Energy Efficiency in
Micro, Small & Medium Enterprises (MSMEs)

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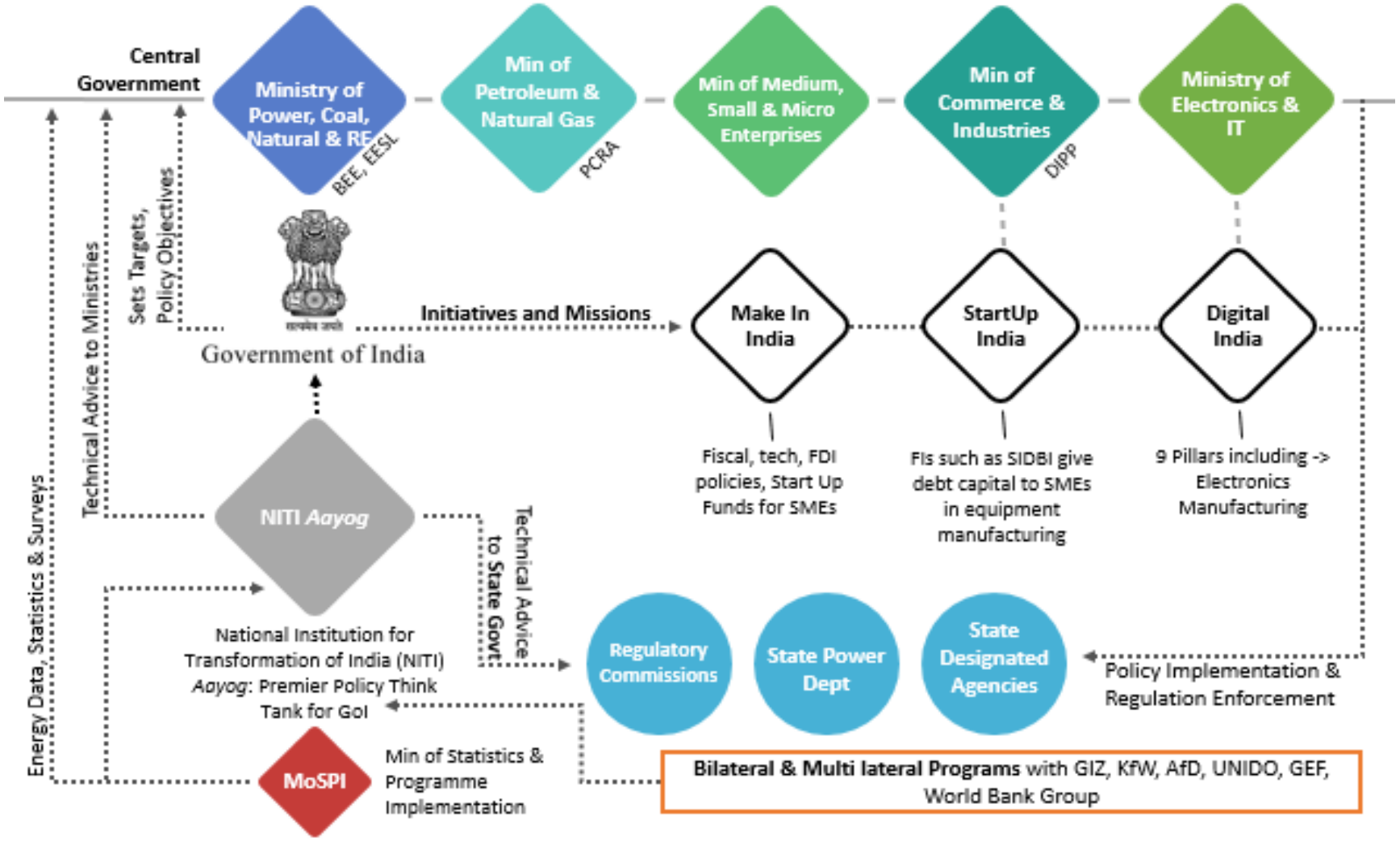
Government of India (GoI): Key Institutions for Small and Medium Enterprises (SMEs)



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Energy Efficiency in MSMEs

MSMEs – backbone of Indian Economy

Over 1157 Industrial Clusters in India comes under MSME

Energy cost alone constitutes 30-40% of production costs in MSMEs

Large energy saving potential in - Foundries, Brass, Textiles, Bricks, Ceramics, Rice Mills and others

Bureau of Energy Efficiency (BEE) selected 35 Clusters and undertook Energy and Technology Audits in 25 clusters (18 Sector Types)

Source: D&B Research and Advisory

BEE's Energy Efficiency in MSMEs - Programme Highlights

1250 Energy Audits Completed. 375 DPRs prepared and peer reviewed

5.6 MTOE total energy consumption in 25 clusters

Energy savings potential 15% i.e., 0.66 MTOE of energy consumption

Total Energy Savings Potential 19.5 Million Euro.

Investment needed 471 Million Euro. Simple Payback 2.4 years and subsidy 25% available for technology upgradation from Ministry of MSME.

Capacity Building of local service providers in 25 SME Clusters and 5 Awareness Workshops.

Limited uptake of EE technologies by SME Units in 25 clusters

Source: BEE

Thrust to EE in MSMEs

BEE has partnered with multilateral financial institutions and bilateral agencies to promote in EE in MSMEs

- Empaneled 12 agencies to support BEE-National programme for energy efficiency in 5 SME Clusters

Created SAMEEKSHA – knowledge sharing website (sameeksha.org) for EE in select25 clusters of MSMEs between various partner agencies, public and private sector.

SIDBI is the financial institution lending for implementation of EE in MSMEs

World Bank, GEF, UNIDO, JICA, KfW, AFD, SDC and others are supporting BEE's EE in MSMEs

EESL is envisioning a retrofit program for SMEs.

SIDBI Energy Efficiency Loans

EE Lending - SIDBI partnership with various multilateral/ bilateral international agencies such as:

- Japan International Cooperation Agency (JICA) - (726 Million Euro in three phases)
- Kreditanstalt fur Wiederaufbau (KfW) (100.8 Milliion Euro), and
- Agence Francaise de Developpement (AFD) - (50.3 Million Euro)

SIDBI has provided loans for various energy efficiency projects using funds JICA, KfW and AFD ranging from EUR 14000 to EUR 2.1 Million .

- 307 MSMEs obtained aggregate term loan of more than 49.3 Million Euro under these LOCs

SIDBI has compiled 50 EE success stories from 20 industrial sectors.

SIDBI implementing EE in 5 energy intensive clusters:

- Foundry, Forging, Limekiln, Chemical cluster & Mixed cluster

GEF-World Bank -SIDBI MSME EE Financing

Timeframe 2010-2014 extended up to 2019

Total Investment 16.67 Million Euro

Payback 12-15 months

10% - 20% Energy Savings

Results – December 2016

- Aggregate EE Investment EUR 13.9 Million achieved.
- 661 IGDPRs prepared
- 600 Energy Auditors trained
- Reached 1500 MSME Entrepreneurs
- Trained 1400 FI sector personnel

UNIDO-GEF - Promoting EE and RE in MSME clusters

Implementers	• BEE, MNRE and MoMSME
Timeline & Funding	• 2011-2016 • EUR 29.6 Million
Project	• Promotion and use of EE and RE • 12 energy intensive Clusters • Brass, Ceramic, Diary, Foundry & Hand tools • Estimated Energy Consumption of 12 clusters - 1.44 MTOE

Project Activities among selected MSME Clusters GEF-UNIDO-BEE Project

- Implemented 6 big and 60 small scale investment projects
- 250 units surveyed in 9 Clusters
- 54 Energy Audits Completed
- 42 DPRs have been prepared, 6 DPRs Implemented
- 27 Best Practices Workshop
- 60 Case Studies Prepared

Other EE Initiatives in MSME

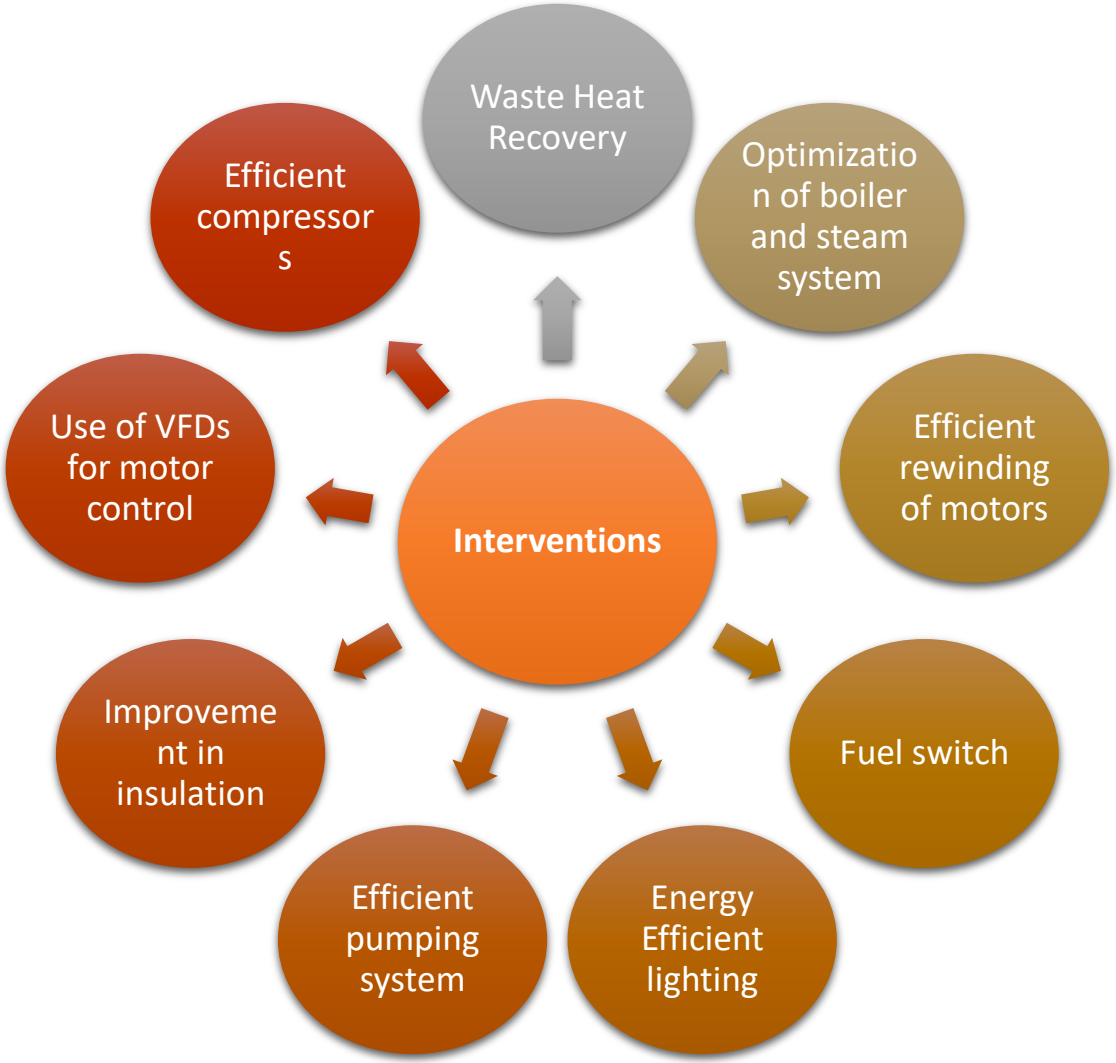
Swiss Agency for Development and Cooperation & TERI

- 100 MSME clusters in India for energy data collation
- Supporting EE Implementation in 3 Foundry Clusters, and two new sectors – aluminium and induction furnaces
- 3 Year project 2014-2017

EESL SME Implementation Plan (SMEIP-E)

- EESL will identify replicable technical interventions and prioritize them
- Identify technology suppliers
- Implement EE measures
- Reduce transaction cost to MSMEs by developing unique financial instruments.

Technical Interventions to increase Energy Efficiency in MSME Sector



COST-BENEFIT ANALYSIS FOR INTERVENTIONS

WASTE HEAT RECOVERY SYSTEM

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Energy Savings (Million toe)	0.265	0.283	0.302	0.323	0.345	0.368	0.393	0.420	0.448
Cost Savings (INR Millions)	7,123	7,606	8,122	8,673	9,263	9,893	10,565	11,284	12,051
Cost (INR Millions)	21,676								

OPTIMIZATION OF BOILER AND STEAM SYSTEM

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Energy Savings (Million toe)	0.073	0.078	0.083	0.089	0.095	0.102	0.108	0.116	0.124
Cost Savings (INR Millions)	413	441	471	503	538	574	613	655	699
Cost (INR Millions)	557								

Cost-Benefit Analysis for Interventions Continued

EFFICIENT REWINDING OF MOTORS

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Energy Savings (Million toe)	0.0030	0.0032	0.0034	0.0036	0.0039	0.0041	0.0044	0.0047	0.0050
Cost Savings (INR Millions)	756	809	864	922	985	1051	1123	1199	1281
Cost (INR Millions)	624								

FUEL SWITCH

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Energy Savings (Million toe)	1.35	1.45	1.54	1.65	1.76	1.88	2.01	2.14	2.29
Cost Savings (INR Millions)	9527	10173	10863	11600	12389	13232	14132	15092	16119
Cost (INR Millions)	24087								

Cost-Benefit Analysis for Interventions Continued

ENERGY EFFICIENT LIGHTING EQUIPMENT

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Energy Savings (Million toe)	0.040	0.043	0.046	0.049	0.052	0.056	0.060	0.064	0.068
Cost Savings (INR Millions)	2879	3078	3288	3509	3747	4002	4274	4565	4875
Cost (INR Millions)	6966								

EFFICIENT PUMPING SYSTEM

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Energy Savings (Million toe)	0.016	0.017	0.018	0.019	0.020	0.022	0.023	0.025	0.026
Cost Savings (INR Millions)	1118	1195	1277	1362	1455	1554	1659	1772	1893
Cost (INR Millions)	874								

Cost-Benefit Analysis for Interventions Continued

IMPROVEMENT IN INSULATION

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Energy Savings (Million toe)	0.314	0.335	0.358	0.382	0.408	0.436	0.466	0.498	0.531
Cost Savings (INR Millions)	12270	13102	13991	14940	15956	17041	18200	19438	20759
Cost (INR Millions)	10517								

VFDS FOR MOTOR CONTROL

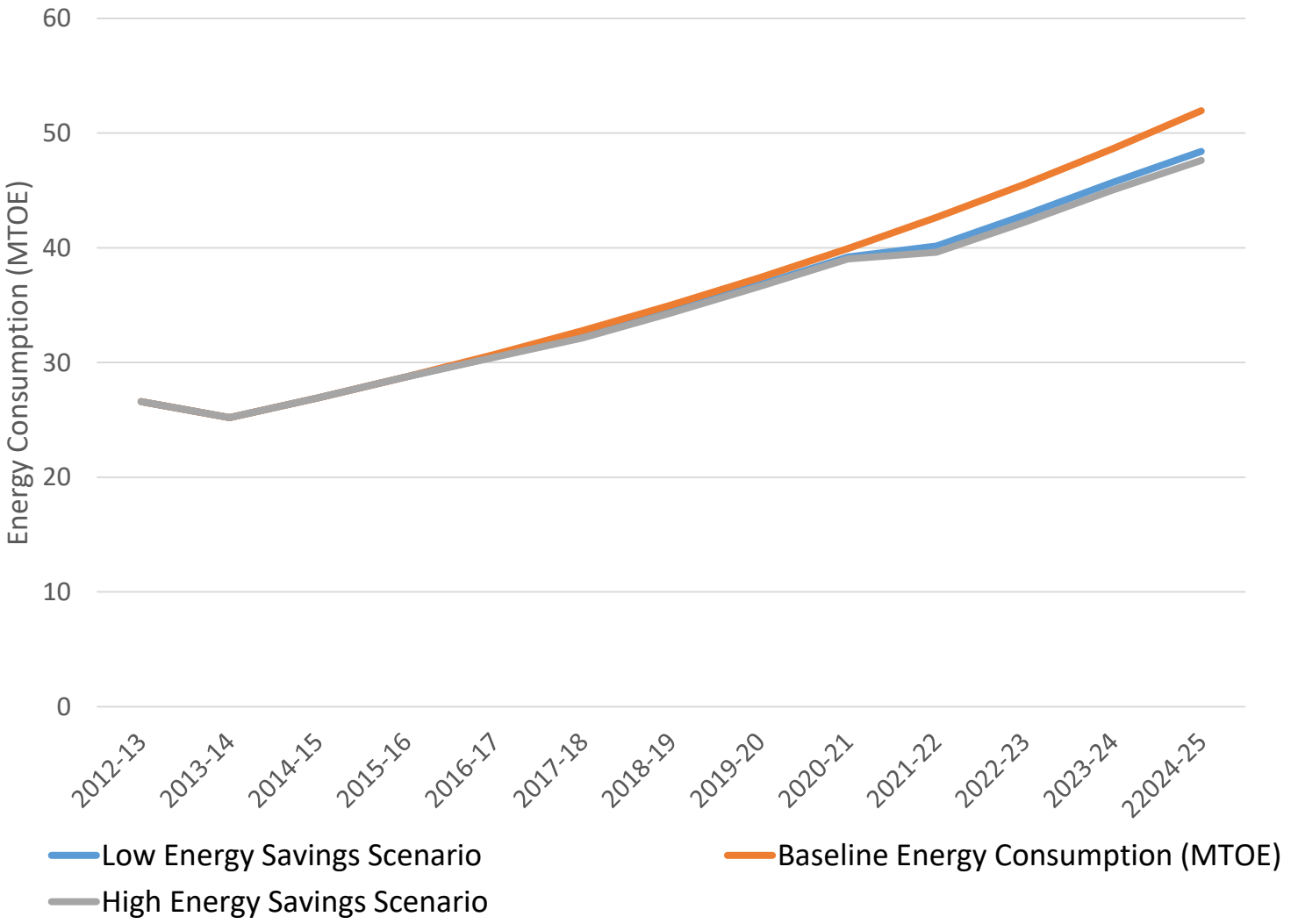
	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Energy Savings (Million toe)	0.23	0.24	0.26	0.28	0.29	0.31	0.34	0.36	0.38
Cost Savings (INR Millions)	16,185	17,304	18,484	19,725	21,066	22,498	24,028	25,662	27,407
Cost (INR Millions)	6584								

Cost-Benefit Analysis for Interventions Continued

EFFICIENT COMPRESSORS

	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25
Energy Savings (Million toe)	0.029	0.031	0.033	0.035	0.038	0.040	0.043	0.046	0.049
Cost Savings (INR Millions)	2073	2216	2367	2526	2698	2881	3077	3287	3510
Cost (INR Millions)	5376								

Energy Efficiency Interventions Impact on Energy Consumption



Barriers to uptake of EE in MSMEs

Finance	• Lack of capital to invest • High transaction cost to shift to EE
Manpower	• Lack of skilled manpower and local sector experts • Lack of suppliers
Information	• Lack of information on EE performance • Wary of new technology and change in production process

Role of ESCOs in Industrial EE and AEEE's Unique Position in it

- Energy Services Companies (ESCOs) can facilitate enhanced energy efficiency in industries. However, the ESCO market in India is still very nascent (<$150 million).
- AEEE is uniquely positioned to enable industries' access to institutional financing for ESCO projects and reduce the inherent trust gap between ESCOs and end users.

AEEE has been closely interacting with 20+ ESCOs that focus on large industries and MSMEs.

Top large industry segments identified	**Chemical/fertilizer, petroleum/refining, paper & pulp, rubber/plastic, iron & steel, food & beverage, textiles, powder metallurgy, dairy, textiles, automobiles, mining, electrical and electronic equipment**
Top ECM categories identified	HVAC, lighting, building automation, drives/pumps/ fans/motors, Boilers/ furnaces/ burners/ waste heat recovery

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Best Technology for Adoption in Large Industries

Cement

Waste Heat Recovery (WHR), Vertical Grinding Mill, VAM

Fertilizer

Feed Stock Change-over, Steam Methane Reformer (SMR)

Pulp & Paper

Black Liquor Recovery, High Pressure Boiler, Double Digestion

Thermal Power Plant

Super Critical Technology, Coal Washeries, Dynamic Coal Balancing

Iron & Steel

Waste Heat Recovery, Coke Dry Quenching, Top Recovery Turbine

Future Energy Saving Opportunities

Bio Tech Textiles

- Improvement of plant varieties used in production of textiles fibres and in fibre properties
- Improvement of fibres derived from animals and health care of the animals
- Novel fibre from biopolymers and genetically modified micro-organisms
- Replacement of harsh and energy demanding chemical treatments by enzymes in textile processing
- Environmentally friendly routes to textile auxiliaries such as dyestuffs
- Novel uses for enzymes in textile finishing
- Development of low energy enzyme based detergents
- New diagnostic tools for detection of adulteration and Quality Control of textiles
- Waste management

Source: Shakti