



### BEE's List of Energy Efficient Technologies (as on 01-February-2023)

| Sl. No.           | Name of Technology                           | About Technology  | Potential Savings (%) | Sector                      | Average Investment (Rs. Lakhs) | Annual Monetary Saving (Rs. Lakhs) | Estimated Payback Period (Months) | Equipment Capacity                        |
|-------------------|--|---|-----------------------|-----------------------------|--------------------------------|------------------------------------|-----------------------------------|---|
| <b>Electrical</b> |  |   |                       |                             |                                |                                    |                                   |   |
| 1                 | Automation and Control System                | Automation and control system provides effective monitoring of process and utility for better resource utilization and loss reduction   | 5-15 %                | Cross-sectoral - Electrical | 20-25                          | 25-30                              | 8-10                              | Not Applicable                            |
| 1.1               | Automation of Withering Troughs              | The automation of withering trough will ensure achieve optimum temperature and ensure effective control thereafter for proper withering of tea leaves   | 10-15%                | Cross-sectoral - Electrical | 15-20                          | 6-8                                | 30-36                             | 8 nos. of Enclosed Trough & 96 HP Motor   |
| 1.2               | Combustion Control System for Boiler         | Combustion control system in boiler provides effective monitoring of flue gas parameters, their temperature and pressure for complete combustion  | 15-20%                | Cross-sectoral - Electrical | 9-10                           | 4-5                                | 25-30                             | 12 TPH                                    |
| 1.3               | Energy Management System                     | The EMS is effective in managing energy flow and consumption, reduce wastage and do necessary rectification in case of any fault  | 15-30%                | Cross-sectoral - Electrical | 7-10                           | 3-4                                | 24-36                             | For 300 smart energy meters               |
| 2                 | Electrical Servo Drives                      | The servo drive is quite efficient in smooth start and stoppage of machine having frequent load fluctuation, and helps reduce energy wastage as well as wear and tear of machine  | 20-30%                | Cross-sectoral - Electrical | 10-15                          | 10-20                              | 10-12                             | 200 KVA                                   |
| 3                 | Energy Efficient Pumps - 5 Star Rating Pumps | EE pumps have optimum impeller design, thereby leading to optimum discharge flow and pressure and energy consumption  | 15-30%                | Cross-sectoral - Electrical | 0.7-4.5                        | 0.25 - 5                           | 20-25                             | 10 - 20 HP                                |
| 4                 | Energy Efficient Screw Compressor            | The screw compressors are the most efficient one to generate compressed air as well as less heat compared to normal air compressor  | 25-40%                | Cross-sectoral - Electrical | 2.5-6.5                        | 1.5 - 7.5                          | 20-25                             | 15 - 150 HP                               |
| 5                 | Energy Efficient Turbo Blower                | Turbo blower is made of anodized aluminium impellers and air foil bearings. As a result it has low weight and high corrosion resistance bearings to provide excellent control over varying rpm                                    | 30-45%                | Cross-sectoral - Electrical | 30-40                          | 20-25                              | 18-24                             | 20,000 and 50,000 rpm                     |
| 6                 | Gasifier for Electrical Application          | Gasifier gasifies coal or biomass to produce gas that can be used for power generation in gas genset or gas turbine   | 15-25%                | Cross-sectoral - Electrical | 20-25                          | 9-12                               | 20-24                             | 50 KW                                     |
| 7                 | Hanger Shot blast Machine                    | Shot blasting systems offer you nearly unlimited options from deflashing, descaling, sanding and rust removal to roughening, matting, smoothing, edge rounding and shot peening   | 30-40%                | Cross-sectoral - Electrical | 18-20                          | 8-10                               | 24-30                             | 500 Kg                                    |
| 8                 | Harmonic filter                              | The harmonic filter is essential in ensuring the power quality and help prevent and fault in electronic component   | 3-8%                  | Cross-sectoral - Electrical | 8-10                           | 5-7                                | 15-18                             | 3rd & 5th Harmonic Filter                 |
| 9                 | IGBT based Induction furnace                 | An induction furnace is a clean, energy-efficient furnace which provides well-controlled melting process, compared to conventional means of metal melting   | 20-30%                | Cross-sectoral - Electrical | 20-25                          | 15-20                              | 15-18                             | 750 KG                                    |
| 10                | IGBT based temperature control               | Installing Insulated Gate Bipolar Transistor (IGBT) based temperature controller for furnace ensures precise controlling of temperature.  | 10-15%                | Cross-sectoral - Electrical | 18-20                          | 5-6                                | 38-40                             | 50-60 KW Furnace                          |
| 11                | Infrared (IR) Heaters                        | Use of IR Heaters results in uniform heating and reduces the baking time. Infrared heaters are extremely quiet and energy-efficient heating devices that produce a very gentle heat   | 10-20%                | Cross-sectoral - Electrical | 3.5-10                         | 1.8-2.0                            | 18-24                             | 100 Kg-5 MT per hour                      |
| 12                | Light emitting diode (LED) Lighting          | Light emitting diode (LED) is a semiconductor light source that emits light when current flows through it. These are energy-efficient lights with long life, durable, and offer better light quality than other types of lighting | 35-50%                | Cross-sectoral - Electrical | 13-15                          | 30-35                              | 3-5                               | connected load 625 kW                     |
| 13                | Light Pipe                                   | Light Pipes are primarily used for illuminating deep interior spaces where there is poor daylighting provisions from doors /windows   | 15-20%                | Cross-Sectoral - Electrical | 5.00                           | 2.27                               | 26                                | 25 nos. Light Pipe for 9 KW Lighting Load |
| 14                | Micro Turbine                                | Micro-turbines are tiny gas turbines that can generate both electricity and heat, and may vary in electrical output from around 25 kW to 250 kW   | 15-30%                | Cross-sectoral - Electrical | 40-45                          | 25-40                              | 14-20                             | 20 - 60 KW                                |
| 15                | Motors (IE3 or IE4 or IE5)                   | EE motors are constructed with improved manufacturing techniques and superior materials, longer insulation and bearing lives, lower waste heat output, and less vibration, all of which increase efficiency and reliability       | 25-40%                | Cross-sectoral - Electrical | 5-7                            | 2-3                                | 20-25                             | connected load 730 kW                     |

|    |   |   |        |                             |     |       |       |                 |
|----|---|---|--------|-----------------------------|-----|-------|-------|-----------------|
| 16 | Screw Compressor with Permanent Magnet (PM) motor     | Screw Compressor is driven by Permanent Motors and thus there is no rotor loss or transmission loss that results from rotor winding   | 15-20% | Cross-sectoral - Electrical | 6-7 | 3.5-4 | 18-24 | 20 HP; 92.5 CFM |
| 17 | Static Reactive Power Generator with Harmonics Filter | In an electric power system, a load with a low power factor & Higher Harmonics draws more current and this results in higher current withdrawal and energy losses. The Static Reactive Power Generator, an IGBT based INVERTER, helps to compensate reactive power as well as selective harmonics (5th, 7th, 11th & 13th Order Only) created by the load and unbalance in the system. This helps to minimize losses | 4-5%   | Cross-sectoral - Electrical | 5   | 6     | 11-12 | 100 KVAR        |

|  |  |  |                              |                             |           |             |       |   |
|--|--|--|------------------------------|-----------------------------|-----------|-------------|-------|---|
| 18   | Temperature controller for cooling tower fan           | This intervention increase the efficiency of electrical energy utilization in the cooling tower by automatic control of cooling tower fans, based on a feedback from the water temperature from the cooling circuit  | 10-25%                       | Cross-sectoral - Electrical | 0.2-0.3   | 0.2-0.3     | 12-15 | Not applicable  |
| 19   | Tri-generation   | Tri-generation technology provides thermal, cooling and electrical energy and it has higher efficiency compared to power generation and cogeneration plants  | 20-25%                       | Cross-sectoral - Electrical | 2500-3000 | 700-1000    | 36-40 | Capacity: 2.75 MW, 20 TPH   |
| 20   | Variable Frequency Drives (VFD)                        | To control speed of various appliances like motors, pumps, compressor motors, ID fan, FD fan, hydraulic press, jet drying machine, Thermic Fluid Pump, Grinding Machine etc.   | 30-40%                       | Cross-sectoral - Electrical | 2.5-3     | 3.5-4       | 8-10  | connected load 430 kW   |
| 21   | Variable Refrigerant flow (VRF) in HVAC                | Variable Refrigerant Flow (VRF) Systems are an excellent choice for buildings that require both heating and cooling to coexist simultaneously. VRF systems have the ability to regulate the flow of refrigerant to various indoor units so that one location can stay cool while the other remains warm. | 15-20%                       | Cross-sectoral - Electrical | 45-50     | 15-20       | 36-48 | 100 TR  |
| 22   | Vertical Roller Mill (VRM)                             | Vertical roller mill is a type of grinder used to grind materials into extremely fine powder for use in mineral dressing processes, paints, pyrotechnics, cements and ceramics. It is an energy efficient alternative for a ball mill.<br>Typical Sector: Cement, Ceramics, limestone, etc.              | 6-10 KWH per MT raw material | Cross-sectoral - Electrical | 20-24     | 5-6         | 36-48 | 1 TPH   |
| <b>Thermal</b>   |  |  |                              |                             |           |             |       |   |
| 23   | Cogeneration   | Cogeneration technology provides thermal and electrical energy both and it has higher efficiency compared to power generation plant  | 30-50%                       | Cross-sectoral - Thermal    | 1000-1200 | 200-250     | 50-60 | 2 MW and 12 TPH extracted steam at 6.5 kg/cm <sup>2</sup> and 245 C |
| 24   | Condensate recovery system in boiler/jet dying machine | For applications with zero contamination, the condensate recovery system can be effectively used to conserve and reuse water in boiler   | 10-15%                       | Cross-sectoral - Thermal    | 12-15     | 7-8         | 18-20 | 4 TPH   |
| 25   | DeSuperheater for Chiller Compressors                  | A desuperheater recovers the heat from the super-heated refrigerant gas at the compressor outlet   | 10-15%                       | Cross-Sectoral - Thermal    | 4-5       | 1-2         | 30-36 | 41 KW Compressor  |
| 26   | Electric Dry Vacuum Pumps                              | Electric dry vacuum pumps do not require any fluid to generate vacuum compared to steam ejectors, thereby eliminating the contamination of process vapours and providing better solvent recovery   | 40-50%                       | Cross-sectoral - Thermal    | 18-20     | Dec-15      | 18-24 | 6 TPH Boiler  |
| 27   | Energy Efficient Boilers                               | Energy Efficient Boilers offer effective combustion of fuel with maximum utilization of energy   | 10-15%                       | Cross-sectoral - Thermal    | 25-30     | 5-6         | 55-60 | 4 TPH   |
| 28   | Energy efficient Refrigeration Compressor              | The refrigeration compressor of latest technology, having good automation and higher Coefficient of Performance (COP) must be used to save electrical energy during refrigeration cycle  | 10-15%                       | Cross-sectoral - Thermal    | 3.5-5     | 2-3         | 18-24 | 60 HP   |
| 29   | Gas fired Annealing furnace                            | The gas-fired annealing furnace is essential to ensure high level of operational efficiency of the furnace w.r.t the electrical-fired furnace, due to high GCV of Gas w.r.t electricity  | 20-30%                       | Cross-sectoral - Thermal    | 14-15     | 5-6         | 30-36 | 1000 MT   |
| 30   | Ground & Water source Heat Pumps (GSHP)                | GSHPs use water-to-water or water-to-air approaches to treat this stable thermal environment as a heat source in the heating season and a heat sink in the cooling season  | 35-40%                       | Cross-sectoral - Thermal    | 1-1.5     | 0.2-0.3     | 36-60 | 1 TR  |
| 31   | Heat Pump  | A heat pump is a device that can heat a building/utility by transferring thermal energy from the outside using the refrigeration cycle   | 30-40%                       | Cross-sectoral - Thermal    | 30-35     | 20-25       | 15-18 | 339 KW  |
| 32   | Hot Air Generator from Briquette                       | Briquette is locally available and commercially cheap alternative fuel compared to coal /wood, prepared by using agro waste, and can be used for low temperature application   | 20-30%                       | Cross-sectoral - Thermal    | 50-55     | 35-40       | 18-20 | 10 Lac Kcal /Hr   |
| 33   | Hot Water Generator                                    | The hot water generator is of natural draft system and doesn't have FD and ID fans. They are the efficient and cost-effective way to generate hot water instantly  | 20-25%                       | Cross-sectoral - Thermal    | 2.5-3.5   | 1.68 - 1.85 | 19-23 | 1000 - 80000 Kcal/hr  |
| 34   | PUF insulation   | Polyurethane Foam (PUF) is the most effective thermal insulation material and having high strength to weight ratio at low temperature, are durable for years with high mechanical strength   | 20-30%                       | Cross-sectoral - Thermal    | 3.5 - 4.0 | 0.6-0.7     | 60-72 | 100 sq.m surface of 120 mm thickness                                |
| 35   | Steam operated pumping traps                           | Steam operated pumping traps are operated on steam and is used for condensate evacuation under all operating conditions, thereby enabling high system uptime and enhanced productivity   | 3-5%                         | Cross-Sectoral - Thermal    | 1.51      | 1.54        | 12    | 2 TPH Boiler  |
| <b>Thermal - Waste Heat Recovery (Low Temperature)</b> |  |  |                              |                             |           |             |       |   |
| 36   | Heat Exchanger   | A heat exchanger is a system used to transfer heat between a source and a working fluid  | 10-15%                       | Cross-sectoral - Thermal    | 4-4.5     | 8-8.5       | 6-12  | 7000 Kg/h   |
| 37   | Hot water generation from cement kiln                  | The waste heat, which otherwise would escape in atmosphere may be recovered using appropriate heat exchanger to pre-heat water for use in utility or process   | 20-25%                       | Cement - Thermal            | 100-125   | 30-40       | 30-36 | 3000 TPD kiln 60 TR VAM system                                      |

|    |  |  |        |                          |         |       |       |           |
|----|--|--|--------|--------------------------|---------|-------|-------|-----------|
| 38 | Low-Grade Waste Heat Recovery System (LGWHR) | Waste heat even below 100 C is recovered by LGWHR and can be used in the low temperature applications. These heat exchangers are specially designed for low-grade waste heat recovery. | 10-15% | Cross-sectoral - Thermal | 10-15   | 5-7   | 30-36 | 24-36 TPH |
| 39 | Thermo Compression                           | Utilization of waste flash steam in chiller and process usage  | 20-25% | Cross-sectoral - Thermal | 150-200 | 70-80 | 24-30 | 3000TR    |

| Thermal - Waste Heat Recovery (Medium Temperature) |  |  |   |                            |             |             |       |                                     |
|--|--|--|---|----------------------------|-------------|-------------|-------|-------------------------------------|
| 40   | Air Pre Heater & Drying Bed in furnace                                     | Use of waste flue gas to pre-heat the material and save fuel   | 18-20%                                      | Cross-sectoral - Thermal   | 5-5.5       | 5.5-6       | 12-14 | 1.5 TPH                             |
| 41   | Economiser in boiler/Thermic Fluid Heater                                  | The use is Economizer is highly recommended to save fuel in thermal application by use of high heat content in flue gas to pre-heat water, which can then be used in utility or process application  | 10-15%                                      | Cross-sectoral - Thermal   | 3-3.5       | 4-4.25      | 6-8   | 4 TPH                               |
| 42   | Gas-fired Reheating Furnace with WHR System                                | A fully automated system ensures better control on temperature of metals in rolling mills, with efficient combustion owing to the use of gas as fuel. In addition, the WHR system will save substantial energy by preheating the metal to the extent possible before reheating | 15-45%                                      | Cross-sectoral - Thermal   | 19-21       | 16 - 28     | 9-14  | 2 - 12 TPH                          |
| 43   | Waste Heat Recovery Boiler   | WHR Boiler is a system which recovers various kinds of waste heat generated from the production process of steel, chemical, cement etc and convert such recovered heat into useful and effective thermal energy  | 10-15%                                      | Cross-sectoral - Thermal   | 3.5-4       | 3-3.5       | 12-15 | 4 TPH                               |
| 44   | Waste Heat Recovery System for Coke Drying Quenching (CDQ)                 | Smelting furnace generates flue gas at high temperature. This flue gas temperature is utilized to heat the atmospheric air that is utilized for coke drying  | 20-25%                                      | Cement - Thermal           | 300-350     | 200-250     | 18-24 | 7 TPH Coke Drying from 15% - 2% W/W |
| 45   | Waste Heat Recovery for power generation                                   | The WHR process is a fuel conservation measure where the heat from waste stream of gases is recovered to generate steam which in turn is used to drive turbine and generate power, instead of using conventional process of burning fuel                                       | 10-15%                                      | Cross-sectoral - Thermal   | 900-1100    | 230         | 54-60 | 1 MW                                |
| Thermal - Waste Heat Recovery (High Temperature)   |  |  |   |                            |             |             |       |                                     |
| 46   | Recuperators   | A recuperator is used to recover the waste heat, usually from the exhaust flue gas generated from furnace and use it to preheat the combustion air, thereby ensuring fuel saving and process efficiency  | 20-25%                                      | Cross-sectoral - Thermal   | 4.5-5       | 3.5-4       | 12-14 | 3 MT                                |
| 47   | Recuperative burner for heat recovery for high medium temperature furnaces | A recuperative burner is the one where recuperator is the integral part of the burner, and the waste heat is recovered to pre-heat the combustion air, thereby ensuring substantial energy saving  | 25-30%                                      | Cross-sectoral - Thermal   | 200-225     | 200-225     | 12-15 | 15TPH rolling mill                  |
| 48   | Regenerative burners for high temperature furnaces                         | In regenerative temperature can go to 1000 degC, resulting huge energy savings and improved furnace productivity. Applicable only for gas fired furnaces   | 15-20%                                      | Cross-sectoral - Thermal   | 20-30       | 20-30       | 12-15 | One unit burner for 110 TPH furnace |
| Sectoral   |  |  |   |                            |             |             |       |                                     |
| 49   | Alternative Fuels & Raw Material (AFR) Utilization                         | Utilize Alternative Fuels such as PTA Sludge, Syngenta Waste, Pines leaves etc, Municipal Solid Waste for thermal energy generation  | Thermal Substitution rate of 5-10%          | Cement                     | 8000-10000  | 1600-2000   | 60-72 | 3.1 MTPA                            |
| 50   | Adiabatic Pre-reformer   | Adiabatic pre-reforming is a well-established process in modern syngas production and implies both economic and operational benefits. The adiabatic prereformer converts hydrocarbon feed-stocks by steam reforming reactions in the low temperature range, 350-550°C          | 4-10%                                       | Fertilizer                 | 1500-1600   | 600-900     | 20-30 | 2000 TPD                            |
| 51   | Air-Dyeing Technology  | Air dyeing technology uses air instead of water to apply colours into textile materials. This method will help to save water up to 95% and energy up to 86%. This method can be only applying on synthetic fibre materials   | 86%   | Textile (Synthetic Dyeing) | 2000-3000   | 2500-3500   | 12-15 | 400-450 Kg                          |
| 52   | BEE 5 Star Rated AC  | Replacement of Conventional Split/Window AC with 5-star AC having higher COP or EER /ISEER   | 20-45%                                      | Building                   | 0.40-0.50   | 0.18-0.20   | 24-30 | connected load 57 kW                |
| 53   | Bleached Chemi Thermo Mechanical Pulp (BCTMP)                              | It is an advanced technology for the production of high-quality chemi-mechanical pulps from hardwoods and annual plants, which is very reliable and achieves highest pulp quality at minimum operating cost and  | 15-20%                                      | Pulp & Paper               | 40000-45000 | 10000-12000 | 48-50 | 1 Lac TPA BCTMP                     |
| 54   | Carbon Fiber Fan   | Carbon Fiber Fan impellers provide next-level speed, strength, and corrosion resistance for those who routinely need to move air in challenging environments without compromising strength   | 15-20%                                      | Textile                    | 70-80       | 150-170     | 6-8   | 1200 mm dia for 100 fans            |
| 55   | Cascaded Condensate Recovery System  | Installing cascaded condensate recovery system increases condensate recovery up to 90%   | 5-7%  | Pulp & Paper               | 8-Oct       | 30-35       | 3-May | Not applicable                      |
| 56   | Cement Calcining Process - Suspension Preheater                            | The Suspension Preheater process improves calcining efficiency by drying and preheating the feedstock using the kiln exhaust gas (waste heat).   | 14.3 kg of standard coal per ton of clinker | Cement                     | 4100-4200   | 4000-4200   | 10-12 | 2000 TPD                            |
| 57   | CNC Machine (Special Purpose Machine)                                      | CNC machine helps enhance productivity and lower Specific Energy consumption as one machine take care of all cutting, boring, drilling, milling, grinding operations, etc.   | 30-35%                                      | Machine Tool               | 35-40       | 25-30       | 17-20 | 400 KN                              |
| 57.1   | CNC Bending Machine  | As above   | 32%   | Machine Tool               | 36.35       | 26.07       | 17    | 400 KN                              |
| 57.2   | CNC Gear Hobbing Machine   | As above   | 25%   | Machine Tool               | 225.00      | 72.27       | 38    | NA                                  |

|      |                                     |   |        |                  |           |           |       |            |
|------|-------------------------------------|---|--------|------------------|-----------|-----------|-------|------------|
| 57.3 | CNC Grinding Machine                | As above  | 23%    | Machine Tool     | 45.61     | 33.73     | 16    | NA         |
| 57.4 | CNC Horizontal M/c Centre           | As above  | 30%    | Machine Tool     | 151.00    | 67.73     | 27    | NA         |
| 57.5 | CNC Lathe Machine                   | As above  | 30%    | Machine Tool     | 40.80     | 14.88     | 33    | NA         |
| 57.6 | CNC Milling M/C                     | As above  | 30%    | Machine Tool     | 73.41     | 28.86     | 31    | NA         |
| 57.7 | CNC Turn –Mill Centre               | As above  | 25%    | Machine Tool     | 50.48     | 17.62     | 35    | NA         |
| 57.8 | CNC Turret Punch Machine            | As above  | 41%    | Machine Tool     | 88.66     | 51.27     | 21    | 20 TON     |
| 57.9 | CNC Wire Cut Machine                | As above  | 35%    | Machine Tool     | 61.00     | 26.07     | 28    | NA         |
| 58   | Compressed Bio-Gas (CBG)            | Compressed Bio Gas or CBG is a purified biogas (methane content more than 90%) with zero trace of carbon dioxide and hydrogen sulphide gases and compressed to maximum 250 bar and filled up in cascades (group of high pressure cylindrical vessels).  | 25-30% | Oil & Gas Sector | 700 - 800 | 140 - 150 | 60-72 | 5 TPD      |
| 59   | Direct Rolling in mini steel plants | The Direct Rolling Technology refers to converting the billet in to a rolled product without any intermediate reheating arrangement, thereby avoiding wastage of sensible heat of steel. Here, the hot billets produced from continuous casting machine is not taken into the storing yard where they will cool down to ambient temperature thereby losing energy, but are diverted in hot condition directly to the rolling section. | 10-15% | Iron & Steel     | 100-120   | 600-700   | 2-3   | 18 TPH     |
| 60   | Divided blast cupola                | For replacement of conventional cold blast cupola for better melting of metals, generated less pollution and saves coal as well   | 20-25% | Foundry          | 6-8       | 3-4.5     | 20-24 | 2 MT/Batch |

|    |  |  |                                    |                   |          |         |        |   |
|----|--|--|------------------------------------|-------------------|----------|---------|--------|---|
| 61 | Electrical Annealing Bogie Furnaces                        | The energy cost in electrical annealing furnaces is low comparatively with wood fired furnaces due to more efficiency of electrical heating, less manpower cost and low energy cost. Further, this also ensures maintain uniform temperature throughout the furnace                      | 25-30%                             | Brass & Aluminium | 8-10     | 4-5     | 22-24  | 60 kW                                       |
| 62 | Energy Efficient Brushless Direct Current (BLDC) Fan       | BLDC fans consumes lower energy compared to conventional fans, having high reliability and life expectations as well   | 35-50%                             | Building          | 4-6      | 1-2     | 24-36  | connected load 243 kW                       |
| 63 | Energy efficient cyclone                                   | Energy efficient cyclone has 97.5% efficiency and it can be installed at the last stage in Pre-heater  | 1.03 KWH & 7000 KCal/MT of Clinker | Cement            | 600-650  | 200-220 | 36-40  | 105 TPH                                     |
| 64 | Energy efficient gas fired pot furnace                     | It has several pots or crucibles in which different small batches of glass can be melted   | 30-35%                             | Glass             | 10-15    | 10-15   | 10-12  | 10-12 pots, each of 500-550 Kg capacity     |
| 65 | Energy efficient impeller                                  | Energy efficient impeller 84% efficiency. The can improve the performance of Fans installed in industries  | 1.08 KWH/MT Clinker                | Cement            | 100-120  | 42-45   | 24-30  | 250 Ton of Clinker                          |
| 66 | Energy Efficient Modulating Burner                         | These burners are provided with variable air/fuel ratio leading to better heat generation and drying of leaves, thereby producing good quality tea   | 10-15 %                            | Tea Processing    | 5-7      | 8-10    | 9-12   | Dryer 1 @450 kg/h;<br>Dryer 2@250kg/h.      |
| 67 | Energy Efficient Tank furnace                              | Tank Furnaces are primarily used in glass industry where continuous flow of glass is needed to feed automatic glass forming machines.  | 15-20%                             | Glass             | 400-450  | 200-300 | 24-30  | 25-40 TPD                                   |
| 68 | Energy Efficient technology for ECBC/Eco-niwas Samhita     | The efficient building envelope helps prevent heat loss /gain between inside space of building and outside atmosphere, thereby ensuring more comfort, maintain appropriate building temperate and also reduce heating /cooling load, thereby saving electrical energy to a great extent. | 15-25%                             | Building          | 220-240  | 230-250 | 10-12  | connected load 15000 kW                     |
| 69 | Energy Efficient Tray Dryer                                | The Tray drying is a batch process used to dry materials that are liquid or wet cake, and works well for material that requires more gentle processing or cannot be atomized in an air stream due to viscosity.  | 15-20%                             | Chemical          | 10-12    | 6-8     | 15-20  | 400 Trays                                   |
| 70 | Exhaust humidity measurement & control system              | To control outlet moisture of Fabric on stenter and control blower motor speed and power consumption as well   | 5-15%                              | Textile           | 2-2.5    | 1-1.25  | 24-30  | 1 unit                                      |
| 71 | Fabricated Water Ring Vacuum Pumps                         | Fabricated water ring vacuum pumps have precise design, reduced dead weight and reduced wear and tear compared to conventional cast iron water ring vacuum pumps   | 30-40%                             | Pulp & Paper      | 50-55    | 45-47   | 18-24  | 230 GSM duplex paper with 2.62 TPH capacity |
| 72 | Falling Film Chillers                                      | Falling Film Chillers are suitable for continuous chilling of liquids close to their freezing point. They are installed before Ice Bank Tank (IBT) to pre-chill the incoming process return water at higher temperature  | 20-22%                             | Dairy             | 35-40    | 35-40   | 12-15  | 350 TR                                      |
| 73 | Fiberglass Reinforced Plastic (FRP) Fan in Withering Units | The Fiberglass Reinforced Plastic (FRP) is light in weight compared to metallic blade and can resist any weather situation and withstand corrosion, waterborne bacteria and organisms  | 10 - 15 %                          | Tea Processing    | 8-10     | 12-15   | 6-8    | 31 troughs, 39 nos. fans                    |
| 74 | Fluidised Bed dryer system                                 | The Fluidised dryer system will ensure better quality tea by ensuring effective drying of tea leaves   | 10-15%                             | Tea Processing    | 15-20    | 7-10    | 24-30  | 500-700 Kg/hr                               |
| 75 | Forging Furnace  | The energy efficient forging furnace provides effective heat for the heating and reheating of large steel ingots, blooms and cast parts, with better temperature control and reduced skin losses from outer surface of chamber   | 15-20%                             | Forging           | 20-25    | 20-25   | 10-12  | 250 KW                                      |
| 76 | Gas Engine based co-generation technology                  | A Cogeneration is a system having gas engine produces heat and electricity simultaneously in a single plant, powered by gaseous fuel having better combustion and less ash generation, thereby guaranteeing a better energy yield  | 30-40%                             | Ceramics          | 800-1000 | 320-350 | 30-35  | 2.72 MW                                     |
| 77 | Gas fired hot air generator system                         | For replacement of conventional wood fired hot air generator system with better combustion control and less emission   | 20-25%                             | Chemical          | 4-5      | 3.5-5   | 10-12  | 120000 Kcal/hr                              |
| 78 | Gasifier For Kilns   | The Gasifier is a cheaper energy source having better yield compared to conventional fuel for combustion in kilns  | 30-35%                             | Limestone         | 55-65    | 24-30   | 28-32  | 30 TPD                                      |
| 79 | Gasifier for Melting And Reheating Process                 | Rice husk works as renewable source of energy. Hence use of rice husk reduced cost of production and waste utilization as well   | 20-25%                             | Brass & Aluminium | 40-45    | 25-30   | 18-24  | 500 KG                                      |
| 80 | Hi-Consistency Pulper                                      | Hi-consistency pulper requires lesser amount of water compared to low consistency pulper.  | 10-15%                             | Pulp & Paper      | 45-50    | 15-17   | 36-40  | 130 kW                                      |
| 81 | High Efficiency Refiner                                    | Refiners are used for mechanical pulping (TMP refiners) and the post-refining of GWP (Ground wood Pulp) mills. Energy efficient refiners can reduce no-load power caused by motor, pumping, and friction losses.   | 7-20%                              | Pulp & Paper      | 480-500  | 450-500 | Dec-15 | 300 TPD                                     |

|    |  |   |   |                            |           |           |       |                                    |
|----|--|---|---|----------------------------|-----------|-----------|-------|------------------------------------|
| 82 | High Pressure Moulding Line in Moulding Area               | High pressure moulding line has advantages such as continuous mould preparation, fast pattern changing time, fully automatic machine and it does not require mould transportation, storage and maintenance which <del>can reduce manpower</del>   | 50-60%                                    | Foundry                    | 150-175   | 26-30     | 60-72 | 2500 kg                            |
| 83 | High Speed Blunger   | Blungler is a machine which can rapidly blunge raw material without changing non plastic raw material structure using stator rotor mechanism  | 35-40%                                    | Sanitaryware & Potteryware | 12-15     | 6-7       | 22-24 | 24 TPD Charge production           |
| 84 | Hot Charging of Billets                                    | Hot charging of billets can serve as an energy efficient alternative for this process in which the steel is melted at slightly higher temperature of 1650°C and then the molten steel is fed into CCM where the temperature of the billet (1150°C) at the output is controlled by PLC, which is directly sent to the rolling bay, thereby eliminating the need of re-heating. | 100% - Complete elimination of re-heating | Iron & Steel               | 150-200   | 300-350   | 6-Aug | 1 Lacs TPA                         |
| 85 | Hydraulic Hammer   | Hydraulic hammers are 30-40% energy efficient than pneumatic hammers. Operation of the hydraulic hammers are very smooth and <del>noise free as compared with pneumatic hammers</del>   | 30-40%                                    | Forging                    | 150-170   | 50-70     | 46-50 | 10 ton                             |
| 86 | Ice Bank Tank (IBT)  | This process of direct cooling ensures no cooling loss or addition of external heat and ensures low energy consumption at compressor due to <del>higher suction pressure</del>  | 25-30%                                    | Dairy                      | 70.00     | 27.00     | 31    | 170 TR                             |
| 87 | Induction Billet Heater                                    | For replacement of Oil Fired Furnaces with having better control on <del>temperature and energy saving as well</del>  | 20-25%                                    | Forging                    | 38-42     | 37-42     | 10-12 | 3-4 ton capacity oil-fired furnace |
| 88 | Installation of Pulverized Coal Injection in Blast Furnace | Pulverized coal injection (PCI) is a process which involves injecting large volumes of fine coal particles into the raceway of the blast furnace (BF). Pulverized coal is an important auxiliary fuel used in the BF ironmaking.  | 30-40%                                    | Iron & Steel               | 1500-2000 | 1200-1600 | 12-15 | 150 kg/thm                         |
| 89 | Installation of Top Recovery Turbine in Blast Furnace      | TRT is basically an energy saving measure at the BF which utilizes the waste pressure energy of the BF top gas to generate electric power.  | 10-15%                                    | Iron & Steel               | 2500-3000 | 2000-2500 | 15-18 | 6.57 MW                            |
| 90 | Latest Generation High Efficiency Clinker Cooler           | It offers significant potential for electrical and thermal energy saving; The total heat loss of latest generation clinker is less than 100 Kcal /Kg Clinker compared to conventional cooler where heat loss is more than 120-150 <del>Kcal /Kg Clinker</del>   | 15-20%                                    | Cement                     | 1800-2000 | 400-500   | 48-60 | 3000 TPD Clinker                   |
| 91 | Liquid Ring Compressor                                     | This Liquid Ring Compressor will function as flare gas recovery system (FGRS) to recover the flare gas and sending it to Delayed Cooker Unit (DCU) wet gas compressor suction, which will further be directed to Fuel gas header to use it as fuel gas in refinery fired heaters. This has also <del>avoided the requirement of dedicated FGRS</del>                          | 10-15%                                    | Refineries                 | 500-600   | 800-900   | 6-8   | 8.5 MT per day fuel oil equivalent |
| 92 | Louisiana State University (LSU) Port Dryer                | This technology ensured uniformly dried product and can be used for <del>different types of grains as well</del>  | 25-40%                                    | Food Processing            | 30-35     | 16-20     | 22-25 | 24 MT                              |
| 93 | Low Consistency Refining (LCR)                             | The refining of pulp prior to papermaking process is one of the most energy intensive and involves the alteration of cell structure of pulp fibers by imparting mechanical action. Low consistency refining can optimize the current refining process to enhance the productivity and save significant amount of energy and chemicals.  | 20-30%                                    | Pulp & Paper               | 15-20     | 22-25     | 8-Oct | 200 TPD                            |



|     |  |  |                          |                 |              |           |       |                         |
|-----|--|--|--------------------------|-----------------|--------------|-----------|-------|-------------------------|
| 94  | Low Thermal Mass cars in Tunnel Kiln                           | The reduction in weight of kiln cars in Tunnel kilns provides significant amount of energy saving and improved material to car weight ratio  | 10-13%                   | Glass & Ceramic | 0.55 per car | 2.5-3     | 2-3   | 1130 Kg per car         |
| 95  | Medium frequency Induction Furnace                             | The medium frequency induction heating furnace adopts the basic principle of induction heating. It is a high-tech product replacing the traditional oxygen, oven and salt slag furnace. It can save energy, save time, fast and improve the quality of the product   | 10-15%                   | Iron & Steel    | 30-35        | 13-15     | 24-30 | 250 KW                  |
| 96  | Membrane Filter Press  | For replacement of conventional Filter Press with better drying of sludge  | 30-40%                   | Chemical        | 40-45        | 15-20     | 30-35 | 60 Plates               |
| 97  | Natural Gas fired Boiler                                       | Replacement of conventional Coal /Wood fired boiler with NG fired Boiler   | 20-30%                   | Foundry         | 6-Aug        | 2-2.5     | 36-40 | 300 kg/hr               |
| 98  | Nutsche Filtration and Drying Process                          | ANFD is used for active pharmaceutical ingredient (API) filtration. It is a combination of slurry filtration, product washing, and vacuum drying processes into a single unit  | 10-20%                   | Pharmaceutical  | 25-30        | 20-25     | 15-18 | 3 KL                    |
| 99  | Oxyfuel Burner   | To increase the oxygen content, the induction furnaces are used with oxyfuel burners along with standard burners which also reduces the content of nitrogen from the air. This improves the efficiency of combustion process   | 30-40%                   | Pulp & Paper    | 300-325      | 45-50     | 72-84 | 200 TPD                 |
| 100 | Palletisation plant - Sponge Iron                              | The palletisation ensures agglomeration of fine iron ores which is easy to handle in blast furnace or EAF  | 10-15%                   | Sponge Iron     | 4000-5000    | 800-1000  | 48-60 | 0.3 MTPA                |
| 101 | Pocket Ventilation System                                      | Pocket Ventilators improve the drying rate, moisture profile and production for paper machines. The ventilators prevent sweating, corrosion and fibre build up   | 5-15%                    | Pulp & Paper    | 30-35        | 75-80     | 5-Jul | Not applicable          |
| 102 | Pulser dyeing technique  | Pulser dyeing is a major breakthrough in the yarn dyeing process, where in liquor requirement per kg of yarn is reduced to 4:1 as against conventional 10:1 requirement, and pumping requirement to maintain flow an pressure of water is reduced to 1/3rd, thereby substantially reducing energy, water, chemical requirement | 20-30%                   | Textile         | 10-12        | 20-30     | 6-8   | 50-1500 Kg              |
| 103 | Radiant Cooling  | Radiant cooling is a hydronic system that circulates chilled water through PEX pipes embedded in the floor or ceiling, or through copper pipes embedded in ceiling panels. Water passing through these pipes first cools the floor/ceiling surface, which then cools the enclosed space through radiation                      | 30-50%                   | Building        | 1.2-1.5      | 0.3-.0.4  | 36-48 | 1 TR                    |
| 104 | Rapier or Auto Loom  | For replacement of conventional Power Loom thereby ensuring enhanced productivity and production, reduced energy and manpower cost   | 15-20%                   | Textile         | 50-52        | 25-30     | 24-30 | 220 rpm                 |
| 105 | Recovery of BOF gas and sensible heat in Basic Oxygen Furnace  | The gas produced in the BOF has a temperature of approximately 1200°C and a flow rate of approximately 50-100 Nm <sup>3</sup> /t-steel. The gas contains approximately 70-80% CO when leaving the BOF and has a heating value of approximately 8.8 MJ/Nm <sup>3</sup> (NEDO, 2008) or 0.84GJ/t-steel                           | 3-5%                     | Iron & Steel    | 3753.3       | 1003.8    | 45    | 30-400 MT               |
| 106 | Replacement of steam turbine drive with high speed motor drive | Replacement of steam turbine drive with high speed motor drive will result in saving of steam and extra power generation   | 15000 Ton of NG per year | Refineries      | 22500-25000  | 7500-8000 | 48-50 | 7.5 MW High Speed Motor |
| 107 | Screw Washer   | For replacement of twin drum washing system with high efficient screw washer to save energy  | 10-15%                   | Paper           | 45-50        | 18-20     | 24-30 | 20000-22000 TPA         |
| 108 | Shoe Press   | Shoe press technology is a papermaking procedure that uses a large concave shoe instead of one of the conventional rotating cylinders; this extends dwell time, thus improving mechanical de-watering compared to that of conventional roll process  | 20-30%                   | Pulp & Paper    | 8000-9000    | 300-350   | 30-36 | Paper machine of 5 m    |
| 109 | Thermal Energy Storage for Bulk Milk Coolers (BMC)             | This system uses vapour compression cycle to form ice which is later used to provide cooling without the need of grid availability during cooling process, thereby eliminating the exposure of milk to higher temperature for a longer duration during their collections and also preserve freshness and aroma                 | 15-20%                   | Dairy           | 4.00         | 7.30      | 6     | 2000 Lit. BMC           |
| 110 | Tube ice plant   | Tube ice machine performs continuous Freezing and Harvesting function, thereby ensuring steady supply of high quality ice at a rate determined by the user   | 10-15%                   | Ice Making      | 17-20        | 8-10      | 30-35 | 20 TPD Plant            |
| 111 | Ultra-High Power Electric Arc Furnace                          | Ultra High Power (UHPs) have become one of main tools for the steel making process since they have high productivity, low cost and high quality of products  | 10-15%                   | Iron & Steel    | 723.7        | 714       | 12    | 100-400 MT              |
| 112 | VAM Chillers   | The working principle of VAMs is based on absorption where a concentrated salt and water solution is used to absorb water vapour and then pressurized by a low-pressure pump to generate chilled water   | 30-40%                   | Building        | 200-250      | 100-125   | 24-36 | 10,000 TR               |
| 113 | Veneering for Industrial furnaces                              | Reduction in surfaces heat losses from furnaces and also store the residual heat during non-firing time  | 20-25%                   | Foundry         | 6-7          | 6-7       | 11-12 | Hearth area - 40 sq ft  |

|  |   |   |                          |  |             |           |         |                                |
|--|---|---|--------------------------|--|-------------|-----------|---------|--------------------------------|
| 114  | Vertical Agitator System for Reaction Vessel                        | The vertical agitation system is more versatile compared to horizontal agitation system, allowing mixing various feed material in one go, is easy to maintain and operate.  | 20-25%                   | Chemical                                     | 2-2.5       | 1-1.5     | 20-24   | 20 KL                          |
| 115  | Vertical shaft brick kilns  | It is a continuous, updraft, moving ware kiln in which the fire remains stationary while there is counter current heat exchange between air (moving upward) and bricks (moving downward).   | 15-20%                   | Bricks                                       | 10-15       | 5-7       | 24-30   | 40-50 Lacs bricks per year     |
| 116  | Waste heat recovery in centrifugal compressor                       | The waste heat is recovered from each stage of compressor owing to losses in the form radiation loss and/or condensation heat and using them in pre-heating of boiler feedwater or process application.   | 10-20%                   | Textile                                      | 30-35       | 25-30     | 12-15   | 3000 CFM                       |
| 117  | Waterless Dyeing Technology   | Waterless Dyeing Technology uses supercritical CO2 gas rather than water to infuse fabric with color. Special temperature- controlled pressure chambers force the carbon dioxide to act as a fluid similar to water (the supercritical fluid CO2) which causes the polymer fiber to swell allowing the dispersed dye to easily diffuse within the polymer, penetrating the fibers, and carrying the dyes into the fabric and dyeing it. | 60-65%                   | Textile (Polyester Dyeing)                   | 2000-3000   | 2500-3500 | 12-15   | 20-200 Kg                      |
| 118  | Zig-Zag Firing  | The zig-zag type firing ensure better turbulence and contact time between flame and bricks, thereby better productivity and reduced SEC   | 20-25%                   | Bricks                                       | 30-50       | 15-20     | 24-36   | 20,000-60,000 bricks per day   |
| <b>Innovative Decarbonisation Technologies</b> |   |   |                          |  |             |           |         |                                |
| 119  | Aluminium pipe for distribution of compressed air system            | Aluminium pipe doesn't rust, unlike mild steel pipes, due to moisture present in compressed air and this avoid leakages and saves 10-20% of losses.   | 10-20%                   | Cement, Iron & Steel, Textile, Other sectors | 300-350     | 120-150   | 24-36   | 6000 MT per day of Clinker     |
| 120  | Electric Vehicles and Charging Infrastructure                       | Electric vehicles are power by battery and electric motor   | 1 Liter Diesel per 15 km | Transportation                               | 12-15       | 3-4       | 48-60   | Diesel sedan car               |
| 121  | Fuel efficient industrial furnace burners specially for rotary kiln | Improved overall combustion efficiency of burners in rotary kilns in Alumina, chemical, lime, sponge iron plants using gas and liquid fuel  | 5-7%                     | Cement, Iron & Steel                         | 30-35       | 15-20     | 20-24   | Not Applicable                 |
| 122  | Nano composite surface treatment for condenser in power plant       | It protects from fouling, scaling, and deposition resulting improvements in power generation efficiency   | 13000 tons of coal/Yr    | Power Plant                                  | 250-300     | 250-300   | 12-15   | 135 MW                         |
| 123  | Plasma Technology in steel melting shop                             | The use of Plasma Technology ensures superhot electrically heated gases that are extremely efficient in melting metals  | 15-20%                   | Iron & Steel                                 | 8000-10000  | 3200-4000 | 30-36   | 20 crore for each plasma torch |
| 124  | Torrefaction Technology   | Torrefaction is thermochemical conversion method to produce coal fuel (bio char) from biomass. It is carbon rich material can be easily burnt in industrial furnaces, boilers, driers, etc.   | Not applicable           | Power Plant                                  | 15-20       | 15-20     | 12-15   |                                |
| 125  | XPLATE on FD Fan to improve boiler combustion efficiency            | XPLATE technology breaks the clusters of gaseous fluid flows inside the boiler and releases trapped molecules of Oxygen (O2) & Nitrogen (N2) in the clusters. This provides more reacting oxygen inside the boiler that enables more complete combustion.   | 3-5%                     | Multiple sectors                             | 50-60       | 20-25     | 36-40   | 55 TPH                         |
| 126  | Oxygen Depolarized Cathodes (ODCs)                                  | Replacement of the hydrogen evolving cathodes in the classical membrane cells by ODCs allows for reduction of the cell voltage and correspondingly the energy consumption of up to 25-35%.  | 25-35%                   | Chlor-Alkali Industry                        | 13500-14000 | 1100-1200 | 140-150 | 250 TPD                        |
| 127  | Hisarna Ironmaking Technology                                       | Hisarna is a new type of furnace in which iron ore is directly injected and liquefied in a high temperature cyclone so that it drips to the bottom of the reactor where powder coal is injected. The two react into liquid iron.  | 15-20%                   | Iron & Steel                                 | 25000-25500 | Dec-15    | 38-40   | 4.6 MT per day                 |
| 128  | Extended Delignification System for Cooking of Wood                 | The extended delignification system recycles majority of the heat generated in the pulping process and stores the recycled heat in the form of black liquor and white liquor.   | 50-60%                   | Pulp & Paper                                 | 4000-4500   | 1100-1200 | 42-48   | 200 Tons of BD pulp/day        |

| <b>Innovative Decarbonisation Technologies (Part-2)</b> |  |   |  |            |                                       |                     |                                   |                         |
|---|--|---|--|------------|---------------------------------------|---------------------|-----------------------------------|-------------------------|
| Sl. No.   | Name of Technology                                       | About the Technology  | CO <sub>2</sub> Capture Percentage (%) | Sector     | Avg. Investment Potential (Rs. Lakhs) | CCU Capacity (MTPA) | Estimated Payback Period (months) | Equipment Capacity      |
| 129   | Gasification Based Production                            | CCUS unit will undertake purification and compression of high conc. CO2 stream for further disposition. Source of CO2 stream is Outlet of the acid gas removal unit.        | 90%                                    | Refineries | 8000-10000                            | 1 MTPA              | NA                                | 70 ktpa H <sub>2</sub>  |
| 130   | NG Based Steam Methane Reforming (SMR) for H2 production | Cryogenic separation has been considered for CO2 capture from tail gas as it ensures high purity CO2 (99.9%) with additional H2 recovery. Source of CO2 stream is tail gas. | 60-65%                                 | Refineries | 70000-80000                           | 0.7 MTPA            | NA                                | 130 ktpa H <sub>2</sub> |

|     |  |   |     |              |               |        |    |                           |
|-----|--|---|-----|--------------|---------------|--------|----|---------------------------|
| 131 | Pressure Swing Adsorption (PSA) Technology           | Pressure Swing Adsorption (PSA) Technology has been applied to separate gas mixtures, such as carbon dioxide capture in ammonia production and in hydrogen purification. PSA is highly cost-effectiveness, simple to operate, high performance at ambient temperatures, high regeneration rate, and low energy intensity. | 90% | Cement       | 160000-180000 | 2 MPTA | NA | 2.5 mtpa clinker          |
| 132 | Water Gas Shift Reactor                              | Water gas shift has been considered to ensure maximum CO2 capture from a single point and potential H2 recovery from the BF gas. Source of CO2 stream is BF gas.  | 50% | Iron & Steel | 160000-200000 | 2 MTPA | NA | 2.0 mtpa BF BOF based ISP |
| 133 | Amine-based Post-Combustion Capture (PCC) Technology | Amine-based carbon capture is a regenerative process using an amine solvent to remove CO2 from flue gas. Reversing the reaction releases pure CO2 for capture and frees up the solvent for re-use. This technology is primarily used for Carbon Capture & Storage.  | 90% | Refineries   | 110000-130000 | 1 MTPA | NA | 5 mtpa crude processing   |