GGGI

BUREAU OF ENERGY EFFICIENCY
Government of India, Ministry of Power

EESL

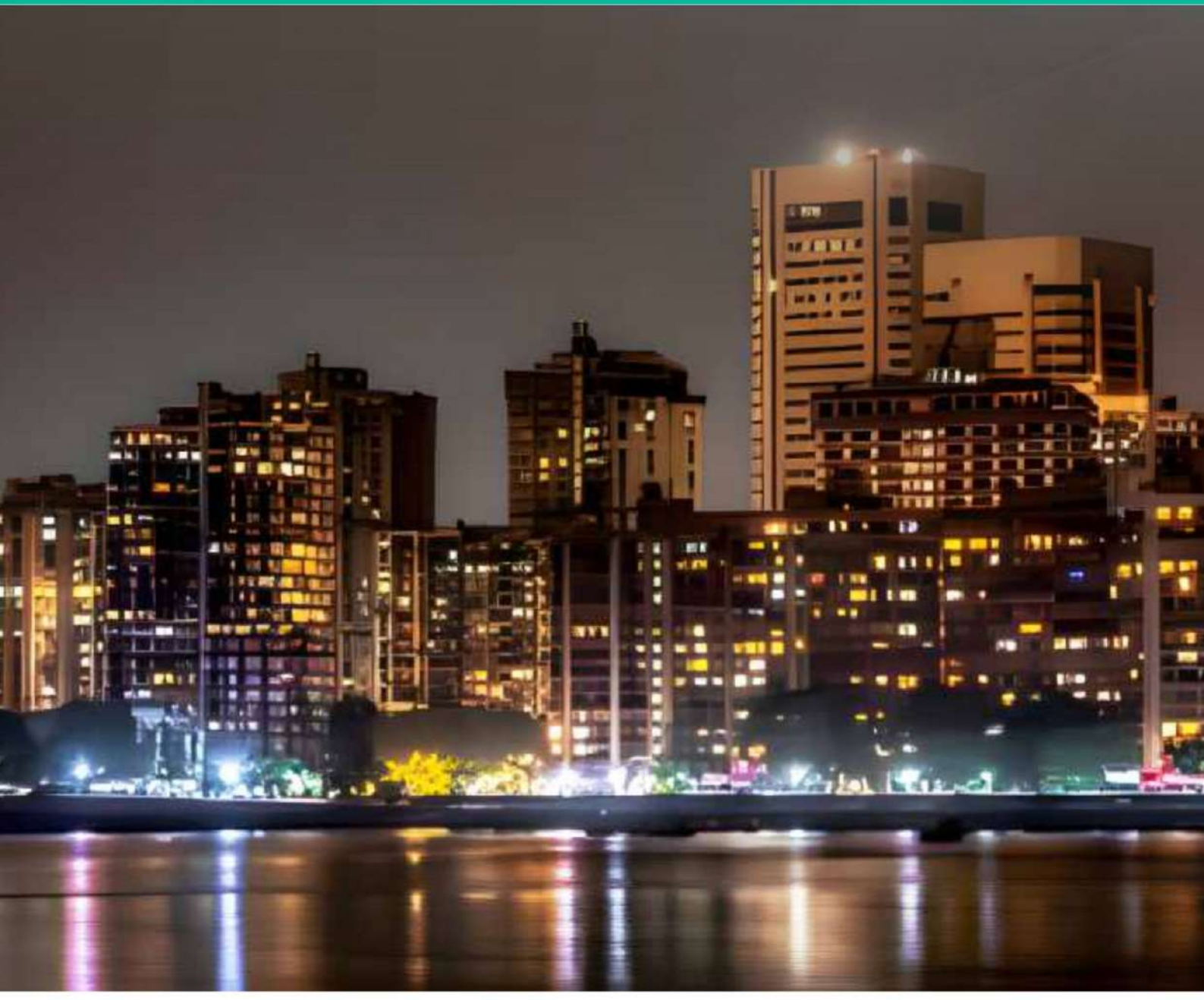
FICCI

Knowledge Paper

STAKEHOLDERS ROUNDTABLE DISCUSSION ON

DOUBLING THE RATE OF ENERGY EFFICIENCY OF INDIAN INDUSTRIES BY 2030

On 10th April 2024,New Delhi



Strategies for Doubling Energy Efficiency of Indian Industries by 2030

In 2019, Bureau of Energy Efficiency (BEE)'s strategic plan Unlocking National Energy Efficiency Potential (UNNATEE) estimates India's industrial energy efficiency (EE) potential at 47.5 Mtoe (11%) and 72.3 Mtoe (16%) in moderate and ambitious scenarios respectively. This requires a potential investment of INR 3,071 – 4,637 billion.

India has, during 2023, voluntarily committed to doubling the rate of its energy efficiency from 2.2% (between 2010 and 2020) to 4.6% (between 2020 and 2030) at various international forums/ platforms such as COP28, G20 New Delhi Leaders' Declaration, and G20 Energy Transition Ministers' Meeting. This translates[1] into ~171.27 Mtoe energy savings compared to BAU. Consequently, the investment required would be INR 11,074 billion. Since Industry represents half of the consumption, **the investment required for doubling industrial EE by 2030 would be INR 5,648 billion.**

To achieve this target, India must adopt a strategic and technology driven approach. An analysis of the list of energy efficiency technologies identified by the BEE's ADEETIE (Assistance in Deploying Energy Efficient Technologies in Industries and Establishments) based on their applicability (single vs cross/ multiple sectors), potential savings %, and payback period throws up 4 distinct categories, each of which needs **customized strategies to exploit India's industrial EE potential** as listed below.

<table>
<tr><th rowspan="2">Savings</th><th rowspan="2">Payback period</th><th rowspan="2">Scope</th><th colspan="3">Strategies to exploit potential towards doubling EE by 2030</th></tr>
<tr><th>Category Level</th><th>Overarching Level</th><th>Ecosystem Level</th></tr>
<tr><td rowspan="2">High (> 20%)</td><td rowspan="2">Low (< 20 months)</td><td>Cross/ multiple sectors</td><td>1. National Programs on Industrial EE with integrated techno-commercial offering</td><td rowspan="2">1. Strengthen ESCO market with appropriate payment security or risk guarantee mechanisms</td><td rowspan="8">1. Introduce Life Cycle Costing approach in Public Procurement of appliances
2. Enforce DSM regulations in the states - promote Utility Based DSM programs
3. Aggressive R&D for accelerated decarbonisation of industrial sectors
4. Training and deployment of Energy Professionals like Energy Auditors and Energy Managers in more practical manner
5. Strengthening of SDAs under EC Act
6. Domestic carbon markets for energy efficiency as well</td></tr>
<tr><td>Single sector</td><td>2. Sector specific targets/ mandates and programs
3. Enable domestic manufacturing through conducive policy</td></tr>
<tr><td rowspan="2">Low (< 20%)</td><td rowspan="2">Low (< 20 months)</td><td>Cross/ multiple sectors</td><td>4. Energy Management Systems
5. EE mandates for states</td><td rowspan="2">2. Widening of PAT scheme to include MSMEs
3. Technology incubators to identify upcoming innovations and nurture them</td></tr>
<tr><td>Single sector</td><td>6. EE mandates for energy intensive sectors</td></tr>
<tr><td rowspan="2">High (> 20%)</td><td rowspan="2">High (> 20 months)</td><td>Cross/ multiple sectors</td><td>7. Deepening of PAT scheme to spur competition and tap into the opportunities beyond the low-hanging ones</td><td rowspan="2">4. Include EE projects under Suitable Financing and provide necessary fiscal incentives for EE projects</td></tr>
<tr><td>Single sector</td><td>8. Sector-specific technology accelerators for improving viability</td></tr>
<tr><td rowspan="2">Low (< 20%)</td><td rowspan="2">High (> 20 months)</td><td>Cross/ multiple sectors</td><td colspan="3" rowspan="2"></td></tr>
<tr><td>Single sector</td></tr>
</table>

[1] GGGI analysis based on BEE's Total Energy Consumption of India in 2031 from UNNATEE, and AEEE's EE improvement rate – Business as usual (BAU) scenario v. "Doubling" scenario

Category level strategies:

1. National Programs on Industrial EE with integrated techno-commercial offering

National programs for cross-cutting and standardized technologies that are commercially viable captures economies of scale from demand aggregation for faster uptake. Some examples:

S. No	Technologies Suitable for National Industrial EE Programs	Market potential by 2030 (INR Billions)
1	Motors	25 – 30
2	Super-Efficient Air-Conditioner	35 – 40
3	Industrial LED Lights	45 – 50
4	Pumping	71
5	Chillers	110
6	Waste Heat Recovery (WHR)	550 – 650
7	District Cooling	1,500

2. Sector specific targets/ mandates and programs

3. Enable domestic manufacturing through conducive policy

6 industries (Steel, Cement, Textile & Leather, Paper & Pulp, Chemical, and others) contribute to 50-55% of industrial energy consumption. 70% of energy consumption in these industries is thermal-related. Thermal efficiency mandates in these sectors backed by national level programs as mentioned in the previous point, would yield significant results. Catalyzing domestic manufacturing for these value chains involving thermal technologies for high quality and efficiency would have a multiplier effect. This can benefit from Industry 4.0 technologies that seamlessly blend the physical, digital capabilities of industry bolstered with the power of Artificial Intelligence.

GGGI's Asia Low Carbon Buildings Transition (ALCBT) Project is a 5-year (2023-28) aims to promote low-carbon (embodied) production of Steel, Cement and other value chains relevant to buildings to exploit the huge EE potential of India by 2030.

One of the key challenges that we have identified so far for transition to low-carbon materials ecosystem is the lack of Environmental Product Declarations (EPDs) for the Indian context. EC3's EPD Database has just 42 concrete EPDs and 1 non-concrete EPD from India, as opposed to 4,000+ concrete EPDs and 89,000+ non-concrete EPDs from USA.

While BEE signalled intent to kickstart the embodied carbon accounting based on good faith on voluntary efforts of the industry in the proposed draft Energy Conservation & Sustainability Business Codes (ECSBC), it is essential to invest in a domestic government verified EPD database that is frequently reviewed and updated, for a robust buildings-based carbon market creation.

GGGI, through the ALCBT Project will extend support to mainstreaming these low-carbon building materials with policy advocacy, capacity building, sharing of techno-commercial best practices etc.

4. Energy Management Systems

Promoting Energy Management Systems (EMS) through standards such as ISO 50001:2011 is a cost-effective way for continuous improvement in EE, often yielding no-cost / low-cost results with payback periods less than 18 months and 10% in energy savings.

5. **EE mandates for states, and energy intensive sectors**

EE mandates for states and energy intensive sectors will nudge them to tap into all the low hanging EE opportunities, even if their potential isn't very high. Energy Conservation Building Code (ECBC) for buildings, waste-to-energy mandates for cement plants using co-processing systems etc., are examples.

6. **Deepening of PAT scheme to spur competition and tap into the opportunities beyond the low-hanging ones**

Perform, Achieve & Trade (PAT) scheme, which will eventually be subsumed under the BEE's domestic carbon markets scheme has been a great instrument for accelerating EE in India. Successive cycles of the scheme have covered more sectors and with increasing depth, leading to 509 Designated Consumers with an overall EE target of 6.627 Mtoe in PAT VII A. This increased competition among industrial sectors, nudged industries to exploit medium to long-term opportunities as well, to enable cross-sale of PAT certificates for more revenue.

7. **Sector-specific technology accelerators for improving viability**

Accelerators such as the UN's Facility for Low Carbon Technology Deployment help sector specific technologies graduate from lab-stage to the market, reducing payback periods, improving its viability and uptake. AIM Smart City Accelerator, Social Alpha's Clean Energy International Incubation Centre (CEIIC), Villgro Innovations Foundation, Intellecap's Circular Apparel Innovation Factory (CAIF), cKinetics etc. are some more examples of this kind.

Overarching Level Strategies:

1. **Strengthen ESCO market with appropriate payment security or risk guarantee mechanisms**

Technologies with high savings potential and with attractive payback periods, are often stalled in deployment because of risk perceptions especially in the early years. Such techno-commercial risks, if addressed through appropriate payment security/ risk guarantee mechanisms will help large companies, and especially MSMEs adopt EE measure widely. Government cannot design such instruments to cover the entire industry – so private sector must be roped, especially through the supply-chain financing angle, in addition to the climate finance from MDBs/ philanthropic community etc.

2. **Widening of PAT scheme to include MSMEs**

MSMEs often operate with a lot of obsolete technologies. Replacing them with commercially mature technologies presents significant potential. Medium size companies can be brought under the ambit of PAT scheme through a value chain approach. This can be designed by optimizing on existing efforts such as BEE-SME Program, GEF-UNIDO-BEE, and GEF-WB-BEE interventions that targeted (1) demonstration through back-end subsidies (2) EE in industrial clusters (3) increased access to commercial finance for EE respectively. Initiatives such as these help MSMEs with awareness programs, technical assistance, DPR preparation, investment mobilization etc.

3. **Technology incubators to identify upcoming innovations and nurture them**

Academic institutions, R&D agencies, universities etc. are critical to identify new technologies and incubate them for graduating them from labs to industrial implementation. Incubators are a critical factor in providing competitive edge to domestic manufacturing and climate change mitigation efforts.

FIIRE, IIM-K, CIIC, iCreate, Atal Innovation Centres' network, DLabs Incubator NSIC, TIDE etc. are all some institutions that are active in this space. Policy efforts must strengthen the innovation ecosystem in the country by supporting these institutions with sufficient funding, technical resources, and industry connects.

4. **Include EE projects under suitable financing and provide necessary fiscal incentives for EE projects**

In addition to ESCO models, various forms of financing such as grants, budget financing, On-bill financing, revolving funds, credit lines with development and commercial banks, partial risk guarantees, bonds, vendor or leasing finance and cash-flow financing all need to be explored to their full potential based on customized strategies for each technology and off-taker group.

Ecosystem Level Strategies:

1. **Introduce Life Cycle Costing approach in Public Procurement of appliances**

Public procurement accounts for around 20% of the GDP in India. Ministry of Finance had worked with BEE to save 250 MW of energy by prescribing standards and star labels for appliances (LEDs, split ACs, frost free refrigerators etc.) to be procured under various office premises. When life cycle costing approach is adopted in such public procurement exercises, the resulting demand aggregation sends demand and pricing signals to the manufacturers and spurs EE. Government e-Marketplace portal has been a critical element in India's public procurement efforts off-late. Prescription of the minimum standards for listing products/ services in the portal based on standardized life cycle costing could boost EE efforts.

2. **Enforce DSM regulations in the states - promote Utility Based DSM programs**

Increasing variability in India's electrical grid because of scaling up of RE resources, brings up the role of demand resource as an additional resource to ensure reliability. Demand-side Management regulations are adopted by many states in India, but the implementation falls short of the vision because of factors such as poor enforcement for non-compliance, lack of expertise in demand forecasting and management, disconnect with Discom's resource planning. Effective DSM implementation especially through Utilities/ Discoms through Time of the Day tariffs, efficient LEDs/ Air Conditioning retrofits, on-bill financing etc. will spur EE achievements.

3. **Aggressive R&D for accelerated decarbonisation of industrial sectors**

India's target of achieving Net-Zero by 2070 needs exploiting all options at its disposal. Aggressive investments in R&D across the entire industrial energy value chains including the physical, digital, and human components with a systems perspective is needed to achieve deep decarbonization of hard-to-abate industries. Fuel switching, process chemistry innovations, digital management, EVs, Green Hydrogen, Energy Storage, Demand Response etc. are all options that are to be exploited.

4. **Strengthening of SDAs under the Energy Conservation (EC) Act**

To address the variability in performance among State Designated Agencies (SDAs) and enhance their effectiveness in promoting EE across India, a more structured and uniform approach could be beneficial. Recommendations include the provision of targeted fiscal assistance to SDAs, the development of their institutional capacities, and the facilitation of cross-functional collaborations. Additionally, mainstreaming energy data reporting and monitoring across sectors could empower SDAs to implement energy conservation initiatives more effectively. Implementing these solutions could lead to more consistent and impactful energy efficiency improvements at the state level, as highlighted by the BEE and supported by findings in the State Energy Efficiency Index.

5. **Training and deployment of energy Professionals like Energy Auditors and Energy Managers in more practical manner**

Unlike the supply-side interventions (for e.g. renewable energy like solar PV) energy efficiency demands highly customized solutions for each context. Hence, BEE's training and certification of Energy Managers and Auditors is a highly critical intervention that defines the successful exploitation of India's EE on a continuous basis. Mandatory employment of these certified experts in industry, backed by frequent refresher and best practice sharing programs, continuous exchange of data with

the State Designated Agencies, organized efforts to mainstream the percolation of this institutional expertise into academic curriculum etc., are highly essential.

6. Domestic carbon markets for energy efficiency as well

India's Perform, Achieve, and Trade (PAT) scheme for industrial EE is anticipated to undergo phased transition into the upcoming Indian Carbon Market. The first phase allowing the trading of energy saving certificates (ESCerts) from the PAT scheme within the compliance market, and an option to convert ESCerts into new Carbon Credit Certificates (CCCs). This approach aims to address the current surplus in certificate supply and stimulate new demand in the market.

The inclusion of the PAT scheme into the carbon market framework provides a structured pathway towards a more cohesive approach to energy efficiency and emission reductions, ensuring alignment with broader national climate goals. By leveraging lessons learned from the PAT scheme, such as the importance of ambitious targets, robust governance, effective compliance, and data transparency, the carbon market can potentially overcome some of the challenges faced by the PAT scheme. This could lead to a more effective mechanism for achieving India's decarbonization goals and contributing to global climate efforts.

Moreover, the consultation and planned structure of the carbon market indicate an openness to learning from past experiences and incorporating features such as fungibility between different types of certificates and setting sectoral targets based on National Determined Contributions (NDCs). This is indicative of a solution-oriented approach that aims to enhance the market's effectiveness and credibility, potentially driving significant environmental and economic benefits.

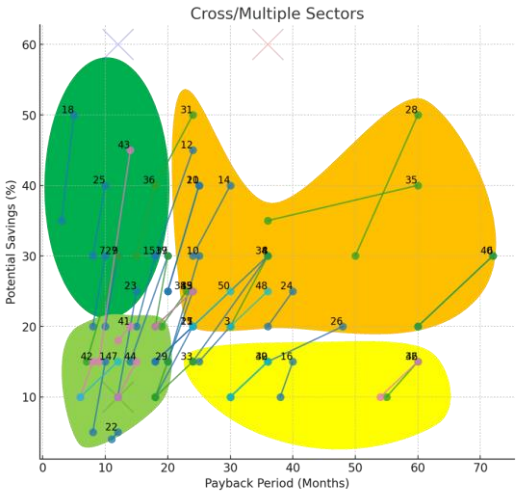


Figure 1 Cross-cutting Energy Efficiency Technologies (Potential Savings Vs Payback Period)

Technology Legend

1: Electrical, Cross/Multiple Sectors, Standardized { Automation and Control System }
2: Electrical, Cross/Multiple Sectors, Standardized { Automation of Withering Troughs }
3: Electrical, Cross/Multiple Sectors, Standardized { Combustion Control System for Boiler }
4: Electrical, Cross/Multiple Sectors, Standardized { Energy Management System }
5: Electrical, Cross/Multiple Sectors, Standardized { AI&ML based IoT platform for Energy and Asset management }
6: Electrical, Cross/Multiple Sectors, Standardized { Electric annealing furnace }
7: Electrical, Cross/Multiple Sectors, Standardized { Electric Extrusion Melting }
8: Electrical, Cross/Multiple Sectors, Standardized { Electric Melting Furnace }
9: Electrical, Cross/Multiple Sectors, Standardized { Electrical Servo Drives }
10: Electrical, Cross/Multiple Sectors, Standardized { Energy Efficient Pumps - 5 Star Rating Pumps }
11: Electrical, Cross/Multiple Sectors, Standardized { Energy Efficient Screw Compressor }
12: Electrical, Cross/Multiple Sectors, Standardized { Energy Efficient Turbo Blower }
13: Electrical, Cross/Multiple Sectors, Standardized { Gasifier for Electrical Application }
14: Electrical, Cross/Multiple Sectors, Standardized { Hanger Shot blast Machine }
15: Electrical, Cross/Multiple Sectors, Standardized { IGBT based Induction furnace }
16: Electrical, Cross/Multiple Sectors, Standardized { IGBT based temperature control }
17: Electrical, Cross/Multiple Sectors, Standardized { Infrared (IR) Heaters }
18: Electrical, Cross/Multiple Sectors, Standardized { Light emitting diode (LED) Lighting }
19: Electrical, Cross/Multiple Sectors, Standardized { Micro Turbine }
20: Electrical, Cross/Multiple Sectors, Standardized { Motors (IE3 or IE4 or IE5) }
21: Electrical, Cross/Multiple Sectors, Standardized { Screw Compressor with Permanent Magnet (PM) motor }
22: Electrical, Cross/Multiple Sectors, Standardized { Static Reactive Power Generator with Harmonics Filter }
23: Electrical, Cross/Multiple Sectors, Standardized { Temperature controller for cooling tower fan }
24: Electrical, Cross/Multiple Sectors, Standardized { Tri-generation }
25: Electrical, Cross/Multiple Sectors, Standardized { Variable Frequency Drives (VFD) }
26: Electrical, Cross/Multiple Sectors, Standardized { Variable Refrigerant flow (VRF) in HVAC }
27: Thermal, Cross/Multiple Sectors, Standardized { Back Pressure Turbine }
28: Thermal, Cross/Multiple Sectors, Standardized { Cogeneration }
29: Thermal, Cross/Multiple Sectors, Standardized { Condensate recovery system in boiler/jet dying machine }
30: Thermal, Cross/Multiple Sectors, Standardized { DeSuperheater for Chiller Compressors }
31: Thermal, Cross/Multiple Sectors, Standardized { Electric Dry Vacuum Pumps }
32: Thermal, Cross/Multiple Sectors, Standardized { Energy Efficient Boilers }
33: Thermal, Cross/Multiple Sectors, Standardized { Energy efficient Refrigeration Compressor }
34: Thermal, Cross/Multiple Sectors, Standardized { Gas fired Annealing furnace }
35: Thermal, Cross/Multiple Sectors, Standardized { Ground & Water source Heat Pumps (GSHP) }
36: Thermal, Cross/Multiple Sectors, Standardized { Heat Pump }
37: Thermal, Cross/Multiple Sectors, Standardized { Hot Air Generator from Briquette }
38: Thermal, Cross/Multiple Sectors, Standardized { Hot Water Generator }
39: Thermal, Cross/Multiple Sectors, Standardized { Mechanical Vapor Recompression (MVR) Evaporator }
40: Thermal, Cross/Multiple Sectors, Standardized { PUF insulation }
41: Thermal - Waste Heat Recovery (Medium Temperature), Cross/Multiple Sectors, Standardized { Air Pre Heater & Drying Bed in furnace }
42: Thermal - Waste Heat Recovery (Medium Temperature), Cross/Multiple Sectors, Standardized { Economiser in boiler/Thermic Fluid Heater }
43: Thermal - Waste Heat Recovery (Medium Temperature), Cross/Multiple Sectors, Standardized { Gas-fired Reheating Furnace with WHR System }
44: Thermal - Waste Heat Recovery (Medium Temperature), Cross/Multiple Sectors, Standardized { Waste Heat Recovery Boiler }
45: Thermal - Waste Heat Recovery (Medium Temperature), Cross/Multiple Sectors, Standardized { Waste Heat Recovery System for Coke Drying Quenching (CDQ) }
46: Thermal - Waste Heat Recovery (Medium Temperature), Cross/Multiple Sectors, Standardized { Waste Heat Recovery for power generation }
47: Thermal - Waste Heat Recovery (Low Temperature), Cross/Multiple Sectors, Standardized { Heat Exchanger }
48: Thermal - Waste Heat Recovery (Low Temperature), Cross/Multiple Sectors, Standardized { Hot water generation from cement kiln }
49: Thermal - Waste Heat Recovery (Low Temperature), Cross/Multiple Sectors, Standardized { Low-Grade Waste Heat Recovery System (LGWHRS) }
50: Thermal - Waste Heat Recovery (Low Temperature), Cross/Multiple Sectors, Standardized { Thermo Compression }

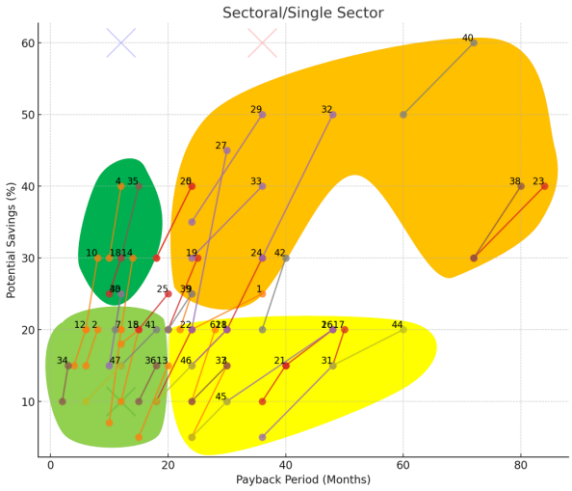


Figure 2 Sectoral Energy Efficiency Technologies (Potential Savings Vs Payback Period)

Technology Legend

1: Textile, Sectoral/Single Sector, Standardized { Auto loom }
2: Textile, Sectoral/Single Sector, Standardized { Carbon Fiber Fan }
3: Textile, Sectoral/Single Sector, Standardized { Exhaust humidity measurement & control system }
4: Textile, Sectoral/Single Sector, Standardized { Gas fired stenters }
5: Textile, Sectoral/Single Sector, Standardized { High-speed carding machine }
6: Textile, Sectoral/Single Sector, Standardized { High-speed Ring spinning frame }
7: Textile, Sectoral/Single Sector, Standardized { Light weight bobbins }
8: Textile, Sectoral/Single Sector, Standardized { Light weight carbon reinforced spinning pot }
9: Textile, Sectoral/Single Sector, Standardized { PLC based dyeing machine }
10: Textile, Sectoral/Single Sector, Standardized { Pulser dyeing technique }
11: Textile, Sectoral/Single Sector, Standardized { Rapier or Auto Loom }
12: Textile, Sectoral/Single Sector, Standardized { SITRA Excel fans }
13: Textile, Sectoral/Single Sector, Standardized { Synthetic sandwich tapes }
14: Textile, Sectoral/Single Sector, Standardized { Ultrasonic technology }
15: Textile, Sectoral/Single Sector, Standardized { Waste heat recovery in centrifugal compressor }
16: Pulp & Paper, Sectoral/Single Sector, Standardized { Black Liquor Gasification }
17: Pulp & Paper, Sectoral/Single Sector, Standardized { Bleached Chemi Thermo Mechanical Pulp (BCTMP) }
18: Pulp & Paper, Sectoral/Single Sector, Standardized { Boiler Conversion: Atmospheric Fluidised bed to Spouted bed }
19: Pulp & Paper, Sectoral/Single Sector, Standardized { Drum pulpers }
20: Pulp & Paper, Sectoral/Single Sector, Standardized { Fabricated Water Ring Vacuum Pumps }
21: Pulp & Paper, Sectoral/Single Sector, Standardized { Hi-Consistency Pulper }
22: Pulp & Paper, Sectoral/Single Sector, Standardized { Modern Brownstock Washers (BSWs) }
23: Pulp & Paper, Sectoral/Single Sector, Standardized { Oxyfuel Burner }
24: Pulp & Paper, Sectoral/Single Sector, Standardized { Shoe Press }
25: Pulp & Paper, Sectoral/Single Sector, Standardized { Vacuum blower }
26: Building, Sectoral/Single Sector, Standardized { Aeroseal duct sealing technology }
27: Building, Sectoral/Single Sector, Standardized { BEE 5 Star Rated AC }
28: Building, Sectoral/Single Sector, Standardized { Desiccant-based cooling systems / DeVAP (Desiccant Enhanced Evaporative) HVAC }
29: Building, Sectoral/Single Sector, Standardized { Energy Efficient Brushless Direct Current (BLDC) Fan }
30: Building, Sectoral/Single Sector, Standardized { Energy Efficient technology for ECBC/Eco-niwas Samhita }
31: Building, Sectoral/Single Sector, Standardized { Energy recovery ventilation (ERV) }
32: Building, Sectoral/Single Sector, Standardized { Radiant Cooling }
33: Building, Sectoral/Single Sector, Standardized { VAM Chillers }
34: Iron & Steel, Sectoral/Single Sector, Standardized { Direct Rolling in mini steel plants }
35: Iron & Steel, Sectoral/Single Sector, Standardized { Installation of Pulverized Coal Injection in Blast Furnace }
36: Iron & Steel, Sectoral/Single Sector, Standardized { Installation of Top Recovery Turbine in Blast Furnace }
37: Iron & Steel, Sectoral/Single Sector, Standardized { Medium frequency Induction Furnace }
38: Iron & Steel, Sectoral/Single Sector, Standardized { Plasma melting furnace }
39: Foundry, Sectoral/Single Sector, Standardized { Divided blast cupola }
40: Foundry, Sectoral/Single Sector, Standardized { High Pressure Moulding Line in Moulding Area }
41: Foundry, Sectoral/Single Sector, Standardized { Lost foam casting technology }
42: Foundry, Sectoral/Single Sector, Standardized { Natural Gas fired Boiler }
43: Foundry, Sectoral/Single Sector, Standardized { Veneering for Industrial furnaces }
44: Cement, Sectoral/Single Sector, Standardized { Latest Generation High Efficiency Clinker Cooler }
45: Cement, Sectoral/Single Sector, Standardized { Modern multichannel burners }
46: Cement, Sectoral/Single Sector, Standardized { Particle size Distribution (PSD) analyser }
47: Cement, Sectoral/Single Sector, Standardized { Vortex rectifier in mill }