UPES Centre for Continuing Education

A comparison study on achievement of target set for Industries under Perform Achieve and Trade (PAT) Scheme

By

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CENTRE FOR CONTINUING EDUCATION

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<u>Declaration by the Guide</u>

This is to certify that Mr Sudipan Ghosh, a student of Executive MBA(Power Management), SAP ID 500066422 of UPES has successfully completed this dissertation report on "A comparison study on achievement of targets set for Industries under Perform Achieve and Trade (PAT) scheme" under my supervision.

Further I certify that the work is based on investigation made, data collected and analysed by him and it has not been submitted in any other University or Institution for award of any degree. In my opinion it is fully adequate, in scope and utility, as a dissertation towards partial fulfilment for the award of Executive MBA.

(Hariharan.S)

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EXECUTIVE SUMMARY

PAT is a regulatory instrument to reduce specific energy consumption (SEC) in energy intensive industries, with an associated market-based mechanism to enhance cost effectiveness through certification of excess energy savings, which could be traded. Energy Savings Certificate (ESCerts) are issued to the industries which reduce their SEC beyond their target. Those companies which fail to achieve their target are required to purchase ESCerts for compliance, or are liable to be penalised. Trading of ESCerts are conducted on existing power exchanges.

The scheme is likely to save about 6 to 7 million TOE (tons of oil equivalent) of energy, and the co-benefit would be a reduction of about 25 million Tons of CO2 equivalent. Considering the cost of 1 TOE to be Rs. 10,154 as notified by BEE in 2011-12, the cost of energy saved amounts to rupees 6782 Crores.

This Report comprises of an effort to study and analyze why the Industries not achieving targets set, why Thermal Power Plants are not achieving the set target by PAT citing one of the examples of thermal plant company.

I have also emphasized on the various components responsible for low Plant Load Factor of IPPs, impact of low Plant Load Factor .

CHAPTER 01: INTRODUCTION

1.1 Introduction

National Mission on Enhanced Energy Efficiency

National Mission on Enhanced Energy Efficiency (NMEEE) is one of the eight missions which form India's National Action Plan on Climate Change (NAPCC), formulated in the year 2008.The objective of this mission is to unlock energy efficiency opportunities through market based approach, estimated to be about Rs. 74,000 crores, annual fuel savings in excess of 23 million toe by 2014-15 and cumulative avoided electricity capacity addition of 19,000 MW.

BEE under Ministry of Power has implemented PAT Scheme a component under NMEEE in India. Perform Achieve and Trade (PAT) is an innovative policy mandated, market based mechanism launched in 2012, designed to accelerate energy savings in energy intensive and large industries by incentivizing energy savings. Overachievement above the assigned targets will result in tradable ES Certs, whereas under-achievers have to comply by purchase of ES certs or by paying a penalty. The scheme covers 392 designated consumers from 13 energy intensive sectors. In the Target achieve/ reduction phases the designated consumers under take measures to reduce their specific energy consumption by developing action plans.

PAT developed in response to government commitment in 2008 National Action Plan on climate change that as a part of National Mission on Enhanced energy efficiency

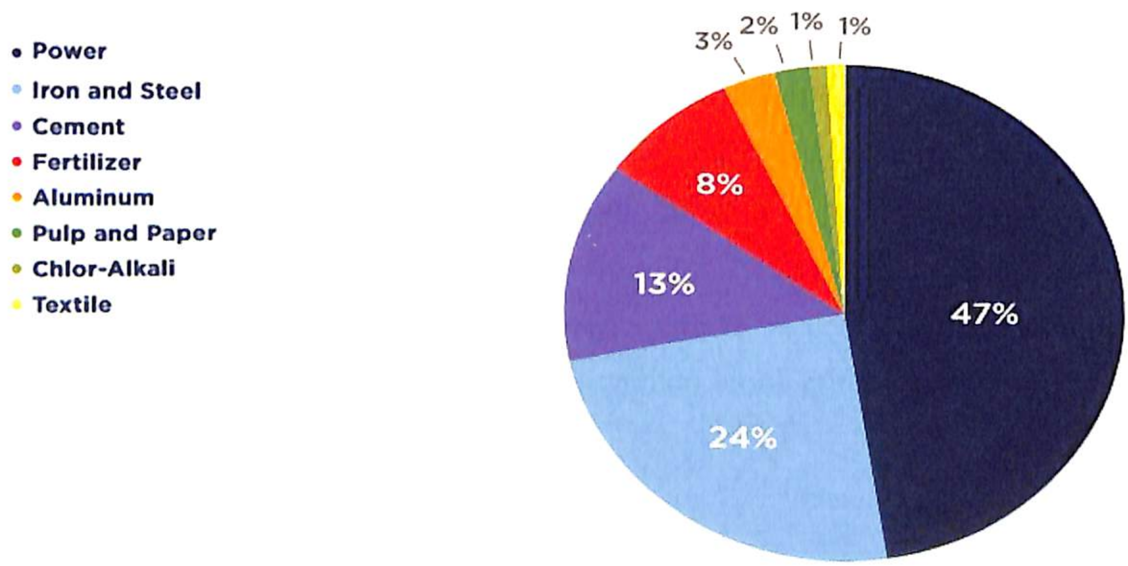


Fig .01: Share of Potential Energy Savings by sector in Million Tons of Oil Equivalent

Parameter	Units	Values
Number of DCs in the sector	nos	478
Total energy consumption of DCs in the sector	million TOE	164.97
Total energy saving target for DCs in PAT Cycle I		6.68
Total energy savings achieved in PAT Cycle I		8.67
Avoided emissions in PAT Cycle – I	million T CO_2 equivalent	31
Estimated Cumulative energy savings with impact of PAT till 2030 over BAU[1]	million TOE	165.23

Fig .02: Brief achievement of PAT

The PAT Scheme is a unique policy instrument and stands out from the pool of several ongoing initiatives across the globe targeted at emissions reduction. The uniqueness of the scheme lies in the overall objective of improving the efficiency of the production process to achieve the ultimate target of energy savings. This approach towards energy saving is a major digression from emission reduction directives followed in several developed and developing economies which, in general, aim at reduction in absolute number of emission/(fuel) consumption units. Thus, the reduction in energy consumption once achieved through PAT will be far more realistic (pointing towards a more efficient and less energy intensive economy) than those reported through other methodologies where absolute reduction of emission units may be influenced by commercial and/or political factors.

1.2 Overview

On 30th March, 2012 energy saving targets for 478 designated consumers belonging to 8 sectors were notified. In the first cycle of PAT (ending in year 2014-15), 478 industrial units in 8 sectors (Aluminium, Cement, Chlor- Alkali, Fertilizer, Iron & Steel, Paper & Pulp, Thermal Power, Textile) have been mandated to reduce their specific energy consumption (SEC) i.e. energy used per unit of production by March,2015. Overall, the SEC reduction targets aim to secure 4.05% reduction in the SEC in these industries totalling an energy saving of 6.686 million tonne of oil equivalent which would account for mitigation of about 24 million tons of CO2.

Sector Specific proforma along with Sector Specific Normalization Factors to streamline the monitoring and verification (M&V) process has been prepared. The sector/ sub-sector specific Normalization Factors were developed to neutralize the effects on specific energy consumption (SEC) in the assessment year as well as baseline year so that undue advantages or disadvantages could not be imposed on any Discoms while assessing the targets. To facilitate the M&V process, M&V guidelines for all the 8 sectors have been developed. BEE has put in place a process of accreditation of Energy Auditors who will be engaged to execute the M&V process of DCs to assess their performances. Development of Energy Saving Certificates (EScerts) trading infrastructure is in process in collaboration with Central Electricity Regulatory Commission (CERC).

Documents on "Pro-forma and Normalization Equation" and "Normalization Document and Monitoring and Verification Guidelines" have been prepared to facilitate the effective implementation of the scheme and copies of same have been provided to all Designated Consumers, Accredited Energy Auditors and State Designated Agencies. The Draft Rules/Regulations for trading of energy savings certificate has been finalized and submitted for getting concurrence of CERC for finalization and Notification. For Development of Repository of trading platform, POSOCO has been identified as repository of ESCerts Trading. PATNET, an online platform for data reporting, trading of ESCerts, etc. is operational.

PAT "Deepening" process has already been initiated to include more DCs while keeping the same threshold and in some sectors such as Iron and Steel and Pulp and Paper by reducing the threshold so that more and more industrial units participate in the energy enhancement scheme. Similarly, "Widening" of the PAT i.e. inclusion of more sector in thePAT fold has also been initiated. Presently, refinery, Electricity DISCOMs, and Railways are under consideration for including in the PAT cycle II. PAT is visualized as a multi-cycle scheme aimed towards raising the efficiency of economy to a higher level.

PAT cycle I was completed on 31stMarch, 2015. From 1st April, 2015 to 14thAugust, 2015 was the M&V phase. The verification of the performance of DCs was carried out by Accredited Energy Auditing

Firms. Currently scrutiny of performance assessment documents (PADs) is under process by State Designated Agencies (SDAs) and by Bureau of Energy Efficiency (BEE). After the scrutiny by BEE and on the recommendation of BEE, the Central Government will issue ESCerts which can be traded at Power Exchanges.

When compared to the baseline energy consumption at the beginning of PAT scheme, the energy efficiency measures have resulted in a savings of around 6% till 2010. n next three years (2016-17,2017-18 and 2018-19), the industrial energy savings are targeted to reach 10% through widening of PAT scheme to new sectors as well as increasing the penetration within the current sectors. In addition, guidelines for mandatory disclosures on energy consumption by companies, under the Companies Act will help in achieving the 10% targets.

As per Guidelines on Energy and Energy Conservation Reporting in Annual Reports of companies, all firms, registered under the Companies Act, are mandated to disclose their annual energy consumption and energy conservation initiatives through the company's annual report. With the appropriate guidelines in place, the scope and nature of data provided, including energy and energy conservation data, will be more streamlined and robust. This will also encourage companies to undertake energy audits, identify energy intensive areas within the firm as well as formulate energy efficiency measures to improve energy savings.

Outreach activities to consult with designated consumers and technology providers including knowledge exchange platform to share experiences within and between sectors.

1.3 Performance Parameters

The performance factor for different energy intensive sectors can be expressed through some common performance factors given below

- For Industries: Specific energy consumption means ratio of the net energy input into the boundary of designated consumers of Aluminium, Cement, Chlor-Alkali, Fertilizer, Iron and Steel, Pulp and Paper and Textile industries, to the total output of equivalent major product produced in the respective designated consumers' boundary, calculated as per the following formula, namely:-

Specific Energy Consumption(metric tonne of oil equivalent (toe)/per unit of equivalent product)=

$$\frac{\text{Net energy input into the designated consumers' boundary}}{\text{Total output of equivalent major product produced in the designated consumers' boundary}}$$

- For Thermal Power Stations: Specific energy consumption or Net Heat Rate in relation to thermal power stations or Plants means the ratio of net energy input in to the designated consumers' boundary in terms of kilo calorie (kcal) to the net generation in terms of kilo Watt hour (kWh) on bus bar taking in to account the effect of the auxiliary power consumption (APC) and expressed in terms of kcal per kWh, calculated as per the following formula, namely: -

  Net Heat Rate=Gross heat Rate/[1-APC(%)]

  Where:

  Gross Heat Rate is the ratio of net energy input in kcal to gross generation in kWh;

  Auxiliary power consumption (APC) of thermal power stations/plant excluding energy consumption in percentage of colony.

- For petroleum refineries sector: Specific energy consumption for petroleum refinery sector shall be measured in MBN which means net energy and loss of the plant calculated in Million British Thermal Unit (MMBTU) per one thousand barrels (Mbbls) per Energy factor (NRGF) and expressed by the following formula, namely:-

  MBN = MMBTU / Mbbls / NRGF

  Where:

MMBTU: Net Energy and loss of the petroleum refinery unit calculated in MMBTU (Million British Thermal Units)

Mbbls : Crude processed in thousand barrels

NRGF : The NRG factor (NRGF) is the indicator of the level of complexity of a refinery and overall energy factor (dimensionless unit) calculated for the refinery based on the volume of feed in each unit and its corresponding energy factor.

- For railways sector:

(a) zonal railways: Specific energy consumption for zonal railways in passenger services and goods services are expressed as below:

(1) for diesel traction: Specific energy consumption is the ratio of diesel consumption in litre per thousand of gross tonne kilometrage and shall be expressed as following:

"Litre/1000GTKm"

(2) for electrical traction: Specific energy consumption is the ratio of electrical energy consumption in kWh per thousand of gross tonne kilometrage and shall be expressed as following:

"kWh/ 1000GTKm"

(b) production units: Specific energy consumption is the ratio of kilo gram of oil equivalent (KgOE) to the number of equivalent units produced and shall be taken in terms of KgOE /number of equivalent units produced and shall be expressed in the following formula, namely: -

SEC=Total energy consumption in Kg of oil equivalent (KgOE) /Total number of equivalent product produced

- For DISCOM sector: Transmission and distribution loss in percentage shall be used to assess energy performance of electricity distribution companies and calculated as per the following formula, namely:-

Transmission and distribution loss (%) = (1-(Total energy billed/Net input energy)*100)

Where:

- Total energy billed (Million kWh) is the Net energy billed (adjusted for energy traded)
- Net input energy (Million kWh) is the energy received at distribution periphery after adjusting the transmission losses and energy traded.

- For commercial building or establishments: Specific energy consumption for building means the annual energy consumption expressed in terms of tonne of oil equivalent per thousand square meter of the area wherein energy is used and includes the location of buildings and shall be expressed by the following formula, namely:-

  SEC(toe / thousand square meter)=

$$\frac{\text{Annual energy consumption in tonne of oil equivalent (toe)}}{\text{Total built} - \text{up area excluding parking and storage (thousand square per meter)}}$$

Where:

-storage is defined as storage of waste items.

- For petrochemical sector: Specific energy consumption is measured in net energy consumed in cracker unit and secondary units producing olefin products only per total equivalent production of olefin products and expressed in terms of the metric tonne of oil equivalent (toe)per unit of equivalent product

SEC = Net energy consumed (toe)/ Equivalent quantity of olefin products produced in tonne

1.4 Current Scenario

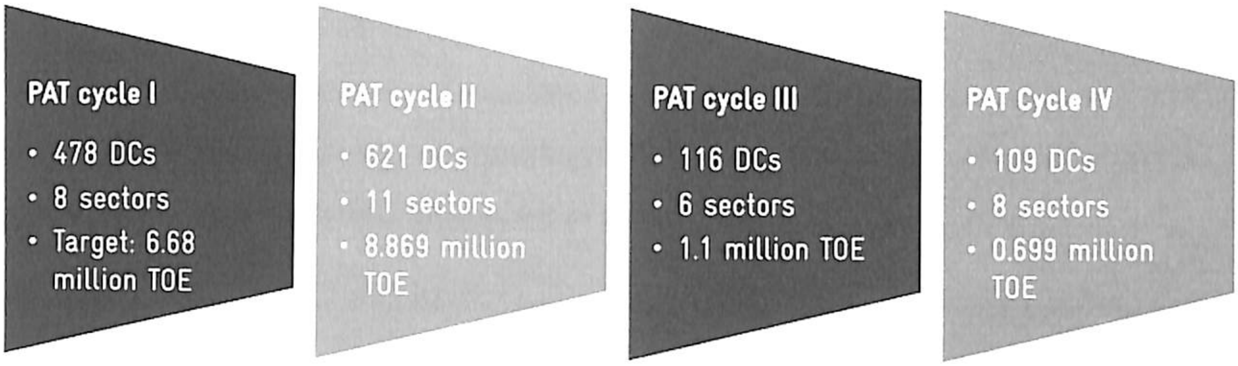


Fig .03: Developments of PAT cycles

Designated Consumer in PAT cycle

Speaking at an event to report the savings accrued under the first cycle, Minister for Power and Renewable Energy, R K Singh said that PAT-1 has overshot it's targeted energy savings by 30 per cent.

He said, "The reported overall achievement for PAT - 1 is 8.67 million tonne of oil equivalent. This exceeds the 6.867 million tonne of oil equivalent (mtoe) target for cycle 1 by 30 per cent."

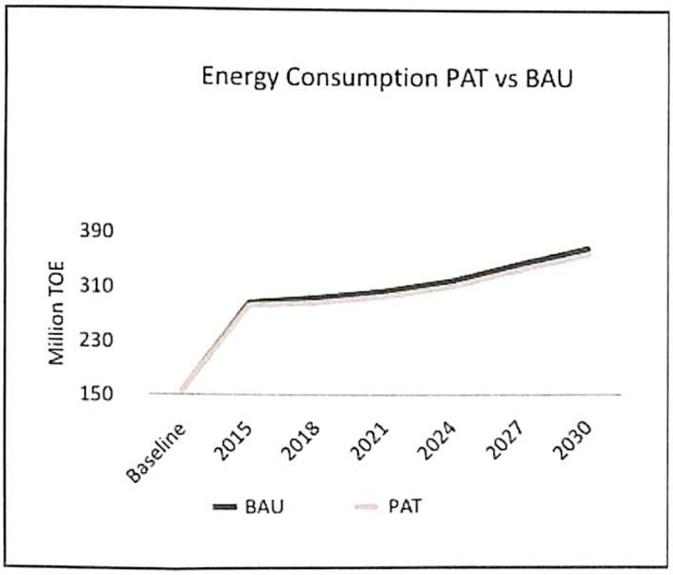
"We will be achieving a total saving of 19 mtoe in the next two PAT cycles," Singh added.

According to the outcome and way forward report, the pulp and paper industry has reported the highest over-achievement at 143 per cent with a saving of 0.29 mtoe. The iron and steel industry has reported a saving of 2.10 mtoe which is a 41 per cent achievement above the target.

The only laggard in the eight sectors chosen for the scheme is the thermal power plant sector. Despite having the highest energy saving at 3.06 mtoe, the sector has missed the targets set for it by 5 per cent.

India is ranked 5th globally, in overall power generation capacity and 3rd in overall generation. With a minimum energy consumption threshold of 30,000 TOE, 144 Thermal Power Plants in India were notified as Designated Consumers under PAT cycle-I. Against a total saving target of 3.21 million TOE, the sector achieved 3.06 million TOE of energy savings, thereby saving 13.64 million tonnes of CO2. However, the achievement of 3.06 million TOE relates to only 120 DCs who carried out the Monitoring

& Verification (M&V) exercise and submitted the same to BEE. The target of these 120 DCs corresponds to 2.58 million TOE. The energy consumption till the year 2030, under scenarios with PAT and business as usual, has been projected for this sector as shown below:



Through subsequent PAT cycles by 2030 the cumulative energy savings possible in Thermal power plant Sector is 45.45 million TOE

Fig .04: Energy consumption till the year 2030

Sl No.	DC Registration No.	DC Name	Status of registration
1	ALM0002OR	Vedanta Aluminium Ltd, Lanjigarh, Kalahandi, Odisha	Under Process
2	CNA0015PB	Punjab Alkalies & Chemicals Limited, Naya Nangal, Ropar	Under Process
3	FTZ0029KL	FACT Udyogmandal(Ammonia)*The Fertilizers and ChemicalsTravancore Limited ,Udyogamandal, Kerala	Under Process
4	INS0021CG	S.K.Sarawagi & Corp. Private Limited, Raipur, Chhattisgarh	Under Process
5	PNP0015AS	Nagaon Paper Mill, Jagiroad, Assam	Under Process
6	PNP0020KL	Hindustan Newsprint Limited, Kottayam, Kerala	Under Process
7	TXT0053MH	Priyadarshini Sahakari Sootgirni, Shirpur, Dhule, Maharashtra	Under Process
8	FTZ0020RJ	CFCL Gadepan-I Chambal Fertilisers and Chemicals Limited	10-04-2019
9	FTZ0023RJ	CFCL Gadepan-II Chambal Fertilisers and Chemicals Limited	10-04-2019
10	CMT0032TS	Orient Cement Limited, Devapur, Adilabad, Telangana	01-03-2019
11	CNA0019AP	TGV SRAAC Limited, Gondiparla, Kurnool Andhra Pradesh-518004	24-01-2019
12	CMT0021TN	The Ramco Cements Limited Alathiyur Works, Cement Nagar, Sendurai, Ariyalur, Pondichery, Chennai, Tamil Nadu	15-01-2019
13	TPP0042GJ	Gujarat State Energy Generation Limited, Mora, Bhatha, Surat, Gujarat	15-01-2019
14	TXT0064RJ	Ronak Processors (P) Limited, Bhilwara, Rajasthan	19-12-2018
15	CMT0069GJ	Tata Chemicals Limited, Mithapur, Jamanagar, Gujarat	09-10-2018
16	CNA0018PB	SIEL Chemical Complex (A Unit of Mawana Sugars Ltd) Village Khadauli, Sardargarh P. B No 52 Rajpura Distt:Patiala Punjab	25-05-2018
17	PNP0014HR	Ballarpur Industries Limited, Unit: Shree Gopal -BILT, Yamunanagar, Haryana	27-03-2018
18	INS0018CG	Rashmi Sponge Iron & Power Industries Limited (RSIPIL) Siltara, Raipur, Chhattisgarh	05-03-2018
19	PNP0008AP	International Paper APPM Limited Rajahmundry, Andhra Pradesh	05-03-2018

20	INS0052MH	M/s. Uttam Value Steels Limited, Lloydsnagar, Wardha, Maharashtra	22-02-2018
21	TPP0011AP	Spectrum Power Generation Limited, East Godavari, Kakinada, Andhra Pradesh	05-02-2018
22	TXT0051GJ	PBM Polytex Limited, Petlad, Anand, Gujarat	02-02-2018
23	INS0026CG	M/s. Topworth Steels and power private Limited, Rasmada, Durg, Chhattisgarh	25-01-2018
24	CNA0001JH	Grasim Industries Limited, Chemical Division Rehla, Ghanshyamkunj, PO : Rehla, Dist. Palamau, 822124, Jharkhand.	19-01-2018
25	INS0046CG	Jayaswal Neco Industries Limited, Siltara, Raipur, Chhattisgarh	18-01-2018
26	CMT0015MP	Jaiprakash Associated Limited, Jaypee Rewa Plant Jaypee Nagar-486450. District Rewa, (MP) India	16-01-2018
27	TPP0140WB	NTPC Ltd -Farakka, Murshidabad Dist, West Bengal	16-01-2018
28	TXT0031MH	Indo Count Industries Limited, Gokil Shirgaon, Kolhapur, Maharashtra	16-01-2018
29	CNA0014GJ	Meghmani Finechem Ltd., CH-1, CH-2; Dahej Industrial Estate, Dahej, Vagra, Bharuch	15-01-2018
30	CNA0016GJ	Reliance Industries Limited, Manufacturing Division, Dahej, Vagra, Bharuch	15-01-2018
31	INS0027CG	Crest Steel & Power Private Limited, Joratari, Rajnandgaon, Chhattisgarh	15-01-2018
32	INS0044OR	Neelachal ISPAT Nigam Limited Kalinga Nagar Industrial Complex, Duburi, Jajpur, Odisha	15-01-2018
33	INS0066KA	SAIL Visvesvaraya Iron and Steel Plant Bhadravathi, Shimoga, Karnataka	15-01-2018
34	TPP0063KL	BSES Kerala Power Limited, Udyogamandal, Kochi, Kerala	15-01-2018
35	TPP0107TN	NLC India Limited Thermal Power Station-2 Neyveli Cuddalore, Tamil Nadu	15-01-2018
36	TXT0036GJ	Kumar Cotton Mills Private Limited, Narol, Ahmedabad, Gujarat	15-01-2018
37	TXT0055RJ	Ranjan Polysters Limited, Guwardi, Bhilwara Rajasthan	15-01-2018
38	FTZ0005PB	National Fertilizers Limited Nangal, Naya Nangal, Distt. Ropar Punjab Pincode-140126	12-01-2018
39	TPP0120UP	Anpara Thermal Power Station, Uttar Pradesh Rajya Vidyut Utpadan Nigam	12-01-2018

		Limited (UPRVUNL), Sonebhadra, Uttar Pradesh	
40	FTZ0004PB	National Fertilizers Limited, Punjab	09-01-2018
41	TPP0037GJ	Kutch (Lignite) Thermal Power Station, Gujarat State Electricity Corp. Ltd., Lakhpat, Kutch, Gujarat	08-01-2018
42	CMT0066GJ	Gujarat Sidhee cement Ltd., Junagarh Sidheegram Veraval-Kodinar Highway , Junagarh, Gujarat	05-01-2018
43	TXT0018KA	Bombay Rayon Fashions Limited, Doddaballa pura Area, Banglore Karnataka	05-01-2018
44	TXT0045MH	Morarjee Textiles Limited, Butibori, Nagpur, Maharashtra	05-01-2018
45	TXT0060MH	Raymond Luxury Cottons Limited, Sangaon, Kolhapur, Maharashtra	05-01-2018
46	CMT0079RJ	JK White Cement Works(A Unit of JK Cement Limited) Gotan, Nagaur Rajasthan	03-01-2018
47	CMT0082RJ	Shriram Cement Works(A Division of DCM Shriram Limited) Kota, Rajasthan	03-01-2018
48	CNA0022GJ	UPL Limited. 750 G.I.D.C., Jhagadia, Bharuch, 393110, Gujarat	03-01-2018
49	CMT0043CG	Century Cement (Prop: Century Textiles and Industries Ltd.)	02-01-2018
50	CNA0005RJ	Shriram Vinyl & Chemical Industries (A Division of DCM Shriram Limited) Chlor Alkali Plant, Shriram Nagar, Kota-324004 Rajasthan	22-12-2017
51	CNA0006TN	DCW Limited, Sahupuram, Tutucorin	22-12-2017
52	FTZ0012RJ	Shriram Fertilisers & Chemicals (A Division of DCM Shriram Limited) Kota Plant, Shriram Nagar, Kota-324004 Rajasthan	22-12-2017
53	TPP0008TS	Ramagundam Thermal Power Station-(Telangana Power Generation Corporation Limited)Karim Nagar, Telangana	22-12-2017
54	TPP0130UP	Panki Thermal Power Station-Uttar Pradesh Rajya Vidyut Utpadan nigam Limited(UPRVNL) Kanpur, Uttar Pradesh	22-12-2017
55	TXT0008PB	Arihant Spinning Mills (A unit of Vardhman TextilesLimited) Mlerkotla, Punjab	22-12-2017
56	TXT0088PB	Vardhman Yarns and Threads Ltd-Unit -1, Hoshiarpur, Punjab	22-12-2017
57	FTZ0003HR	NFL , Panipat, Haryana	21-12-2017
58	FTZ0010MP	NFL, Vijaipur - II, Vijaipur, Guna, Madhya Pradesh	21-12-2017

59	TXT0009HP	Arisht Spinning Mills(A unit of Vardhman Textiles Limited)	21-12-2017
60	CMT0010MP	Maihar Cement Unit-2 (Unit- Century Textile and Industries Limited) Satna, Madhya Pradesh	20-12-2017
61	CNA0017GJ	DCM Shriram Ltd.(Unit: Shriram Alkali & Chemicals), Plot No. 749, GIDC Industrial Estate, Jhagadia - 393110, Distt. Bharuch, Gujarat	20-12-2017
62	CNA0021KL	The Travancore Cochin Chemicals Limited, PB No-2, Udyogamandal, Kochi 683501, Kerala	20-12-2017
63	TPP0105TN	Neyveli Thermal Power Station-I (Expansion),NLC India Limited, Neyveli, Tamil Nadu	20-12-2017
64	CMT0019RJ	Shree Cement Limited, Bangur Nagar, Beawar, Ajmer, Rajasthan	18-12-2017
65	FTZ0009MP	NFL, Vijaipur - I, Vijaipur, Guna, Madhya Pradesh	18-12-2017
66	INS0050MH	Bhushan Steel Limited, Raigarh, Maharashtra	15-12-2017
67	INS0064CG	SKS ISPAT & Power Limited, Raipur, Chhasttisgarh	15-12-2017
68	TXT0038TN	Loyal Textile Mills Limited, Kovilpatti,Tamil Nadu	15-12-2017
69	TXT0084TN	Valli Textile Mills, A unit of Loyal Textile Mills Limited, Venkateshwara Puram, Post-Sathur, Tamil Nadu	15-12-2017
70	INS0051UP	Bhushan Steel Limited, Sahibabad, Uttar pradesh	14-12-2017
71	TPP0119TR	Rokhia Gas Thermal Power Plant, Rokhia, Sonamura, Tripura	14-12-2017
72	INS0036OR	Jindal Stainless Limited	13-12-2017
73	PNP0010TN	Seshasayee Paper and Boards Limited Pallipalayam, Erode, Tamil Nadu	13-12-2017
74	TPP0015AS	Namrup Thermal Power Station, APGCL, NTPS , Namrup Dibrugarh, Assam	13-12-2017
75	TPP0019CG	Dr. Shyamaprasad Mukharjee Thermal Power Station Korba CSPGCL, Korba, Chhattisgarh	13-12-2017
76	TPP0033GJ	Dhuvaran CCPP , Anand Khambhat, Anand, Gujarat	13-12-2017
77	TXT0080RJ	Swastika Suitings Ltd, 7-14 industrial Area, Bhilwara, Rajasthan	13-12-2017

78	CMT0034RJ	Birla Corporation Limited-Chanderia Cement Works, Madhav Nagar, Chanderia, Chittorgarh, Rajasthan	11-12-2017
79	FTZ0006GJ	GNFC ,Bharuch, Gujarat	11-12-2017
80	INS0017GA	Ambey Metallic Private Limited, Pissurlem, Sattari, Goa	11-12-2017
81	TXT0083RJ	SANWARIYAJI TEXFAB INDUSTRIES LIMITED, 11/12 km, Guwardi, Bhilwara, Rajasthan	11-12-2017
82	CMT0045MP	Maihar Cement (Unit-Cement Century Textile and Industries Limited) Sarlangar Maihar, Satna, Madhya Pradesh	08-12-2017
83	INS0007WB	Durgapur Steel Plant, SAIL, Durgapur, Burdwan, West Bengal	08-12-2017
84	INS0060OR	Aarti Steels Limited	08-12-2017
85	TPP0057KA	Ballary Thermal Power Station-Karnataka Power Corporation Ltd (KPCL) Limited	08-12-2017
86	TPP0086PY	Puducherry Gas Power Plant (Puducherry Power Corporation Ltd.), Puducherry	08-12-2017
87	TXT0025HR	DCM Textiles(A Division of DCM Limited)	08-12-2017
88	INS0008KA	JSW STEEL LIMITED, Vijayanagar Works, PO Vidyanagar, Village : Toranagallu District : Bellary PIN : 583275 , Karnataka (India)	06-12-2017
89	TPP0012AP	Vijaywada (Dr. Narla Tata Rao) Thermal Power Station, Ibrahimpatnam, Krishna Dist., Andhra Pradesh	06-12-2017
90	TXT0005GJ	Alok Industry VAPI (Integrated Textile Solution)- Alok Industry Limited	06-12-2017
91	TPP0058KA	Raichur Thermal Power Station, (Karnataka Power Corp. Ltd.), Shakti Nagar, Raichur, Karnataka	04-12-2017
92	TXT0013HP	Auro Spinning Mills (A Unit of Vardhman Textiles Limited), Nalagadh, Solan, Himachal Pradesh	04-12-2017
93	TPP0020CG	Hasdeo Thermal Power Station Korba (West), CSPGCL, Korba West, Darri, Korba, Chhattisgarh	01-12-2017
94	TXT0006MP	Anant Spinning Mills (a Unit of Vardhman Textiles Limited), Mandideep, Raisen, Madhya Pradesh	01-12-2017
95	INS0038CG	MSP Steel & Power Limited, Raigarh, Chhattisgarh	30-11-2017

96	TPP0013AS	Kathalguri Gas Based Power Plant , AGBP, NEEPCO Ltd, Bokuloni Chariali, Dibrugarh, Assam	30-11-2017
97	TPP0014AS	Lakwa Thermal Power Station-Assam Power Generation Corporation Limited (APGCL)	30-11-2017
98	TPP0022CG	Korba Thermal Power Station, Korba (East)-Chhattisgarh State Power Generation Company Limited (CSPGCL) Station-1	30-11-2017
99	TPP0043GJ	Surat Lignite Power Plant (Gujarat Industries Power Company Ltd.), Nani Naroli, Mangrol, Surat, Gujarat	30-11-2017
100	TPP0102TN	malco energy limited	30-11-2017
101	TPP0117TR	Agartala Gas Turbine Power Plant, NEEPCO, Agartala, Tripura	30-11-2017
102	TPP0121UP	Harduaganj Thermal Power Station-Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited (UPRVUNL)	30-11-2017
103	TXT0029KA	Gokak Textiles Limited, Gokak Mills Division, Gokak Falls, Dist. Belgaum, Karnataka- 591308	30-11-2017
104	TXT0058MP	Raymond Limited (Textile Division), Bore gaon, Chhindwara, Madhya Pradesh	30-11-2017
105	TXT0062PB	Rishab Spinning Mills Jodhan, VPO-Jodhan, Ludhiana, Punjab	30-11-2017
106	CMT0013HP	ACC Ltd. (Gagal Cement Works -I), Bilaspur, Himachal Pradesh	24-11-2017
107	CMT0014HP	ACC Ltd. (Gagal Cement Works -II), Bilaspur, Himachal Pradesh	24-11-2017
108	CMT0030RJ	Birla Corporation Limited - Birla Cement Works Madhav Nagar, Chanderia, Chittorgarh, Rajasthan	24-11-2017
109	CMT0044KA	ACC Limited (Wadi Cement Works) Wadi, Gulbarga, Karnataka	24-11-2017
110	CMT0057RJ	UltraTech Nathdwara Cement Limited, Tehsil-Pindwara, Sirohi, Rajasthan	24-11-2017
111	CMT0077CG	ACC Limited (Jamul Cement Works), District Durg, Chhattisgarh	24-11-2017
112	CNA0003PY	Chemplast Sanmar Limited, Melavanjore, Karaikal Region, U.T. of Puducherry	24-11-2017
113	FTZ0008GJ	KRIBHCO Hazira, Dist Surat , Gujarat	24-11-2017
114	INS0039ML	Shyam Century Ferrous Limited, Ribhoi, Meghalaya	24-11-2017
115	INS0048OR	VISA Steel Limited, Kalinganagar, Odisha	24-11-2017
116	PNP0029AP	Delta Paper Mills Limited, Vendra, West Godavari Dist, Andhra Pradesh	24-11-2017

117	TPP0045GJ	Utran Gas Based Power Station (Gujarat State Electricity Corp.) GSECL, Utran, Gujarat	24-11-2017
118	TPP0065KL	Kozhikode Diesel Power Project-Kerala State Electricity Board Limited (KSEBL)	24-11-2017
119	TPP0092RJ	KOTA super thermal power station-rajasthan rajya vidyut utpadan nigam limited(rrvunl)	24-11-2017
120	TPP0129UP	OBRA Thermal Power Station-Uttar Pradesh Vidyut Utpadan Nigam Limited (UPRVUNL)'	24-11-2017
121	INS0001GJ	Essar Steel India Limited, 27th KM , Surat-Hazira Road, Hazira, Surat, Gujarat-394270	23-11-2017
122	CMT0076OR	ACC Limited (Bargarh Cement Works), Bardol, Bargarh, Odisha	17-11-2017
123	CMT0081TN	ACC Ltd. (Madukkari Cement Works), Madukkari, Coimbatore, Tamil Nadu	17-11-2017
124	FTZ0014GJ	Gujarat State Fertilizers & Chemicals Limited (GSFC), P.O. Fertilizernagar, Dist. Vadodara, Gujarat, India	17-11-2017
125	INS0005CG	Bhilai Steel Plant, SAIL, Bhilai, Chhattisgarh	17-11-2017
126	TPP0017BR	NTPC Ltd- Kahalgaon, Kahalgaon, STPS, Bhagalpur, Bihar	17-11-2017
127	TPP0039GJ	NTPC Ltd - Kawas , Aditya Nagar, Kawas, Surat, Gujarat	17-11-2017
128	TPP0090RJ	Dholpur combined cycle power station-rajasthan rajya vidyut utpadan nigam limited(rrvunl)	17-11-2017
129	TPP0093RJ	NTPC Ltd - Anta, Baran, Rajasthan	17-11-2017
130	TPP0095RJ	Ramgarh Gas Thermal Power-Rajasthan Rajya Vidyut Utpadan Nigam Limited (RRVUNL)	17-11-2017
131	TPP0096RJ	SURATGARH SUPER THERMAL POWER-RAJASTHAN rajya vidyut utpadan nigam limited(rrvunl)	17-11-2017
132	TPP0116TN	Valuthur Gas Turbine Power Station Ramanathapuram, Tamil Nadu	17-11-2017
133	TPP0128UP	NTPC Ltd- Unchahar (Feroze Gandhi Thermal Power Project), Raibareli, Uttar Pradesh	17-11-2017
134	TPP0131UP	Parichha Thermal Power Station, Uttar Pradesh Rajya Vidyut Utpadan Nigam Limited (UPRVUNL)	17-11-2017
135	TXT0050RJ	Orient Syntex (Prop: APM Industries Limited), Bhiwadi, Alwar, Rajasthan	17-11-2017

136	TPP0074MH	Khaperkheda Thermal Power Station , MAHAGENCO, Khaperkheda, Nagpur, Maharashtra	10-11-2017
137	TPP0077MH	New Parli Thermal Power Station, MAHAGENCO Parli Vaijnath, Dist. Beed, Maharashtra	10-11-2017
138	TPP0079MH	Parli Thermal Power Station, MAHAGENCO, Parli Vaijnath, Beed, Maharashtra	10-11-2017
139	TPP0110TN	PPN POWER GENERATING COMPANY PRIVATE LIMITED	10-11-2017
140	TPP0114TN	Thirumakottai (Kovil Kalapal), Gas Turbine Power Station, Mannargudi, Tamil Nadu	10-11-2017
141	CMT0027CG	Ambuja Cements Limited, (Bhatapara Cement Works), Baloda Bazar, Raipur, Chhattisgarh	09-11-2017
142	CMT0038RJ	Ambuja Cements Limited, Unit: Rabriyawas , Jaitaran, Pali, Rajasthan	09-11-2017
143	CNA0004TN	Chemplast Sanmar Ltd. Plant-[3], Veerakkalpudur, Raman Nagar Post, Mettur Dam, Salem District	09-11-2017
144	FTZ0028GJ	IFFCO Kalol Unit, Kasturinagar, Ghandhinagar, Gujarat	09-11-2017
145	INS0024CG	Monnet ISPAT & Energy Limited, Hasoud, Raipur, Chhattisgarh	09-11-2017
146	TPP0048GJ	Wanakbori Thermal Power Station , Kheda, Thasra, Kheda, Gujarat	09-11-2017
147	TPP0071MH	Bhusawal Thermal Power Station, MAHAGENCO, Deep Nagar, Tah. Bhusawal, Jalgaon, Maharashtra	09-11-2017
148	TPP0075MH	Koradi Thermal Power Station, MAHAGENCO Koradi, Kamti, Nagpur, Maharashtra	09-11-2017
149	TPP0078MH	Paras Thermal Power Station, MAHAGENCO Paras, Vidyut Nagar, Balapur, Akola, Maharashtra	09-11-2017
150	TPP0100TN	Kuttalam Gas Turbine Power Station- Tamilnadu Generation and Distribution Corporation Limited (TGDCL)	09-11-2017
151	TXT0072RJ	Sarvodaya India Limited (Formerly - Shree Charbhuja Processors Limited), Swaroopganj, Bhilwara, Rajasthan	09-11-2017
152	CMT0022MP	ACC Ltd. (Kymore Cement Limited), Vijraghavegarh, Katni, Madhya Pradesh	02-11-2017

153	FTZ0013UP	IFFCO Phulpur - I, Phulpur, Allahabad, Uttar Pradesh	02-11-2017
154	FTZ0018UP	IFFCO Phulpur - II, Phulpur, Allahabad, Uttar Pradesh	02-11-2017
155	FTZ0022UP	IFFCO, Aonla - II, Bareilly	02-11-2017
156	FTZ0025UP	IFFCO Aonla - I, Bareilly, Uttar Pradesh	02-11-2017
157	TPP0036GJ	CLP INDIA PRIVATE LIMITED, Paguthan, Bharuch,Gujarat	02-11-2017
158	TPP0054JH	Jojobera Power Plant- (THE TATA POWER COMPANY LIMITED), Rahargora, Jamshedpur, Jharkhand	02-11-2017
159	TPP0076MH	Nasik Thermal Power Station, MAHAGENCO Eklahare, Nasik, Maharashtra	02-11-2017
160	TPP0082MH	Uran Gas Power Station, Mahagenco, Raigarh, Maharashtra	02-11-2017
161	TXT0007RJ	SHRI ANANT SYNTEX LIMITED, Bhilwara, Rajasthan	02-11-2017
162	TXT0052MH	Pee Vee Textiles Limited, Samudrapur,Wardha, Maharashtra	02-11-2017
163	TXT0059MH	Raymond UCO Denim Private Limited,Lohara, Yavatmal, Maharashtra	02-11-2017
164	TXT0079MH	SURYALAKSHMI COTTON MILLS LIMITED, Nagardhan, Tal. Ramtek, Nagpur, Maharashtra	02-11-2017
165	CMT0017TN	Chettinad Cement Corporation Private Limited, Puliyur Works , Karur, Tamil Nadu	27-10-2017
166	CMT0072OR	OCL India Ltd, Odisha, Rajgangpur, Sundergarh, Odisha	27-10-2017
167	FTZ0024UP	Yara Fertilisers India Private Ltd, Babrala, Indira Dham, Babrala Dist-Budaun, Uttar Pradesh	27-10-2017
168	INS0003OR	SAIL Rourkela Steel Plant, Rourkela, Odisha	27-10-2017
169	INS0047MH	JSW Steel Coated Products Limited, Vasind, Maharashtra	27-10-2017
170	PNP0021OR	Emami Paper Mills Limited, Balgopalpur, Post-Rasulpur, Balasore, Odisha	27-10-2017
171	TPP0038GJ	NTPC Ltd - Jhanor Gandhar, Bharuch, Urja Nagar, Bharuch, Gujarat	27-10-2017
172	TPP0083OR	IB Thermal Power Station, Orissa Power Gen. Co. Ltd, Jharsuguda, Odisha	27-10-2017
173	TXT0017HP	Birla Textile Mills (A unit of Sutlej Textiles and Industries Limited), Baddi, Solan, Himachal Pradesh	27-10-2017

174	TXT0022MH	Century Enka Limited, Bhosari, Pune, Maharashtra	27-10-2017
175	TXT0028HP	G.P.I.Textiles Limited, Nalagarh, Solan, Himachal Pradesh	27-10-2017
176	TXT0041RJ	Maharaja Shree Umaid Mills Limited Pali marwar, Rajasthan	27-10-2017
177	CMT0018TN	Dalmia Cement (Bharat) Limited, Dalmiapuram, Trichy, Tamil Nadu	20-10-2017
178	FTZ0027UP	Kribhco Fertilizers Limited, Piprola, Shahjahanpur , Uttar Pradesh	20-10-2017
179	TPP0035GJ	Gandhinagar Thermal Power Station (Gujarat State Electricity Corp. Ltd), Gandhi Nagar, Gujarat	20-10-2017
180	TPP0041GJ	Sikka Thermal Power Station, Jamnagar (Gujarat State Electricity Corporation Ltd.) GSECL, Sikka, Dist. Jamnagar, Gujarat	20-10-2017
181	TPP0044GJ	UKAI Thermal Power Station GSECL, Vidyut Bhawan, Vadodara, Gujarat	20-10-2017
182	TPP0112TN	TAQA Neyveli Power Company Private Limited ,Uthanjal, Cuddalore, Tamil Nadu	20-10-2017
183	TPP0122UP	NTPC Ltd - Auraiya, Auraiya, Uttar Pradesh	20-10-2017
184	TXT0030GJ	GRASIM INDUSTRIES LIMITED (UNIT - INDIAN RAYON), Veraval, Junagadh, Gujarat	20-10-2017
185	TXT0046PB	Nahar Industrial Ent Limited, Jalalpur, Mohali, Punjab	20-10-2017
186	TXT0056RJ	Rajasthan Textiles Mills, Bhawani Mandi, Rajasthan	20-10-2017
187	TXT0073TN	Shri Ramalinga Mills Limited, A unit, Amppukottai, Tamil Nadu	20-10-2017
188	CMT0002CG	Nuvoco Vistas Corporation Ltd , Sonadih Cement Plant, Baloda Bazar , Chhattisgarh	13-10-2017
189	CMT0003CG	Nuvoco Vistas Corporation Ltd , Arasmeta cement Plant, Gopalnagar, Janjgir-Champa, Chhattisgarh	13-10-2017
190	CMT0048MH	Manikgarh Cement, Korpana, Chandrapur, Maharashtra	13-10-2017
191	CMT0060TS	My Home Industries Private Limited	13-10-2017
192	CMT0073JH	ACC Ltd (Chaibasa), Chaibasa Jinkpani Singhbhoom, Jharkhand	13-10-2017
193	CNA0012UP	Grasim Industries Limited, Chemical Division Renukoot, Renukoot, Sonebhadar, Uttar Pradesh.	13-10-2017
194	INS0004JH	SAIL, Bokaro Steel Plant Ispat Bhawan, Bokaro Steel City, Jharkhand	13-10-2017

195	INS0006JH	Tata Steel Limited, Bistupur, Jamshedpur, Jharkhand	13-10-2017
196	PNP0030PB	Trident Limited (Paper & Chemical Division), Dhaula, Barnala, Punjab	13-10-2017
197	TPP0010AP	Reliance Smalakot Thermal Power Station, IDA Peddapuram, Samalkot, Andhra Pradesh	13-10-2017
198	TPP0024CG	NTPC Ltd-Sipat, Ujjwal Nagar, Bilaspur, Chhattisgarh	13-10-2017
199	TPP0059KA	Toranagallu Thermal Power Station (JSW Energy Ltd.),Toranagallu, Bellary, Karnataka	13-10-2017
200	TPP0060KA	Toranagallu Thermal Power Station (JSW Energy Limited), Toranagallu, Bellary, Karnataka	13-10-2017
201	TPP0085OR	NTPC Ltd-Talcher Thermal , Talcher, Angul, Odisha	13-10-2017
202	TPP0091RJ	Giral Lignite Power Limited, Barmer, Rajasthan	13-10-2017
203	TXT0002PB	Trident Limited (Home Textile Division), Dhaula, Barnala, Punjab	13-10-2017
204	TXT0003PB	Trident Limited (Yarn Division), Barnala, Punjab	13-10-2017
205	TXT0004RJ	AK Spintex Limited, Bhilwara, Rajasthan	13-10-2017
206	TXT0023MH	Grasim Industries Limited (Unite-Century Rayon), Murbad Road, Shahad, Thane, Maharashtra	13-10-2017
207	TXT0078RJ	Sulzer Processors Pvt. Ltd., Mandal, Bhilwara, Rajasthan	13-10-2017
208	TXT0087MP	Vardhman Yarn, Plot No-A1-A6, Satalapur (Mandideep), Raisen, Madhya Pradesh	13-10-2017
209	CMT0040MH	ACC Limited (Chanda Cement Works), Chandurpur, Maharashtra	06-10-2017
210	FTZ0007MH	RCF, Thal, Tal Alibag, Dist Raigad, Maharashtra	06-10-2017
211	INS0023KA	BMM Ispat Limited, Danapur, Hospet, Karnataka	06-10-2017
212	INS0030CG	Nalwa Steel & Power Limited, Taraimal, Raigarh, Chhattisgarh	06-10-2017
213	INS0043MH	Sunflag Iron & Steel Co. Limited, Nagpur, Maharashtra	06-10-2017
214	TPP0001AP	Gas Turbine Power Station, Andhra Pradesh Gas Power Corporation Limited, Vijjeswaram, Andhra Pradesh	06-10-2017

215	TPP0006TS	NTPC Ltd. Ramagundam Super Thermal Power Station, Jyothi nagar, Karim Nagar, Telangana	06-10-2017
216	TPP0049HR	NTPC Ltd - Faridabad Tigaon Road, Mujedhi, Faridabad, Haryana	06-10-2017
217	TPP0125UP	NTPC Ltd -Rihand, Rihand Nagar, Sonebhadra, Uttar Pradesh	06-10-2017
218	TPP0126UP	NTPC Ltd- Singrauli, Shakti Nagar, Sonebhadra, Uttar Pradesh	06-10-2017
219	TPP0144WB	Titagarh Thermal Power Station, North 24 Parganas, West Bengal	06-10-2017
220	TXT0048MP	Nahar Spinning Mills Limited, Simrai, Mandideep, Raisen, Madhya Pradesh	06-10-2017
221	FTZ0001AS	BVFCL, Namrup-II, Namrup, Distt-Dibrugarh, Assam	29-09-2017
222	FTZ0002AS	BVFCL, Namrup-III, Namrup, Distt-Dibrugarh, Assam	29-09-2017
223	INS0031CG	Singhal Enterprises Private Limited, Gerwani, Tharaimal, Raigarh, Chhattisgarh	29-09-2017
224	TXT0086PB	Vardhman Spinning & General Mills , Ludhiana, Punjab	29-09-2017
225	ALM0003OR	National Aluminium Company Limited, Mines & Refinery Complex, Damanjodi, Dist- Koraput, Odisha	28-09-2017
226	ALM0010MH	Hindalco Industries Limited Plot No. 2, MIDC Taloja, A.V, Navi Mumbai, Dist Raigad, Maharashtra	28-09-2017
227	CMT0001HP	Ambuja Cements Limited, Suli, Darlaghat, Solan, Himachal Pradesh	28-09-2017
228	CMT0009TN	Chettinad Cement Corporation Private Limited, Karikkali , Dindigul Rani Meyammai Nagar, Guziliamparai, Dindigul, Tamil Nadu.	28-09-2017
229	CNA0002GJ	Grasim Industries Limited, Unit- Indian Rayon Veraval, Junagadh Road, Veraval, Gir Somanath, 362266, Gujarat.	28-09-2017
230	FTZ0011MH	RCF, Trombay -V, Mahul Road Chembur, Mumbai , Maharashtra	28-09-2017
231	TPP0007AP	NTPC-Simhadri, Vishakhapatanam, Andhra Pradesh	28-09-2017
232	TPP0068MP	NTPC Ltd -Vindhyachal Vindhya Nagar, Singrauli, Madhya Pradesh	28-09-2017
233	TPP0123UP	NTPC Ltd - Dadri Gas, GB Nagar, Uttar Pradesh	28-09-2017

234	TPP0134WB	Budge Budge Thermal Power Station, South 24 Parganas, West Bengal	28-09-2017
235	TPP0143WB	Southern Replacement Thermal Power Station, C.E.S.C. Ltd. Kolkata, West Bengal	28-09-2017
236	TXT0047RJ	Nahar Industrial Enterprises Limited, Bhiwadi, Rajasthan	28-09-2017
237	CMT0012MP	UltraTech Cement Limited - Bela Cement Works , Rewa, Madhya Pradesh.	27-09-2017
238	CMT0036RJ	JK Cement Limited, Kailash Nagar-I, Nimbahera, Chittorgarh, Rajasthan	27-09-2017
239	CMT0078KA	HeidelbergCement India Limited, Turuvekere, Tumkur, Karnataka	27-09-2017
240	INS0062MH	M/S Mukand Limited, Dighe Kalwa, Maharashtra	27-09-2017
241	PNP0026PB	Kuantum Papers Ltd. , Sailakhurd , Hoshiarpur, Punjab	27-09-2017
242	TPP0028DL	NTPC Ltd-Badarpur, Badarpur, New Delhi	27-09-2017
243	TPP0080MH	Trombay Combined Cycle Power Plant - (THE TATA POWER COMPANY LIMITED), Chambur, Maharashtra	27-09-2017
244	TPP0081MH	Trombay Thermal Power Station (Coal & Oil) - (THE TATA POWER COMPANY LIMITED), Chambur, Maharashtra	27-09-2017
245	TPP0124UP	NTPC Ltd - Dadri Coal, GB Nagar, Uttar Pradesh	25-09-2017
246	TXT0035RJ	Kanchan India Limited, Bhilwara, Rajasthan	25-09-2017
247	CMT0052TS	Kesoram Cement (Prop. Kesoram Industries Limited), Basantnagar, Karimnagar, Telangana	22-09-2017
248	INS0010WB	SAIL-IISCO Steel Plant, Burnpur - 713325 , District -Bardhhaman, West Bengal	22-09-2017
249	INS0037CG	Hira Ferro Alloys Limited, Urla, Raipur, Chhattisgarh	22-09-2017
250	INS0045MH	JSW Steel Limited, Gitapuram, Raigadh, Maharashtra	22-09-2017
251	PNP0018MP	Orient Paper Mill, Shahdol, Madhya Pradesh	22-09-2017
252	PNP0019WB	ITC Limited, Tribeni, West Bengal	22-09-2017
253	TPP0089PB	Guru Nanak Dev Thermal Plant, Bhatinda-(PUNJAB STATE POWER CORPORATION LIMITED), Punjab	22-09-2017
254	TXT0033RJ	Janki Corp Limited, Bhilwara, Rajasthan	22-09-2017
255	TXT0040GJ	Mafatlal Industries Limited Textile Division, Nadiad Unit, Nadiad, Gujarat	22-09-2017
256	TXT0089HP	Winsome Textile Industries Limited, Baddi, Solan, Himachal Pradesh	22-09-2017

257	ALM0007OR	National Aluminium Company Limited, S & P Complex, Nalconagar, Angul, Odisha	21-09-2017
258	CMT0047RJ	ACC Limited (Lakheri Cement works), Lakheri, Bundi, Rajasthan	21-09-2017
259	CMT0056AP	The K C P Limited, Macherla, Guntur, Andhra Pradesh	21-09-2017
260	CMT0063KA	Vasavadatta Cement, Sedam, Gulbaraga, Karnataka	21-09-2017
261	INS0019MH	JSW Steel (Salav) Limited, Vill. - Salav, PO - Revdanda, Dist. - Raigad - 402202, Maharashtra.	21-09-2017
262	INS0022GJ	Welspun Steel Limited, Welspun City, Versamedi TA-Anjar (Kutch), Gujarat	21-09-2017
263	INS0042OR	Balasore Alloys Limited, Balgopalpur, Balasore, Odisha	21-09-2017
264	PNP0024TN	ITC Limited, Mettupalayam, Coimbatore, Tamil Nadu	21-09-2017
265	PNP0031PB	Satia Industries Limited, Rupana, Muktsar, Punjab	21-09-2017
266	TPP0018CG	ACB (INDIA) LIMITED, Chakabura, Korba, Chhattisgarh	21-09-2017
267	TPP0021CG	Jindal Power Limited, Tamnar O.P. Jindal Super Thermal Power Plant, P.O. Tamnar, Tahsil Tamnar, Raigarh, Chhattisgarh	21-09-2017
268	TXT0001PB	Aarti International Limited, Ramgadh,CHD road Ludhiana, Punjab	21-09-2017
269	TXT0010TN	Aruppukottai Sri Jayavilas Limited, Cotton Spinning Mills, 'A' Unit MELAKANDAMANGALAM, Tamil Nadu	21-09-2017
270	TXT0011GJ	Arvind Limited, Khatraj, Kalol, Gandhinagar, Gujarat	21-09-2017
271	TXT0012GJ	Arvind Limited (Division of Ankur Textiles) , Outside Raipur Gate, Ahmedabad, Gujarat	21-09-2017
272	TXT0026HP	Deepak Spinners Limited, Baddi, Solan, Himachal Pradesh	21-09-2017
273	TXT0075RJ	Sona Processors I Limited, Bhilwara, Rajasthan	21-09-2017
274	ALM0001KA	Hindalco Industries Limited, Belgaum, Karnataka	15-09-2017
275	CMT0039RJ	Ultratech Cement Limited (Aditya Cement Works), Adityapuram Sawa, Chittorgarh, Rajasthan	15-09-2017
276	INS0053GJ	Welspun Corp Limited, Welspun City, Kutch, Gujarat	15-09-2017

277	PNP0002TS	ITC Limited-PSPD, Unit Bhadrachalam, Telangana	15-09-2017
278	TPP0108TN	North Chennai Thermal Power Station, TNEB, Chennai, Tamil Nadu	15-09-2017
279	INS0035CG	Hira Power And Steels Limited, Urla, Raipur, Chhattisgarh	13-09-2017
280	PNP0003TN	Tamil Nadu Newsprint and Papers Limited, Kagithapuram, Gram Newsprint, Karur, Tamil Nadu	13-09-2017
281	PNP0022GJ	Shree Rama Newsprint limited, Barbodhan, Olpad, Surat, Gujarat	13-09-2017
282	TPP0046GJ	Vadodara Gas Power Station, (Gujurat Industries Power Company Ltd), Petro Chemicals, Vadodara, Gujarat	13-09-2017
283	TXT0057GJ	Rankas Texfab Private Limited (Bhairvnath Industries), Piplej, Ahmedabad, Gujarat	13-09-2017
284	TXT0074RJ	Shriram Rayons, Kota, Rajasthan	13-09-2017
285	CMT0051UP	Dalla Cement Works (UltraTech Cement Ltd.) , Dalla , Sonebhadra, Uttar Pradesh.	12-09-2017
286	CMT0085MP	Diamond Cements Prop. HeidelbergCement India Limited, Village Narsingarh, Damoh, Madhya Pradesh	12-09-2017
287	INS0032CG	Godawari Power & Ispat Limited, Siltara, Raipur, Chhattisgarh	12-09-2017
288	INS0054MH	JSW Steel Coated Products Limited, kalmeshwer, Nagpur, Maharashtra	12-09-2017
289	TPP0023CG	NTPC Ltd-Korba, Jamnipali, Korba, Chhattisgarh	12-09-2017
290	TPP0026CG	R R Energy Ltd., Garhumaria, Raigarh, Chhattisgarh	12-09-2017
291	TPP0113TN	TCP Limited, Chennai, Tamil Nadu	12-09-2017
292	TPP0127UP	NTPC Ltd -Tanda, Ambedkar Nagar, Uttar Pradesh	12-09-2017
293	FTZ0017KA	Mangalore Chemicals & Fertilizers Ltd , Panambur, Mangalore, Karnataka	08-09-2017
294	FTZ0026UP	Grasim Industries Limited (Unit - Indo Gulf Fertilisers) , Jagdishpur, Sultanpur, Uttar Pradesh	08-09-2017
295	TPP0084OR	NTPC Ltd -Talcher Kaniha, Deepsika, Angul, Odisha	08-09-2017
296	TXT0039HR	M/s Grasim Bhiwani Textiles Limited, Unit: Bhiwani Textile Mills & Elegant Spinners, Bhiwani, Haryana	08-09-2017
297	CMT0046RJ	Mangalam Cement Limited, Aditya Nagar, Kota, Rajasthan	05-09-2017

298	INS0055OR	SMC Power Generation Limited, Hirma, Jharsuguda, Odisha	05-09-2017
299	INS0057CG	Mahendra Sponge & power Limited, Siltara , Raipur, Chhattisgarh	05-09-2017
300	TPP0027DL	Gas Turbine Power Station , a unit of Indraprastha Power Generation Company Limited, IP Estate, Ring road, New Delhi-110002	05-09-2017
301	TPP0029DL	Pragati Power Corporation Limited, Station -1, IP Estate, Ring Road, New Delhi	05-09-2017
302	TPP0051HR	DCRTPP, HPGCL (Haryana Power Generation Co. Ltd.), Yamunanagar, Haryana	05-09-2017
303	TPP0069MP	Sanjay Gandhi Thermal Power Station MPPGCL, Birsinghpur , Umaria, Madhya Pradesh	05-09-2017
304	TPP0087PB	Guru Gobind Singh Super Thermal Power Station, Ropar, Roop Nagar, Punjab	05-09-2017
305	TPP0088PB	Guru Hargobind Thermal Power Plant, Lehra Mohabbat- (PUNJAB STATE POWER CORPORATION LIMITED) , Bathinda, Punjab	05-09-2017
306	TPP0115TN	Tuticorin Thermal Power Station Tuticorin, Tamil Nadu	05-09-2017
307	TXT0063RJ	Rolex Processors Private Limited, Bhilwara, Rajasthan	05-09-2017
308	TXT0085MP	Vardhman Fabrics (Unit of Vardhman Textiles Limited),Tehsil-Budhni, Sehore, Madhya Pradesh	05-09-2017
309	ALM0004JH	Hindalco Industries Limited Muri, Ranchi, Jharkhand	01-09-2017
310	ALM0009UP	Hindalco Industries Limited, Renukoot, Sonbhadra, Uttar Pradesh	01-09-2017
311	CMT0004CG	Ultratech Cement Limited, Hirmi Cement Works, Hirmi, Raipur, Chhattisgarh	01-09-2017
312	CMT0006CG	Ultratech Cement Ltd. (Rawan Cement Works), Grasim Vihar Village, Raipur,Chhattisgarh	01-09-2017
313	CMT0025GJ	Ambuja Cements Limited, Ambujanagar, Junagadh, Gujarat	01-09-2017
314	CMT0026MH	Ambuja Cements Limited, Unit: Maratha Cement Works, At Post Upparwahi, Taluka; Korpana Dist- Chandrapur, Maharashtra-442908	01-09-2017

315	CMT0035TS	Rain Cements Limited Unit-1, Ramapuram Village, Mellacheruvu Mandal Nalgonda, Telangana	01-09-2017
316	CMT0074AP	Ultratech Cement Limited (AP Cement Works), Bhogasamudram ,Tadipatri,Anantapur , Andhra Pradesh	01-09-2017
317	CMT0080RJ	Ultratech Cement Limited, Unit- Birla White, Jodhpur, Rajasthan	01-09-2017
318	CNA0008GJ	Gujarat Alkalies and Chemicals Limited, Dahej, Vagara, Dist. Bharuch	01-09-2017
319	CNA0010GJ	Gujarat Fluorochemicals Limited, 12/A, Dahej GIDC Complex, Vagra, Bharuch	01-09-2017
320	CNA0011TN	Tamilnadu Petroproducts Limited, Manali Express Highway, Chennai-68, Tamil Nadu	01-09-2017
321	INS0029GJ	Gallantt Metal Limited, Samakhyali, Bhachau, Kutch, Gujarat	01-09-2017
322	PNP0001MH	BILT Graphic Paper Products Limited, Indapur, Pune, Maharashtra	01-09-2017
323	PNP0004UK	Century Textiles and Industries Ltd-Century Pulp & Paper division, Ghansyamdham, Lalkua, Nainital, Uttarakhand	01-09-2017
324	TPP0052JH	Bokaro Thermal Power Station, Damodar Valley Corporation BTPS "B", Bokaro Thermal, Bokaro, Jharkhand	01-09-2017
325	TPP0094RJ	Raj WestPower Limited, Barmer, Rajasthan	01-09-2017
326	TPP0138WB	Mejia Thermal Power Station, Damodar Valley Corporation, Durlavpur, Bankura, West Bengal	01-09-2017
327	TXT0019RJ	BSL LIMITED(Processing Division), Mandpum, Bhilwara, Rajasthan	01-09-2017
328	TXT0020RJ	BSL Limited, Mandpum, Bhilwara, Rajasthan	01-09-2017
329	TXT0082MH	The Bombay Dyeing & Mfg. Co. Ltd. Plot no-1, Industrial area, MIDC, Patalganga, Raigad, Maharashtra	01-09-2017
330	CMT0011MP	Prism Cement Ltd , Satna , Madhya Pradesh	28-08-2017
331	CMT0024MH	UltraTech Cement Limited (Awarpur Cement Works), Korpana, Chandrapur, Maharashtra	28-08-2017
332	CMT0037MP	Birla Corporation Limited (Satna Cement Works), Birla Vikas, Satna , Madhya Pradesh	28-08-2017
333	CMT0062KA	UltraTech Cement Limited(Rajashree Cement Works), Adityanagar, Gulbarga, Karnataka	28-08-2017

334	CMT0065GJ	Shree Digvijay Cement Co. Limited, Digvijaygram, Jamnagar, Gujarat	28-08-2017
335	CMT0068AP	Rain Cements Limited Unit-II, Boinchervupally (V),Peapully (M), Kurnool, Andhra Pradesh	28-08-2017
336	INS0041OR	Navabharat Ventures Limited, Khadagprasad Meramandali, Dhenkanal, Odisha	28-08-2017
337	PNP0006MH	BILT Graphic Paper Products Limited, Chandrapur, Maharashtra	28-08-2017
338	TPP0025CG	NTPC-SAIL Power Company Limited , Joint Venture of NTPC & SAIL, Purena , Bhilai East, Chhattisgarh	28-08-2017
339	TPP0050HR	Panipat Thermal Power Station - I HPGCL, Assandh, Panipat, Haryana	28-08-2017
340	TPP0053JH	Chandrapura Thermal Power Station, Damodar Valley Corporation Bokaro Dist., Jharkhand	28-08-2017
341	TPP0101TN	Lanco Tanjore Power Co.Ltd, ABAN Power Co.Ltd, Karuppur, Thanjabur Dist.Tamil Nadu	28-08-2017
342	TPP0104TN	Mettur Thermal Power Station-(TAMILNADU GENERATION AND DISTRIBUTION CORPORATION LIMITED), Salem, Tamil Nadu	28-08-2017
343	TPP0109TN	Pioneer Power Ltd. (Penna Electricity Ltd), Valantharavai, Ramnad Dist., Tamil Nadu	28-08-2017
344	TPP0136WB	Durgapur Thermal Power Station, Damodar Valley Corp. Ltd., Durgapur, West Bengal	28-08-2017
345	CMT0042TS	Zuari Cement Limited , Sitapuram Works, Dondapadu Post Chintalapalem Mandal Suryapeta District -508 246 Telangana State (T.S.)	18-08-2017
346	CMT0049RJ	Ultratech Cement ltd. (Kotputli cement Works), Mohanpura, Kotputli, Jaipur, Rajasthan	18-08-2017
347	CMT0084PB	Ambuja Cements Limited, Doburji, Lodhimajra, Ropar, Punjab	18-08-2017
348	INS0009CG	Jindal Steel & Power Limited, Raigarh, Chhattisgarh	18-08-2017
349	INS0013MH	Gopani Iron & Power (I) Private Limited, Tadali, Chandrapur, Maharashtra	18-08-2017
350	INS0040OR	Indian Metals & Ferro Alloys Limited, KaliaPani, Sukinda, Jajpur, Odisha	18-08-2017

351	PNP0005GJ	JK Paper Limited, Unit: CPM, Fort Songadh, Tapi, Gujarat	18-08-2017
352	PNP0011OR	JK Paper Mills, Rayagada, Odisha	18-08-2017
353	TPP0005AP	Lanco Kondapalli Power Limited, Ibrahim Patanam, Krishna, Andhra Pradesh	18-08-2017
354	TPP0070MP	Satpura Thermal Power Station MPPGCL, Sarni, Madhya Pradesh	18-08-2017
355	TXT0027MH	Eurotex Industries and Exports Limited, Gokil Shirgaon, Kolhapur	18-08-2017
356	CMT0041RJ	Shree Cement Limited, Jaitaran, Pali, Rajasthan	16-08-2017
357	ALM0005CG	Bharat Aluminium Company Limited, Balco Nagar, Korba, Chhattisgarh	10-08-2017
358	ALM0006OR	Hindalco Industries Limited Hirakud Smelter, Hirakud, Sambalpur, Odisha	10-08-2017
359	CMT0070GJ	Saurashtra Cement Limited, Ranavav, Porbandar, Gujarat	10-08-2017
360	CNA0009GJ	Gujarat Alkalies and Chemicals Limited, Petrochemicals, Vadodara	10-08-2017
361	PNP0009KA	West Coast Paper Mills Ltd. , Dandeli, Karnataka	10-08-2017
362	TPP0066KL	NTPC Ltd- Kayamkulam (Rajiv Gandhi Combined Cycle Power Plant),Choolatharuvu,Alappuzha,Kerala	10-08-2017
363	CMT0005TN	Ultratech Cement ltd (Reddipalyam Cement Works), Reddipalyam, Ariyalur, Tamil Nadu	04-08-2017
364	CMT0033ML	Meghalaya Cements Limited, Lumshnong, Jaintia Hills, Meghalaya	04-08-2017
365	CNA0007MP	Grasim Industries Limited, Chemical Division, Birlagram, NAGDA	04-08-2017
366	INS0015GA	Shraddha Ispat Private Limited, Sanguem, Goa	04-08-2017
367	INS0025CG	Anjani Steel Limited, Athagarh, Cuttack, Chhattisgarh	04-08-2017
368	INS0028GA	Goa Sponge & Power Limited, Santona, Goa	04-08-2017
369	PNP0007UP	Star Paper Mills Limited, Saharanpur, Uttar Pradesh	04-08-2017
370	TXT0054RJ	RSWM Ltd Unit Mandpam, Mandpum, Bhilwara, Rajasthan	04-08-2017
371	TXT0065RJ	RSWM Limited, Ringas, Rajasthan	04-08-2017
372	TXT0066RJ	RSWM Limited, Kharigram, Gulabpura, Bhilwara, Rajasthan	04-08-2017
373	TXT0067RJ	RSWM Limited, Rishabhdev, Udaipur, Rajasthan	04-08-2017
374	TXT0068RJ	RSWM Limited, Lodha, Banswara, Rajasthan	04-08-2017

375	TXT0069RJ	RSWM Limited (Fabric Div.), Mordi, Banswara, Rajasthan	04-08-2017
376	TXT0070RJ	Sangam (India) Ltd., (Processing, Flock & Weaving Division) Atun, Bhilwara, Rajasthan	04-08-2017
377	CMT0023TS	Penna Cement Industries Limited, Ganeshpahad, Wadapally, Nalgonda, Telangana	03-08-2017
378	CMT0064AP	Penna Cement Industries Limited, Boyareddypalli, Yadiki Mandal, Anantapur, Andhra Pradesh	03-08-2017
379	CMT0075AP	Penna Cement Industries Limited, Talaricheruvu Mandal, Anantpur, Andhra Pradesh	03-08-2017
380	INS0011OR	Tata Steel Long Products Limited,Keonjher,Odisha	03-08-2017
381	TXT0014RJ	Banswara Syntex Limited, Banswara, Rajasthan	03-08-2017
382	TXT0061RJ	Reliance Chemotex Industries Limited, Kanpur, Udaipur, Rajasthan	03-08-2017
383	TXT0090PB	Winsome Yarns Limited, Kurawala, Barawal Road, Mohali, Punjab	03-08-2017
384	INS0034CG	Vandana Global Limited, Siltara, Raipur, Chhattisgarh	01-08-2017
385	TXT0016GJ	Birla Cellulosic Birladam, Kharach, Kosamba(RS), Bharuch, Gujarat	01-08-2017
386	CMT0008MP	Ultratech Cement ltd. (Vikram cement Works), Khor, Neemuch, Madhya Pradesh	28-07-2017
387	CMT0059GJ	Ultra Tech Cement Ltd (Naramada Cement), babarkot Village, Amreli, Gujarat	28-07-2017
388	CMT0083UP	ACC Limited, Tikaria Cement Works, Gauriganj District, Chhatrapati Shahuji Maharaj Nagar, Uttar Pradesh	28-07-2017
389	INS0033CG	Shri Bajrang Power & Ispat Limited, Borjhara, Raipur, Chhattisgarh	28-07-2017
390	TXT0037TN	L.S.Mills Limited, 'B' B unit, Muthu Thevandatty, Theni, Madurai, Tamil Nadu	28-07-2017
391	ALM0008OR	Vedanta Limited, Burkhamunda, Sripura, Jharsuguda, Odisha	27-07-2017
392	TPP0073MH	ADANI ELECTRICITY MUMBAI LIMITED,Thane, Maharashtra	27-07-2017
393	CMT0058GJ	UltraTech Cement Limited (Gujarat Cement Works), Rajula, Amreli, Gujarat	26-07-2017
394	INS0067MH	Lloyds Metals and Energy Limited, Chandrapur, Maharashtra	26-07-2017

395	TPP0040GJ	Sabarmati Thermal Power Station, Torrent Power Ltd, Ahmedabad, Gujarat	26-07-2017
396	TPP0067MP	Amarkantak Thermal Power Station, Chachai, Madhya Pradesh	26-07-2017
397	TXT0032PB	J. C. T. Limited, Phagwara, Punjab	26-07-2017
398	TXT0049RJ	Nitin Spinners Limited, Hamirgadh, Bhilwara, Rajasthan	26-07-2017
399	CMT0031RJ	JK Lakshmi Cement Limited, Jaykaypuram, Sirohi, Rajasthan	20-07-2017

Table 03:No. of DC's in the year 2017-2019

1.5 Objective of Project

- To Identify sectors with potential for inclusion in future PAT cycles.
- To Identify Target setting methodology for new DCs in future cycles.
- To Identify penalties can encourage trading/compliances.
- To identify why industries are not achieving targets set.
- To identify which industries are achieving the targets set.

1.6 Sector specific data analysis

The overall trend of various categories of power plants indicating the unit heat rate, APC and the net heat rate for the assessment year is tabulated in Fig.05, for PAT Cycle 1.

Category	Gross Unit Heat Rate		APC		Net Heat Rate	
	National Best	Average	National Best	Average	National Best	Average
MW	kCal/kWh	kCal/kWh	%	%	kCal/kWh	kCal/kWh
<100	2606	3082	8.38	11.18	2908	3470
100 – 150	2450	2718	6.92	11.48	2687	3070
150 – 300	2274	2554	5.86	7.36	2496	2757
300 – 600	2244	2386	5.34	6.66	2419	2556
Gas	1837	2161	1.43	3.47	1881	2239

Fig .05: Specific Energy Consumption & APC % (National Average vs. National Best)

In order to analyze the sectoral profile of the power industry, the units of the thermal power plants are categorized into five different segments, based according to the size of the installed capacity namely, (1) <100 MW (2)100 – 149 MW (3) 150-300 MW (4) 300 – 600 MW (5) >600 MW.

Based on the data received from BEE, analysis was carried out by compiling and analyzing data for 78 TPPs and 34 Gas Turbine modules (CCGT), which is equivalent to 75% of the power plants shortlisted in PAT cycle-I.

Category	No. of Units	Installed Capacity	Operating Load		Gross Generation		PLF	
		AY	BY	AY	BY	AY	BY	AY
		MW	MW	MW	MU	MU	%	%
<100	46	2,717	2,280	1,719	17,263	11,543	67.23%	62.11%
100 - 149	65	7,755	5,189	5,525	28,742	26,290	50.15%	44.46%
150 - 300	183	39,690	33,489	34,094	219,351	192,855	65.65%	56.33%
300 - 600	56	27,180	19,603	24,575	66,210	78,576	43.19%	33.00%
>600*	3	1,980	-	617	-	14,340	-	82.67%
TPP Total (A)	**331**	**77,112**	**60,562**	**66,529**	**331,566**	**323,604**	**58.13%**	**47.91%**
Gas (B)	68	10,558	7,831	6,512	63,361	32,134	68.51%	34.74%
Sector Total (A+B)	**399**	**87,670**	**68,392**	**73,041**	**394,927**	**355,738**	**59.58%**	**46.32%**

***The first 660 MW unit in India was commissioned in 2010, and hence, units with capacity of 660MW and beyond were not available in baseline period of PAT Cycle-I**

Fig .06: Installed capacity and operating load for BY and AY

From the above table, the percentage variation trend for operating capacity and the gross units generation was estimated with respect to Assessment Year (AY) and Baseline Year (BY) and is tabulated Table 14. It can be inferred that the total operating capacity of thermal power plant increased by 9.85%, but the gross generation was reduced by 2.4%. This is an indicative of reduced plant load factor due to increase in larger capacity units, resulting in increase in average heat rate of the sector.

Similar comparisons were constructed to analyze the trend of average unit heat rate and the net heat of the corresponding categories. Based on the analysis, the trend of the same was also evaluated. The unit heat rate of all the categories, with the exception of 300 – 600 MW units, have decreased by at least 2% (on weighted average) for the thermal power plants. The unit heat rate of 300 – 600 MW segment and the gas turbine modules increased by at least 2%. Majority of the units operate with gross unit heat rates deviating by up to 10% with respect to the design heat rate, wherein the plant load factor and decreasing gross generation have been detrimental to the gross unit heat rate.

Category	Gross Unit Heat Rate (Wt. Avg)				
	Design	BY	AY	Range BY	Range AY
	kCal/kWh	kCal/kWh	kCal/kWh	kCal/kWh	kCal/kWh
<100	3,476	3,205	3,082	2,606 - 3,886	2,606 - 3,940
100 - 149	2,802	2,967	2,718	2,321 - 3,886	2,213 - 2,678
150 - 300	2,306	2,603	2,554	2,275 - 3,182	2,273 - 3,138
300 - 600	2,263	2,326	2,386	2,226 - 2,976	2,244 - 2,835
>600	2,207	-	2,284	-	2,272 - 2,293
Gas	1,956	2,114	2,161	1,807 - 4,503	1,837 - 4,780

Fig .07: Unit Heat Rate comparison of assessment and baseline year

The following table is the evaluation of the % increase or decrease of unit heat rate and the deviations of the heat rate in the assessment year and baseline year, with respect to design.

Category	% Increase	Deviation w.r.t. Design	
		BY	AY
	%	%	%
<100	-3.85	-7.78	-11.34
100 - 149	-8.41	5.9	-3.0
150 - 300	-1.90	10.31	8.21
300 - 600	2.55	2.8	5.42
>600	-	-	-
Gas	**2.25**	**8.1**	**10.53**

Fig .08: Percentage increase or decrease of unit heat rate

Percentage increase or decrease of unit heat rate

Similar to the unit heat rate comparison, the APC of the power plant units of various categories were also evaluated and is tabulated in Fig.08.

The APC% for 150-300 MW units have significantly reduce by almost 10%, while the other categories have shown increase.

Category	Auxiliary Power Consumption % (Wt. Avg)				% Increase
	BY	AY	Range BY	Range AY	APC
	%	%	%	%	%
<100	10.40	11.18	7.98 - 14.26	8.38 - 15.39	7.5
100 - 149	11.06	11.32	7.38 - 19.76	6.92 - 21.78	3.8
150 - 300	8.85	7.36	4.53 - 14.26	5.86 - 14.54	-16.84
300 - 600	6.37	6.66	4.50 - 10.78	5.34 - 8.82	4.55
>600	-	5.34	-	5.34	-
Gas	2.59	3.47	1.68 - 10.42	1.43 - 9.67	33.98

Fig .09: APC comparison of assessment and baseline year

The decreasing net heat rates of the thermal power sector from 2768 kCal/kWh in the baseline period to 2712 kCal/kWh in the assessment year

is the result of the implementation of the

PAT scheme, wherein the wt. average net heat rates of various categories can be observed in Table 1012

Category	Net Heat Rate (Wt. Avg)				% Increase
	BY	AY	Range BY	Range AY	Avg Net HR
	kCal/kWh	kCal/kWh	kCal/kWh	kCal/kWh	%
<100	3,577	3,470	2,870 – 4,532	2,908 – 4,300	-3.01
100 - 149	3,336	3,070	2,506 – 4,559	2,687 – 4,861	-7.97
150 - 300	2,856	2,757	2,492 – 3,661	2,496 – 3,506	-3.48
300 - 600	2,484	2,556	2,413 – 3,277	2,419 – 3,014	2.87
>600	--	2,413	-	2,400 – 2,422	-
Gas	2,170	2,239	1,843 – 4,613	1,881 – 5,072	3.17

Fig .10: Net heat rate comparison of assessment and baseline year

Supplementing the analysis illustrated above, comparisons were made to analyze the number of cold/warm/hot boiler startup during baseline and assessment year. It can inferred from Figure 20 that, for the overall thermal power sector, the number of cold/warm startup have increased

by almost one-third and the number of hot startups have reduced by 23%. It is imperative to understand that, particularly the 150-300 MW category has experienced a majority of these cold/warm startups, increasing almost two-fold in the assessment year.

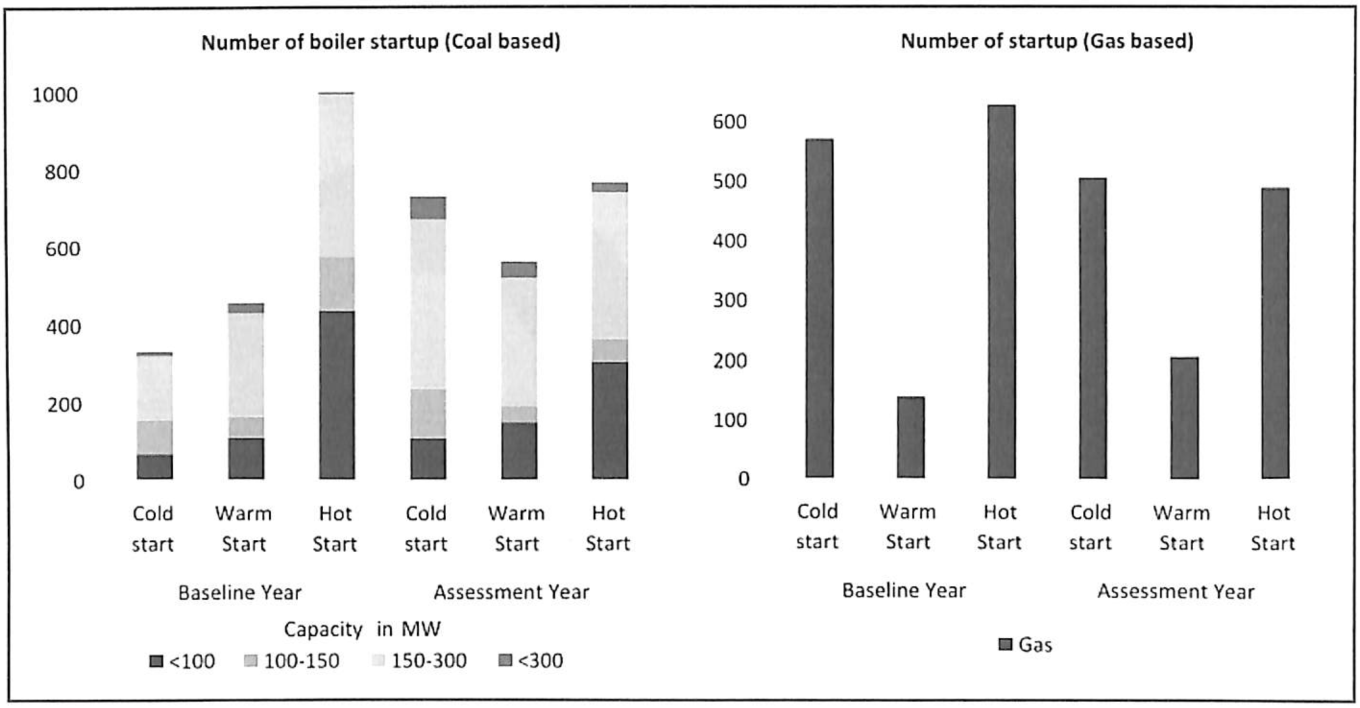


Fig .11: Comparison of no. of boiler startups for BY and AY in PAT Cycle 1

The variation in the number of cold/warm/hot startups can be attributed to various factors:

- Decreasing PLF of the power sector/Load scheduling
- Resource unavailability (fuel, water, etc.)
- Environmental compliances
- Surplus electricity resulting in lower peak

demands, hence, decreased hot startups in AY All of the aforementioned factors are not only indicative of the sector's operational efficiency, but also reflect on the primary energy consumed by the sector. The percentage share of the primary energy consumption of the sector for the baseline and the assessment year is shown in Figure 12.

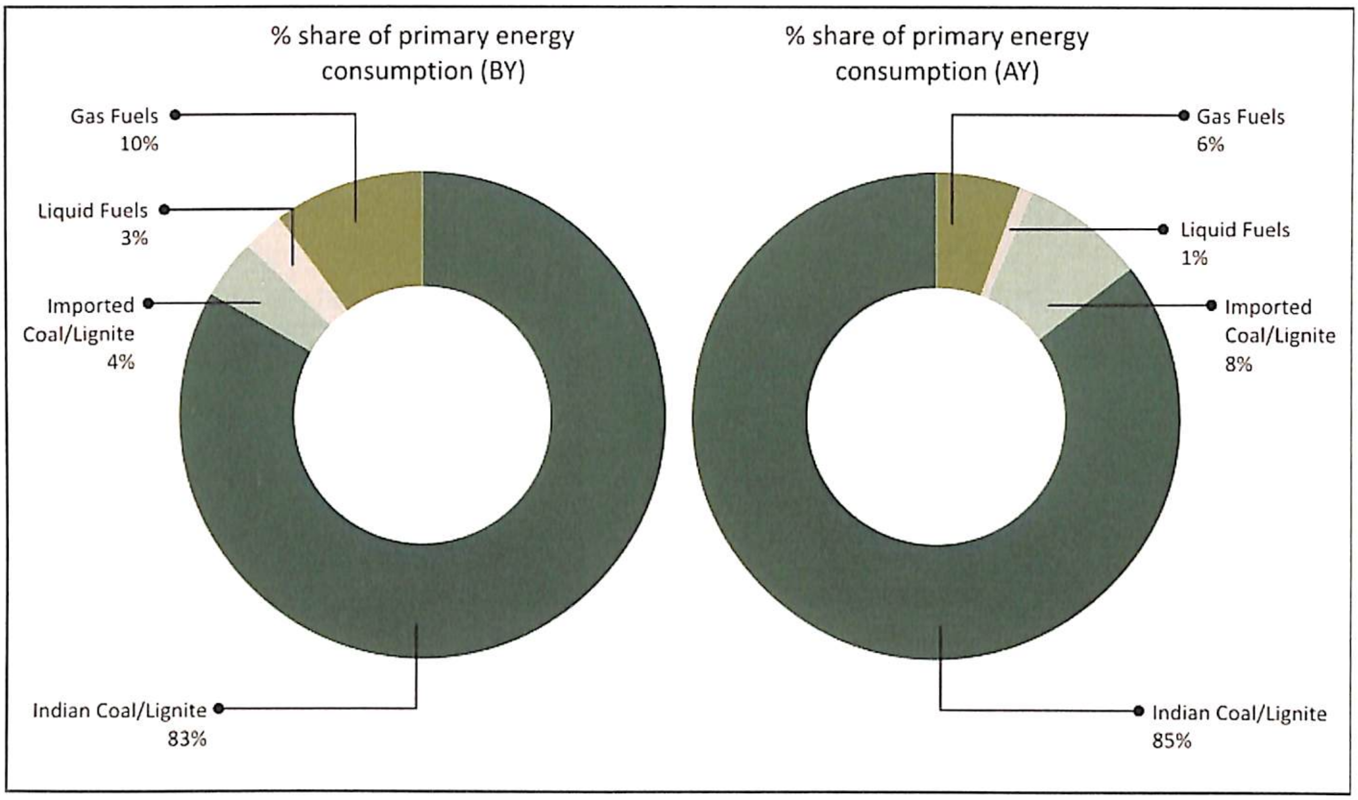


Fig .12: Percentage share of primary energy consumption in BY and AY in PAT Cycle 1

The percentage share of the primary energy consumption of the sector for the baseline and the assessment year is shown in Figure 12. The figure evidently indicates the decrease in the consumption of liquid and gas fuels, while the consumption of imported coal has doubled between the baseline and assessment year. Based on the trends of primary fuel consumption, the following conclusions were drawn.

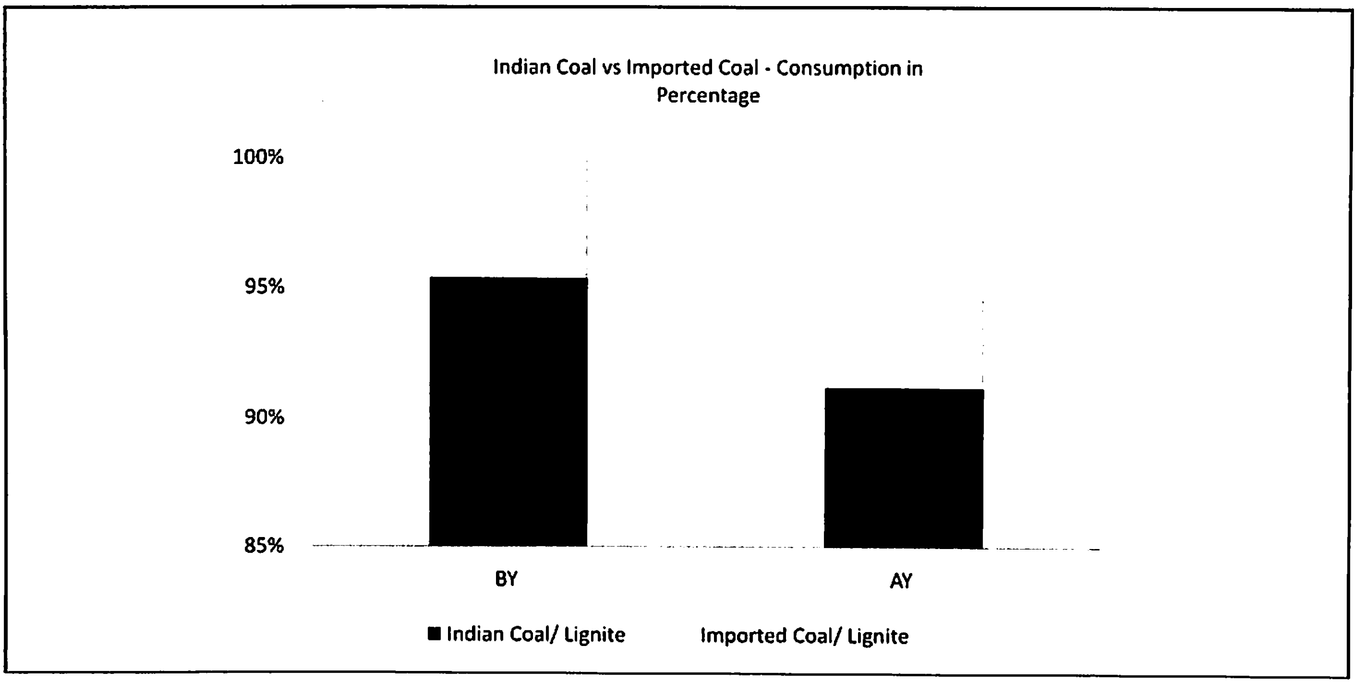


Fig .13: Comparison of consumption of Indian coal and imported coal

Demand & Supply gap of coal: With India's coal reserves being able to cater to only 75% of coal requirements, and the demand for coal increasing at a CAGR of 6% every year, the imports of coal have increased substantially in order to avoid fuel shortages.

• Fuel quality of coal: India's domestic coal is characterized as a fuel with low GCV, high ash content and high moisture content, and the alternative to blend domestic coal with imported coal provides impetus to the generating stations to operate more efficiently. The increase in imported coal consumption has increased by 4.2% as shown in Figure 13.

• Increase in installed capacity: With the commissioning of larger power plants, and increase in the operating load of medium capacity (300-500 MW) power plants, has resulted in increased demand for coal

• Unavailability of gas: The utilization of NG fuel has witnessed a 4% decline between the baseline and the assessment year, majorly attributing to the low availability of gas fuel.

• Shutdown of diesel based plants: Owing to various environmental compliances and high cost of generation, various diesel based plants are also being shut down, therefore resulting in reduced consumption of liquid based fuels

1.7 About the Organisation

M/s Korba west Power company Limited(KWPCL) , a company incorporated under the companies Act 1956 and having its registered office at 301,Rajinigandha,Green Garden Estates, City Centre,Gwalior-474011,Madhya Pradesh. The KWPCL has installed capacity of 1X600 MW coal based thermal power plant at Village-Chhote Bhandar, PO-bade Bhandar, Tehsil-Pussore, Dist-Raigarh, Chhattisgarh. The main plant BTG portion was supplied by BHEL, India.

The various mile stones of KWPCL are:

Zero Date	01st May 2009
First Boiler light Up	06th Mar 2013
Steam Blowing	23rd Aug 2013
Oil Synchronisation	08th Oct 2013
COD	01st Apr 2014
72Hr. Full Load Operation	27th Feb 2015

Table 1: Mile stones of KWPCL

The KWPCL entered into a Power Purchase Agreement (PPA) with Chhattisgarh State Power Trading Company Limited on dated 09th Feb 2015 for supply of 05% of the net power generated from the power station i.e. 30 MW. As of record KWPCL do not have any Long term Open Access for its rest 95% of power. However it can sell its rest of generating power in power trading market to different open access consumers in different region of India. Another option is to put its power sell bid on the power exchange.

Fuel Supply Agreement (FSA) was made on dated 9th November 2015 between Mahanadi Coalfields Limited (MCL) and KWPCL on dated 9th Nov 2015 for the supply coal to its 600MW power plant.

Total LOA quantity is 2.315 MT, out of which 0.115749MT was allotted against long term PPA furnished (Annual Contracted Quantity-ACQ) including admissible quantity for transmission loss and auxiliary consumption (for 30 MW).However for rest 2.199251 MT coal, no long term PPA was furnished/available till date. This agreement is valid for 20 years from the effective date of 23.07.2015.

Description	**FY 2015-16**	**FY 2016-17**
Generation Capacity (MU)	5270	5256
Actual Generation (MU)	2272	2819
Plant load Factor (PLF) %	43.11	53.6
Aux Power Consumption%	6.5	5.79
Specific Oil Consumption ml/KWH	0.73	0.38
Specific Coal consumption gm/KWH	743	739

Table 02: KWPCL Statistics

If we see the performance of for the FY2015-16 and FY2016-17, it is observed that PLF in both the FY were 43.11% and 53.6% respectively. The Auxiliary Power Consumption (APC), Specific Oil Consumption (SOC), Specific Coal Consumption (SCC) are in improved trend from the FY16 to FY 17 and this indicates that Plant performance was better , but due to less demand PLF was on down trend. If plants like this is shutdown then how PAT scheme will be effective for Thermal Power's. Due lack of coal, PPA plants are stressed and whenever they are running at that time looking for profit.

1.8 Problem Statement

Business Specific

- Decision-making in India is still based on 'Investment and payback' and not on 'life cycle costing approach' leading to less efficient equipment
- Recessionary trends already putting lot of pressure on the toplines and bottomlines of DCs
- Low capacity utilization, inconsistent quality and unreliable availability of coal leads are the major impediments for PAT cycle I under achievement Lack of skilled labour leading to inefficient operations and thereby poor energy performance

ESCerts related

- In absence of price clarity for ESCerts, it is very difficult to justify any EE capex investments to the top management
- Oversupply of ESCerts likely to affect the ROI for the investment in energy efficient projects by the DCs

Regulatory

- Regulators are still unclear about the framework and methodology for PAT
- No guidelines or suggested measures by BEE for energy cost reduction
- 'Measurement and verification', an important part of baselining and improvement is still not focussed on
- CPP utilization is going down due to EE and RE measures leading to lower PLF and hence, higher SHR
- Power plants not incentivised to reduce auxiliary power consumption as PPA is silent on sale of additional energy due to efficiency improvements
- No adjustments provided in SEC for installation of additional pollution control equipment required by stringent CPCB norms

Funding related

- Credible ESCOs required for capex intensive energy efficiency projects like WHR

- Project based funding at low interest rates still very limited for energy efficiency projects
- For thermal power plants, EE capex is not considered statutory expenses unlike in case of pollution control equipment. Hence, passing such expenditure to consumers is very difficult

CHAPTER 2: LITERATURE REVIEW, POLICY REVIEW AND RESEARCH METHODOLOGY.

2.1 Literature Review

The target for the PAT scheme's first commitment period, from 2012 to 2015, is an overall reduction of 10 million tons of oil equivalent across the eight industries, which include 478 designated consumers.Each industry is responsible for a share of the total reduction target, proportional to the weight of its total energy consumption. Industry targets are further divided among the 478 designated consumers using a gate-to-gate methodology. This approach examines a designated consumer's total energy input in relation to its total product output. A baseline specific energy consumption value is first calculated for each plant, based on consumption data supplied by the designated consumer for the previous three years. Once a baseline is determined, officials analyze the plant's existing efficiency measures and potential for further improvements. The analysis includes various factors, such as production capacity, raw material quality, product mix and the age of the facility, and is used to set reduction targets, which take the form of percentage reductions from the baseline specific energy consumption value.

Under this methodology, less-efficient designated consumers are called on to reduce emissions more than more-efficient ones, relative to their baseline values. During the compliance period, the consumers will submit annual reports on their energy efficiency efforts and progress toward their targets. Companies that exceed their targets will receive energy savings certificates.4 Each certificate represents one metric ton of oil equivalent, and the number to be issued will depend on the degree of overachievement. Throughout the compliance period, the consumers can trade energy savings certificates bilaterally or through power or commodity exchanges. They can also trade "obligations," which are similar to energy savings certificates, but are based on future energy savings rather than realized efficiency improvements.

At the end of the compliance period, consumers that fall short of their targets can either purchase energy savings certificates from other designated consumers or pay a monetary penalty. The penalty for noncompliance is INR 1 million (approximately USD 18,000), plus an additional amount depending on the spread between the established target and actual performance.

Compliance is determined by a transparent measurement and verification system. Designated energy auditors conduct energy audits to verify data provided by the consumers, such as the energy performance of equipment, energy conservation options and efficiency measures already implemented by the plant. Assessments are performed for the specific energy consumption baseline year and at the end of the three-year cycle.

Audits must be consistent and impartial, following rules and procedures established by the Bureau of Energy Efficiency, and auditors must report findings clearly and openly, with supporting documentation. To ensure that auditors are accountable for the quality of their services, the Bureau of Energy Efficiency accredits only fully independent organizations with legal standing. Accredited auditors must be able to enter into binding contracts that have legal and financial consequences if the auditor fails to perform as agreed.

2.2 Policies

Major policies and regulations

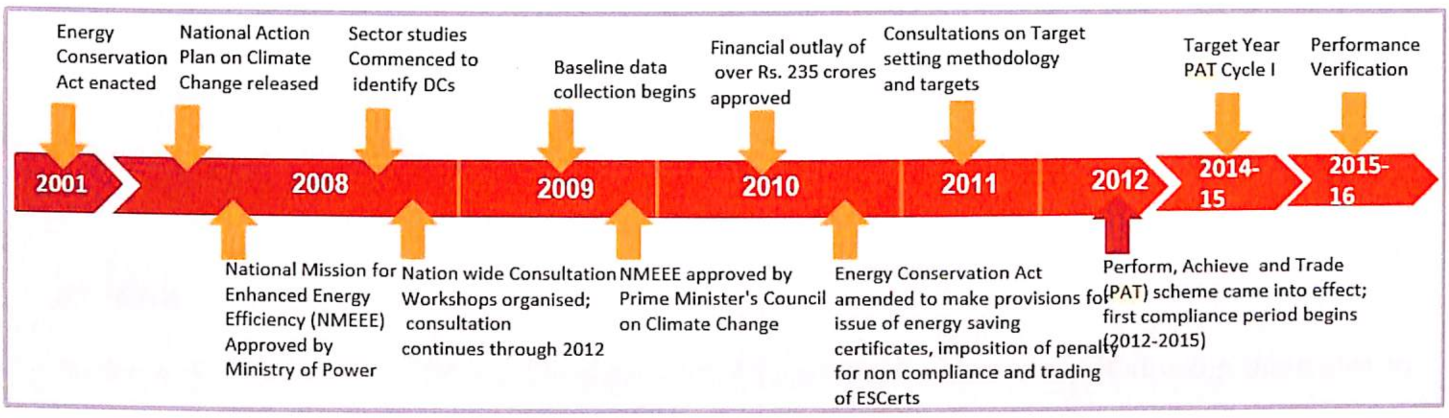


Fig .14: Major years till PAT implemented

In exercise of powers conferred under the Energy Conservation Act, 2001 (52 of 2001), the Central Government has made the following rules, namely:-

EC Rules, 2012 "Energy Conservation (Energy Consumption Norms and Standards for Designated Consumers, Form, Time within which, and Manner of Preparation and Implementation of Scheme, Procedure for Issue of Energy Savings Certificate and Value of Per Metric Tonne of Oil Equivalent of Energy Consumed) Rule, 2012.

- EC Amendment Rules, 2016

- Energy Conservation Rules, 2012 (PAT Rules)

- The procedure for establishment of energy consumption norms and standards and specify such norms and standards for Designated Consumers (Rule 3 & 4)
- Scheme for preparation and implementation of efficient use of energy and its conservation. (Rule 5)
- Assessment of Performance by the Designated Consumers with reference to the energy Consumption Norms and Standards specified for them (Rule 6)
- Procedure for Assessment of performance through Monitoring & Verification (M&V) and Check verification by Empaneled Accredited Energy Auditor (Rule 7 & 8)
- The Procedure regarding compliance with energy consumption Norms and Standards and for issue of ESCerts . (Rule 9, 11, 12 & 13).
- Role and responsibilities of various stake holders (Rule 10 & 15)
- Establishment of new Baseline for the next PAT Cycle (Rule 14).
- The procedure for notifying the price of one tonne of oil equivalent (toe) for purposes of penalty (Rule 16).
- The reporting and verification format for compliance with Energy Consumption Norms and Standards (Form A, Form B, Form C and Form D).
- The procedure and formulae for Normalization (Schedule I & II)
- The timelines for various activities under Perform, Achieve and Trade

2.3 Power sector

National Action Plan on Climate Change (NAPCC) and NDC lists out the following strategies to improve efficiency of coal-based power sector:

Assigning mandatory targets to improve energy efficiency in 144 old thermal power stations

Stringent emission standards applied to old, inefficient power plants

Installation of forty units of supercritical thermal power stations with capacity of 27.5 GW by 2022 Development of ultra-super critical technology to reduce emissions by 20%

Reduce AT&C losses to 6-8% by 2030 ySmart grid projects sanctioned in 1,412 towns

Adoption of "clean coal technologies" such as coal gasification. These technologies will make coal plants more efficient by converting coal to gas, which can be burned more cleanly in power stations but actually has a higher lifecycle carbon footprint than directly burning coal.

2.4 Carbon Emission From Power Sector

The world over consumption of fossil fuel is the primary contributing factor in the build-up of atmospheric concentration of GHGs like carbon dioxide resulting in Global warming. As per UN Human Development Report 2015, the per capita carbon dioxide emission in India is among the lowest and is estimated to be around 1.7 metric tonnes as compared to the world average of 4.6 tonnes per capita and 17.0 tonnes per capita for USA

Per capita emission of CO_2 of different countries

Country	Per capita CO_2 emission in the 2011 (tonnes of CO_2)
India	1.7
USA	17.0
Australia	16.5
U.K	7.1
Japan	9.3
China	6.7
World	4.5

Source: UNDP Human Development report 2015

Fig .15: Per Capita emission of CO2 of different countries.

About half of total carbon dioxide from India is estimated to be generated from power sector. The other major contributors of CO2 emission in our country are transport and industrial sector. CEA is annually estimating the amount of CO2 emissions from grid connected power stations. The total amount of CO2 emission from grid connected power stations in the year 2015-16 has been estimated at 846.3 million tonnes. Year wise carbon di-oxide emissions from Indian power sector during the last 5 years are given in Figure 16

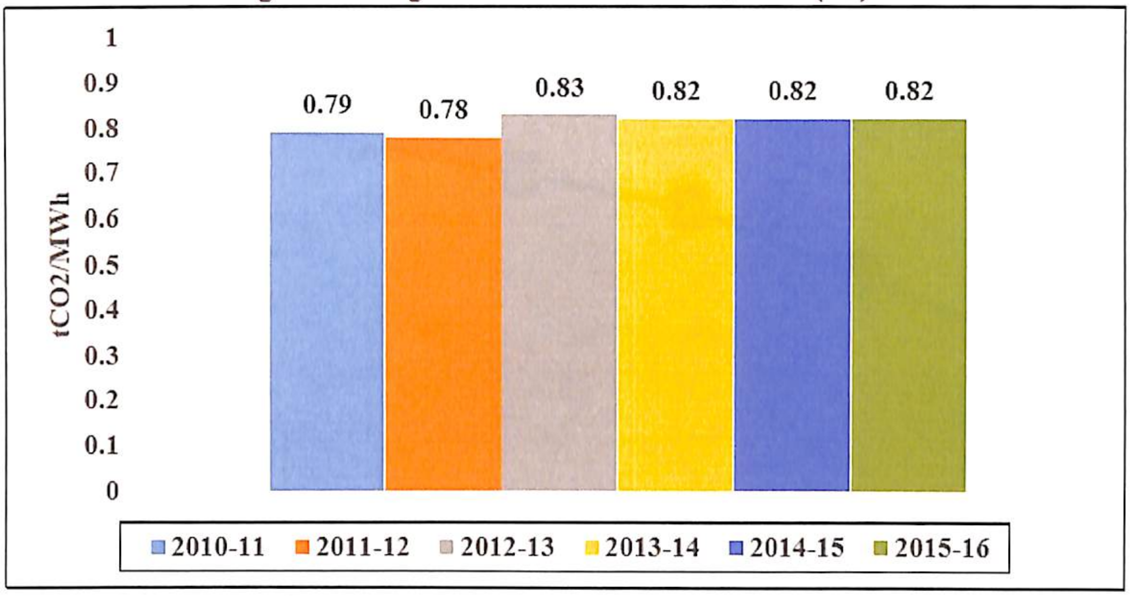
Total Absolute Carbon Di-oxide Emissions of the power sector (2010-11 to 2014-15) in Mtonnes CO_2

	2010-11	2011-12	2012-13	2013-14	2014-15	2015-16
India	598.35	637.8	696.5	727.4	805.4	846.3

Source: CEA CO_2 baseline database for the Indian power sector version 11.0 March 2016)

Fig.16: Total Absolute CO2 Emission of the power sector

In the year 2015-16, the weighted average CO2 emission rate from grid connected power stations (excluding captive power stations and stations on islands and from Renewables) is 0.82 kgCO2/kWhnet. During the year 2015-16, the weighted average has increased marginally due to the increase in percentage of coal-based generation and decrease in hydro and gas based generation.



Source: CO2 baseline database for power sector

Fig. 17 :Year wise weightage average emission factors

The CO2 emission from gas based power stations is almost half of that is generated by coal based power stations. The weighted average CO2 emissions for various fossil fuels used in Indian power stations are shown in Figure 16

Weighted average specific emissions for fossil fuel-fired stations in FY 2015-16, in tCO_2/MWh_{net}

Coal	Diesel	Gas*	Lignite
0.99	0.57	0.46	1.36

Fig. 18 : Weighted average CO2 emissions

The weighted average emission rate of coal and lignite based generation is 0.99 kg CO2/ kWhnet and 1.36 kg CO2/ kWhnet respectively during the year 2015-16. However, the average emission rate from coal based stations has been on declining trend due to the fact that more number of efficient supercritical technology based units are getting commissioned and also due to introduction of Perform Achieve and Trade (PAT) scheme which aims at improving the efficiency of power plants.

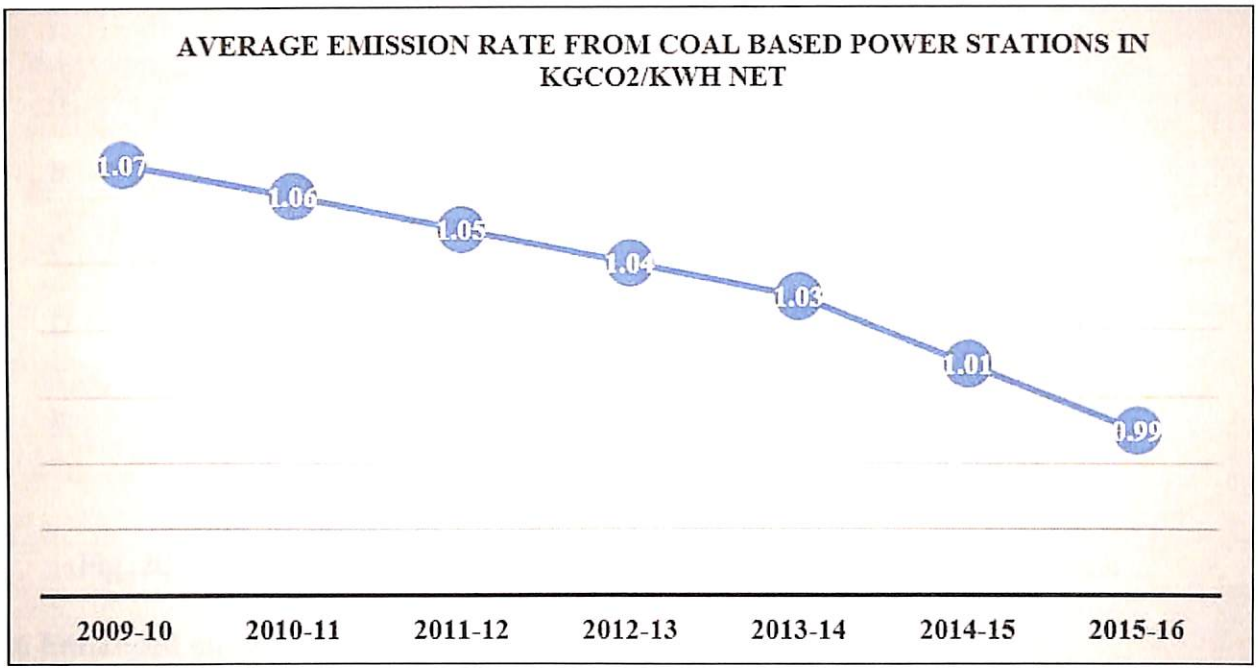


Fig. 19 : Avg Emission Rate from Coal Based Power Stations

2.5 Impact On CO2 Emissions Due To Capacity Addition From Supercritical Technology Based Coal Power Stations

With the rapidly expanding thermal generation capacity, installation of large size supercritical units is being encouraged to enhance efficiency of power generation, reduce coal consumption and GHG emissions. Supercritical technology based units have about 2% more efficiency than sub critical technology based power plants. The country is going ahead with installing Supercritical technology based units in recent time. As on 31st March, 2017, 60 No. of units based on Supercritical technology have already been commissioned. An Analysis has been carried out to estimate reduction of quantum of amount of CO2 emissions by installing supercritical units in the country by 31st March,2017. It shows that about 20.69 Million tonnes of CO2 emissions have been avoided due to commissioning of Supercritical technology based units assuming that business as usual scenario would have been commissioning of sub critical technology based units. Details of the analysis is given in Figure 18.

Impact of Supercritical technology based units on CO_2 emissions

A	Total Generation capacity added from Supercritical units as on 31.3.2017	**41,310 MW**
B	Total actual gross generation from Supercritical units during 2016-17 in Million Units	**559,314.6 MU**
C	Business as usual :500 MW subcritical: estimated CO_2 emission (Kg CO_2/kwh Gross) [based on designed heat rate]	**0.853**
D	Super Critical Units: Estimated CO_2 emissions (Kg CO_2/kwh Gross) [based on designed heat rate]	**0.816**
E	CO_2 emission reduction {(C-D)/1000 x B in Million Tonnes	**(0.037*/1000) x 559,314.6= 20.69 Million Tonnes**

Fig. 20 : Impact Of Supercritical Technology based units on CO2 emissions

2.6 Enhanced energy efficiency

Earlier assessments of future installed capacity in various studies (including IEA) have been revised and lowered down as energy efficiency has brought significant decrease in demand. The trend in reduced demand is expected to continue through policy instruments like PAT scheme for industries, LEDs for lighting etc. Regulatory and disciplinary actions are also resulting in reducing commercial and line losses. Promoting smart grids and smart meters would rationalize the consumption and improve the grid performance.

Figure 18 presents sectoral breakdown of emissions in NDC scenario. The share of emissions from power sector initially increases to 48% in 2020 from 43% in 2010, and subsequently decreases to 37% in 2050. This trend is observed due to a combined impact of 1) increase in renewable share, 2) decrease in ATC losses, and 3) increase in fuel and technical efficiency in thermal based power plants. The share of industry sector is observed to decrease from 41% to 39% due to implementation of energy efficient programme (PAT) under NMEEE. There is an observed increase in share of building sector from 5% to 9% and transport sector from 11% to 15% due to growing energy demand resulting from rising urbanization and increasing income of the population The demand for electricity has been increasing considerably at a rate of 5-7% across all the sectors. The energy supply mix is heavily dependent on the fuel based on its availability, accessibility, affordability geographical location, demand of end-use sectors and price. As observed in Figure 19, coal occupies more than 70% of the fuel mix in 2010, which is reduced to 28% in 2030 and 24% in 2050. At the same time, the share of natural gas increases form 13%

in 2010 to 35% in 2050. With cancellation of several UMPPs and bouts of acute shortage of coal stock in new super-critical power plants, cutting tax rate , natural gas will grow to be a good contender against coal as it takes very less time to start-up or shut down for NTPC and state-owned power plants that have fully and/or partially operated systems. Efforts have been made by the central government to shift towards cleaner and renewable fuels in order to meet the NDC commitments by 2030. The government push has resulted in solar gaining prominence in the renewable mix share. Solar energy occupies 17% of energy mix in 2050 followed by wind (5%).Industry is the second largest energy consumer. The energy demand has been growing since 2000 and is targeted to increase further due to renewed thrust on industrial growth under the 'Make in India' policy of the present government (Vishwanathan et al., 2017). The introduction of perform, achieve and trade (PAT) represents an attempt to reduce energy intensities along with overall energy consumption by targeting LPS that have been identified as energy-intensive designated consumers. Figure 14 shows the fuel mix in industry sector. The share of coal in the energy mix reduces from 56% (2010) to 54% (2050), while that of gas and electricity increases 6% and 12% to 13% and 18% respectively. The decrease in coal consumption is due to improved efficiency and fuel shift to natural gas and electricity in energy intensive industries (iron and steel, cement). Thermal coal consumption increases at growth rate of 2.2% till 2030 and at a rate of 0.5% from 2030-2050.

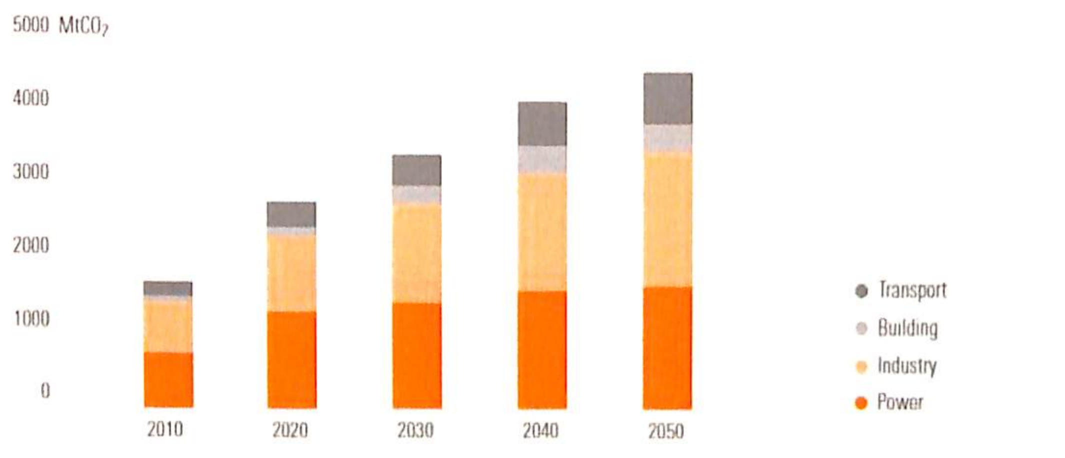


Fig. 21 : Sectoral Breakdown of emission in NDC scenario

Thermal consumption NDC scenario

Energy Mix in Power sector NDC scenario

Technology Used In Coal Plant, PAT target setting for thermal plant

Projections of reduction of energy demand for the year 2017-2022, Sectoral Snapshot

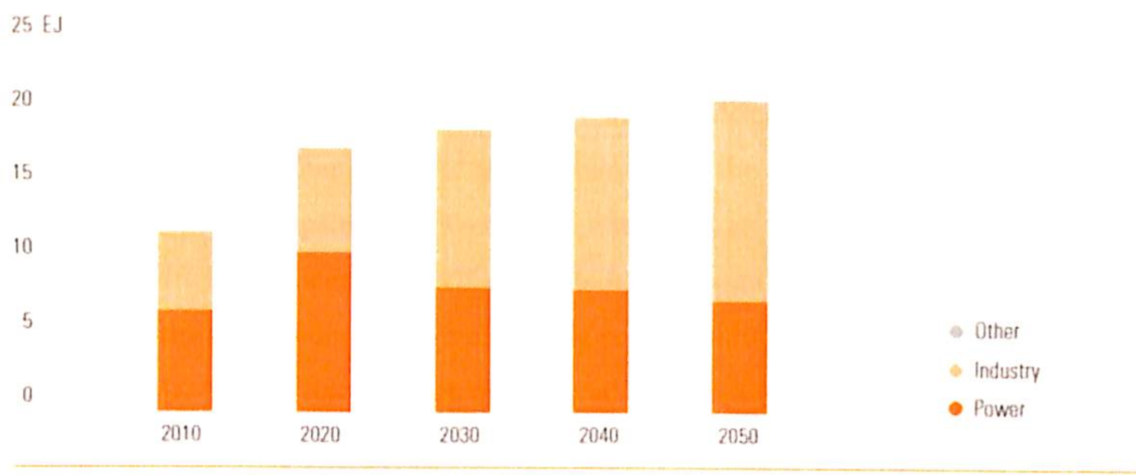


Fig.19: Thermal consumption NDC scenario

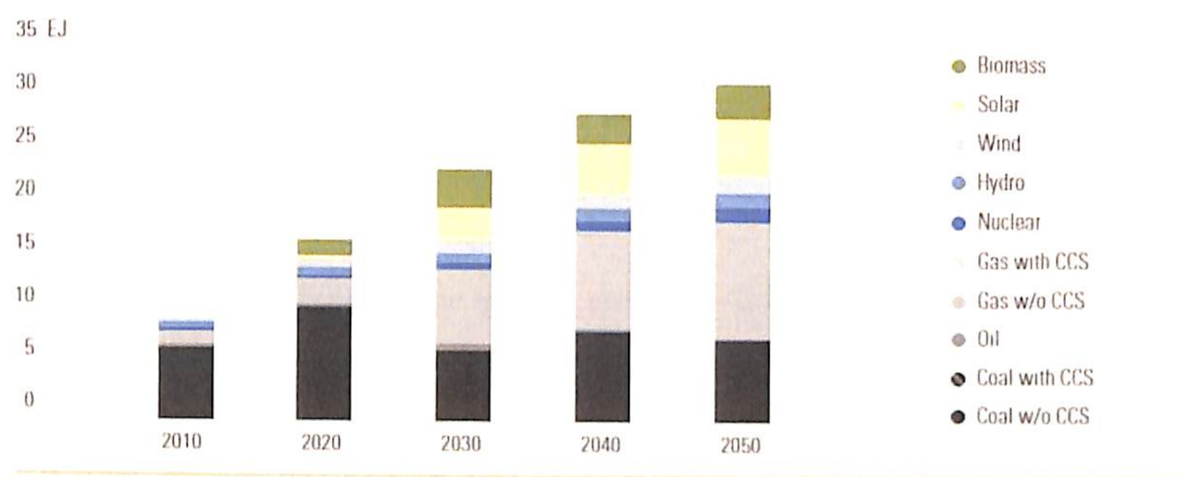


Fig. 20 : Energy Mix in Power sector NDC scenario

Power Phasing out of old, inefficient power plants with new super-critical plants India has cancelled 52% (451.6 GW) of planned coal capacity between 2006-07 and 2016-17 (Shearer et al. 2017). As mentioned in Section 1, NTPC (along with state and private) plans about 92 GW of super-critical plants by 2027 and phase out about 50 GW of old power plants due to age and other problems (air pollution, water). At the same time, it is renovating and modernizing the middle aged power plants (above 20 years). NDC scenario does observe stranded power plants in lieu of shifting towards cleaner fuels after 2025. Nevertheless, the share of stranded assets in sustainable 2°C scenario increase by 34% due to shift towards natural gas, renewables and nuclear. Each of the fuel sources faces unique opportunities and challenges in the event of rapid scale up in the next decade.

Adjusting the power market design to more efficiently integrate renewables and thermal power generation. As higher levels of renewables enter the market, the remuneration design may need to change in order to provide power to the entire Indian population including energy poor at reasonable prices. Efficient power production needs to be promoted with increasing share of renewables while keeping the average and marginal costs of power within reasonable levels. While the existing coal-based power plants may have higher operational expenses (opex), the renewable plants may have a higher capital expenditure (capex). The peak and off-peak scheduling needs, and intermittency of renewable power creates further challenges. The asset ownership model, the opex model and the capex model would need to be therefore improved for an optimum economic dispatch of power so that overall power delivery costs remain viable for producers and affordable for users. Moreover, coal-based power plants are not flexible to adjust to load variations. The market design may therefore need to evolve to allow for more effective remuneration of coal assets that follow the residual load and which are remunerated not just for schedule-based generation, but rather for generation and for market services in addition to basic generation.

Improving the efficiency of the existing coal fleet As a first step, India can and should significantly enhance the efficiency of its coal resource use by improving on current NDC policies, such as: Phasing out more old, inefficient plants. The power plants commissioned to be built after 2022, or 2027 should not be installed. This is because there is a high probability that they will become stranded due to shift in energy mix under a carbon constraint; All newly built plants that have been mandated should have super-critical technologies with water efficient or dry cooling technologies based on their geographic locations Improve PLF of coal (current0% to 75-90%) and gas (current 25% to 70-90%) power plants; Reduce energy demand through energy efficiency and energy conservation measures in power and other end use (PAT sectors and 778 plants, transport, buildings, agriculture) sectors through smart grids and micro-grids.

2.7 Downtrend in Independent Power Producer's Plant Load Factor

India's financial year (FY) 2018-19 was marked by a record slowdown in thermal generation capacity additions in the electricity sector.

From the highs of 20 gigawatts (GW) of new coal-fired power plants commissioned every year between FY13 to FY16, net capacity additions from coal over the past three years have been 7 GW, 5 GW and 1.2 GW, respectively.

The FY19 net capacity additions for coal account for 3.3 GW of new capacity added during the financial year minus 2.1 GW of capacity retired up to 11 months (plant retirement data is not yet published for March 2019).

The continued decline in thermal capacity additions is the result of a fundamental change in electricity market dynamics driven by competition from cheaper renewable energy sources.

Lack of policy clarity and power evacuation infrastructure, the imposition of trade duties on imported solar modules, and the high number of tender cancellations materially tempered the momentum in renewable generation capacity as well.

Only 6.7 GW of renewable capacity was added until February 2019 compared to 12 GW added during the previous financial year.

Renewable energy tendering activity is still exhibiting the pace required to achieve the government's ambitious target of 175 GW of renewable capacity by FY22.

According to the Ministry of Renewable Energy's recent statement, 75 GW of renewable capacity has been installed, 28 GW auctioned and 38 GW of capacity is under various stages of tendering and bidding. Further, more than 95 per cent of awarded variable renewable capacity last year came in at sub-Rs. 03 per kilowatt hour (kWh).

India's timely transition to a low-cost, lower-emission, domestic-focused electricity sector is inevitable. New Global Energy Monitor (GEM) data released in January 2019 showed that state-owned thermal power giant NTPC proposed more than one-fifth of the country's pipelined capacity that currently lies in various pre-construction stages.

Private players are especially vulnerable because they cannot receive letters of assurance for coal allocation without PPAs. Domestic coal prices have also been increasing year-on-year over the past six years, and already financially strapped generators must pass on that cost to consumers.

Yet another issue assailing generators is the exorbitant cost of freight, which constitutes 20% to 30% of fuel costs for thermal plants – which are typically sited away from coal sources. "Freight charges in India are among the highest in the world," and they have increased by nearly 50% over the last five years alone.

Finally, compounding supply and demand challenges faced by coal generators, a large number of projects experience execution challenges, which inevitably result in delays and cost overruns.

2.8 Reason behind Low PLF

It is clear that the low PLF was not just on account of coal shortage, as it was made out to be. The low PLF is, paradoxically, an indicator of excess base load capacity in the system, even when there are shortages during peak hours. Due to the cyclical nature of demand, several coal plants operate at sub-optimal loads during the night and off-peak hours, resulting in low, average annual PLF. Not only does such cycling cause harm to the machinery, but adds inefficiencies to generation.

Reserve margin of a system is defined as the difference between the Installed Capacity and the peak load met as a percentage of the peak load met. This factor depends on a number of parameters, major ones being the mode of power generation i.e. hydro, thermal, and renewable and the availability of the generating stations which primarily is a function of forced and planned shutdown of the generating units, capacity of the Discoms to procure power. This increase in Reserve Margin is on account of decrease in thermal PLF from 73.32 % in 2011-12 to 59.88 % in 2016- 17.

Lowest PLF, even when the output has touched a trillion unit mark is a concern which needs to be examined and corrective action needs to be taken. Otherwise, the burden of under utilised capacity will have to be borne by those same consumers for whom various subsidy schemes are being worked out. A possible solution to this is that certain flexible technologies like storage hydro plants and gas-based reciprocating engine plants are also made part of the system. This will not only bring down the overall investment requirement for the same installed capacity, but also improve efficiency of the coal or base load stations by allowing it to operate at optimum PLF, while the variability is taken care by flexible plants.

The reason behind the low PLF could be that there has been a sharper increase in total capacity as compared to the growth in demand. Coal shortages and grid problems are also responsible. But a more fundamental problem is the dysfunctional nature of distribution companies (DISCOMS) – inefficiently run with huge losses, they don't have the money to buy power and supply it to people. Meanwhile, huge generating capacity lies idle. This also exacerbates pollution problem – DISCOMS prefer buying from the older, more polluting power plants because their electricity is cheaper than that generated by the new plants.

This happens because the old plants are fully depreciated and, as a result, their input cost is lower. While the introduction of standards for new plants is a welcome move, more work is needed to address impacts of the existing old power plants. Old plants accounted for the bulk of the environmental impacts in the CSE study. Without stricter requirements on old plants, there will be little incentive to invest in improved technologies.

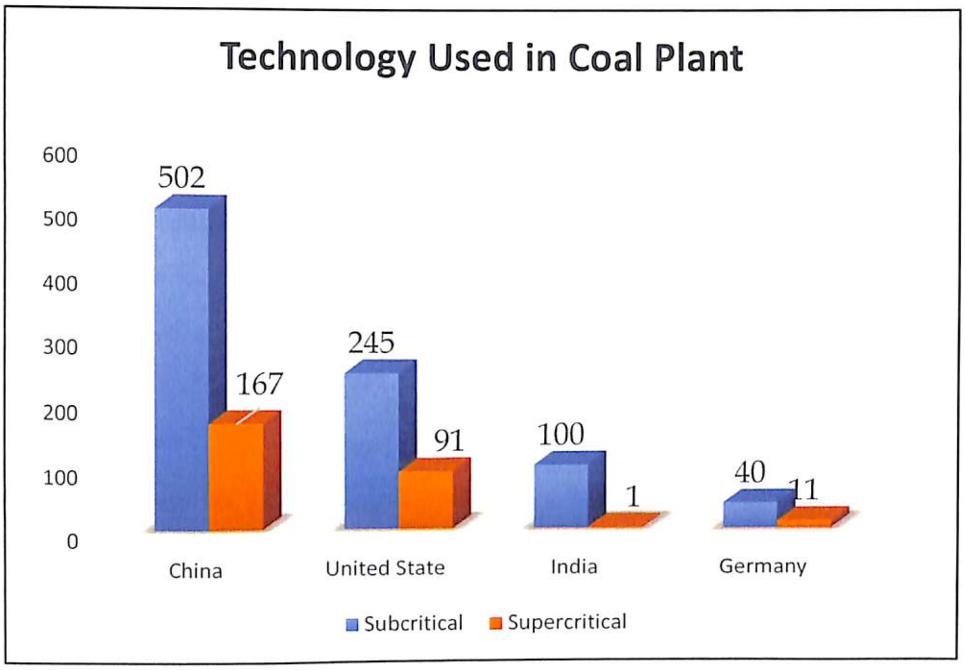


Fig. 21: Technology Used In Coal Plant

In a recent departure from its policy to retire relatively small capacity (around 4 GW of capacity in the 13th Five Year Plan period), the government announced it plans to retire 36 GW of old coal-fired units.

2.9 Way to Improve Low Plant Load Factor

Development of Power Projects on Tariff Based Bidding ensures the competitive procurement of electricity by the distribution licensees is expected to reduce the overall cost of procurement of power and facilitate development of power markets. As per the revised Tariff Policy "All future requirement of power should continue to be procured competitively by distribution licensees except in case of expansion of existing projects or where there is a company owned or controlled by the State Government as an identified developer and where regulator will need to restore to tariff determination based on norms provided that expansion of generation capacity by private developers for this purpose would be restricted to one time addition of not more than 100% of the existing capacity.

Development of Ultra Mega Power Projects.

Development of Ultra Mega Power Projects is to achieve faster capacity addition and to minimize the cost of power to consumers due to economy of scale. Four UMPPs were awarded to the developers selected through tariff based competitive bidding which are Mundra UMPP in Gujarat, Sasan UMPP in MP, Krishnapatnam UMPP in AP and Tilaiya UMPP in Jharkhand. All units of Mundra UMPP (5X800 MW) and Sasan UMPP (6X660 MW) have been commissioned. The developer of Krishnapatnam Ultra Mega Power Project, namely M/s Coastal Andhra Power Ltd (CAPL), had started the construction work but has stopped the construction work citing new regulation of the Government of Indonesia as the reason which prohibits sale of coal, including sale to affiliate companies, below bench mark price. Andhra Pradesh Southern Power Distribution Company Limited (APSPDCL), who is the lead procurer from Krishnapatnam Project has issued termination notice to Coastal Andhra Power Limited (CAPL). CAPL had approached the High Court of Delhi. The Delhi High Court has dismissed the petition of CAPL on 2nd July, 2012. CAPL has approached Division Bench, Delhi High Court as well as Indian Arbitrator Council for arbitration. The matter is subjudice. For Tilaiya UMPP, the developer (Jharkhand Integrated Power Ltd, a subsidiary of RPL) has issued notice of termination of Power Purchase Agreement on 28th April, 2015 citing non transfer of land to the developer by the Jharkhand Government. Procurers have accepted the termination notice in November, 2015 and after transfer of

SPV (Special Purpose Vehicle), necessary development activities for re-bidding would be started as per revised standard bidding documents(SBDs).

Distribution is the most important link in the entire power sector value chain. As the only interface between utilities and consumers, it is the cash register for the entire sector. Under the Indian Constitution, power is a concurrent subject and the responsibility for distribution and supply of power to rural and urban consumers rests with the States. However, Government of India provides assistance to states through various Central sector / centrally sponsored schemes for improving the distribution sector.

Efficient operation of the thermal unit is very critical due to cost and reliability factors. The cost implication due to excess in the heat rate, oil consumption, make-up water consumption, excess air, condensed back pressure, etc indicate the urgent need to control these parameter. Autonomous & IT system have made the power plants much more efficient and faster.

3.0 RESEARCH METHODOLOGY

In this project, Descriptive and Historical research methodology is used for various analysis. Descriptive research is usually a fact finding approach generalizing a cross-sectional study of the present and future energy market condition in India.

In addition to the Indian and English literature review on different energy efficiency measures to save electricity, the study is also relied on one primary methodological tool, observation, and other secondary methodological tool, web based data and print media. Salient points of the methodology adopted for this research are discussed here. a. Identifying Respondents. PAT may be a Market primarily based mechanism to reinforce energy potency measures in energy intensive industries. Interviewing the respondents to find out their reviews, positive and negative impacts of PAT cycle can facilitate India to induce clear plan regarding the results of PAT cycle one at the top of 2019.

b. Sources/Tools of Data Collection: Industrial sectors underneath PAT theme can bear watching and verification section. This section forms the backbone of the assessment method of PAT theme. In this project assembling actual information relating to pat cycle from industrial sectors is tough as a result of industries being government adjusted, they may or they will not share there company information thanks to its confidentiality.

Does the design of PAT incorporate the key elements of a well-functioning market based regulatory instrument?

PAT is the first of its kind energy efficiency trading scheme in the domain of environmental policy in India. Thus within India there is no precedence of a similar scheme.

Four key design elements has been identified for assessment, these include flexibility, simplicity, monitoring and verification protocol and quantum of penalty.

What is the potential economic efficiency of the PAT scheme?

This criterion is selected to assess the overall economic efficiency of the PAT scheme, including social and environmental impact of the scheme. The target of the PAT scheme is to save energy through improvements in energy efficiency. Through this process of energy savings, equivalent amount of carbon intensive energy production in India would be avoided. There exist a number of negative effects with respect to carbon intensive fossil fuel based energy generation. These include, effect on human health, negative impact of climate change on global ecosystems and all of their associated negative social implications

Does PAT promote cost-effective improvement in energy efficiency in the industry?

In PAT each individual plant has the three options of compliance; (a) by investing in energy efficient technologies, (b) by buying the energy efficiency certificates and (c) by a combination of both investing and buying of certificates. From financial perspective the specific strategy of compliance chosen by each plant would be guided by their respective marginal cost of energy efficiency improvement. The marginal cost of energy efficiency improvement varies between different industrial sectors as well as between different plants within a sector.

CHAPTER 04: ANALYSIS & REMEDIAL ACTION

4.1 Analysis

Simple rule for target setting and compliance assessment method are considered essential to reduce contestability and chances of manipulation of the system. The salient features of the rules for establishing the (i) baseline SEC, (ii) target setting, (iii) compliance assessment and; (iv) normalization process are briefly described below.

- Baseline specific energy consumption:

The baseline specific energy consumption will be calculated as per the following formula.

SEC=Total Energy input to the plant boundary/Quantity of the product

In addition following guidance is provided for the estimation of the baseline energy efficiency.

(a) The total energy input would be the normalized average of the baseline period 2007-2010

(b) All forms of energy except renewables will be considered as energy input

(c) What constitute product is clearly defined in the methodology. For power sector it is electricity measured in Million kWh.

Target setting

First of all PAT has a broad sector specific targets. Further these broad targets are disaggregated at each individual plant level within a sector, such that the total savings from all the plants within a sector is equal to the sector wide target. The decision to set plant specific target has been taken to avoid complexity of adjustment with respect to individual plant specific characteristics, such as, age of plants and machinery, technologies, raw materials, product mix, which might have been required in case a common sector specific target was to be mandated. Further it is believed that plant specific target would also minimize any intrinsic technological barriers that might prohibit achievement of the targets. The basic philosophy for target setting is to give the lowest target to the best performing plant and highest target to the worst performing plant with respect to energy efficiency. The methodology for target setting is same for all sectors except for power plants.

For power sector the principle of target setting is based on the deviation from operating efficiency from the design efficiency. For plants which are operating at much lower operational efficiency than the design efficiency, the target is higher and for plants operating close to the design efficiency the target is lower. The range of target depending upon the variation of operational heat rate from design heat rate. As mentioned before heat rate is the chosen parameter for energy efficiency in power plant under the PAT mechanism.

Variation in net station heat rate from design heat rate	Reduction target for % deviation in the net station heat rate	% reduction target in net station heat rate
Up to 5%	10%	0.5
More than 5% and up to 10%	15%	0.75 to 1.5
More than 10% and up to 20%	20%	2 to 4
More than 20%	25%	5 and above

Fig. 22: PAT target setting for thermal plant

- Compliance assessment: The formula for compliance assessment under PAT scheme is the following.

Energysaving=P(base year){SEC(base year)-SEC(target year)}

Where, P(base year): Production in base year

SEC(base year): Specific energy consumption in the base year

SEC(target year): Specific energy consumption in the target year

4.2 Technological barrier assessment

At the outset it needs to be mentioned that an exhaustive assessment of the technological barrier for energy efficiency improvement in the thermal power and iron and steel sectors is beyond the scope of this thesis. Instead, focus of this assessment is to identify the key generic elements of technological barriers both for the thermal power. Literature reviews and interviews have revealed the following four elements of technological barriers to energy efficiency improvement with respect to India. These include, (1) availability of technology, (2) raw materials, (3) age of plant and machinery and (4) plant layout. Brief discussions on each of these four elements are presented below.

(1) Availability of technology:

The National Mission for Enhanced Energy Efficiency document mentions that the achievement of the targets under PAT cycle 1 is possible through implementation of the existing technologies in each sector (Ministry of Power and Bureau of Energy Efficiency 2008). Taylor et.al., (2008) in their report on financing of energy efficiency measures in India, China and Brazil also mentions that technology for energy efficiency improvement are available in India. However, one important aspect of technological barrier has been revealed during the interviews. Particularly the respondents from the thermal power sector have mentioned that often they find it difficult to find technology supplier who will provide services for energy efficiency improvements through retrofitting measures. Typically the big power plant technology suppliers are not interested in engaging themselves in the retrofitting exercise; instead they push for replacement of the old equipment. The interviewees have mentioned that cost of achieving the same amount of energy efficiency improvement by retrofitting is often 5 to 6 times less as compared to replacement of the entire equipment. Interviewees felt that promotion of energy service companies (ESCO) can potentially remove this barrier.

2) Raw materials:

There are mainly two issues pertaining to raw materials that can impact the energy efficiency performance of thermal power. These are availability and quality. Shortage of raw material restricts the capacity utilization and thus increases the energy intensity of production. Quality of raw material can make specific processes of production more energy intensive.

Availability of raw material has been found to be a particular problem for the natural gas based power plants in India (Press Trust of India 2011). During the interviews the respondents associated with the natural gas based power plants have mentioned, that their specific energy consumption has been very high in the past due to acute shortage of raw materials. The interviewees have mentioned that the gas availability is as low as 60%-70% of he total requirement. The respondents have mentioned when the gas is available the energy efficiency of natural gas based power plants improve significantly and operates within 5% of the net design efficiency.

Quality of raw materials impact the energy efficiency performance of both coal fired power plant. For coal fired power plant the problem is with respect to ash content and moisture content of the coal (BEE 2011). The higher the ash and moisture content, the lower the specific energy consumption of power generation. Indian coals generally have high ash content and thus restricts the power producer to achieve improvement in energy efficiency of operation (Sinha & Kumar 2009). A number of power producer in India also imports high quality coal with low ash content from abroad (BEE 2011) to mitigate this problem but this again adds to the cost of power generation, since imported coal is costlier than the domestically produced coal.

(3) Age of plants and machinery:

The age of plants and machineries is an important factor affecting the energy efficiency performance of both thermal power plants. Ageing of equipment results in wear and tear and reduces its original design efficiency of operation. The ageing of plants and machinery at times prohibits improvement of energy efficiency improvements. The problem is similar in public sector coal fired power plants in India, most of which has a capital stock of more than 20 years old as compared to the newly built more efficient power plants in India (Shanmugam & Kulshreshtha 2005).

(4) Plant layout:

The plant layout at times can be an impediment for energy efficiency improvement.

CHAPTER 05 : SUGGESTION CONCLUSION AND SCOPE OF FUTURE WORK

5.1 Conclusion

However, the real outcome of PAT scheme is not only the savings in terms of toe and CO2, but it is the change in behavior towards energy efficiency. It is astonishing to see the amount of resources and concepts the industries have put together in achieving the target. Some state-of-the-art projects implemented in PAT cycle-I are cross cutting and could have significant potential across the sectors. Some of the positive outcomes of this scheme were the utilization of waste heat in generation of steam and power, adoption of cogeneration, use of alternate fuel and raw material.

The objective of this research was to evaluate the first compliance period (2011-14) of Perform Achieve and Trade (PAT) scheme currently proposed in India against four criteria. These four criteria were; (i) design of PAT; (ii) economic efficiency; (iii) cost-effectiveness; and; (iv) assessment of barriers to energy efficiency improvement. The focus of the evaluation was on thermal power This sector is the most dominant sectors among all the eight industrial sectors covered under PAT, from the perspective of the share of annual energy consumption. To define the specific scope of assessment, a number of specific guiding questions were also formulated under each of the four criteria.

The design assessment of PAT reveals that PAT provides a number of flexibility to designated consumers with respect to compliance options. This aspect together with the formulation of simple methodological rules with respect to baseline and target setting and compliance assessment are the positive features of the design. The main concerns with respect to design are the lack of a detailed monitoring and verification protocol and low level of penalty which is not found to be a sufficient deterrent to non-compliance. It is learnt during the research that Bureau of Energy Efficiency is currently in the process of preparing a detailed monitoring and verification protocol and is also considering to revise the penalty amount. Addressing these two concerns is deemed to be important to achieve satisfactory performance of PAT.

The evaluation indicates that if the two sectors comply with the energy efficiency target assigned to them, the same would provide significant net positive benefit to the society. Thus it can be said that PAT promises to improve energy consumption behavior in the industry in an economically efficient way.

However, at least in the first cycle of PAT, equalization of maximum marginal cost of energy efficiency improvement is not expected, due to setting of apparently easier level of target for energy efficiency improvements in this sector. Thus the first cycle of PAT does not promise to enable cost effective energy efficiency improvement in the chosen sector.

The potential for improvement of energy efficiency has been found to be substantial in thermal power. The role of PAT is expected to be important, considering PAT is the first regulatory instrument which mandates energy efficiency improvement in the large scale industrial sectors. However certain barriers, particularly the institutional and technological barriers are found to be the most significant which can hamper the performance of the PAT in near future.

In general it can be said on the basis of the assessment, that PAT is a very promising instrument which has the potential to play a major role in providing momentum to the improvement of energy efficiency in Indian industrial sector. The most significant positive aspect of PAT is in its potential to provide substantial net positive socio-economic benefit to the society. However, this socio-economic benefit will be only realised if PAT achieves 100% compliance. Two most important issues which can hinder the 100% compliance level in near future are penalty for non-compliance and institutional barrier. The assessment reveals the present level of penalty does not appear to be a significant deterrent to non-compliance. In addition, institutional barrier with respect to capacity of the government agency in charge of PAT (Bureau of Energy Efficiency) to administer the scheme can be a major hindrance to

achieve 100% compliance. Further in future beyond the first compliance period, informational, financial and technological barriers can be a major deterrent for full compliance, unless efforts are taken to alleviate these barriers. Another drawback of PAT at least in its first cycle is the lack of ambitious target. This reduces the cost-effectiveness of the scheme. In absence of cost-effective compliance of energy efficiency targets, the least cost equilibrium outcome of PAT will be prohibited. This in turn will reduce the net positive socioeconomic benefits to the society by increasing the total cost of compliance. The transaction cost has been estimated to be nominal in the present format of PAT. However, in future when the scope of PAT is expected to have wider sectorial coverage, unless various barriers are eased, the transaction cost will tend to be higher and in turn will impact both economic efficiency as well as cost-effectiveness of the scheme.

The author of this thesis hopes, that this small research endeavor will provide some meaningful early insights to stakeholders of the PAT scheme, which will help in further improvement of the scheme. Hopefully the research will also help in providing some useful information on the application of market based instruments in Indian context.

A logical next step from this research is to assess the actual performance of the PAT scheme in its post-implementation phase. Hopefully this research can provide some foundation to the potential future research endeavors on PAT.

A number of other potential research areas have also been identified during the course of the thesis. These include; (i) quantification of transaction cost to energy efficiency improvement in various energy consuming sectors in India; (ii) quantification of local and global externality of Indian coal fired power plants; and; (iii) the impact of behavioural, managerial and organisational barrier to energy efficiency improvement in Indian corporations.

Projections of reduction of energy demand for the years 2017-22

Program	2017-18	2018-19	2019-20	2020-21	2021-22
S&L (BU)	56.49	60.33	64.43	8.81	73.49
Buildings (BU)	6.52	8.04	9.64	6.25	6.56
Agriculture(BU)	0	2.7	3.6	4.59	5.63
Industries (PAT Scheme)(BU)	29.7	49.17	61.33	78.11	90.37
National Energy Conservation Awards (NECA)(BU)	13.8	14.2	15.2	16.3	17.4
LED Domestic Lighting(BU)	28.87	39.375	42.5	43.6	45.3
LED Street Lighting(BU)	5.2	7.6	9.7	9.9	10.3
Total (Billion Units)	**140.5**	**181.4**	**206.4**	**227.5**	**249.0**
Savings (million toe)	35.14	45.36	51.61	56.89	62.27
Peak Avoided (MW)	7,693	8,411	8,838	9,432	10,055
Peak Avoided (MW) due to installation of SWHS*	800	800	800	800	800
GDP (Billion ₹)	81,138	86,798	92,852	99,328	1,06,256
Savings/GDP (kgoe/ ₹ GDP)	0.00043	0.00052	0.00056	0.00057	0.00059
Energy Intensity (BAU) - kgtoe/₹ GDP	0.012	0.011	0.011	0.011	0.011
Energy Intensity Reduction (%)	**3.58%**	**4.73%**	**5.09%**	**5.18%**	**5.36%**

Fig.23: Projections of reduction of energy demand for the year 2017-2022

Projections of reduction of energy demand for the years 2022-27

Program	2022-23	2023-24	2024-25	2025-26	2026-27
S&L(BU)	78.49	83.82	89.52	95.61	102.11
Buildings(BU)	6.89	7.23	7.59	7.97	8.36
Agriculture(BU)	2.93	2.03	1.04	0	0
Industries (PAT Scheme) (BU)	98.9	107.7	116.7	126.0	136.1
National Energy Conservation Awards (NECA) (BU)	18.6	19.9	21.3	22.8	24.4
LED Domestic Lighting(BU)	47.4	49.3	51.0	52.6	54.1
LED Street Lighting(BU)	10.8	11.2	11.5	11.8	12.0
Total (Billion Units)	**263.92**	**281.16**	**298.74**	**316.74**	**337.12**
Savings (million toe)	65.98	70.29	74.68	79.19	84.28
Peak Avoided (MW)	10569	11169	11811	12494	13225
GDP (Billion ₹)	113667	121595	130076	139149	148854
Savings/GDP (kgoe/ ₹ GDP)	0.00058	0.00058	0.00057	0.00057	0.00057
Energy Intensity (BAU) - kgtoe/₹ GDP	0.010	0.010	0.010	0.010	0.009
Energy Intensity Reduction (%)	**5.80%**	**5.80%**	**5.70%**	**5.70%**	**6.33%**

Fig.24: Projections of reduction of energy demand for the year 2022-2027

5.2 Scope of Future work

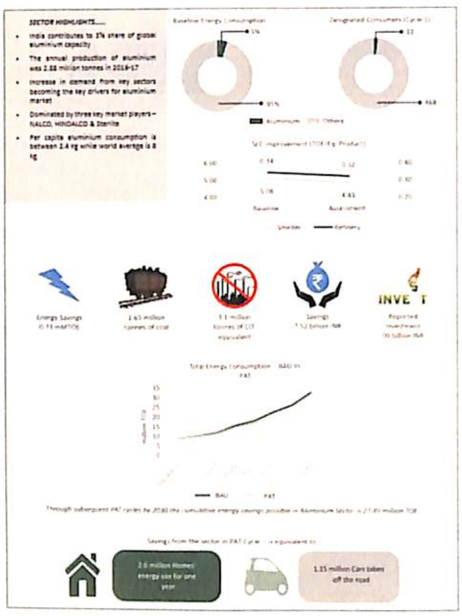
The Bureau of Energy Efficiency is developing an online platform "PAT- Net", a control software which is an online integrated information system for operation, transfer, trading, data management for cancellation and creation of ESCert.

The PAT mechanism will improve the energy efficiency in the designated industries which heavily depend on the non renewable source of energy. It helps the industries to incorporate more and more new technology into the existing system which improve the station heat rate which in turn reduces the consumption of coal and reduce the cost of generation of electricity. The greenhouse gas emission can also be controlled by the implementation of PAT as per the The National Action Plan on Climate Change (NAPCC). There should be also a mechanism to include small and medium scale industries to the boundary of PAT by doing this we can have an affective and efficient energy conservation among all the level.

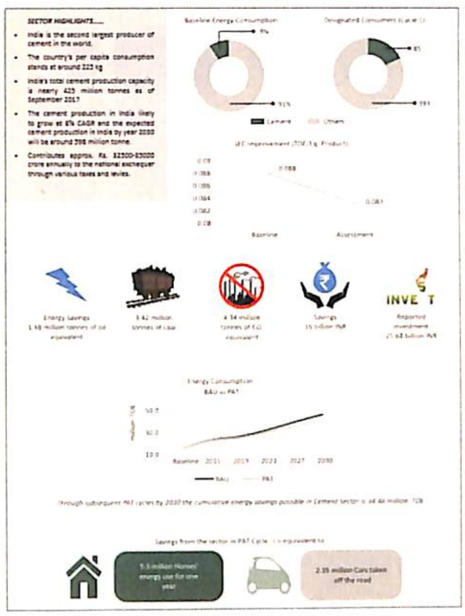
The success of the program depends upon the implementation of the scheme so there should be a fine balance of carrot and stick approach for successful implementation of PAT

Fig.25: Sectoral Snapshot

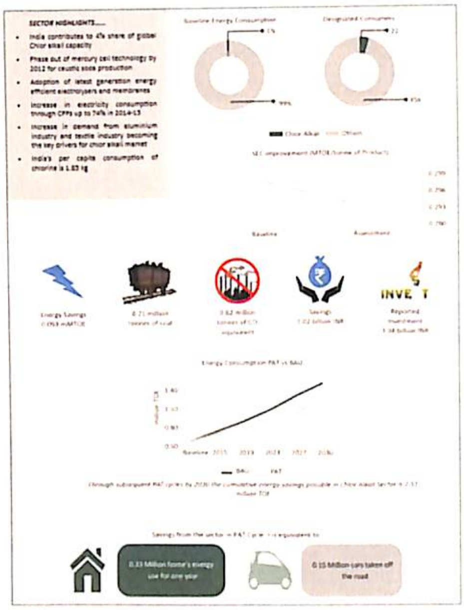
ALUMINUM



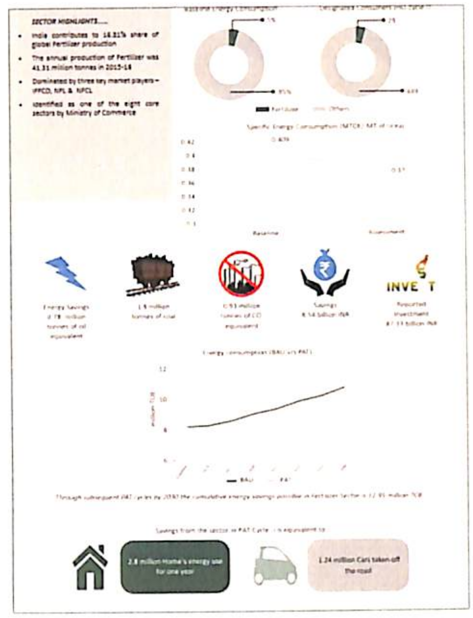
CEMENT



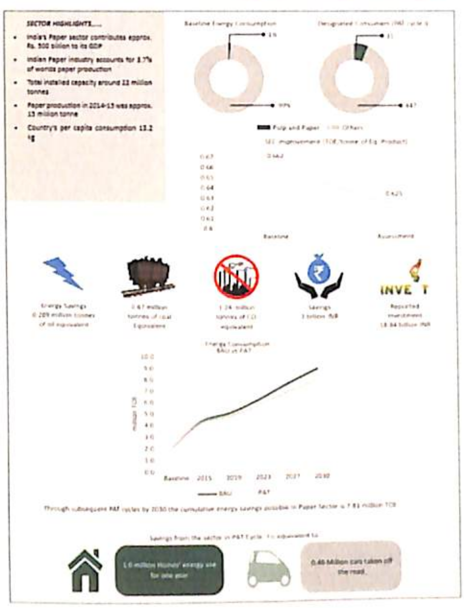
CHLOR ALKALI



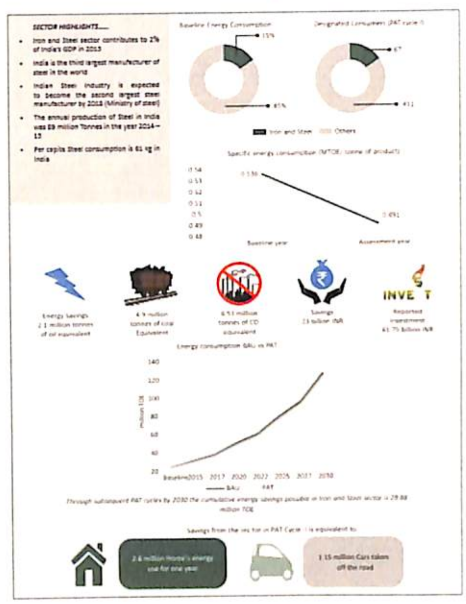
FERTILIZER



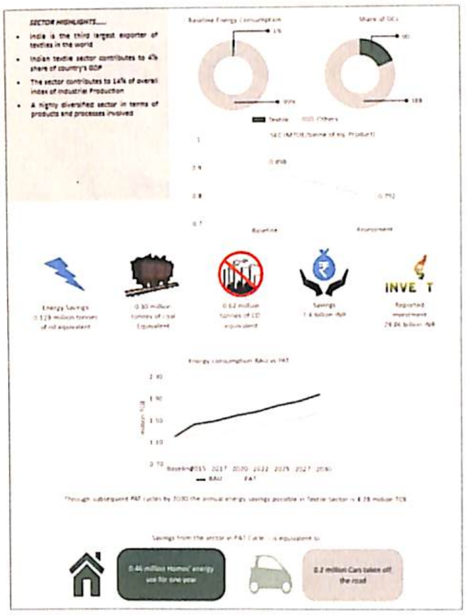
PULP AND PAPER



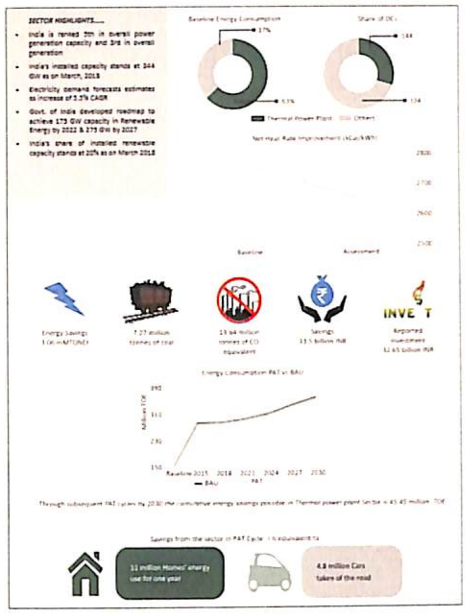
IRON AND STEEL



TEXTILE



THERMAL POWER PLANT



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