Perform, Achieve and Trade (PAT) scheme in India: A Review and Compilation of Secondary Literature

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Executive Summary

This paper reviews and compiles the major findings of the literature available on the Perform Achieve and Trade (PAT) scheme, which was launched in March 2012 to promote energy efficiency amongst India's largest industrial power consumers. The scheme was introduced by the BEE under the NMEEE (National Mission for Enhanced Energy Efficiency) and it works by lowering a Designated Customer's (DC) Specific Energy Consumption (SEC). The PAT scheme covers the following sectors:

Aluminium, Cement, Chlor-Alkali, Fertilisers, Iron & Steel, Paper & Pulp, Thermal Power Plants and Textiles. These were notified in PAT Cycle 1 (2012-15).

Cycle 2 (2016-2019) included all of the above sectors and brought in Petroleum Refineries, the Railways and DISCOMs. Cycle 4 (2018-2022) brought in Petrochemicals and Commercial Buildings (Hotels). Cycle 7 started in 2022 and will continue through 2025.

The scheme calculates the SEC for a DC according to:
Specific energy consumption (SEC) = net energy input into the designated consumers' boundary / total quantity of output exported from the DC's boundary.

Each DC is then allotted a target reduction in its power consumption, which is calculated by the formula:
Target for reduction =Plant SEC/Best SEC* X (where x is the reduction target in % for the best performing plant)

The DCs were chosen for energy efficiency targets if their annual energy consumption was above a certain minimum threshold. However, even within an industry there were huge variations amongst individual plants because of the variations in their location, production capacity, raw material quality and product mix. So targeted SEC norms were mandated after BEE consulted with the DCs themselves, energy auditors/ managers, industry associations and academics. The guiding principle behind the PAT scheme was that higher the energy consumption of a DC, the higher its potential for energy savings. Yet the scheme does not consider renewable energy in a plant's inputs.

Proof of Performance

Every 1 MWh of energy saved gets an energy savings certificate (ESCert) from BEE/EESL. These can be sold on India's two power exchanges by the DCs that achieve their targets and bought by those that fall short, apart from also paying a penalty for the shortfall.

PAT Achievements

Data so far has been available for PAT Cycle 1 & 2. In Cycle 1 the scheme achieved:

1. A total savings of 8.67 million tonnes of oil equivalent (MTOE)

2. Monetary savings of INR 9,500 crore (in terms of coal, oil, gas, electricity and other fuel sources) from saved energy consumption
3. Emissions reduction of 31 million tonnes of CO2 equivalent
4. Capacity building of over 5,000 engineers and operator
5. Encouraged investments of about INR 26,100 crore in energy efficient technologies

Cumulatively, PAT Cycle-I realised 30 percent more than the targeted energy saving. Cycle 2 saved 13.28 million tonnes of oil equivalent, 61.34 million tonnes of CO2 equivalent accruing monetary savings of INR 31,445 crores. 621 DCs participated from 11 industries, up from 419 DCs in cycle 1.

Overall performance

The PAT Scheme has been immensely successful in conserving energy. Apart from identifying untapped opportunities for major power consumers to lower their operational bills, some of the scheme's major success have been:

A. **Low Opportunity Cost for Energy Intensive Units:** It was observed that energy-inefficient firms were able to reduce their energy consumption at a much lower cost. Through simple investments they were able to affect significant energy savings over their more energy-efficient counterparts and enjoy considerably lower operational costs
B. **Increased awareness around energy efficiency:** BEE's workshops for energy managers from each sector through its Knowledge Exchange Platform (KEP) has enabled the exchange of important information amongst India's industrial sectors and mainstreamed the concept of industrial energy efficiency
C. **Benefits for the suppliers of energy efficient technologies:** The scheme has opened up a market opportunity for the suppliers of energy efficient technologies, which is a dual benefit to the economy

Yet the scheme has also been criticised for its shortcomings, of which the most prominent are:

A. **Lack of Additionality:** The targets set for certain industries were too lenient and would have been achieved by general energy efficiency improvements that were driven by concerns around rising electricity costs. The PAT scheme failed to provide additionality in these instances, which meant that the DCs had little incentive to comply
B. **Possibility of Price Volatility and Disincentive to Invest in Energy Efficiency:** It was theorised that less stringent SEC reduction targets could lead to several firms overachieving their targets and producing an excess supply of ESCerts. This will drop their market prices and be a deterrent to investing in energy-efficient technologies and innovations in the first place
C. **Marginal firms may face profitability constraints:** The cost of investing in energy-efficient technologies may impact the profitability of smaller DCs unless they are able to scale up their production adequately to be at par with their larger

counterparts. The possibility of competitive disadvantage may be a deterrent for DCs that are marginally above the threshold for participation

Recommendations for improvement

The PAT scheme's 7th cycle is ongoing and concludes in 2025. Going forward, the following key recommendations would help bring clarity around its implementation:

1. **Setting a floor price for ESCerts:** To make sure that a certain degree of predictability always exists when trading them in the market
2. **Clarity on ESCerts as assets or financial instruments:** To help the DCs account for their trading and banking options well in advance
3. **Long-term price goals through consistent PAT goals**: The scheme needs to set consistent long-term goals to instil confidence in the investments it demands from the DCs
4. **Tax concessions, loans and R&D funds**: To help the DCs avail low cost financial support for their energy efficiency investments and gain access to the latest research
5. **Switching to specific, activity-level SECs instead of "gate-to-gate"**: To gain better understanding of process-level energy consumption and help with more accurate measurement and verification
6. **Grouping all units of a DC for simplified records**: Grouping all units of an operator and calculating a single SEC to prevent redundancies and simplify the process around registries, verification etc
7. **Make trading ESCerts cost-effective**: To lower the cost of the trading process, especially when the price of the ESCerts is expected to be low
8. **Include MSMEs**: The Scheme needs to include India's MSME sector, which accounts for 20-25% of the country's power consumption
9. **Ease access for MSMEs**: Investing in energy efficiency upgrades may be cost-prohibitive for MSME units unless they are helped financially
10. **Banks must be encouraged to offer support to MSMEs** despite the high transactional costs relative to the size of the investment

The paper concludes by listing additional recommendations around the Monitoring, Reporting and Verification (MRV) of the PAT scheme. These include:

- The need to institute independent and mandatory audits by accredited energy auditors
- Accurately calculating the SEC of plants that have multiple by-products
- Bringing data transparency and online monitoring capabilities
- Clarity around the consequences of not sticking to timelines.

Future areas of enquiry are also suggested, including how the PAT scheme may get replaced by the country's shift towards trading carbon credits.

1. Introduction

The Perform Achieve and Trade (PAT) scheme was notified by the Govt. of India on 30th March 2012 as a regulatory instrument to reduce the Specific Energy Consumption (SEC) of the country's industrial sector. Overseen by the Bureau of Energy Efficiency (BEE), the PAT scheme identifies specific energy-intensive industries within certain key sectors as Designated Consumers (DCs) and assigns them energy reduction targets. Energy saved above the assigned targets results in the issuance of tradable Energy Saving Certificates (ESCerts). Conversely, the under-achievers are mandated to purchase ESCerts as a penalty for non-compliance. Under the PAT scheme the ESCerts are traded between the DCs which overachieve and those which underachieve their targets (*Oak and Bansal 2021*).

The scheme is a part of the National Mission for Enhanced Energy Efficiency (NMEEE, 2009) and has been operationalised through a series of cycles, each with revised targets that are designed based upon the feedback and experience from the preceding iteration. The scheme is likely to save about 26 million tonnes of oil equivalent (MTOE) of energy and 70 million tonnes of CO2 by 2023[1].

Since 2012, a total of seven cycles of the PAT scheme have been launched and till April 2020, 1073 industries from 13 service and industrial sectors had participated. The sectors include commercial buildings (hotels and airports), petroleum refineries, thermal power plants, iron and steel, cement, aluminium, pulp and paper, fertiliser, chlor-alkali, petrochemicals, DISCOMs, textiles and railways (BEE, 2020). Table 1 lists out the duration, sectors, energy reduction targets for each cycle of the PAT scheme.

Table 1: List of Sectors, DCs and Energy Saving Targets/Achievements under PAT scheme

Cycles	Duration	Sectors	Number of Designated Consumers	Energy Saved (MTOE)
Cycle 1	2012-15	1. Aluminium 2. Cement 3. Chlor-Alkali 4. Fertiliser 5. Iron & Steel 6. Paper & Pulp 7. Thermal Power Plant 8. Textile	478	8.67 million tonnes of oil equivalent (MTOE) translating into emission reduction of

[1] See Press Release, Bureau of Energy Efficiency https://beeindia.gov.in/sites/default/files/press_releases/Brief%20Note%20on%20PAT%20Scheme.pdf

				about 31 million tonnes of CO2.
Cycle 2	2016-2019	1. Aluminium 2. Cement 3. Chlor-Alkali 4. Fertilizers 5. Iron & Steel 6. Paper & Pulp 7. Thermal Power Plant 8. Textile *9. Refineries (new addition)* *10. Railways (new addition)* *11. DISCOMs (new addition)*	621	14.08 MTOE translating into emission reduction of 66.01 million tonne of CO_2
Cycle 3	2017-2020	1. Thermal Power Plant 2. Cement 3. Aluminium 4. Pulp & Paper 5. Iron & Steel 6. Textile	116	1.745 MTOE
Cycle 4	2018-2022 (extended due to COVID)	1. Aluminium 2. Cement 3. Chlor-Alkali 4. Fertilizers 5. Iron & Steel 6. Paper & Pulp 7. Thermal Power Plant 8. Textile **9. Petrochemicals (new)** **10. Commercial Buildings (Hotels)(new)**	106	0.6998 MTOE (targeted)

Cycle 5	2019	1. Aluminium 2. Cement 3. Chlor-Alkali 4. Commercial Buildings (Hotels) 5. Iron & Steel 6. Pulp & Paper 7. Textile 8. Thermal Power Plants	110	0.5130 MTOE (targeted)
Cycle 6	2020 (ongoing)	1. Cement 2. Commercial buildings (hotels) 3. Iron and Steel 4. Petroleum Refinery 5. Pulp and Paper and Textiles	135	1.277 MTOE (targeted)
Cycle 7	2022-23 to 2024-25	1. Cement 2. Commercial buildings (hotels) 3. Iron and Steel 4. Petroleum Refinery 5. Pulp and Paper and Textiles	509	6.627 MTOE(targeted)
Cycle 8	2023-24 to 2025-26	1. Aluminium 2. Cement 3. Chlor-Alkali 4. Iron & Steel 5. Paper & Pulp 6. Textile	138	Not available yet

Source: *Press Information Bureau, GOI*

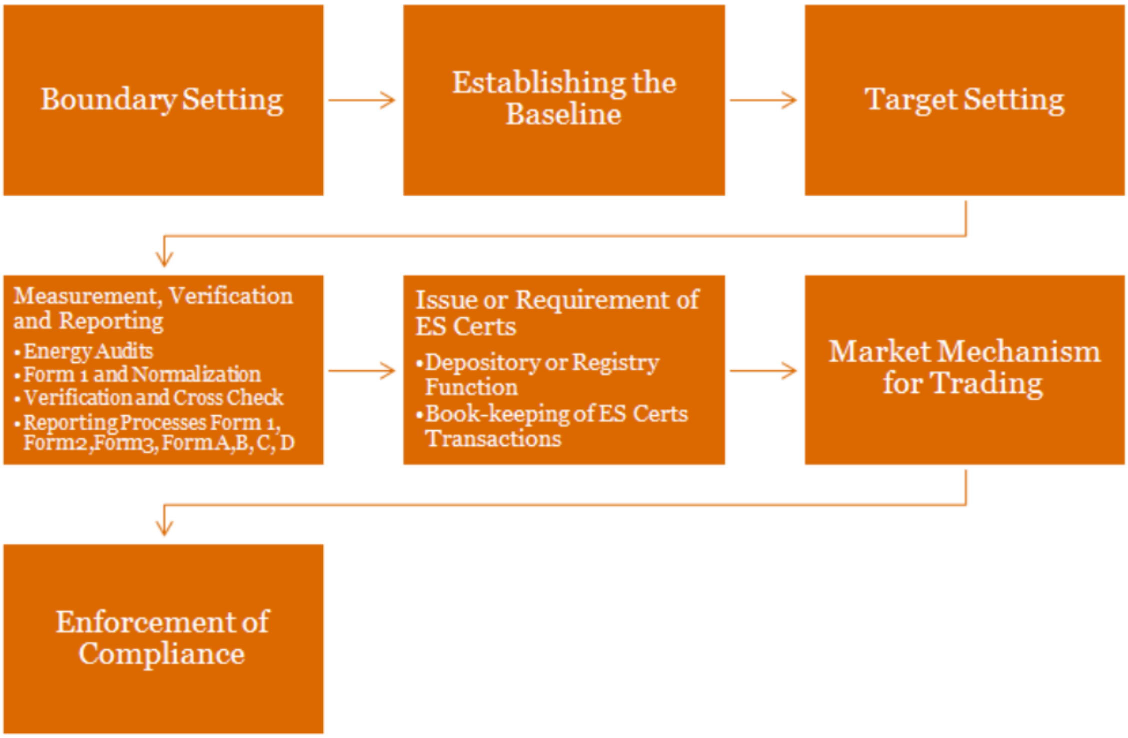
2. Process

The PAT scheme proceeds through five key steps:

1. Setting the overall target
2. Designing a framework to identify obligated entities
3. Distribution of targets within the obligated entities
4. A methodology to allocate ESCerts
5. Framing the rules for market transactions

The steps and substeps are illustrated in Fig. 1:

Figure 1: Steps in PAT scheme



Source: *The PAT Scheme: Analysis, Insights and Way Forward by PWC and Shakti Sustainable Energy Foundation, 2014*

2.1. Selection of DCs and Target Setting

Data from the Energy Statistics, India (2021) report (Ministry of Statistics and Programme Implementation, MoSPI) showed that the industrial sector consumed the highest share of energy in the country at 55.85% of the total final energy consumption in 2019-20 (Oak 2023). It was therefore specifically targeted for energy efficiency initiatives under PAT. The energy consuming entities are selected by BEE-empanelled and accredited energy auditors who survey the numbers of units in a sector and study their energy consumption patterns. The studies reveal the minimum threshold of energy consumption to be used as the benchmark for the selected sector. BEE energy auditors found a wide range of SECs for the industrial sub-sectors and also the potential for large energy savings.

The threshold of minimum energy consumption varies according to the industrial sector selected, and any plant whose annual energy consumption crosses the threshold limit is mandated to participate in the scheme. Table 2 depicts the sector specific thresholds and number of DCs in each sector for cycle 1.

Table 2: Energy Consumption Threshold for each sector in PAT cycle 1

Sector	Minimum annual energy consumption for the DC (tonnes of oil equivalent)	No. of DCs
Aluminium	7500	10
Cement	30000	85
Chlor-alkali	12000	22
Fertilizer	30000	29
Iron and steel	30000	67
Pulp and paper	30000	31
Textile	3000	90
Thermal power plant	30000	144
Total		**478**

Source: *PAT Booklet, BEE, Ministry of Power, GoI*

It was found that there were enormous differences in the energy saving possibilities amongst the different industrial sub-sectors and plants within the same industry because of the differences in raw materials, their quality and overall product output. To set the targets for Designated Consumers, BEE carried out discussions with the DCs as well as energy auditors/ energy managers, industry associations and academics etc. The solicited comments were framed to complete the PAT mechanism.

Specific Energy Consumption (SEC) was calculated as follows:

Specific energy consumption (SEC) = net energy input into the DC's boundary / total quantity of output exported from the designated consumers' boundary.[2]

[2] See PAT Booklet https://reap.py.gov.in/sites/default/files/pat-bookletm.pdf

The target for each individual plant (except power plants) was fixed according to the following formula:

Target for reduction = Plant SEC/Best SEC* X (where x is the reduction target in % for the best performing plant) (Paul 2011)

While calculating SEC of the plant, all the various forms of energy used in it (including manufacturing the products) are considered. This is called the "gate-to-gate" approach, where absolutely all of the energy consumed is all considered to estimate a site's consumption. However, renewable energy is not considered as an input. The potential for energy savings depends on the site's energy consumption trends and in general, the higher the site's energy efficiency (or the lower the SEC), the lower its energy-savings potential.

Changes in Cycle II

Cycle II introduced the process of **"Deepening"** the scheme by including new DCs, which was done by decreasing the minimum energy threshold. It also introduced **"Widening"** of the scheme, by including new sectors. Every DC gets its successive target in the fourth cycle after completion of their first targets. For example, PAT-II DCs will get their next target notified in PAT Cycle-VI, and PAT-III DCs will get their next target in PAT Cycle-VII. This is because the first year is used to assess the DC's baseline energy consumption, the second year is used to make the efficiency upgrades and the third year is used to assess the improvements in energy consumption and sell the ESCerts.

2.2. Issuance of Certificates

ESCerts are issued for each **1 MWhs of energy saved** and they are issued by the Ministry of Power (MoP) upon verification by the State Designated Agencies (SDAs) and further recommendation to the MoP by BEE.

2.3. Trading of ESCerts

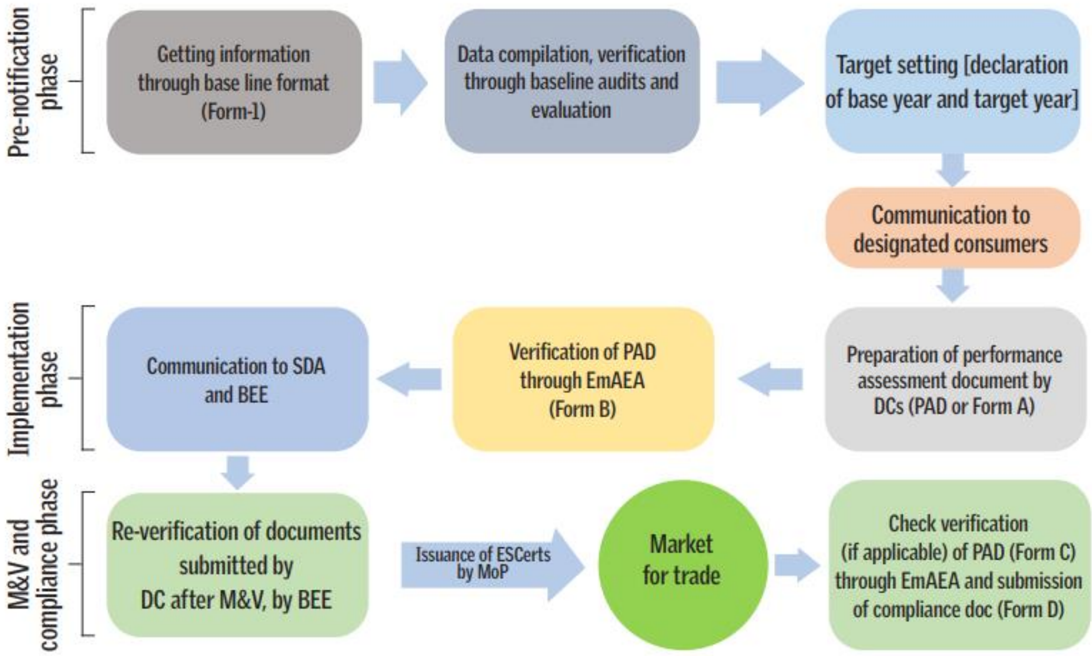
The trading of the ESCerts is regulated by the Central Energy Regulatory Commission (CERC), which notifies the regulations and approved procedures, and the certificates are traded in the country's power exchanges: India Energy Exchange (IEX) and Power Exchange India Ltd. (PXIL) (BEE 2020). The prices of such certificates are market determined, based on demand and supply[3]. BEE recommends that while placing bids for selling, DCs should set the bid price based on the marginal cost of investment for their respective PAT Cycle. This is designed to

[3] See press release, Bureau of Energy Efficiency, Ministry of Power, Government of India https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1811051

benefit both the buying and selling DCs. While placing the bids for buying, DCs are recommended to place the bid price based on the potential investment for achieving energy efficiency plus compliance penalty cost accrued in a PAT cycle (BEE 2021).

The implementation process is illustrated below:

Figure 2: Implementation Process of PAT



Source: Perform, Achieve and Trade (Pat) Scheme of Thermal Power Plants A Critical Analysis, CSE, 2021

3. Implementing, Monitoring & Ensuring Compliance

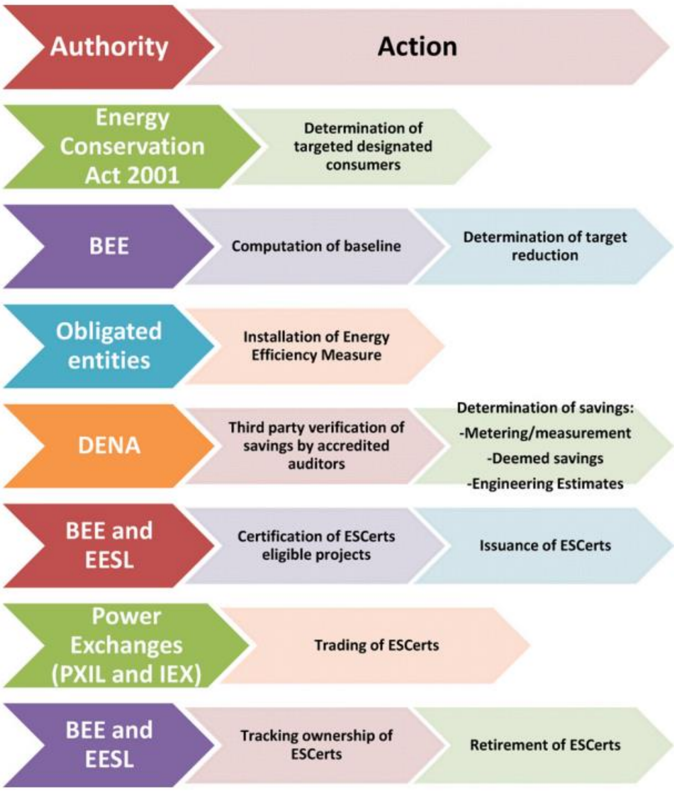
The PAT scheme is overseen by the Bureau of Energy Efficiency (BEE), the trading of ESCerts is regulated by the CERC and the scheme derives inputs from a range of stakeholders, including industry associations and accredited energy auditors. Figure 3 captures the scheme's regulatory structure.

Figure 3: Implementing Authorities of PAT

<table>
<tr><th></th><th>Operational Mechanism</th><th>Compliance Enforcement</th><th>Trading Mechanism</th></tr>
<tr><td rowspan="3">Regulators, Adjudicators, Quasi-Judicial and Judicial Institutions</td><td colspan="3">Bureau of Energy Efficiency (BEE)</td></tr>
<tr><td></td><td>Supreme Court
Appellate Tribunal</td><td>CERC</td></tr>
<tr><td></td><td>SERCs and Adjudicating Officers</td><td></td></tr>
<tr><td rowspan="2">Agencies authorized and responsible to interact with DCs</td><td colspan="2">SDA and Inspecting Officers</td><td>Power Exchanges</td></tr>
<tr><td colspan="2">Accredited Energy Auditors (AEAs)</td><td>Depository</td></tr>
<tr><td rowspan="2">Designated Consumers (DCs) and associated Interest groups</td><td colspan="3">Designated Consumers (DCs) and EA/EM at DCs</td></tr>
<tr><td colspan="3">Industry Associations (National and Sector Specific)</td></tr>
<tr><td rowspan="2">Agencies that may provide Services to DCs and other stakeholders</td><td>ESCOs</td><td>Legal Experts</td><td>Traders</td></tr>
<tr><td colspan="2">Sector-wise Process Experts</td><td>Market Makers</td></tr>
</table>

Source: The PAT Scheme: Analysis, Insights and Way Forward by PWC and Shakti Sustainable Energy Foundation, 2014

Figure 4: Actions by Implementing Authorities



Source: Bhattacharya and Kapoor 2012

The State Designated Agencies (SDAs) enforce compliance. The agencies review and comment on the appropriateness of the reports received from the DCs, advise BEE on the "need or appropriateness of conducting check verification" *(Bhattacharya and Kapoor 2012)*, and trigger penalty proceedings against the non-compliant DCs. The Designated Consumers (DCs) within certain key sectors are required to appoint energy managers, file energy consumption returns every year and conduct mandatory energy audits.

4. Performance of PAT in Cycles I and II

4.1. PAT Cycle I

The PAT scheme has had major successes from its very first cycle. Cycle I resulted in:

1. Savings of 8.67 million tonnes of oil equivalent (MTOE)
2. Monetary savings of INR 9,500 crore (in terms of resources that would have been spent on acquiring coal, oil, gas, electricity and other fuel sources)
3. 31 million tonnes of CO2 equivalent in emissions reduction
4. The capacity building of over 5,000 engineers and operators
5. INR 26,100 crore in investments in energy efficient technologies

It was reported that PAT Cycle I achieved 30 percent more energy savings than its target of 6.686 MTOE. Table 3 summarises the performance of the individual sectors:

Table 3: Energy Savings Achieved by Sectors in PAT I

S No	Sector	Number of DC	Energy savings Achieved (Mtoe)	CO2 Emissions (Mn tonne of CO2 /year)
1	Aluminium	10	0.73	3.10
2	Cement	85	1.48	4.34
3	Chlor-Alkali	22	0.09	0.62
4	Fertilizer	29	0.78	0.93
5	Iron & Steel	67	2.10	6.51
6	Pulp & Paper	31	0.29	1.24
7	Textile	90	0.13	0.62
8	Thermal Power Plant	144	3.06	13.64
Total		**478**	**8.67**	**31.00**

Source: *Bureau of Energy Efficiency, Ministry of Power, Government of India*

Approximately 38.25 lakh ESCerts were issued by the Ministry of Power to 309 DCs while 110 DCs were directed to buy 14.23 lakh ESCerts to make up for non-compliance (BEE 2021).

In terms of market trading of ESCerts during 2017–2018 on the Indian Energy Exchange (IEX), under PAT Cycle I approximately 13 lakh ESCerts were traded for an overall business of Rs.100 crores. 96% of the DCs met their compliance requirements and of 427 participating DCs, only 281 DCs registered with IEX participated in ESCerts trading. The DCs from the thermal power sector led the trading entities and the trading was carried out under the mechanism of a double-sided uniform price auction. The market price discovered through trading fluctuated widely over the trading period, ranging from as low as 200 INR per ESCert to a high of 1200 INR (BEE 2021). The total investment done in all the sectors on energy efficiency-related projects to improve their SEC across PAT cycles I was INR 43,721 crores, as reported by 390 units (BEE 2020).

4.2 PAT Cycle II

PAT Cycle II led to the savings of:

1. 13.28 million tonnes of oil equivalent
2. 61.34 million tonnes of CO2 equivalent
3. Monetary savings of INR 31,445 crores (otherwise spent on acquiring fossil fuels)

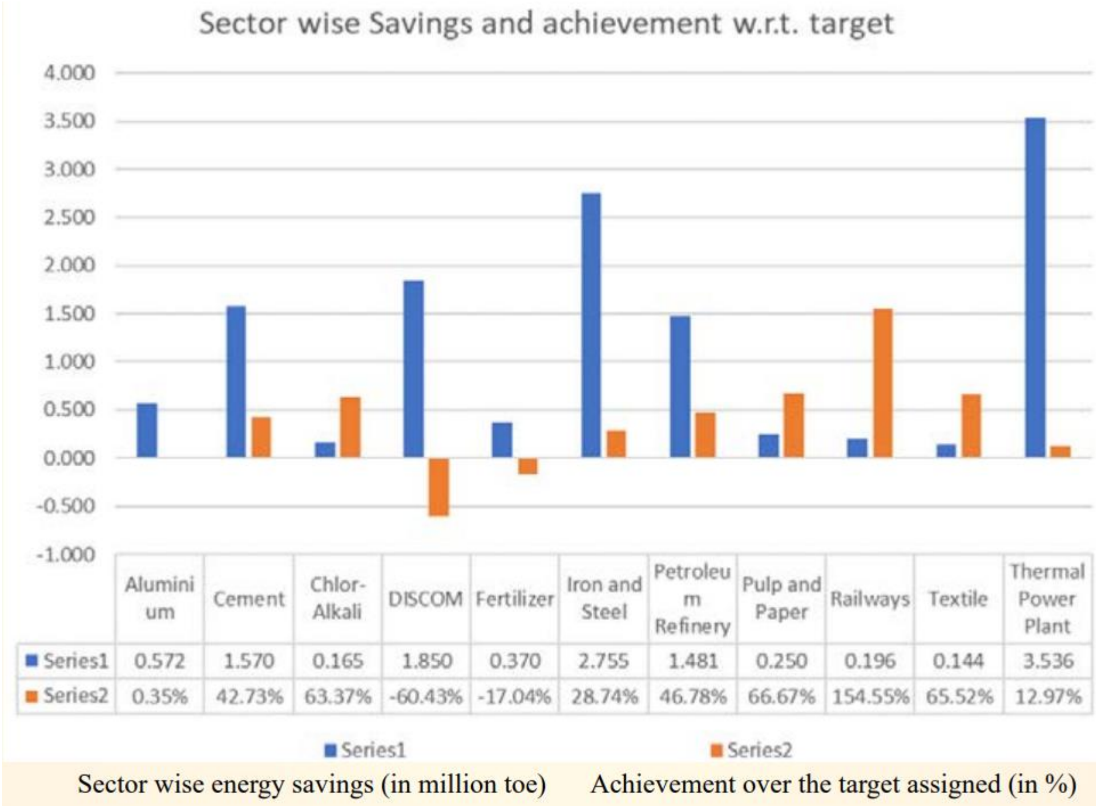
Cycle II saw the participation of 621 DCs from 11 industries and three new sectors – namely petrochemical refineries, DISCOMs and the railways – were added to the list of industries covered. The energy savings achieved by different sectors in PAT Cycle II are listed in Table 4.

Table 4: Energy Savings Achieved by Sectors in PAT II

PAT Sector (Demand Side)	PAT Sector (Supply Side)	Number of PAT DCs analyzed for M&V	Energy Savings Achieved (Mtoe)	% Share of Savings (Sector-wise)	% Share of Savings (Demand & Supply wise)
Aluminium		11	1.226	8.7%	48.24%
Cement		99	1.559	11.1%	
Chlor-Alkali		24	0.133	0.9%	
Fertilizer		36	0.383	2.7%	
Iron and Steel		67	2.845	20.2%	
Pulp and Paper		24	0.315	2.2%	
Textile		85	0.135	1.0%	
Railways		22	0.196	1.4%	
	Thermal Power Plant	118	3.435	24.4%	51.76%
	Petroleum Refinery	17	1.430	10.2%	
	DISCOM	39	2.423	17.2%	
Grand Total		**544**	**14.08**	**100%**	**100%**

Source: *Bureau of Energy Efficiency, Ministry of Power, Government of India*

Figure 5: Energy Savings- Targets Vs Achievements by Sectors in PAT Cycle II



	Aluminium	Cement	Chlor-Alkali	DISCOM	Fertilizer	Iron and Steel	Petroleum Refinery	Pulp and Paper	Railways	Textile	Thermal Power Plant
Series1	0.572	1.570	0.165	1.850	0.370	2.755	1.481	0.250	0.196	0.144	3.536
Series2	0.35%	42.73%	63.37%	-60.43%	-17.04%	28.74%	46.78%	66.67%	154.55%	65.52%	12.97%

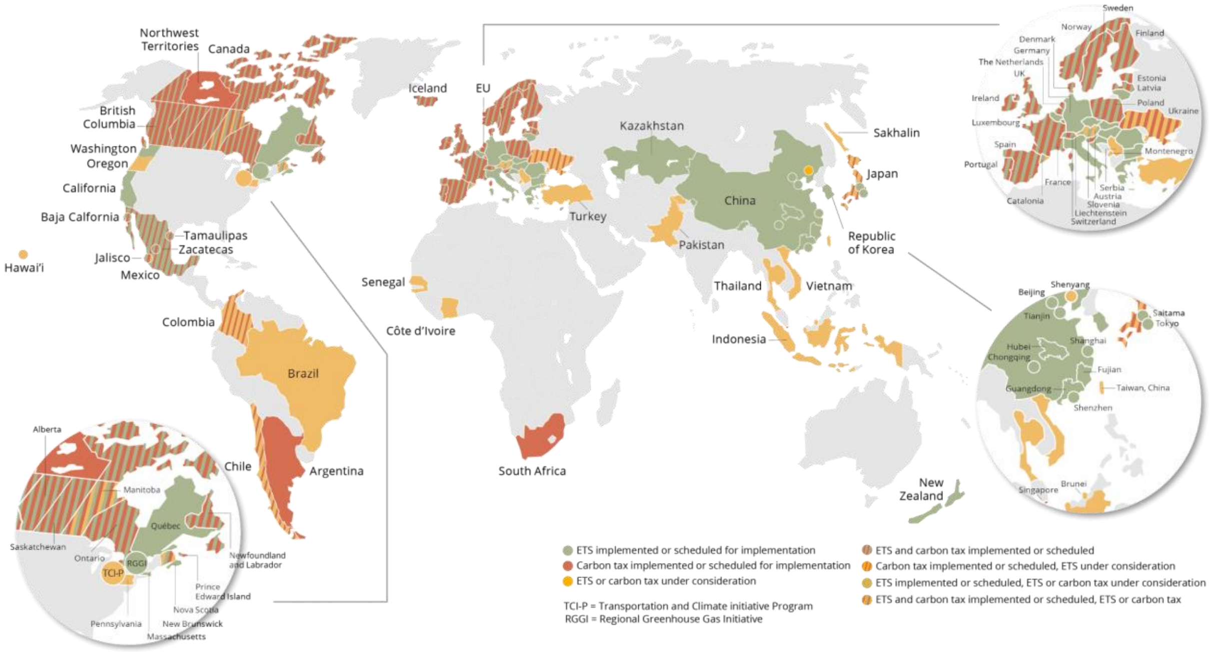
Source: *Bureau of Energy Efficiency, Ministry of Power, Government of India (2020)*

It was interesting to note that less energy-intensive sectors like paper mills and the railways achieved the maximum energy savings in relation to their assigned targets, even though the quantum of energy savings from these sectors only contributed to around 3% and 1% of the PAT scheme's overall energy savings. This was because these industries are not as energy-intensive as iron and steel manufacturing, or thermal power plants. The latter group had the largest contribution towards the scheme's overall energy savings.

Most importantly, with the number of DCs growing to 542 under PAT Cycle II, the potential to trade ESCerts has grown significantly. In 2021 the Ministry of Power approved the issuance of 57 lakh ESCerts to 349 DCs and directed 193 DCs to purchase 36.68 lakh ESCerts (BEE 2021).

5. Cap and Trade Policies Around the World

Fig. 6: Global Cap and Trade policies



Source: Centre for Climate and Energy Solutions

Many European nations and the United States have used "white certificates" – also called Energy Saving Certificates – as tradable commodities to quantify and guarantee the quantum of energy saved.

One of the earliest examples are the white certificates used in many European countries and the US. These certificates, also known as an Energy Saving Certificate, or Energy Efficiency Credit, are tradable and guarantee that a certain amount of energy saving has been achieved. The energy saving obligations are imposed on some categories of energy market operators, and result in possession of a white certificate after the energy saving has been achieved (Oak 2023). The UK, Italy, France and Denmark have had some positive results from these schemes. Another example is Poland which introduced an energy efficiency obligation in 2012 to meet its targets as a part of EU's Energy Efficiency Directive, although the energy savings achieved were not enough to meet the target.

Efficient use of energy is essential for all sectors, and it is especially crucial for the industrial sector because of its considerable dependence on non-renewable energy. However, despite the high consumption of the industrial sector, the Energy Efficiency Directive for the EU member nations does not have a policy that is specifically designed for the industrial sector.

In the Indian case, Perform-Achieve-Trade (PAT) is a policy similar to the White Certificate as it aims to improve energy intensity through the use of tradable energy saving certificates or ESCerts. But the scheme was designed specifically for the industrial sector, unlike the policies of the EU or USA (Oak 2023).

The following sections include a detailed summary of secondary literature on the PAT scheme

Secondary Literature on the PAT scheme can be categorised as follows:

- Analysis of the performance of the scheme in its first and second cycles
- Critical Reflections on the design of the scheme with recommendations for improvement
- Financial Avenues for PAT
- Implementational Design and MRV challenges faced in the early cycles of the scheme

An attempt has been made below to summarise the key arguments under each of these themes.

6. Performance of PAT scheme in cycles I & II

6.1. Energy reduction goals in Cycle 1 of PAT were primarily driven by improvement in utility and component efficiency rather than process and/or systems efficiency

The Alliance for Energy Efficient Economy (AEEE) and Shakti Foundation conducted a survey on the types of projects undertaken by Designated consumers (DCs) in Phase 1. The study covered a sample of 47 Designated Consumers (DCs) from the 8 PAT sectors and reviewed 426 projects undertaken. The survey revealed that DCs in the first phase were primarily focused on driving utility and component efficiency rather than process and/or systems efficiency. Nearly 65% of the projects undertaken in cycle 1 addressed efficiency mainly through retrofits and routine optimization.

Thus, the first phase was characterised by low capex, short pay-back projects and were incremental in nature. Mostly dominated by cement, aluminium and iron and steel sectors, these projects were primarily linked to utility operations, motors operations, upgrade of technology components, optimization in process parameters; retrofits in plant electrical & thermal utilities; up-gradation of technology components especially in drives (like energy efficient motors, use of VFDs etc.), air compressors, HVAC systems and pumps. Similarly, adoption of waste heat recovery projects was noted in many sectors as an option to improve energy efficiency.

Enhancement of capacity utilisation of plant (or equipment) lowered the SEC in many cases. Thus, low hanging fruits were tapped in this class, which required low investments and had a short term pay-back. As indicated above almost 70% of the retrofit and optimization projects carried out under PAT phase 1 were non-sector specific and can be leveraged across multiple sectors. More than 60% of projects carried out were relevant across sectors (and not sector-specific) (*PAT Pulse 2016*).

Sector-specific Assessments

6.2 PAT-driven Energy Efficiency Gains Observed During Compliance Period in Cement, Fertiliser and Paper Industries

Oak and Bansal (2019) examined the additional energy efficiency gain that was achieved by the first phase of the PAT scheme in three of the highly energy intensive industries identified under it, namely, cement industry, fertiliser industry, and pulp and paper industry over the compliance period April 2012 - March 2015. The key findings from the research are summarised below:

- Energy intensity defined as energy supplied to the economy per unit value of economic output was used as a proxy of energy efficiency in this research. The authors use the ratio of power & fuel expenditure to total sales (in monetary units) as an indicator of energy intensity (EI). Regression analysis was used in this study. The analysis considers the impact of variables like Per unit capital investment, Research & Development (R&D) intensity, Size of the firm and Ownership of the firm on energy intensity

- The authors estimate the differential impact of the PAT scheme on DCs relative to their energy intensity before the implementation of the scheme, and relative to non-DCs in each industry.

- Although the average energy intensity of designated and non-designated consumers follows the same trend in the pre-treatment period, mean comparison of the two groups indicate that by the end of the compliance period, DCs became significantly more energy intensive and larger in terms of gross fixed assets than non-DCs in all the three industries. Further DCs also had significantly higher per unit R&D expenditure which might have resulted in more efficient utilisation of energy resources.

- For DCs in the cement industry, between the years 2011-12 and 2014-15, power & fuel expenditure decreased by Rs. 40635.72 million on an average which in turn amounts to a reduction of carbon emissions by 9.53 million tonnes. The estimate of the additional energy efficiency gain, on average, that was achieved by DCs due to the PAT scheme is 2.1%. Fall in power & fuel expenditure can be attributed to a fall in the consumption of non-coking coal and electricity. The study finds that 1 unit increase in the R&D Expenditure-Sales ratio reduces energy intensity by 2.18 units in the cement industry. Size of firm and capital investment had an insignificant effect on intensity.

- The PAT scheme helped to reduce energy intensity of designated consumers from the fertiliser industry with a total decline in predicted power & fuel expenditure by Rs. 17162.84 million which translates into a total decline of 1.37 million tonnes of carbon equivalent. This implies on an average DCs have been able to achieve additional energy efficiency gains of 1.5% under the PAT scheme. The analysis also found that 1 unit rise in per unit capital investment increases energy intensity by 0.002 units. This could be because this sector had reached a point of technological stagnation as most of the DCs in this sector have switched from oil-based fuels to natural gas. Most of the naphtha and fuel oil-based plants have converted to natural gas, which is far more energy efficient. Hence the scope for further reduction in energy intensity is limited.

- The PAT scheme did not have any effect on the designated consumers of the pulp and paper industry. This suggests that energy intensity of the pulp and paper & firms was higher in 2012-13 to 2014-15 than 2004-05 to 2011-12. The pulp and paper industry suffers from technological obsolescence. A huge investment in assets and research and development activities will be required to improve energy consumption per unit of output. Factors like absence of financial opportunities, lower economies of scales, etc. make it difficult for investments to flow in. The size of the firm (given by log of gross fixed assets) has a negative and statistically significant effect on the energy intensity of this industry. As the firm size increases, there is a fall in the energy intensity.

6.3. Efficiency Scores Dropped After the Completion of PAT Cycle in Cement Industry

Oak (2023) estimates the energy efficiency scores for the period 2007-2021 for 27 such firms in the cement industry which were included under PAT-I and II but were dropped from PAT-III and IV cycles. Using data envelopment analysis (DEA), the paper estimates if the scores continued to improve for the firms after they were excluded from the PAT Cycles.

- The study uses an input-oriented BCC model that aims to minimise inputs while keeping the output at the given levels to compute the efficiency scores. Two inputs have been used in the calculation. One is power and fuel expenditure that represents an energy input and is defined as the cost of consumption of energy for carrying out the business of a company that includes the cost of consumption of electricity, petroleum products, coal and other sources of energy. The other input is raw materials used that represent a non-energy input.

- Results show that on an average, efficiency scores were higher when the firms were a part of PAT-I and II, and it declined thereafter. Between 2018-19 to 2020-21 almost 60% of the firms recorded a decline in efficiency scores. This was also a period where energy intensity was higher, implying a rise in the power and fuel expenditure per unit production. Estimates from firms which were dropped in the third and fourth cycles reveal the following: After PAT-III and IV implementation periods started (2017-18 to 2019-20 and 2018-19 to 2020-21 respectively), the average power and fuel expenditure of these firms was 71.58% higher than the period 2007-2017, while production was only 59.38% higher, thereby causing the average energy intensity to be 7.15% higher in the second period. Therefore, being part of the PAT scheme lowered the average energy intensity of the cement industry.

- The top 10 cement producers recorded higher efficiency scores than the other firms. Tobit regression results show that royalty and degree of capitalization help to increase efficiency scores, while with age the scores decline for all firms.

- Royalty refers to the payment made by the firm in millions of rupees, for using technical knowhow/technology that the firm uses. Degree of capitalization is defined as the ratio of gross fixed assets and compensation to employees, both measured in millions of rupees. Age is a quantitative variable that is defined as the difference between the current year and the year of incorporation of the firm.

6.4. Reduction targets too lenient and achievement subpar for the thermal power sector:

Yadav et al (2021) assessed the effectiveness of the first cycle of the PAT scheme in the thermal power sector. Their key findings are as follows:

a. Lenient targets

The PAT scheme is designed to achieve a unit-wise reduction in the heat rate, defined as the heat energy required to generate one unit of electricity, of thermal power plants against plant-specific targets. The targets are set using the deviation of heat rate (operating heat rate) from the heat rate estimated at the time of design of the plant (Design heat rate), as determined from past energy consumption and production data furnished by the individual units. Under the PAT scheme, the target for heat rate reduction is set as a fraction of the difference between the operating heat rate in the base year and the design heat rate for each power plant.

If the variation of the thermal power plants operating net heat rate is more than 5 per cent from the design net heat rate, it is given a target of reducing 10 per cent from the deviation percentage. Similarly, for the other bands of thermal power plants respective percentages of energy reduction were assigned. For instance, if a design heat rate of a plant is 2,500 kCal/kg but it is operating at a deviation of 2,625 kCal/kg (5 percent higher than the design heat rate), the scope to reduce energy use by the unit in this case is 125 kCal/kg, but the target by the government for such units is only 12.5 kCal/kg (which is 10 percent of this 5 percent deviation). According to experts, a power-generating unit can operate very close to its design heat rate provided it gets coal of similar quality as per the design. As plants are designed taking into account the availability of coal of similar properties, it must not be impractical to tighten the reduction targets.

b. Energy Consumption was High in Cycle II despite inclusion in Cycle I

Out of 156 plants in Cycle 2, 131 generating units were repeated from Cycle 1 with revised targets. Ideally, energy use for plants in Cycle 2 must reduce as they had reduced their consumption in Cycle 1. But this analysis reveals for 10 per cent of the generating units (14 units of 131 units), energy use reduction targets remained constant in both cycles. Thirteen of these 14 units were run by the government. Decreasing plant load factor means increased energy consumption. And this could be one of the probable reasons for increased baseline energy consumption between PAT Cycles 1 and 2.

The thermal power plant sector was the lowest scorer among the sectors listed in Cycle 1 and 2; this is despite it being given the least percent energy reduction target with respect to its overall energy consumption. As a result, its CO2 emission reduction from Cycle 1 and Cycle 2 are 13.6 and 11.9 million tonnes of CO2 while emissions from the entire energy production sector is 825.6 million tonnes of CO2. The sector's CO2 emission reduction from Cycle 1 and Cycle 2 is only 1.64 and 1.44 per cent respectively, which are very low compared to the overall emission reduction from the energy sector.

c. Poor Efforts to Comply

Eleven thermal power plants common to Cycles 1 and 2 had the same baseline consumption. This means that these thermal power plants have not shown any improvement in their operation for reducing their energy consumption. West Bengal had the highest number of thermal power plants that had not taken any steps to improve their energy efficiency. Despite such loose and controversial reduction targets, power stations showed poor efforts to comply. Nearly half the thermal power stations had not met even the smallest targets.

The studies suggest that even in 2021, 13 thermal power plants in PAT Cycle 1 had not conducted monitoring and verification of energy savings although the cycle was completed in 2015. Governance of PAT by the Bureau of Energy Efficiency should be made stricter than the existing system.

d. Non-compliance made cheaper

Even though the target was low, only 68 per cent and 47 per cent of the total thermal power plants listed in Cycles 1 and 2 achieved their targets by energy reduction respectively. Since the purchase value of ESCert was very low, in the range of Rs 200–1,200 in Cycle 1, many energy inefficient plants earned compliance by buying EScert than achieving energy reduction.

e. Lack of data transparency and deadlines overlooked

The objective of reducing energy consumption was not achieved beyond 3 percent in the power sector. The assessment documents by DCs are not submitted in a timely manner—they are submitted any time during the PAT cycle. This information is not available for the public view and is kept confidential (*Yadav et al 2021*).

f. Targets set by BEE are way more lenient considering the national benchmark value set by Central Electricity Authority (CEA)

It was found that the targets set by BEE for thermal power plants with the national benchmark value set by Central Electricity Authority (CEA) for the operation of the thermal power plants are more lenient than the benchmark value set for the given capacity of plants. The study infers that for 5 percent deviation in heat rate, 112.5 kCal/kWh, which can be reduced, is left untouched in the least case. On the higher side, for more than 20 per cent deviation, 475 kCal/kWh still leaves a gap between design and target heat rate. The gap is added in later cycles, with targets further reduced.

Figure 7: Difference between BEE Target and CEA benchmark

BEE target and CEA benchmark Difference range (in kCal/kWh)	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5	Total
0–500	53	78	27	15	14	187
1,000–2,000	19	12	-	-	-	31
500–1000	32	42	2	1	1	78
Over 2,000	1	-	-	-	-	1

Source: Perform, Achieve and Trade (Pat) Scheme Of Thermal Power Plants, A Critical Analysis, CSE, 2021

The recommendation was that the targets set should be more ambitious for the thermal power plants to drive the value in investing in better energy efficiency (*Yadav et al 2021*).

6.5. Targets based solely on technology improvement and not managerial efficiency

The literature reports that the assessed medium and small firms (MSEs) in the power sector overachieved their PAT targets through changes in managerial efficiency alone, and without any technological improvements. This implies that the MSE sector can be a prime case study in implementing better managerial processes and that the PAT targets for this sector do not generally lead to appreciable reductions in emissions.

Sahoo et al (2017) compared the energy saving potential of the plants with the energy reduction targets assigned to the respective plants using data envelopment analysis models.

Based on data from 71 plants, the study found that in most cases, the targets were much less than the actual potentials of the thermal power sector, coupled with inefficiencies from the managerial setup. If the sector were to realise its full potential, then the ESCert market may witness a surplus of 4.7 million certificates from the thermal power sector alone.

Key inferences drawn in this study are summarised below:

- Improvement in energy efficiency can be realised by implementing various management improvement programs and adopting the appropriate technology. Therefore, it is essential to know what fraction of energy saving potential can be achieved by improving the managerial practice and how much can be achieved through improvements in technology, so as to develop a fine-tuned, unit-level energy saving strategy.

- However, as matters stood at the time, the targets under the PAT scheme were set by considering the potential of energy-use efficiency improvement only.

- Small units were seen to be able to realise 95% of their reduction target through better managerial practices alone while medium units could achieve even beyond their targets through tighter managerial inputs. On the other hand, for large scale units, only 43% of the target could be achieved through improvements in managerial practices. The results imply that unlike the average small and medium plants, large plants would have to invest in energy efficient technologies to remain PAT-compliant.

- It was observed that while the maximum demand for certificates was expected from large plants, the medium size plants between 500 MW and 1000 MW were the best performers, with the least demand and highest potential for earning ESCerts. By extension, unless the impact of managerial processes was factored into the target determination process, in every likelihood, this could lead to generating ESCerts without yielding any actual improvements in efficiency or emissions reduction.

- In the PAT scheme, the energy saving potential due to plant availability, coal quality, load factor are input parameters but these lie beyond the control of a plant's management. The deficiencies in these parameters due to unfavourable conditions are compensated for in the assessment year through a **process of normalisation**. However, how these factors are accounted for are strongly influenced by management decisions.

  Therefore, the normalisation process provides an opportunity for negotiating the targets, which otherwise can be improved through managerial practices to begin with. Thus when the target is less than or equal to the potential under managerial efficiencies, the unit in most likelihood would be tempted to plead for normalisation and after adjustment become PAT-compliant, without actually adopting any technological or managerial measures for better efficiencies.

6.6. PAT fared well in terms of Industrial and Socio-economic Efficiency in Power and Iron and Steel Industries

Paul 2011 analyses the transaction cost for the whole industrial sector for implementing PAT and also studies the industrial and socio-economic efficiency of PAT in the thermal power and iron and steel sectors in cycle I.

Transaction Cost: The total estimated investment in PAT cycle 1 is 6.8 billion USD equivalents (Ministry of Power & Bureau of Energy Efficiency 2008). The estimated transaction cost was around 0.80% of the total estimated investment under PAT scheme in cycle I.

Industrial Efficiency: Internal rate of return (IRR) was chosen as a tool to estimate industrial efficiency. The estimated industrial efficiency for the PAT scheme for both thermal power and the iron and steel sector was found to be robust. The industrial efficiency for the iron and steel sector was substantially higher than the same for the thermal power sector – for which the estimated industrial efficiency was about 37%. In contrast, for the iron and steel sector the figure stood at 171%.

Socio-economic Efficiency: For socio economic efficiency assessment the economic benefit of positive externalities associated with the avoided fossil based power generation owing to the savings of energy under the PAT scheme were accounted for. The assessment of economic efficiency shows that PAT promised to provide economically efficient improvement in energy efficiency improvement in the thermal power and the iron and steel sector, due to its dual benefit of robust financial return to the industry and substantial net positive benefits to the society. The socioeconomic efficiency under the PAT scheme for the thermal power sector was estimated to be 167%; for iron and steel it was 753% (Paul 2011).

7. Assessment of the Design of the PAT scheme

Published between 2011-2017 these studies assessed the design of the scheme before the first cycle and its performance during the time period. Some recommendations were based on the learnings from similar schemes, like the EU-ETS. The studies covered in this section are *Dasgupta et al 2016, Bhandari and Shrimali 2017, Kumar et al 2013, Bhattacharya and Kapoor 2012, Paul 2011.*

Table 5: Details of Studies

Study	Objective	Methodology
Dasgupta et al 2016	Analysis of the lessons learnt during the pilot phase of EU-ETS to identify similar issues that might arise in the context of PAT	Policy analysis
Bhattacharya and Kapoor 2012	Analysis of Energy Saving Instruments: EScerts in India	Policy analysis
Kumar et al 2013	Estimation of firm specific shadow prices (marginal cost) of meeting the desired energy efficiency standards for the six industrial sectors.	KLEM production function specification used for estimation of shadow price of energy
Bhandari and Shrimali 2017	Assessment of effectiveness of PAT in terms of cost and equity	Policy analysis
Dube et al 2011	Assessment of the effectiveness of PAT both in design and implementation	Stakeholder consultation and policy analysis
Paul 2011	Provide early insight into the design and functionality of PAT and its potential impact on the targeted energy intensive industries through an ex-ante evaluation	Policy analysis and stakeholder consultation and interviews

7.1. Positive Aspects of the PAT Scheme:

a. Low Opportunity Cost for Energy Intensive Units

Kumar et al (2013) analysed firm specific shadow prices (marginal cost) of meeting the desired energy efficiency standards for the six industrial sectors namely thermal power plants, fertiliser, cement, pulp and paper, textiles, iron & steel, and aluminium. They estimated industry specific marginal rate of technical substitution between capital and energy inputs as a proxy for the shadow price of per unit of energy saved at margin. The study found that energy inefficient firms can reduce their energy consumption at lower cost in comparison to the energy efficient firms. Thus the marginal cost of abatement is lower for inefficient units.

This is because the firms that observe high energy intensity or those that are less efficient to begin with can save energy at lower opportunity cost relative to the firms that already operate under the highest levels of technological and managerial efficiencies. For them it would be very expensive to upgrade their setups further for marginal additional efficiency gains. Given the high variability in the opportunity cost of saved energy (marginal cost of energy saved), the PAT mechanism would help in achieving the targets at lower cost in comparison to command and control kind of framework (Kumar et al 2013).

b. Deepening and Widening of Scope Make PAT Cost-effectiveness

A successful cap and trade scheme relies on heterogeneity of abatement costs across the obliged entities. The broader the range of sources, the lower the cost of achieving the target. A broader program creates a larger scope for pursuing the lowest cost measures. A cap across different sectors allows policymakers to counteract the uncertainties that may lie in any one sector within the economy (Bhandari and Shrimali 2017).

c. The PAT scheme can increase awareness around energy efficiency and market-based mechanisms

The PAT scheme may provide a platform for knowledge exchange that could lead to adoption of technologies in the future. The BEE has been conducting workshops for energy managers from each sector through its Knowledge Exchange Platform (KEP). The goals of the KEP are to facilitate an exchange of information within and between the industrial sectors through exchange of information and peer to peer learning (Bhandari and Shrimali 2017).

d. Flexible Banking Options and Fungibility of ESCerts:

There is a provision of banking in the PAT design. DCs can bank up to 30% of their additional savings certificates for two consecutive PAT cycles, i.e, for a period of 6 years. In addition PAT makes EScerts fungible with the renewable energy certificate scheme. The ability to bank the ESCerts holds two advantages: First, if the prices of the certificates drop in the current trading cycle, DCs can bank them and trade them at a later point. Second, for energy efficiency improvement certain investments have a payback period of more than 3 years. Banking provision helps incentivize such investments which goes beyond the one single PAT cycle of 3 years (Paul 2011). It also increases their cost effectiveness and promotes longer term price stability, which has been found to be attractive to the DCs. The ability to bank the ESCerts could also assist in building investor confidence which leads to measures that have a longer lifetime and come with a lower risk of long term price volatility (Bhandari and Shrimali 2017).

The fungibility of EScerts was also welcomed. Dasgupta et al (2016) suggested that DCs can purchase REC to overcome any shortfall in meeting their target SEC reduction. It could be a cost effective way to achieve energy efficiency and resultant emission mitigation through the establishment of some kind of a relationship between ESCerts and RECs, not least because India's power exchanges are expected to be the major agencies in both the markets and it could lead to very low transaction costs (Dasgupta et al 2016). The fungibility would allow the industry more flexibility with respect to PAT compliance, including under scenarios where the owner of the selected plant is also in the business of renewable energy generation (Paul 2011).

e. Benefits for the suppliers of Energy Efficient Technologies

One of the major stockholders in the PAT scheme are the suppliers of energy efficient technologies, for whom an assured client base was established and thus led to new business opportunities (Kumar & Agarwal 2013).

7.2. Criticisms

a. Lack of Additionality: Energy efficiency measures are likely to be driven by high energy costs and not PAT

Energy efficiency measures by DCs have been primarily driven by rising electricity prices that they would have incurred in the absence of the PAT scheme as well. So for PAT to be effective, it is essential that it incentivises change above and beyond the business as usual scenario. This is known as "additionality", which due to the scheme's lenient targets, is oftentimes missing. This is further complicated by the fact that some

DCs may provide inaccurate information to establish erroneous baselines to begin with. Secondly, setting accurate baselines and classification of additionalities may require high administrative and transaction costs that may prove to be costlier than can be recovered through the benefits of the scheme (Bhandari and Shrimali 2017).

b. Lack of clarity and consistency of rules within the PAT scheme could hinder effectiveness in the long-term

There was a lack of stringent timelines and rules. The first cycle was delayed by over a year. Clear standardisation and normalisation processes for SEC values were not developed (till at least after the first cycle) (Bhandari and Shrimali 2017).

c. Lack of long term goals and uncertainty in future caps may hinder long-term effectiveness

The success of a cap and trade relies heavily on setting a “trajectory of caps” that becomes more stringent with time. Long term goals provide indications of the long term certainty in costs. Uncertain costs, on the other hand, lead to uncertain investments. A cap and trade scheme that develops both interim and long term caps provides a long term price signal that may promote investment in the development and deployment of new technologies to increase energy efficiency.

The lack of such commitment leaves the PAT scheme vulnerable to large uncertainties. Lack of future caps leaves uncertainty around measures that require longer payback periods (Bhandari and Shrimali 2017). DCs enrolled in one cycle would be assigned their next targets only in the fourth year, which due to the time lag may be a deterrent to investing in long term efficiency measures.

d. It is unclear whether the penalties have been set sufficiently high to incentivize investments

Non-compliant firms have to pay an upfront penalty up to Rs. 1 million and for continuing failures a daily penalty that could extend to Rs. 10,000 till the non-compliance is rectified. But the criticism was that it was unclear how ‘continuing failure’ was defined. The value of per MTOE of energy consumed for the purpose of these rules was specified as Rs. 10,154 for the year 2011-12 and it was to be reviewed every year.

This quantum was deemed to be too modest and perhaps not heavy enough to motivate the DCs to adopt energy efficient measures, given the shadow value (marginal cost) of capital required to reduce one MTOE of energy at the margin (Kumar et al 2013). On top of that, if the penalties were not invoked in an effective and time-bound manner, there would be a lack of stringency in the obligation to reduce emissions (*Bhattacharya and Kapoor 2012*).

e. PAT might fail due to a lack of real scarcity of energy efficiency due to moderate energy efficiency standards

The success of the scheme such as PAT depends on whether there is a scarcity of the traded commodity (ESCerts) in the market. From 2000 to 2010 the annual rate of improvement in energy efficiency in the economy was 2.7 percent, though it declined in the later years. In the first three years (2012-15), the targeted reduction under the PAT scheme was 4.3 percent, i.e., a meagre 1.5 percent per year. This therefore raised the question on whether the PAT scheme was able to create and address a tangible scarcity for energy savings in the economy (Kumar et al 2013).

f. Possibility of Price Volatility and Disincentive to Invest in Energy Efficiency

Less stringent SEC reduction targets might lead to maximum firms overachieving the target producing an excess supply of ESCerts. This could lead to a drop in the price of the certificates resulting in a disincentive for firms to invest in energy saving technologies and innovations in order to overachieve their targets in future (Dasgupta et al 2016).

Long term stable price signals are essential in promoting stakeholder participation and allowing for long term investment planning. Price volatility may arise in a cap and trade scheme due to lack of knowledge about marginal abatement costs resulting from a wide variation in energy prices and technology costs. PAT is vulnerable to high price volatility due to a wide variation in the SECs and energy saving potentials across the 478 DCs over 8 sectors (Bhandari and Shrimali 2017).

Bhattacharya and Kapoor (2011) highlighted that of the major problems arising during the initial phase of the PAT scheme is that the ESCerts are issued ex-post, i.e. they are issued after the verification of the savings that have taken place in the initial reduction phase. This means that there are no up-front traded prices for ESCerts and therefore the requisite price signals for energy efficiency investments would be absent. This is an issue as it does not guarantee the DCs a minimum return on their investments (Bhattacharya and Kapoor 2012).

g. The PAT Scheme could be susceptible to the Rebound Effect

In the case of energy-intensive industries covered under PAT, energy costs account for a large proportion of total costs. So a decline in their energy use per unit of production would lead to a decline in the marginal cost of production, which could incentivise an increase in total output. This in turn would increase the unit's total energy consumption and thus interfere with the prime objective of the policy to lower energy use and emissions (Dasgupta et al 2016).

h. Linking PAT with carbon offset schemes like Clean Development Mechanism Generates the Problem of Double Counting

International Finance Options for PAT: The two prominent methods discussed by experts for making the international finance available to PAT scheme are: first, international finance can be directly utilised for the trading the ESCerts and second, the use of carbon offset fund can help the Indian government to create a domestic fund which in turn may finance the energy efficiency projects through providing soft loans.

Linkages with CDM are not specified in PAT. But this lack of specification might generate a scope for some units to earn supernormal profits. For instance, a technology installed with CDM funds lowers a unit's emissions below the baseline through a significant decline in its SEC. This unit would then earn credits both under CDM and under the PAT scheme through ESCerts. This would open the possibility of double accounting and the avenues to earn supernormal profits (Dasgupta et al 2016).

i. Market Gaming May be a Possibility under the PAT scheme

One of the arguments against cap and trade schemes is that potentially valuable assets could be generated in the form of the ESCerts and creating these assets could lead to rent seeking behaviour through hoarding. Bhandari and Shrimali (2017) pointed out that if a firm is expected to be a seller in that market, "they may withhold their allowances to raise the prices of the permit. On the other hand, if they are expected to be a buyer, they may limit purchase to keep the price low. Due to the broad range of DC's from within different sectors with different energy saving potential, the potential for market concentration may be reduced".

j. High Transaction Costs May Reduce the Value of Certificates

Transaction costs extend beyond the direct costs of energy savings measures. In a tradable permit scheme, these consist of costs related to searching for the appropriate technologies, negotiating with the vendors, monitoring & enforcement, and certification & approval. The cumulative transaction costs decrease the value of certificates and lower the cost effectiveness of the scheme.

k. Equity Challenges of PAT scheme

Equity concerns around PAT emerge for multiple reasons:

1. **Impact on customers:** Energy efficiency measures are unique in that they not only reduce energy usage but also result in savings through avoided energy costs. Thus, in many cases, the projects are likely to have positive net present value (NPV). However, in case of negative NPV projects, DCs may pass on the costs of compliance to consumers, which may impact their low-income consumers for no fault of their own.

2. **Boundary vs Process based Target Setting:** The primary equity concern in relation to the DCs lies in the way they calculate their SEC baseline and targets. So far, the BEE has based this on a unit's geographical boundary, and has not accounted for site-specific characteristics. Entities that decide to move higher consumption activities off-site could game the system.

3. **Capacity Utilisation of firms:** Further issues may exist in relation to capacity utilisation of plants, since high fuel costs and supply shortages could reduce the production capacity of the plant, which would potentially increase its SEC. The scheme has also failed to address the decrease in capacity utilisation that may arise from an economic recession and fluctuating market demand for the finished products. BEE is trying to address these concerns through normalisation.

4. **Firms in Margin Adversely Affected:** Another concern is related to the PAT threshold, with the DCs on the margin being negatively impacted. For example, the current energy consumption of a specific DC within the cement sector, the only wet process cement plant, is 42,000 toe; and they are an obligated entity given the PAT threshold of 30,000 toe. However, according to them this threshold is not fair, given that other obligated cement companies have energy consumptions close to 100,000 toe. They believe that this threshold puts them at a competitive disadvantage compared to others since they would be more limited in terms of resources and may have less accessible energy improvements to be made.

5. **Issues with Standardization**: A significant concern lies with the standardisation of the products across different sectors. BEE currently assigns standardisation values for the products produced by each DC. Higher quality products often have higher SEC values.

But site specific factors do not account for products of higher quality. Further, facilities that run on manual labour have a much higher likelihood of achieving the targets than plants that are automatic since automatic plants are more modernised yet more energy intensive.

6. **Process Technology:** An additional equity concern is related to the process technology since the choice of process includes factors such as weather conditions, access to raw materials and cost of fuel at the specific location. This issue is in part addressed by the creation of sub-sector targets for different processes within each sector. Yet the process technology is still challenging to standardise across the DCs.

7. **Feasibility of Targets and Limited Scope for Improvement:** Meeting the target would be very difficult for certain sectors within future cycles as energy efficiency of certain sectors are already at much higher levels than the other sectors. They might have absolutely no margin for any meaningful increase in energy efficiency due to a number of technical and economic factors such as low financial returns on the technologies, the lack of cost-effective technical options and operational reliability issues with conversion to new technologies. A DC's prevailing energy efficiency levels & the feasibility for it to institute further improvements should be factored in by the PAT scheme prior to arriving at future targets.

7.3. Recommendations for Improvement:

1. **Establishment of a Floor price to Prevent Volatility**

   Protection against price volatility and uncertainty might be partly achieved by attaching a floor price to the ESCerts. This would imply that the price would never go down below the level (Dasgupta et al 2016). This can be done by regulating the circulation of ESCerts and allowing government intervention to purchase ESCerts whenever prices approach the decided floor price. Once the ESCerts are in circulation and are being actively traded, the Government (through BEE) should maintain a price band (expressed as a percentage of the market price of ESCerts). Further, the Government (Ministry of Power) should maintain a dedicated fund to intervene in the ESCerts market whenever the prices exceed the decided band in either direction (Bhattacharya and Kapoor 2012).

2. **Pre-defined penalties can assist in setting a price ceiling and reducing price volatility**

   An additional requirement to enable investments and trading would involve setting penalties that are above the transaction costs of trading within the market. This penalty should be set significantly high so as to incentivize the obliged entities to participate in trading and installing energy conservation measures (Bhandari and Shrimali 2017). For example, in the U.K. tradable white certificate scheme, the penalty is as high as 10% of the participating company's total turnover. The steep penalties have been a major driver of the high levels of compliance in the U.K (Paul 2011).

3. **Clarity on the Nature of Asset**

Another criticism was that it is important to define the nature of an ESCert; whether it should be considered as an asset or not. If it is considered to be an asset one has to clarify if it should be an 'intangible asset' or a 'financial instrument' as the accounting frameworks would vary per the nature of the asset. A very clear guideline needs to be laid down in order to fit it in the existing accounting structure of a firm well in advance before the trading and awarding of ESCerts. Since the National Action Plan on Climate Change (NAPCC) also mentions that banking options of ESCerts would be available, this issue is even more important (Dasgupta et al 2016).

4. **Promote long-term investments via clear and consistent goals**

The current rules must be strengthened to instil investor confidence through clear and consistent long term PAT goals, which would ensure stable long term price signals and incorporate provisions that account for longer lifetime measures. This would require good technological understanding of each industrial sector, and could be done through a group of sector-specific experts who would assist in transfer of knowledge and the creation of sector-specific marginal cost abatement curves (Bhandari and Shrimali 2017).

5. **Incentives for the promotion of energy efficient technologies**

Bhattacharya and Kapoor (2011) suggest certain incentives for promoting energy efficient technologies, which include:

- **Fiscal incentives:** Tax concessions (excise duties, customs, VAT, etc.) should be extended to the producers of energy efficient technologies that would be used by the targeted industries for SEC reduction.
- **Financial support:** Extension of the Partial Risk Guarantee fund as part of Framework for Energy Efficient Economic Development (EEED) mechanism under NMEEE to the producers of Energy efficient technologies. This would include easy access to loans to these producers and partial coverage of risk exposure against loans extended to them.
- **R&D Fund:** Setting up a dedicated fund by the Central Government (through the Ministry of Power) to promote research and development on energy efficient technologies.

- **Regulation:** Agreements, if any, between the producers of energy efficient technology and consumers (energy intensive industries) should be regulated by BEE to avoid conflicts and ensure smooth functioning of the market (*Bhattacharya and Kapoor 2012*).

6. **Boundary Setting Based on Processes**

For effective implementation of the scheme, it is advised that the unit or DC boundary for Specific Energy Conservation (SEC) under PAT should be determined based on 'activity' rather than 'gate to gate' definition which is suggested under the current format of scheme. Sub-metering or additional measurement boundaries around specific processes or activities within a DC should be encouraged. Making process or activity-level SEC data available has advantages in that it facilitates a granular understanding of energy consumption, which then enables a minute-level identification of energy saving opportunities, besides helping in accurate measurements and verification (Shakti 2014; Dube et al 2011).

Dube et al (2011) recommend clustering at processes level and not on an overall DC level energy consumption. To take care of wide variations in raw materials and technology use, there is a need to classify the activities under the purview of PAT as sequential/parallel/exclusive processes before performing the clustering on each class of processes (Dube et al 2011).

7. **Grouping of DCs under Same Operator to Reduce Extra Costs**

It is recommended that units under the same operator be grouped. In some sectors there are companies that own and operate more than one unit. It makes sense to combine these units as one designated consumer and calculate a single SEC for the company which will be the weighted average of individual SECs of different units. This is likely to provide greater flexibility to the operator, prevent redundancies and extra costs as a single PAD (PAT Assessment Document), registry, verifier etc. could be used by the company. This manner of grouping would also simplify the normalisation process (Dube et al 2011).

8. **Ensuring Protection of DCs through Rebate**: **Export Competitive Test**

To take certain protection measures to minimise the risk of negative impact on international competitiveness, BEE should define and introduce Export Competitive Test and monitor it on a continuous basis. The test would help evaluate how PAT targets affect the export competitiveness of a sector and/or if it renders it vulnerable to cheaper imports. There should be provisions to assist the sector through rebates if it fails the Export Competitive test.

It is also recommended that the umbrella agreement between BEE and sector committee/associations or individual DCs should have throughput or production protection measures in place. If the production of a sector or individual DC falls below a threshold, there should be a provision for rebates to be activated to prevent additional burdens on the sectors or individual DCs in already worsening operating conditions (Dube et al 2011).

Other recommendations that have been suggested include:

1. Setting realistic, additional targets that account for rising energy costs.

2. Reducing equity concerns via normalised targets and standardised auditing. Clear guidelines for auditing and for target setting should be published to limit variability in calculations and assessments made by the auditing agencies. These guidelines should clearly address site specific characteristics such as capacity utilisation and difference in quality of the products.

3. To keep a cap and trade scheme as cost-effective as possible, it should be designed to minimise the overall transaction costs, especially when the certificate prices are expected to be low (Bhandari and Shrimali 2017).

4. The proposed PAT program is required to focus around large industries and has a missing link for Small and Medium Enterprises (SMEs). This sector accounts for 20-25% of the country's power consumption, which is estimated to be worth around 50 MTOE[4].

[4] *https://www.iea.org/policies/7469-national-programme-on-energy-efficiency-and-technology-up-gradation-of-smes*

8. Finance Mechanisms for PAT

The Alliance for Energy Efficient Economy (AEEE) and Shakti Foundation conducted a survey in 2016 on the Designated consumers (DCs) participating in Phase 1 of PAT which highlighted the need for low cost finance for energy efficiency projects (PAT Pulse 2016).

The study estimates that the investment potential of industrial energy efficiency interventions for the DCs across PAT sectors (excluding thermal power sector), would be about Rs. 34,000 crore (~USD5 billion) by 2020. They analyse the most optimal financing routes to realise the investment potential in 7 sectors (excluding thermal power sector). Out of the total investment potential presented by industrial energy efficiency in the 7 sectors 17% or approximately Rs 5,500 crores (USD 0.8 bn) would be required as company contribution /equity/margin money. The remaining 83%, i.e Rs 27,000 crores (USD 4.2bn) can have multiple financing routes including:

1. Project Specific Term Loan (>5 yr tenure)
2. Clubbed with loans within existing lines of credit
3. Vendor finance ESCO model
4. Pay for Performance ESCO model
5. Mezzanine Debt Capital

However, currently the key challenge is unwillingness of many companies to invest equity in savings projects such as those linked to energy efficiency instead of growth projects which will enhance the top line performance. Out of the total Rs. 34,000 crore investment potential, approximately, 4% or Rs. 1400 crore, is currently the unmet financing need for energy efficiency projects/process interventions.

Figure 8: Financial Challenges in PAT

Industry	• Unwillingness to prioritize Energy Efficiency. Investments more driven by growth and revenue enhancement rather than cost savings. • Validation of actual savings realized from energy efficiency projects; lack of standardization a key impediment
Financial Institutions	• Lack of enforcement of performance contracts for energy efficiency projects • Difficulties in measurement and verification (M&V) of energy efficiency • Lack of standardized project documentation and appraisal procedures • Lack of awareness and experience among banks for types of EE projects • Limited availability of collateral for project financing • Low ticket size of investment for the energy efficiency projects
ESCOs	• Weak balance sheet of most ESCOs • Lack of demonstrability/track record • Lack of capacity: perceived limited understanding and limited capacity of sector specific processes • Lack of standardized measuring and verification systems • Litigation process costly and time consuming for non-compliance with performance contracts

Source: PAT Pulse, 2016

The study suggests that:

- 50% of the investment potential can be financed by getting clubbed with loans within existing lines of credit.
- Large DCs are likely to fund EE through Internal accruals but Vendor/ESCO route is promising for small DCs.
- Cross-cutting Technologies (e.g. VFDs, Waste Heat recovery, etc. that cut across industries) have maximum potential for Vendor finance/ESCO model.
- Projects in Chlor-Alkali and Aluminium sector can account for maximum financing through project specific term loans.
- Cement and Fertilizer can get clubbed with loans within existing lines of credit
- Policy push and standardisation in EE projects are key levers to realise the investment potential

There is a need for policy push to prioritise energy efficiency which can include:

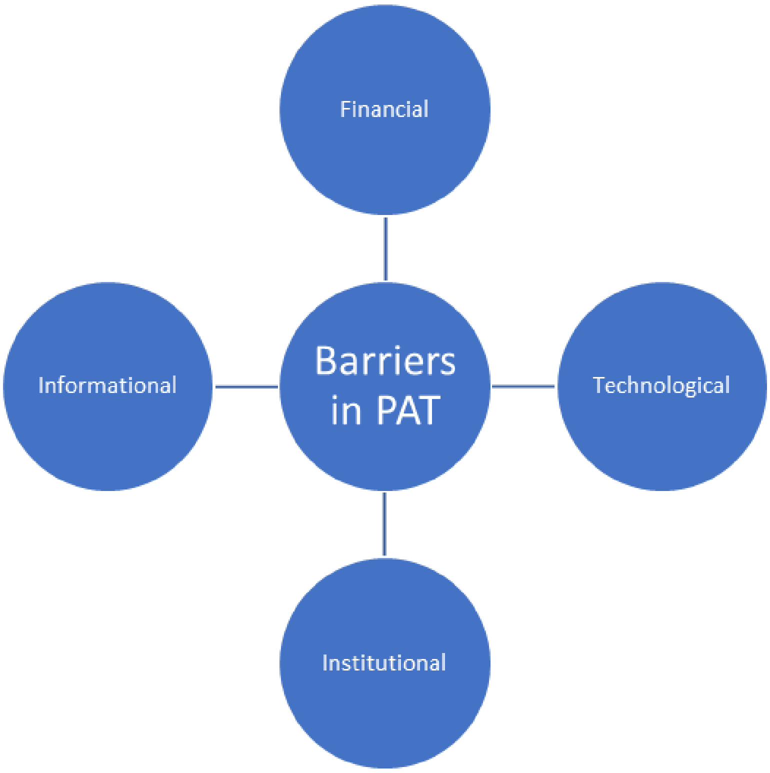
1. More stringent energy efficiency norms and a policy that levels the playing field for all companies in a sector, regardless of their size
2. Providing tax incentives for companies to adopt the ESCO route, similar to what was adopted in China
3. Developing standardised M&V protocol, project document templates, reporting templates, underwriting procedures and capacity building of lenders to understand energy efficiency financing and more so ability to make use of existing lines/guarantee facilities
4. Standardised pay for performance contracts to be created coupled with the use of advanced measurement systems to quantify savings generated against dynamic baselines which would reduce the risk perception associated with some of the energy efficiency interventions and allow greater participation by Energy Service Companies (ESCO) in the industrial energy efficiency market. This would also include: a. exploring pooling of standardised projects by ESCO in order to make the ticket size of debt more meaningful and diversify the risk for a bank (provided the ESCO's balance sheet allows it).

9. Implementation and MRV Challenges in PAT

9.1. Implementation Barriers in PAT

Paul 2011 analyses the barriers facing DCs in implementing energy efficiency projects. The findings are as follows:

Figure 9: Implementation Barriers in PAT



Financial Barrier for Small Industries

The financial barrier is particularly a major bottleneck among the small and medium scale industries for two reasons.

A. For small and medium scale industries there is a general lack of awareness about the performance of energy efficient technologies, thus despite potential high financial returns, the chosen benchmark of discount rate in taking decisions to invest in energy efficiency improvement projects are kept at significantly higher level than any other projects. For this reason a number of energy efficiency projects do not qualify for self financing in this sector.

B. In addition, there is a general lack of interest among the banking community to finance energy efficiency projects in small scale industries due to their perceived high transaction cost associated in conducting the due diligence necessary for the risk assessment of energy efficiency projects. Further, transaction cost for such energy efficiency projects in terms of percentage of the total loan amount also becomes significant due to their relatively small size.

Other barriers identified in the study include:

- **Technological barrier:** Availability of raw material, plant layout, availability of technology, age of plants and machinery.

- **Institutional Barrier:** Administering PAT would be in addition to all the existing roles and responsibility already performed by BEE. Considering the vast scope and extent of PAT, the performance of BEE is extremely crucial in successful implementation of PAT. Despite the valiant effort by BEE, the launch of PAT cycle I was delayed.

- **Informational Barrier:** Lack of information on energy efficient technologies can significantly prohibit the uptake of energy efficiency improvement projects. The informational barrier can manifest itself in a lack of motivation among the industries due to lack of awareness about the importance of energy efficiency improvement, by driving up the financial return expectation due to perceived higher risk association with the energy efficient technologies and by increasing the transaction cost in realising the benefits of energy efficiency improvements (Paul 2011).

9.2. Assessment of Implementation Mechanism Design and MRV Process:

Shakti Sustainable Energy Foundation studied the institutional mechanism design of the PAT scheme in 2014 based on the first cycle and identified some weaknesses. They are as follows:

1. **Limited experience and technical capabilities of State Designated Agencies:** One relatively weak link in the chain is the State Designated Agencies (SDA). A primarily regulatory role has been assigned to these organisations, a majority of whom have been traditionally involved in promotional roles or service oriented roles. Thus the resource requirements and amount of training and development needed is relatively high at the SDAs.

2. **Possibility of DCs Influencing Energy Auditors:** Since the Accredited Energy Auditor (AEA) firm for verification is appointed by the DC, there is a possibility of potential influence that the DC can exert on the AEA firm. There are provisions for independence of AEA firms conducting verification and check verification. However, the rules presently seem to be silent on whether an AEA can conduct mandatory energy audits in a DC where he is employed.

Janardhan et al (2013) further identified possible loopholes in the Monitoring Reporting and Verification (MRV) of PAT. Those are summarised below:

3. **Centre-State Administrative Dilemma:** The differences in jurisdiction of the state government and the central government over specific industrial units will be a critical factor in determining the efficacy of the MRV process that is being developed under the PAT scheme.

4. **Lack of in-house capacity of DCs:** The most critical challenge faced by the DCs in adhering to the PAT scheme is the lack of adequate in-house capacity in terms of estimating, managing and implementing energy efficient practices within the premises of industrial units. A survey by Shakti Sustainable Energy Foundation also reveal that a significant proportion of the DCs are lacking in terms of benchmarkable and quality data related to their energy performance (PAT Pulse, 2016)

5. **Lack of information about requirements under PAT**: Even though the top management might be aware of the procedures and requirements of PAT through various consultation processes, the lower level staff are not adequately well informed about what information/data to preserve and in what format. The energy management cell at many plants being understaffed, and hence, unorganised, make the reporting and verification process cumbersome.

6. **Methodological challenges of standardisation plague the MRV process:** Calculating SEC is particularly complex in case of multiple by-products from a plant. Since the SEC is to be measured for the plant and not different products, SECs for all by products are required to be converted and aggregated into the SEC of the main product that the plant produces (Janardhan et al 2013)..

7. Yadav et al (2021) further add that there is a **lack of data transparency** in PAT. Very little information such as baseline and target energy consumption, methodology for target setting, and basis of consideration of normalisation factor is available on the internet. Important data of designated consumers such as capacity of thermal power plants, achieved energy consumption by individual DC in each PAT cycle, list of

noncompliant DCs, and number of ESCerts awarded and purchased by individual DCs is not available in the public domain and is kept confidential (Yadav et al 2021).

9.3. Recommendations for Improvement

1. **Need for online monitoring system:** Online monitoring of the plant efficiency can be installed by thermal power plants to keep track of their plant performance. This monitoring system needs to be supported with an alert system in case plant performance is poor for a prolonged time (Yadav et al 2021).

2. **Impartial Audits through Verification Checks:** In order to maintain impartial energy audits, it is important for BEE and SDAs to commission a good number of check verifications (say at least 10%) in the initial cycles (Shakti 2014).

3. **Training and Development for the DCs and SDAs**: A sustained interest and commitment towards PAT can only be facilitated by providing an enabling environment for energy efficiency to the DCs. Facilitating better access to efficient technologies for the sector, through technology roadmaps and compendiums, along with cost benefit analysis Facilitating experience exchange among the DCs of a sector, setting up software platforms like e-networking for frequent experience exchange (Shakti 2014).

4. **Strict MRV timelines**: Various timelines for activities or milestones are clearly laid out in PAT rules. However, there should be better clarity on consequences of not meeting these deadlines for any of the stakeholders involved.

5. **Two Tier Structure of PAT:** In line with the climate change agreements in the UK, Duve et al 2012 recommends that BEE appoint an independent body (sector committee/trade association) capable of representing most units covered under a particular sector. The independent body can conduct a detailed study on Sector Average Target SEC (SATS) that the sector collectively can achieve over a time period. The independent body can also advise individual DCs on the average SEC targets that they should take in each target period. This could ease the process of implementation and relieve some of BEE of some of its workload (Dube et al 2012).

6. **Bigger role for renewables:** Even though the PAT scheme does not factor renewable energy into its calculations, it should play a bigger role in the DCs' energy targets. Wherever the DCs use renewable energy – whether within the plant boundaries or in

ancillary operations – they should receive additional credits and factoring this in would make for a more holistic understanding of their energy profiles. All DCs must also individually endeavour to increase their share of renewable energy consumption across their operations' and products' life cycles (to the extent possible), since the objective of the PAT scheme is ultimately to lower emissions.

10. Future Directions of Enquiry

India is on the verge of establishing three new industries as it expands its economy:

A. **Nuclear power**: India is looking to up its current nuclear power production of around 7,840 MW to 22,480 MW by 2031-32[5]. Both centralised and small modular reactors (SMR) reactors will be part of the mix.

B. **EV manufacturing**: The country aims to become a hub for manufacturing electric vehicles and the goal dovetails into its decarbonisation targets by 2030. For EVs to have verifiable green credentials, the power and processes used in their manufacture must be efficient and low/zero carbon.

C. **Green hydrogen manufacturing**: India's National Green Hydrogen Mission aims to produce 5 million metric tons of the fuel a year by 2030. Manufacturing at this scale will require enormous amounts of power and the output is also planned to be exported to establish India's position as a reliable energy partner.

The three industries (helped with smaller inputs from geothermal, offshore wind and ocean thermal power) will be significant players in the country's developmental plans and their massive energy consumption must be planned to be as low and efficient as possible. At the same time, the consumption of coal will grow in absolute terms as the fuel will remain a primary source of energy and, along with liquified natural gas (LNG), an enabler for energy security in the foreseeable future. Thus targeted reductions in consumption will be a common denominator to the country's energy strategy.

However, the emergence of carbon markets – domestic and international – could alter the relevance of the PAT scheme and it is possible that PAT Cycle 8 and subsequent cycles may not be necessary. The low prices discovered for the ESCerts (generally under Rs. 1840 per ESCert) are possibly not a strong incentive for the DCs to continue investing in lowering their SECs from a cost-benefit perspective. Converting the unsold ESCerts to carbon credits and

[5] *https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1988863*

trading them on the domestic carbon market could be an alternative in the making, but as the details of this route are beyond the scope of this paper, they could be explored separately.

The carbon trading scheme could in fact emerge as India's primary vehicle to account for energy savings and/or green ratings going forward. In addition, Paul 2011 had suggested assessing the impact of behavioural, managerial and organisational barriers to energy efficiency improvement in Indian corporations. Together with a deep dive into individual industries through focussed discussions and site visits, a future round of investigations could be useful in further assessing how to meaningfully lower India's energy consumption.

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