7th July 2017

# Western Region Workshop on "Capacity Building of Officers from Petroleum Refinery Sector on Efficient Use of Energy"

# *CROSS SECTORIAL BEST PRACTICES FROM OTHER SECTORS*

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# About Confederation of Indian Industry (CII)

- Non-government, not-for-profit, industry led & industry managed apex industry association
  - Founded over 120 years ago
  - Direct membership : 7,900+ organizations
  - Indirect membership: 200,000+ enterprises
- Wide network
  - 66 offices in India, 8 overseas offices, 9 Centres of Excellences
  - Institutional partnerships with 312 counterpart organizations in 106 countries
- Serves as reference point for Indian industry and international business community
- Catalyses Change
  - Government – Policy Issues
  - Industry – Improving competitiveness & expanding business opportunities
- Platform for consensus building & networking
- Projecting positive image of businesses
- Diverse areas of work:
  - Health, education, livelihood, diversity management, skill development, environment, etc

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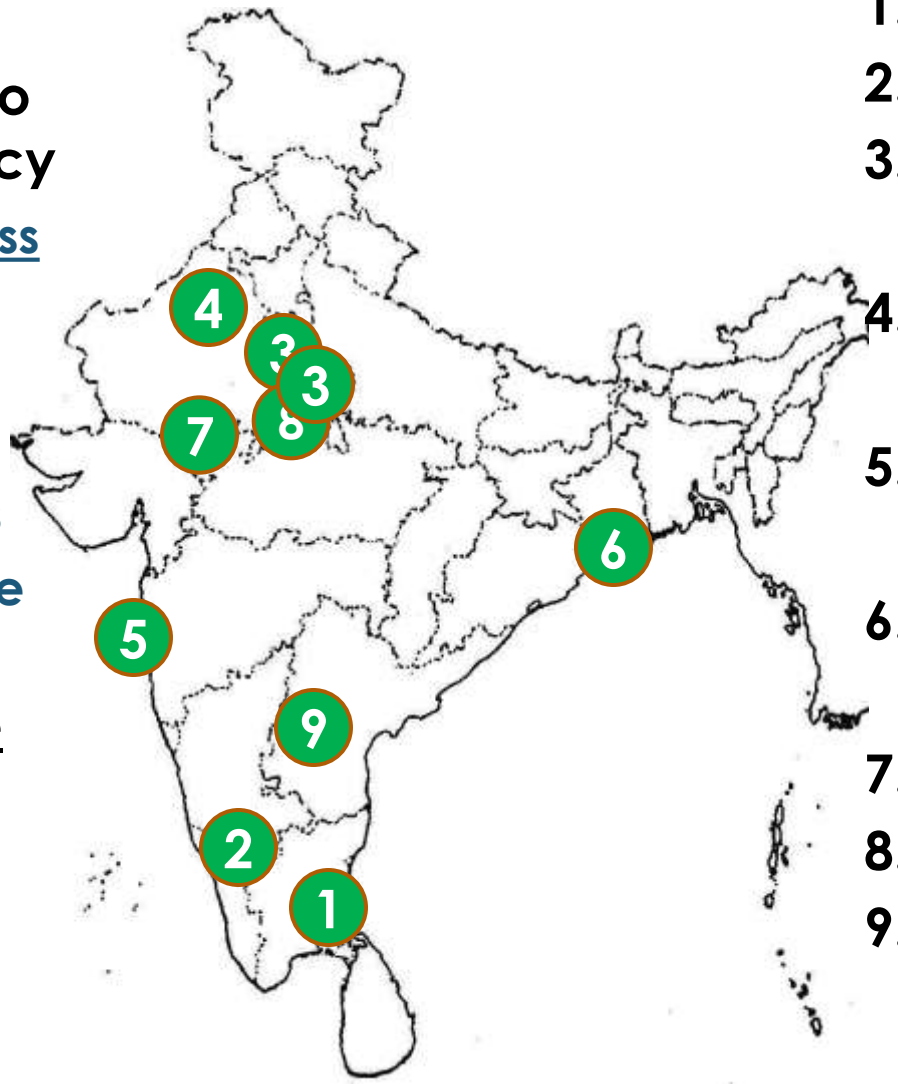
# CII - Centres of Excellence

- CII's proactive role to go beyond policy advocacy
  - Building competitiveness in the industry
- Presently 9 Centers of Excellence
  - Niche areas of services
  - Adding significant value to the industry
- Each COE has a unique area/sector of focus




1. CII Institute of Logistics, Chennai
2. CII Institute of Quality, Bangalore
3. CII-ITC Centre of Excellence for Sustainable Development, Delhi
4. CII AVANTHA Centre for Competitiveness, Chandigarh
5. CII Naoroji Godrej Centre of Excellence, Mumbai
6. CII Suresh Neotia Centre of Excellence, Kolkata
7. CII Triveni Water Institute, Jaipur
8. CII Faces, New Delhi
9. CII Sohrabji Godrej Centre of Excellence, Hyderabad

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# CII - Sohrabji Godrej Green Business Centre, Hyderabad

"Centre of Excellence" for Energy, Environment, Green Buildings, Renewable energy & Climate change activities in India

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# CII – Godrej Green Business Centre

- **Energy Efficiency**
  - Over 1550 energy audits carried out (all industrial sectors)
  - Rs. 2450 Million recurring energy saving achieved
- **Green Buildings**
  - 686 Certified Green Buildings; 3000+ registered projects
  - 2.75 Billion Sq Ft - Green Building Footprint
- **Water Management**
  - 45 Water Audits conducted; 4 Million $m^3$/year saving
- **New Ventures**
  - 15 Green SMEs Funded; USD 3.0 Million Green Investment Facilitated
- **Mission on Sustainable Growth**
  - 449 Industrial units subscribe to CII – Code for Ecologically sustainable Business Growth

- Housed in a 'LEED Platinum' rated Green Building
- Team Size – 100+ full-time staff
- Extensive interaction with all stakeholders – industry, government, academia, etc

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# Energy Efficiency Activities of CII …

- 25 years+ experience carrying out energy audits
- Experienced team of 38 energy engineers
  - 6 Accredited Energy Auditors
  - 18 Certified Energy Auditors
- Energy audits in all industrial sectors
- International energy audits - Japan, South Korea, Thailand, Indonesia, Lebanon and Zambia, Sri Lanka, Malaysia, Singapore, Togo
- National Best Energy Auditor for 5 consecutive years

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# Refinery – Industry vs. Sector

**Industry**

- Unit wise approach
- Individual targets

**Sector**

- Efforts to work together
- Learning & Sharing

# STRIVING TO ATTAIN ENERGY EFFICIENCY – INDUSTRIAL APPROACH

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# How should Industry approach PAT & Energy Conservation?

- Achieve/Exceed PAT targets set
- Achieve maximum energy saving & meet PAT targets with minimum investment
- Identify specific opportunities for enhancing energy efficiency
- Explore opportunities of monetizing the energy benefits by trading through PAT scheme

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# Innovative Energy efficiency ideas

- Indian Refinery sector,
  - ENCON measures part of the plant operation,
    - Continues operational improvement
    - Class apart in Manufacturing
    - Latest technology adoption
    - **Need of the hour – Performing at their best,**
    - In Plant technical team – Ideas: Small or Big
    - Open mind – Learning from other sectors

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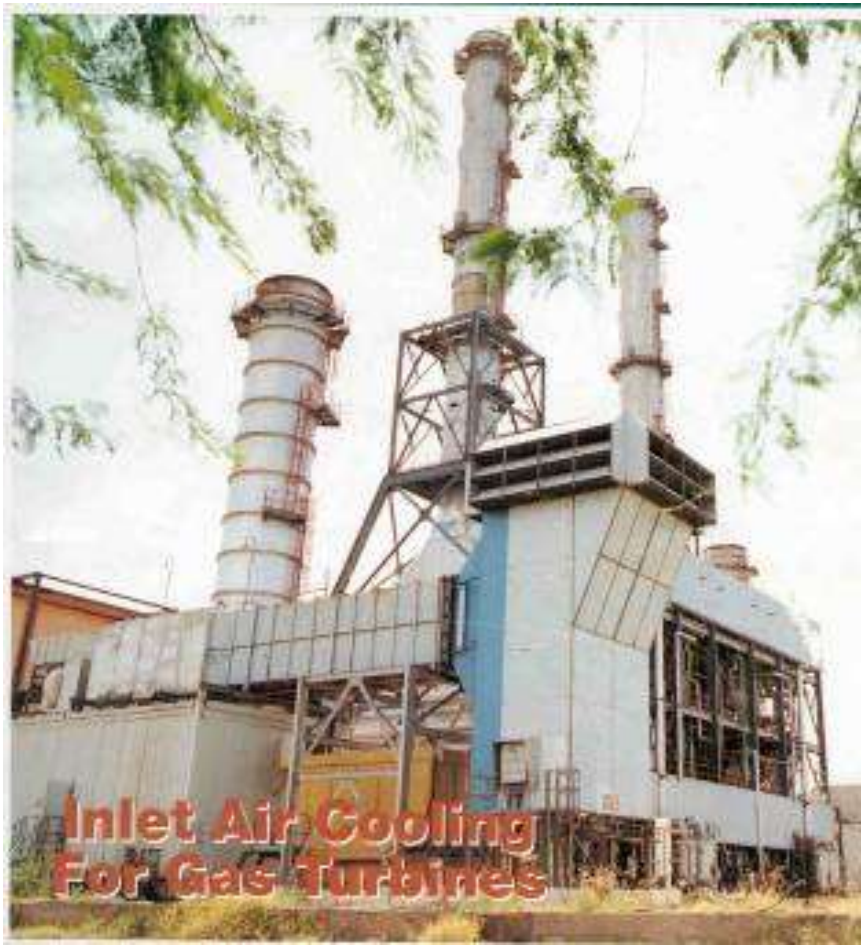
# Approach 1
# "Out-of-the-Sector" Ideas

# Inlet air cooling for Gas Turbines

- **Effect of ambient temperature**
  - Power output decreases with increased temperatures
    - Decrease in temperature from $40^0$C to $15^0$C improves system efficiency from 5 – 12%
    - Power o/p improved: 15 – 30%
    - Reduced compressed air per kW

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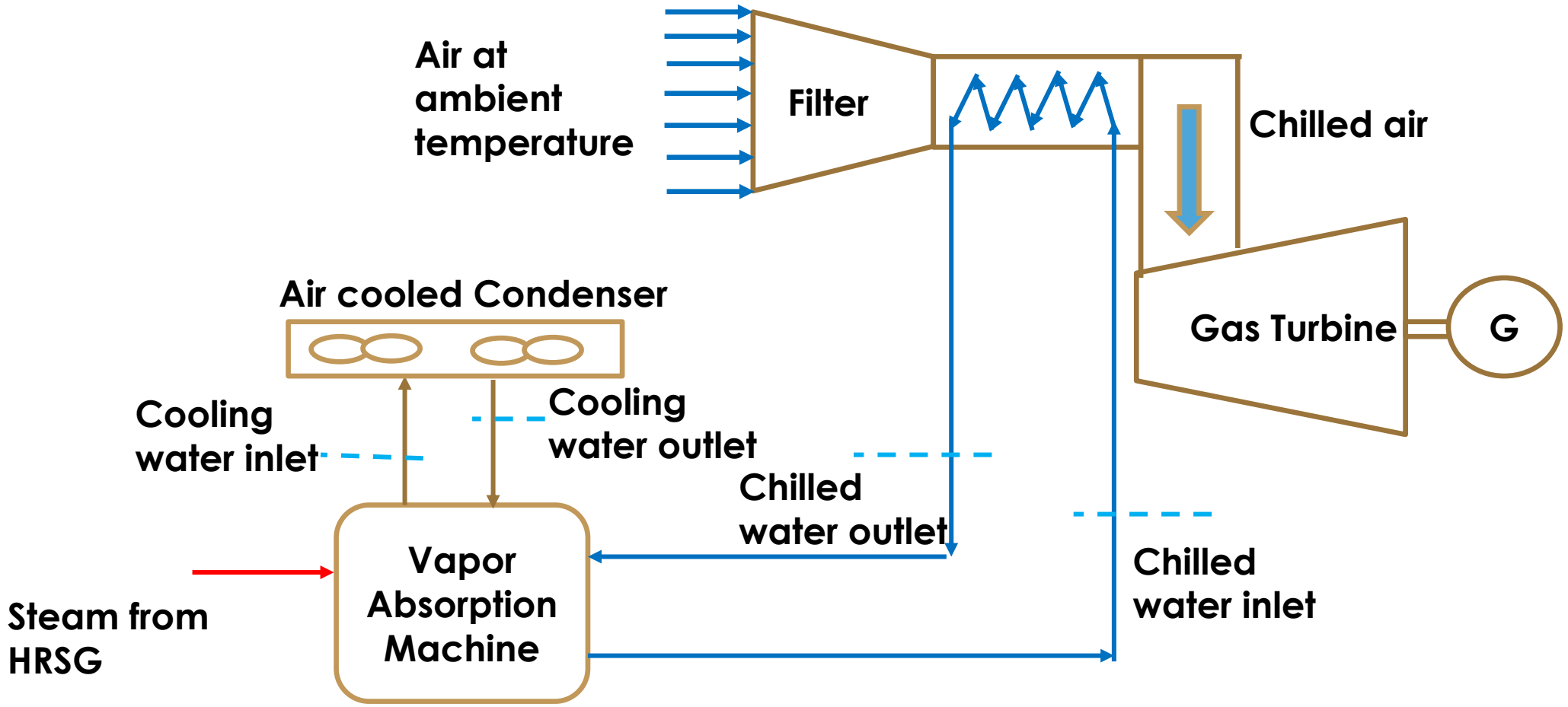
# VAM for inlet air cooling

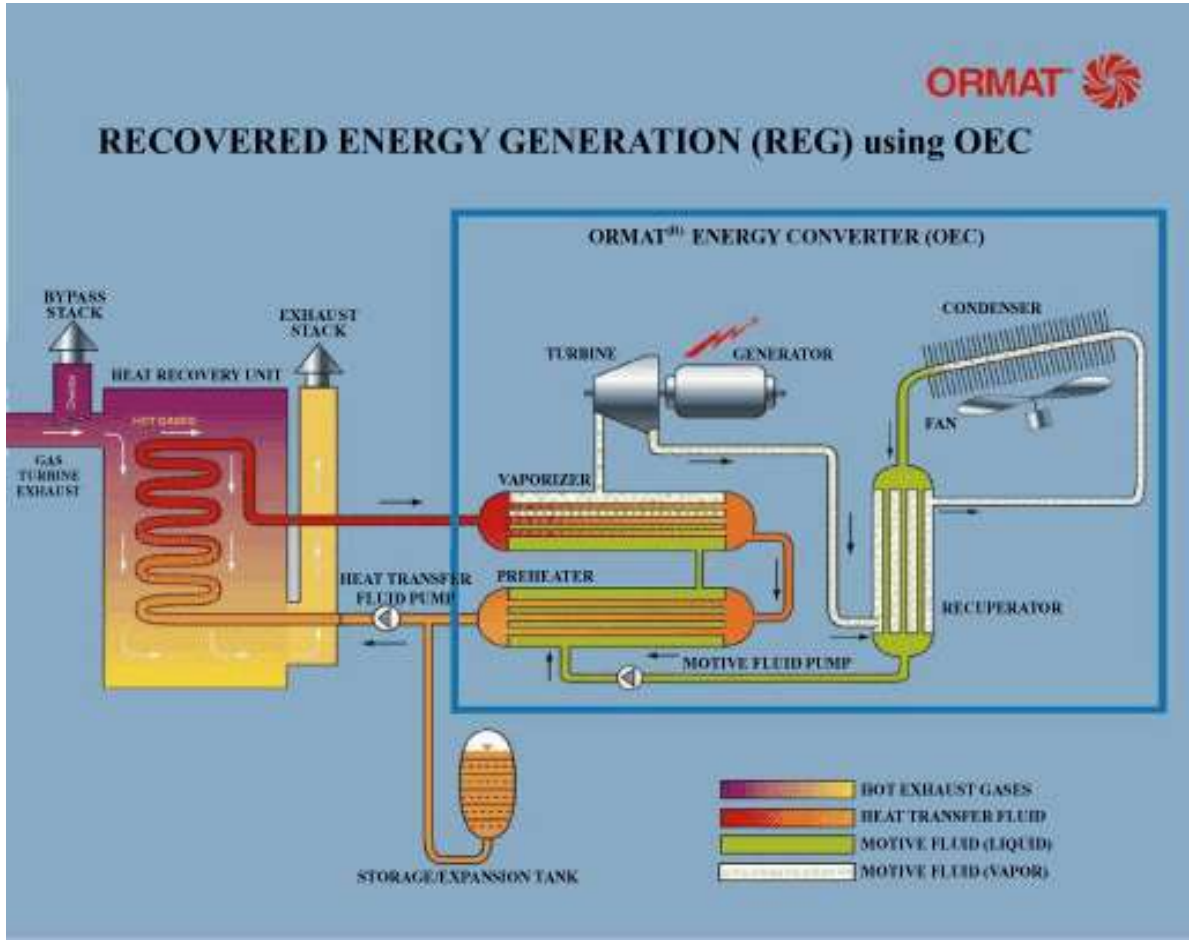


# VAM for inlet air cooling

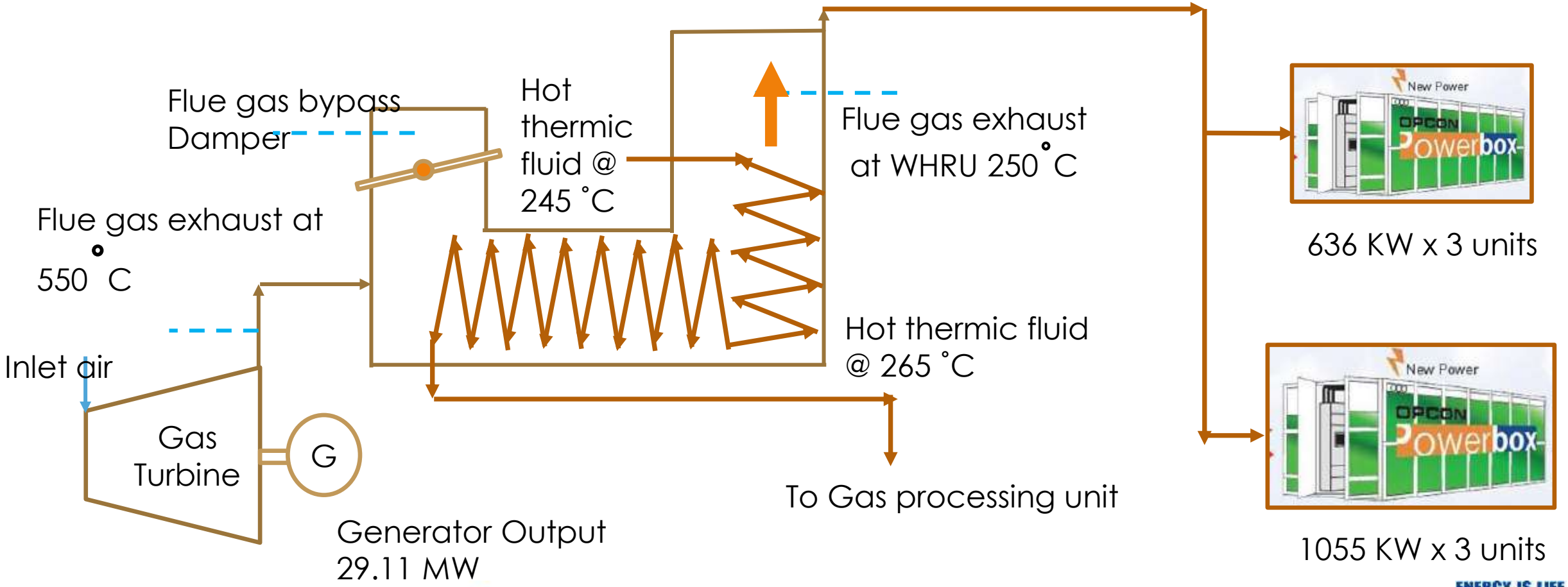
- Power generation from existing turbines lower than rated
  - Potential to generate additional steam
  - Steam to be used in VAM for cooling inlet air
  - Additional power generation – New Turbine
  - Steam heating for Gas
- Benefits
  - 15-20$^0$C reduction in inlet air
  - Heat rate improvement by 3%
  - Electrical heaters switched off

# Organic Rankine Cycle for Power Generation

- Organic Rankine Cycle is a thermodynamic process where heat is transferred to fluid at constant pressure
- Fluid is vaporized and then expanded in a vapour turbine that drives a generator, producing electricity.
- The spent vapour is condensed to liquid and recycled back through the cycle
- Several successful installations



# Tap exhaust heat from WHR flue gas

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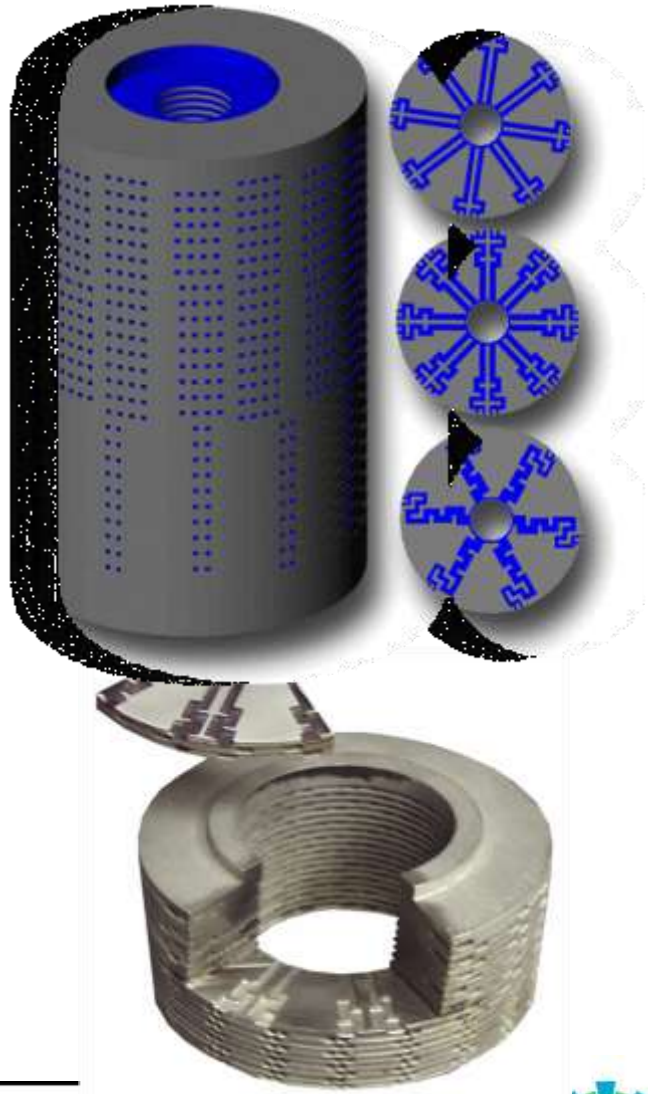
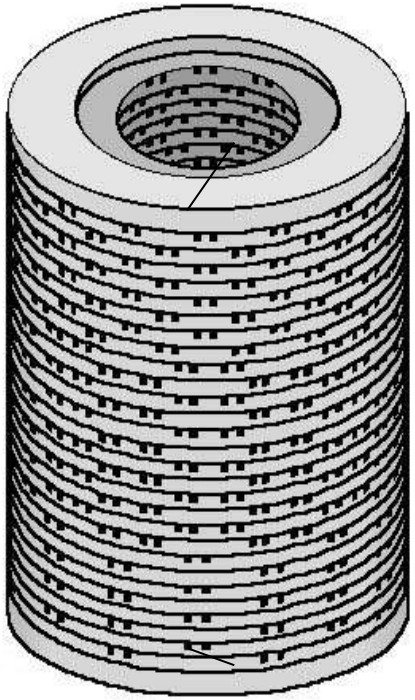
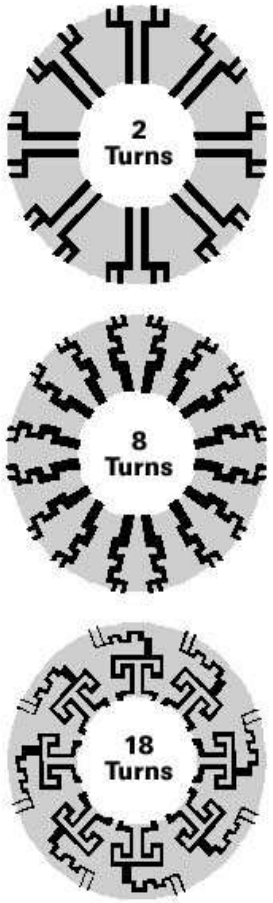
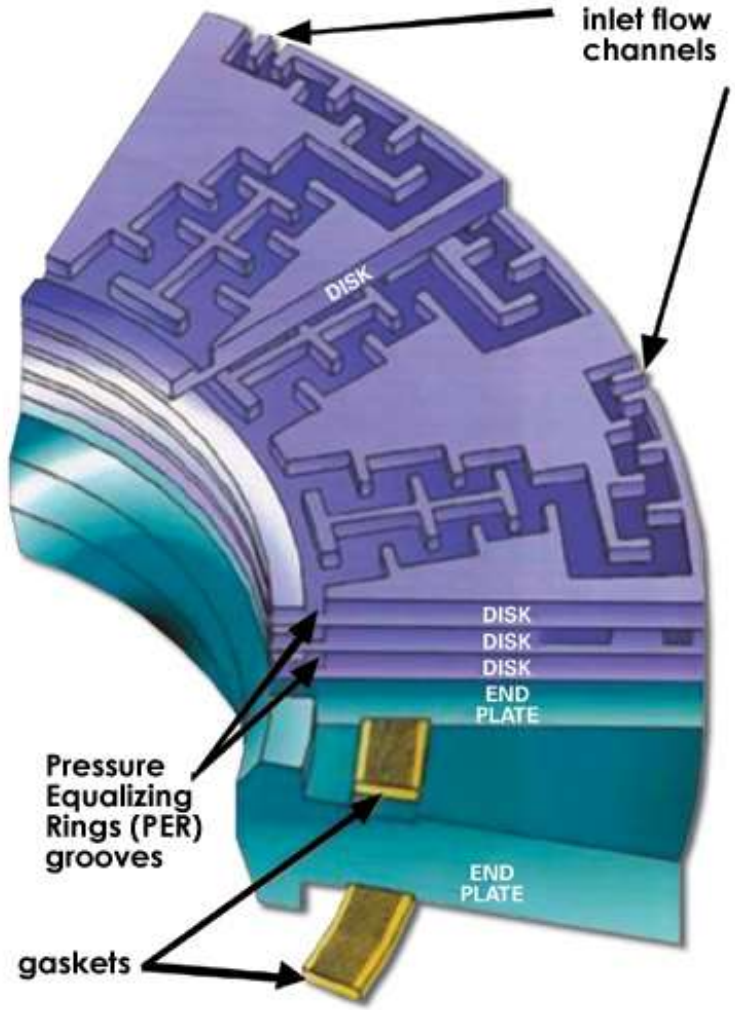
# Multistage Drag Valves





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# Multistage Drag Valves

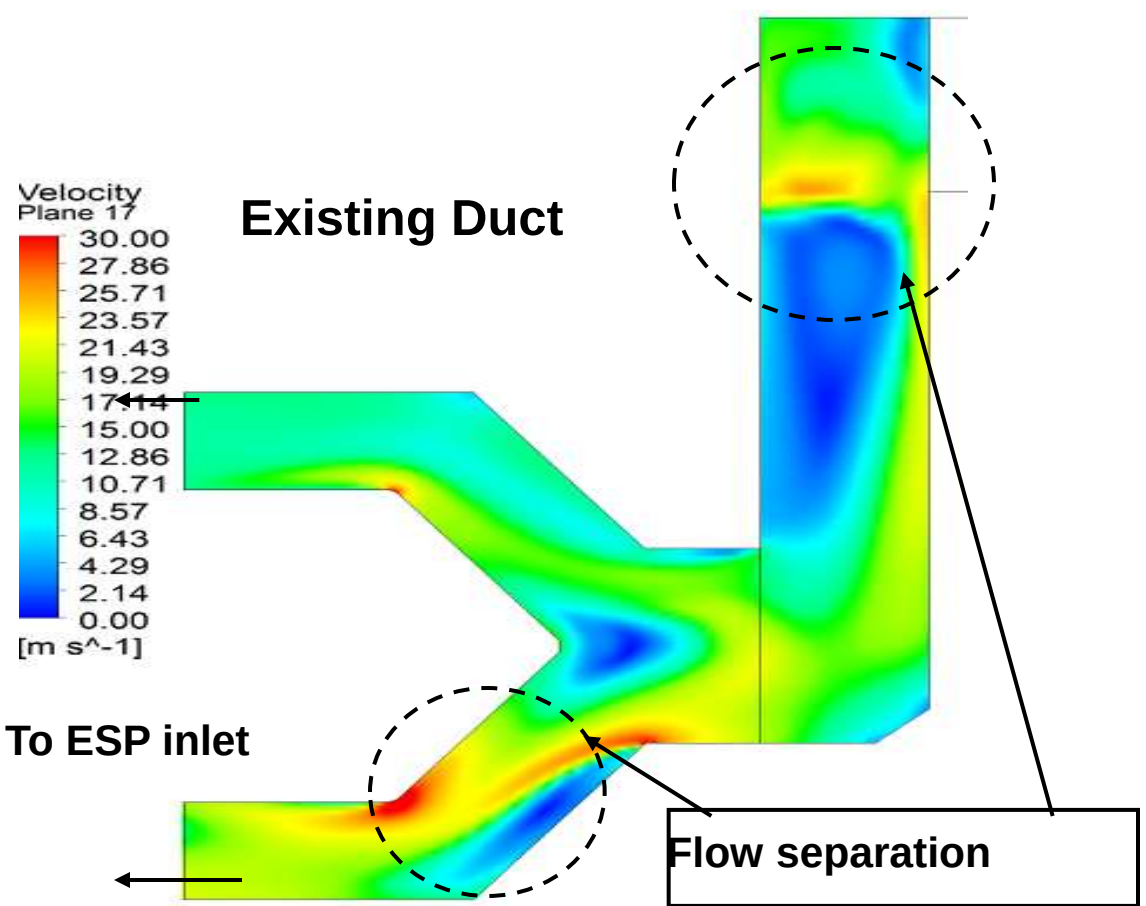
- **Multi stage drag reduction valves**
  - Reduce pressure in number of stages
  - Reduces exit trim velocities
  - Eliminates the erosion that results in wear and tear
  - Higher life cycle
  - 15 years without any maintenance

- **Extensively used in power plants, sugar and pulp & paper sector**

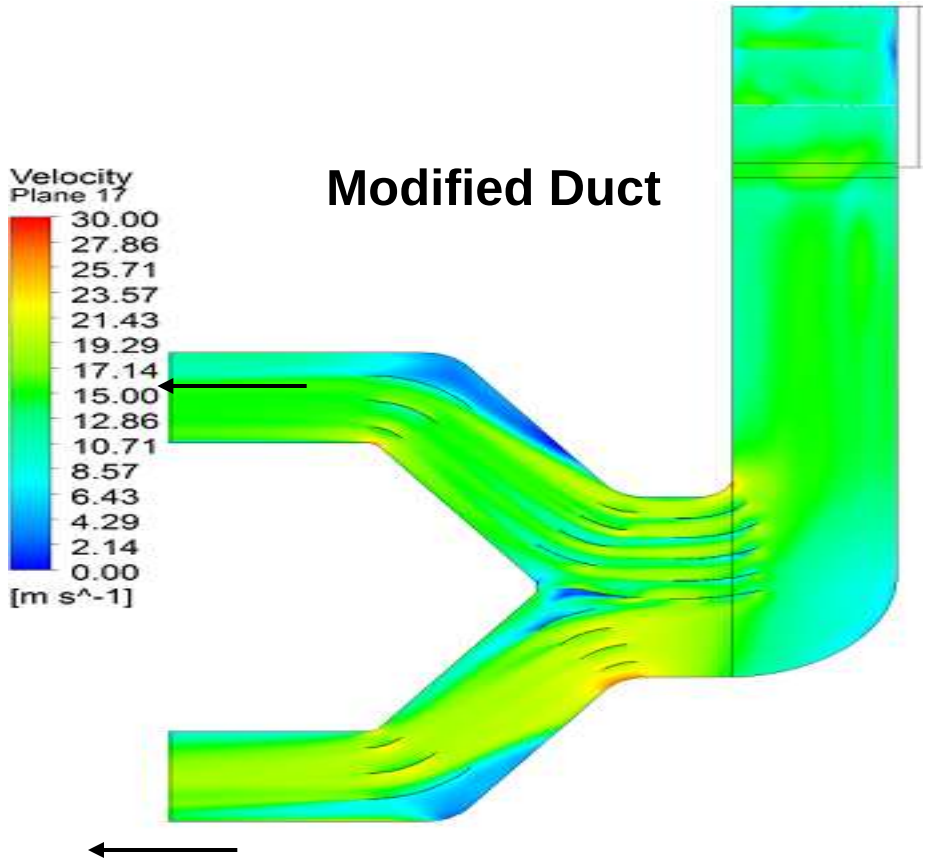
# Computational Fluid Dynamics

- **Computational Fluid Dynamics**
  - Initially – Extensively used in Power Plants
  - Cement Industry adopted CFD
  - Several innovative applications
- **Potential exists in all process industries**
  - All fluid flow applications
  - Excellent results

# Flue Gas path in power plants




Existing Duct Pressure Drop From AH Outlet to ESP Inlet: 43 mm WC




Modified Duct Pressure Drop From AH Outlet to ESP Inlet: 20 mm WC

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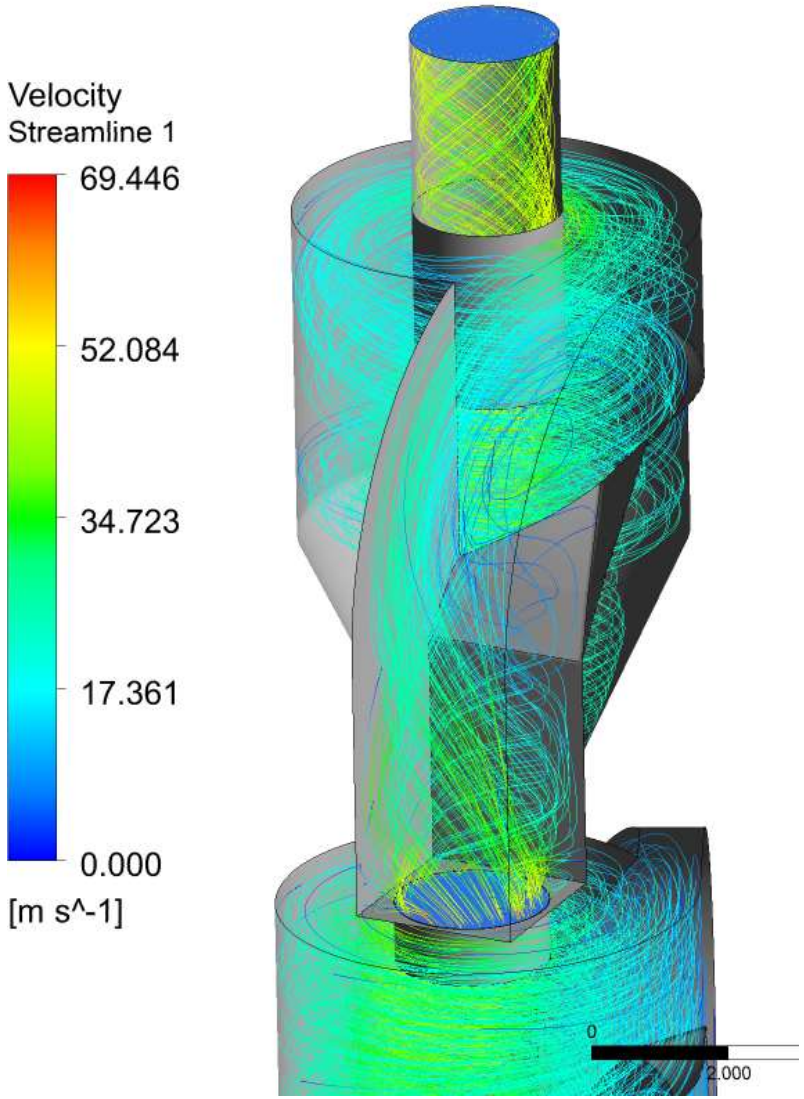


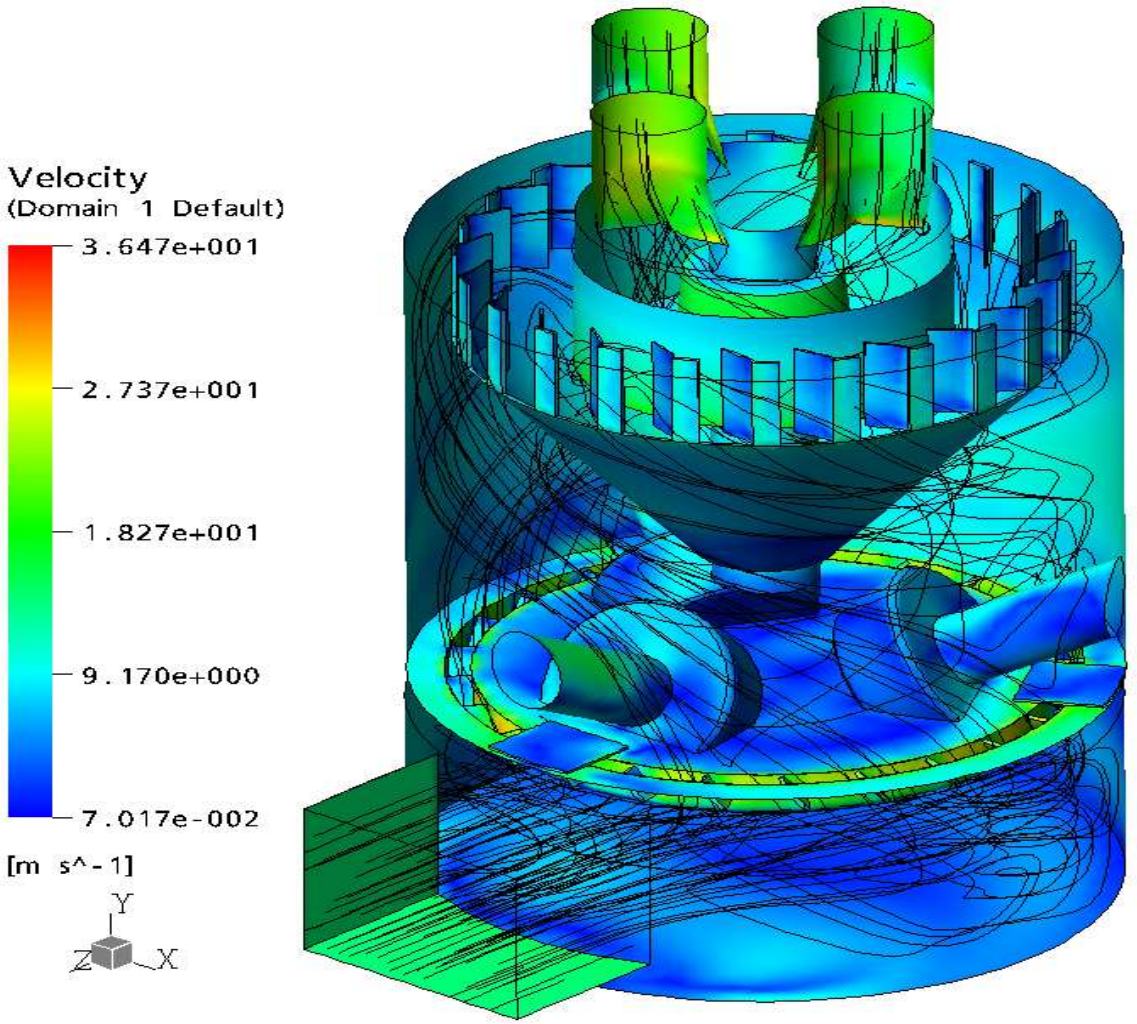

# Micro-turbines

- Captive power plants
  - PRDS – a common feature
  - Meet system requirements
- Isenthalpic process
  - Yet Opportunity to generate power lost
- Latest trend – installation of micro-turbines
  - Range: 50 kW to 2MW

- Very effective
  - Utilizes even the smallest of energy generating opportunity
- Applicable in variety of industries
  - Fertilizer, Textile, Cement CPP, Paper, etc

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# Gas Expanders

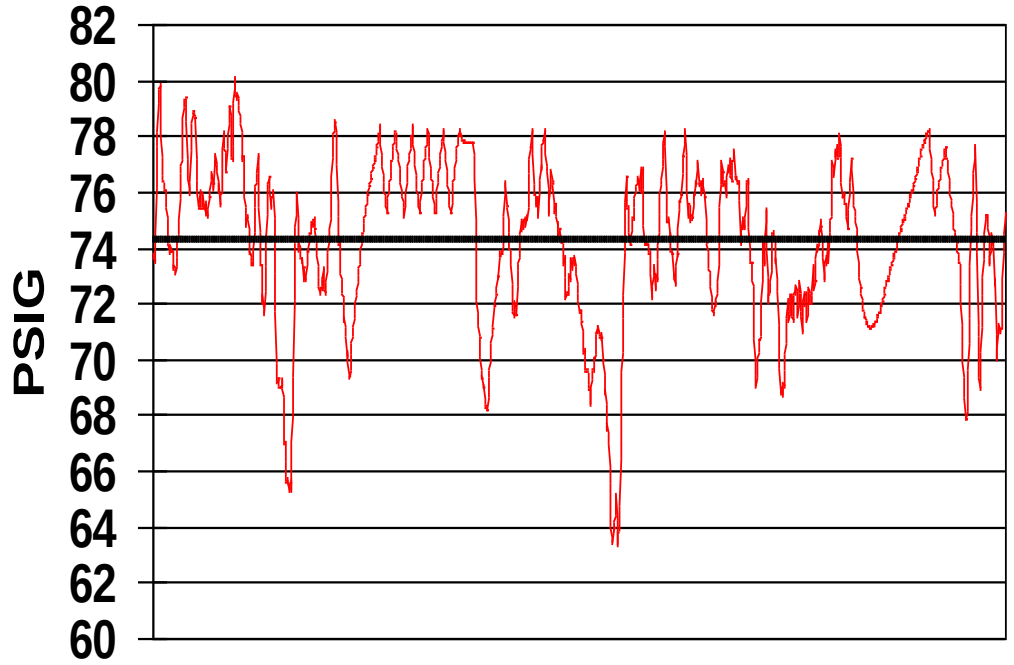
- Pressure reduction through gas flow control stations
  - Pressure lost across control valves
- Potential to recover energy & generate power through gas expanders
- No problem with the pressure & flow fluctuations
  - Operating cost is less than the normal steam turbines

**Pressure Letdown**

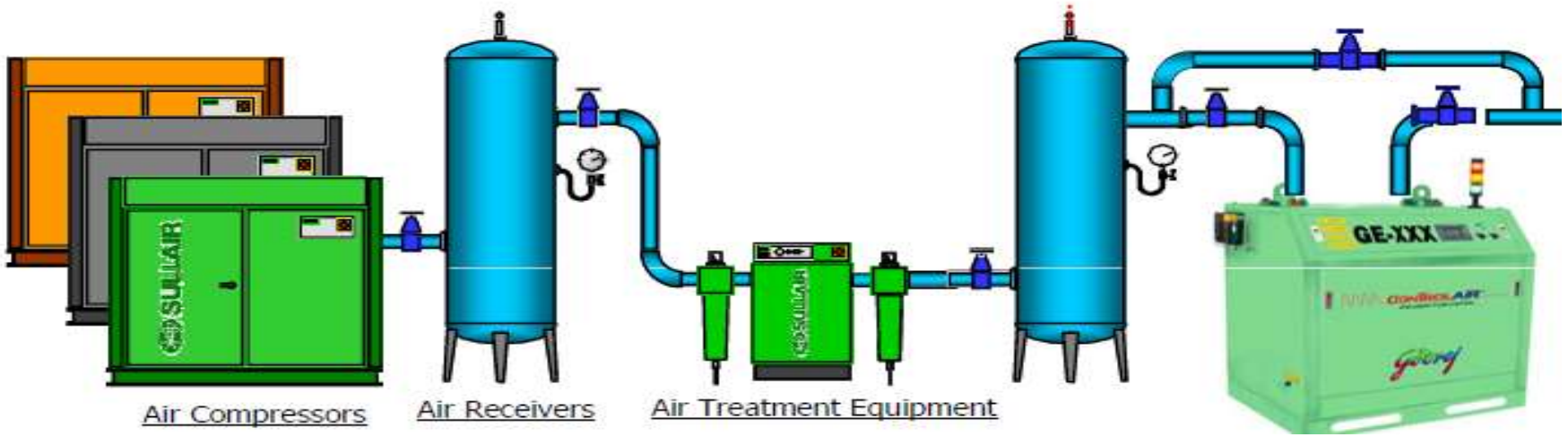
Integrally-geared generator-loaded turboexpander in a pressure-letdown application in Italy.

**Frame/Type:** Three-stage ETG 190 MS-3
**Inlet pressure:** 51 bar(a) (740 psia)
**Inlet Temperature:** 170 °C (338 °F)
**Flow:** 60,582 Nm³/hr (37,699 scfm)
**Recovered Power:** 4,526 kW (6,070 HP)

# Intermediate controllers for compressed air




- Artificial demand - compressor tries to maintain higher set pressure in the entire system
- Consumption increases at
  Open end users such as cleaning
  Leakage of compressed air increases
- Results in increased compressor power consumption




*Power Consumed:*

- $P_{load}$ = 90KW X 16.8hrs
  = 1512 kWh
- $P_{unload}$ = 30KW X 7.2hrs
  = 216 kWh
- $P_{Total}$ = $P_{load}$ + $P_{unload}$
  = 1728 kWh/day

*Power Consumed:*

- $P_{load}$ = 90KW X 14.4hrs
  = 1296 kWh
- $P_{unload}$ = 30KW X 9.6hrs
  = 288 kWh
- $P_{Total}$ = $P_{load}$ + $P_{unload}$
  = 1584 kWh/day

- Lower Energy Consumption
- Reduced maintenance costs
- Lower operating costs
- Minimum Interruptions in production schedules

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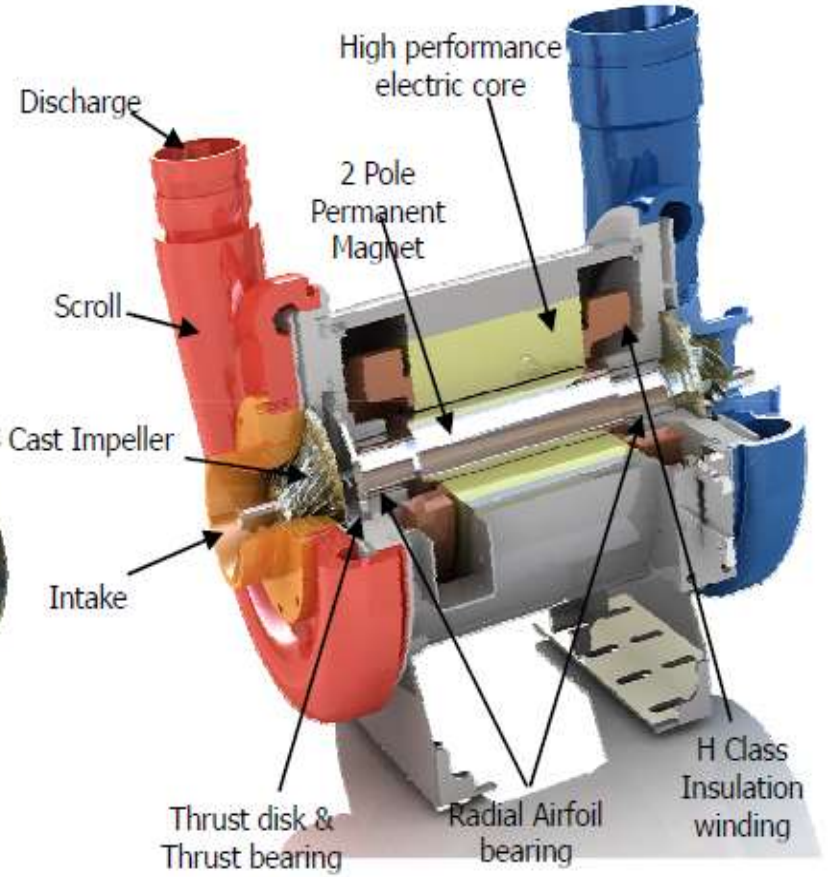
# Turbo Blower

- User selectable operation
  - Constant Flow
  - Constant Pressure
  - Constant Power
  - DOL control



# Turbo Blower - Features

- Permanent Magnet Motor: a) Power required only to rotate & not for magnetizing of rotor; b) Can be started & stopped any number of times; c) High Efficiency even at part load
- No Gear Box: No transmission loss due to direct drive & no lubrication required.
- Variable Speed Drive for achieving high speed, smooth starts (reduced starting current) & energy efficient capacity control as part of the Blower package.
- Air Foil bearing for high speed operation (used in Jet engines)
- Oil Free air
- Low Noise: 80 dB against 100 dB of PD blowers
- Entire range is air-cooled & no need of water for cooling.

# Case Study: Results in Cement Industry at Rajasthan

## Application: Kiln Jet Air Burner Pipe

| Recip LP Compressor | Aerzen Turbo blower | Power saved |
|---|---|---|
| **E**quipment:<br>Recip Comp: 66-m3/min, 1.5 bar, 210kW<br><br>**O**perating data<br>Dis. pressure: 0.6-bar<br>Delivery: 40-m3/min<br>Power drawn: 175kW<br>Sp. Power:<br>4.375-kW/m3/min | **E**quipment: TB200-1.0S<br>Aerzen Turbo Blower: 89-m3/min, 1 bar 164kW.<br><br>**O**perating data<br>Dis. pressure: 0.6-bar<br>Delivery: 40.5-m3/min<br>Power drawn: 57kW<br>Sp. Power:<br>1.4-kW/m3/min | **P**ower saved: 67%<br>(Constant Pressure mode) |

- **Energy Savings = 118 kW x 24 hrs x 350 days = 9,91,200 kWh/year**

# Approach 2
# On-site Renewable Energy

# Renewable Energy & PAT

- On-site RE generation
  - Considered as zero energy input
  - No fossil energy
- Various DCs innovatively adopting RE onsite
  - Solar PV
  - Solar Thermal
  - Hybrid systems
  - Biomass gasifiers

# Solar Thermal for Air Conditioning

- Solar thermal for Air-conditioning
- 130 TR AC load met through solar thermal energy
- Use of parabolic dish and concentrator
  - Hot water : 130 Deg C
  - Chilled Water : 8 Deg C

# Process water heating

- Solar thermal for process water heating
  - Up to ~200 Deg C
- Significant improvement in heat rate
- Use of parabolic dish and concentrator
- Several options available

# Solar Hybrid System


| SOLAR COMPONENT | |
|---|---|
| Maximum Power (Pmpp) | 245 W |
| Voltage at Max Power (Vmpp) | 30.1 V |
| Current at Max Power (Impp) | 8.2 A |
| Open Circuit Voltage (Voc) | 37.7 V |
| Short Circuit Voltage (Isc) | 8.7 A |
| *Reduction in module efficiency with decrease in irradiation level from 1000 W/m² to 200 W/m² (at 25 degrees C) | |
| Maximum System Voltage | 1000 V |
| Solar Cells | Monocrystalline |
| No. of Cells | 60 |

| WIND COMPONENT | |
|---|---|
| Turbine Rated Power Output | 143 W @ 11 m/s |
| Turbine Maximum Power Output | 500 W @ 17 m/s |
| Maximum Voltage | 57 DC |
| Maximum Current | 30 Amps |
| Rotor Diameter | 12.99 in \| 0.33 m |
| Cut-In Wind Speed | 4.5 mph \| 2 m/s |
| Cut-Out Wind Speed | 38.03 mph \| 18.5 m/s |
| Swept Area | 1,519 in² \| 0.980 m² |
| Turbine Material | Galvanized G-90 Steel |

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# Approach 3
# Implement projects faster

# China Top 1000 program

- Top-1000 Energy-Consuming Enterprises program
  - 33% of National; 47% of Industrial Energy Cons.
  - Designed & implemented rapidly
    - Needed quick results
- One key activity
  - Government negotiated investment costs with various EE suppliers

# Implement Projects Faster

- Common sourcing of key EE / RE equipment
  - MV VFDs
  - EE Compressors
  - Solar Thermal Systems – Low Temperature
  - Solar Street Lighting systems
  - EE Lighting systems
  - Solar Hybrid RE Systems

# Implement Projects Faster

- Technical Support services driven
  - Consolidation of requirements at all DCs
- Offers several advantages
  - Makes several projects attractive
  - Faster implementation across organization
  - Creates euphoric implementation of EE projects

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# Approach 4
# Well-directed Investments

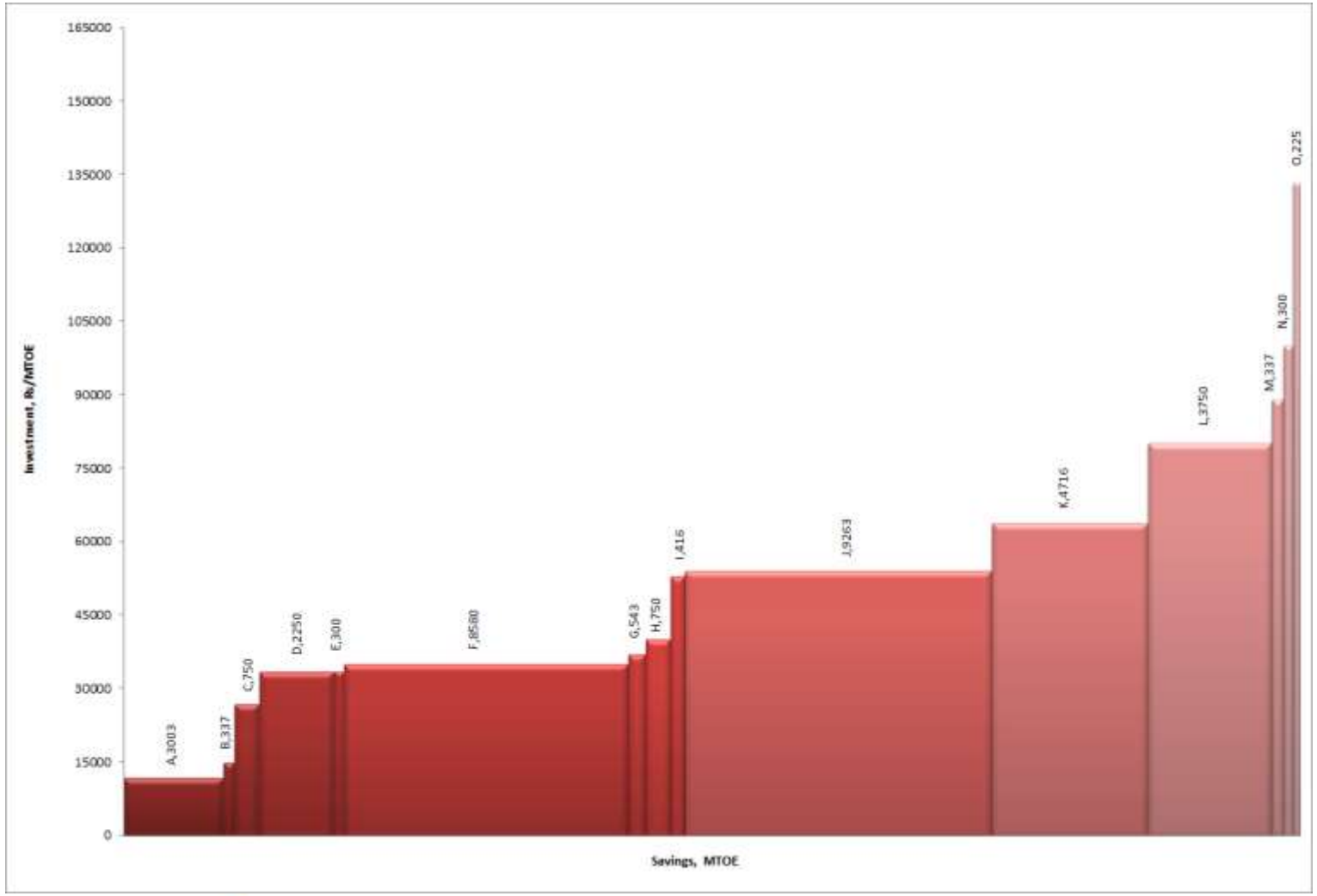
# EE – Traditional Approach

| NAME OF THE PROJECT | SAVINGS (Million Rs) | INVESTMENT (Million Rs) | PAYBACK (Years) |
|---|---|---|---|
| Installation of High Efficiency Clinker Coolers | 37.5 | 300 | 8 |
| Increase the number of pre-heater cyclone stages | 22.5 | 75 | 3.3 |
| Installation of Waste Heat Recovery Systems | 80 | 500 | 7 |
| Increasing TSR in Cement Plants | 17 | 300 | 17.5 |
| Utilization of Automation systems in Cement Manufacturing | 3 | 10 | 3.3 |
| Installation of Rotor Weigh Feeder for Coal Feeding | 3 | 30 | 10 |
| Installation of High Efficiency Separators | 5.9 | 20 | 3.4 |
| Installation of HT VFD/ SPRS in place of GRR for Speed Control | 4.5 | 22 | 4.8 |
| Installation of Fly Ash Dryer | 2.4 | 30 | 12.5 |
| Installation of Pre-grinder along with Ball Mill for Material Grinding | 51.4 | 300 | 5.8 |
| Installation of Tertiary Crusher for Raw Mill Production Increase | 3.6 | 30 | 8.2 |
| Installation of Variable Frequency Drives (VFDs) for major Fans | 1.6 | 2.4 | 1.4 |

# EE – The PAT approach

| NAME OF THE PROJECT | SAVINGS MTOE | INVESTMENT Rs/MTOE |
|---|---|---|
| Installation of High Efficiency Clinker Coolers | 3750 | 80000 |
| Installation of Cross Belt Analyzers | 750 | 40000 |
| Increase the number of pre-heater cyclone stages | 2250 | 33333 |
| Installation of Waste Heat Recovery Systems | 9263 | 53978 |
| Increasing the Thermal Substitution Rates in Cement Plants | 8580 | 39465 |
| Utilization of Advanced Automation systems in Cement Manufacturing | 300 | 33333 |
| Installation of Rotor Weigh Feeder for Coal Feeding | 300 | 100000 |
| Installation of High Efficiency Separators | 543 | 36832 |
| Installation of HT VFD/ SPRS in place of GRR for Speed Control | 416 | 52885 |
| Installation of Fly Ash Dryer | 225 | 133333 |
| Installing Particle Size Distribution (PSD) Analyzer for Cement Quality Improvement | 337 | 89021 |
| Increase the PPC Production / % addition of Fly Ash in PPC Manufacturing | 3003 | 11655 |
| Installation of Pre-grinder along with Ball Mill for Material Grinding | 4716 | 63613 |

# Cost abatement Curve – Cement

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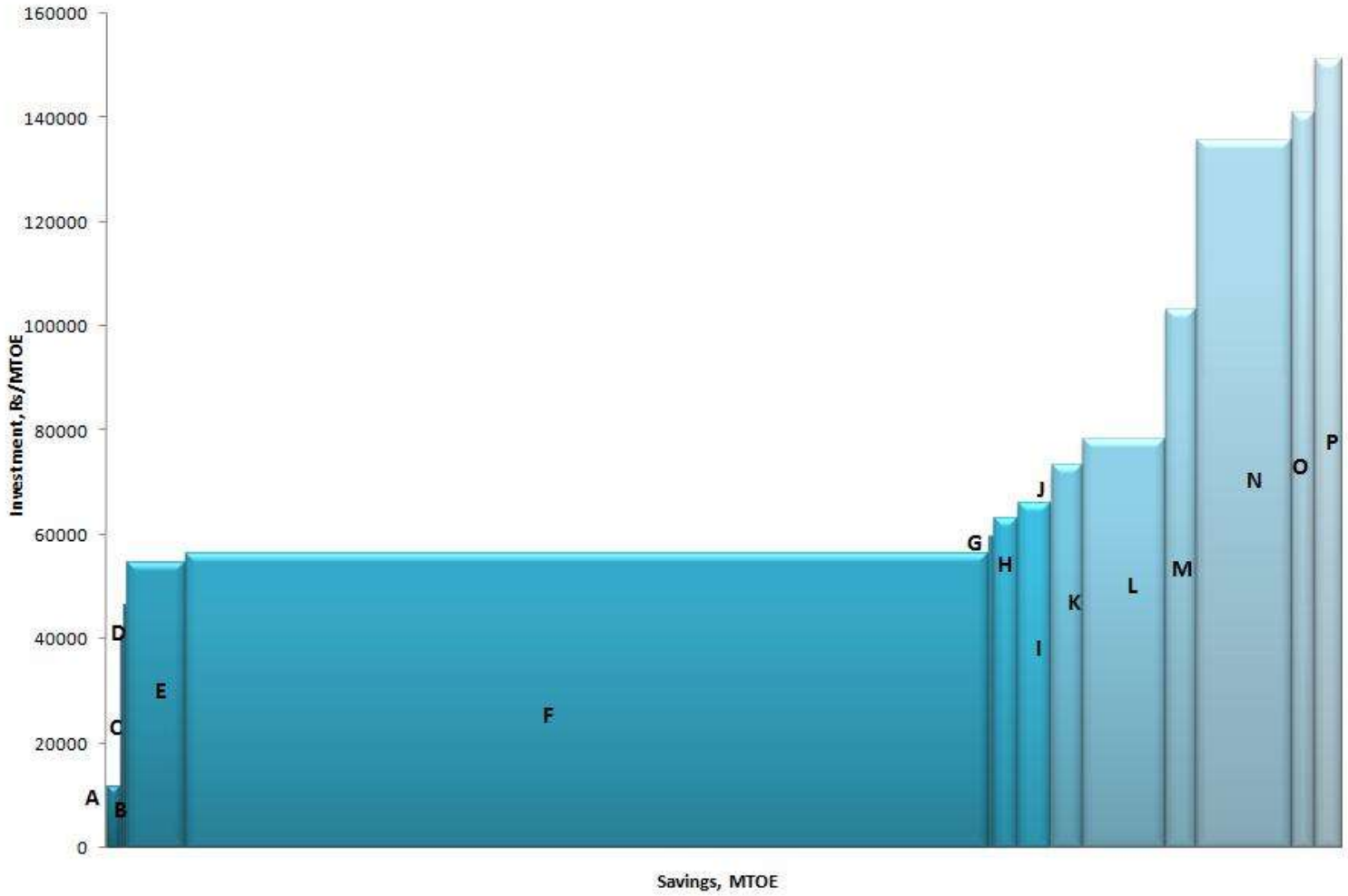
# Example for Chlor-Alkali sector

| | | Investment, Rs/MTOE | savings, MTOE |
|---|---|---|---|
| A | Reduce MV drop in MCC-1 Electrolyzers bus bar joint | 0 | 6.8 |
| B | Reduction in furnace oil consumption in auxiliary boiler by process modification. | 3680.53 | 43 |
| C | Replace steam ejector with water ring vacuum pump for brine Dechlorination | 12881.85 | 8 |
| D | Replace exhaust blower with new energy efficient blower | 14722.12 | 8 |
| E | Increase the operating parameters of hydrogen boiler and install a micro back pressure steam turbine to generate steam and power | 17320.14 | 182.75 |
| F | Low energy consumption in Chlor- Alkali cells using oxygen reduction Electrodes | 17844.99 | 2483.25 |
| G | Provide VFD for one chlorine compressor and avoid bypass control during load variation | 18928.44 | 15 |
| H | Install thermocompressor and utilise flash steam in the I- effect heat exchanger | 19980.02 | 75.25 |
| I | VFD for the brine pumps | 20912.10 | 102.16 |
| J | Install intermediate controller for the compressed air system | 22649.42 | 2.795 |
| K | Replace existing reciprocating refrigeration compressors by energy efficient (screw) Compressor | 23235.67 | 95.3568 |
| L | Replace old rectifier (diode based) with thyrister based rectifier | 24784.71 | 255.42 |
| M | Install hydrogen fired vapour absorption machine (VAM) | 32715.82 | 96.75 |
| N | Recoating of electrodes reduces the specific power consumption of caustic soda production | 42939.51 | 294.857 |
| O | Install adaptive control system and minimize variation in feed Temperature | 44612.48 | 70.95 |
| P | Install commercial co-generation system for Chlor–Alkali industry | 47846.89 | 85 |

# Cost abatement curve – Chlor Alkali

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# ENERGY EFFICIENCY – SECTOR LEVEL APPROACH

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# What Indian refineries can do as a sector?

- Energy saving schemes & practices
  - Unit wise – Good !!
  - Sector wise – Equally important
- Activities collaborating different units
  - Working together – Improves sector
- Indian Cement Industry – Perfect Example!!
  - Learning and sharing – Fruitful results

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# *Best practices from other sectors*

# Developing Benchmarks – Cement sector

- **Benchmarking – An effective way of comparison**
  - Best Plant – *Follows Benchmarks*
  - World class units – *Set benchmarks*
- **Indian Refineries**
  - Benchmarking practices effectively followed,
    - Solomon and Energy Intensity Index
      - Continued efforts to maintain or lower values
      - Highly appreciable

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# Island of Excellences – A different concept !!

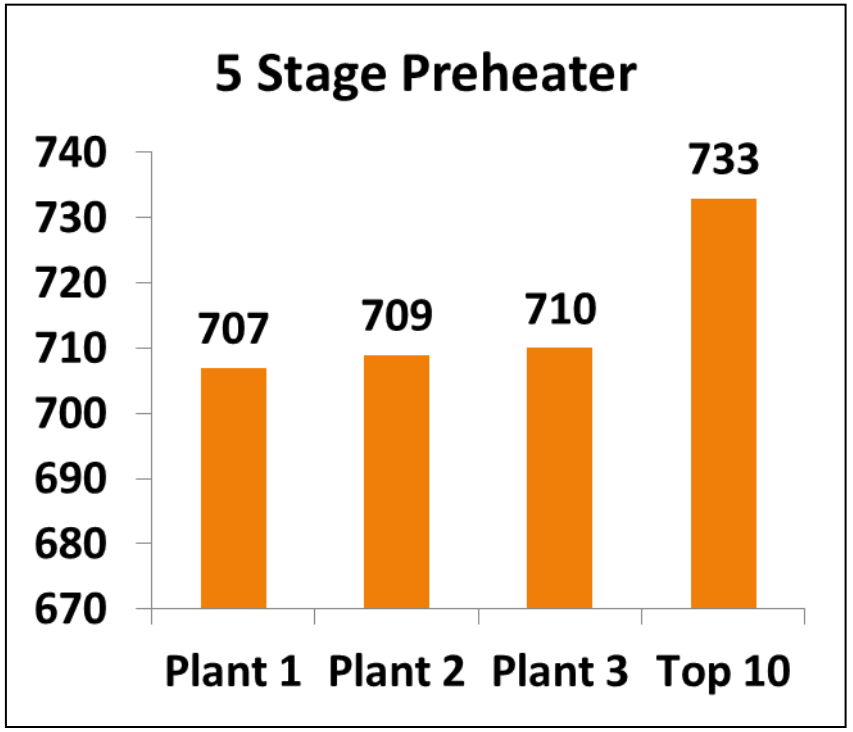
- **Benchmarking with a different approach,**
  - Different and Novel concept
  - Process or Equipment wise targets
    - Targets for ADU, VDU, FCCU etc.,
    - An apple to apple comparison
  - Values to be brought on a common platform
    - Reference for improvement of entire sector
    - Common in other sectors
      - Cement, Power etc.,

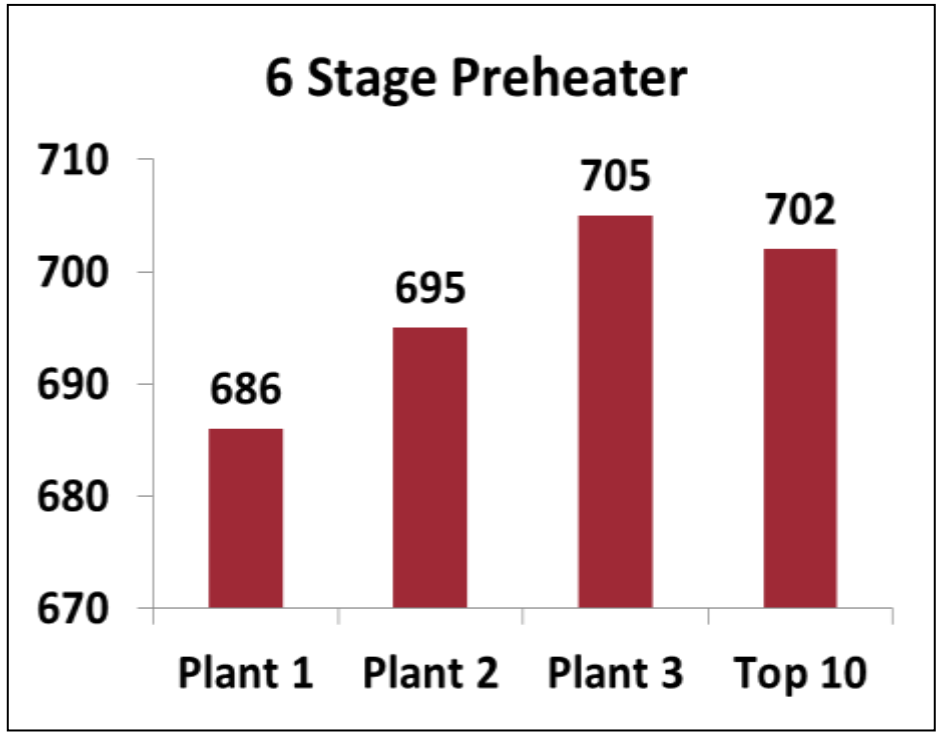
# Benchmarking vs. PAT targets

- Strong indicator of areas to improve
  - Easy to identify scope for improvement,
    - Higher returns on lesser efforts
  - Indicator from other units
    - Understanding opportunity to act on,
      - Reasons and ideas
    - A platform to aim for betterment

# ❖ Thermal SEC comparison of Preheaters

## ◘ kcal/kg clinker

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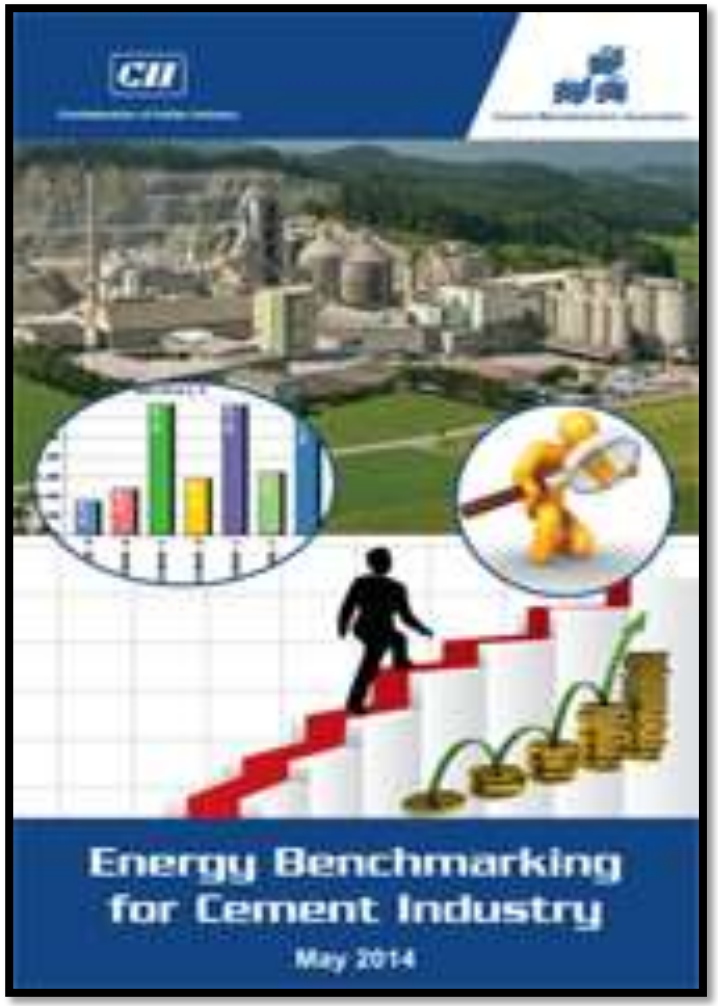
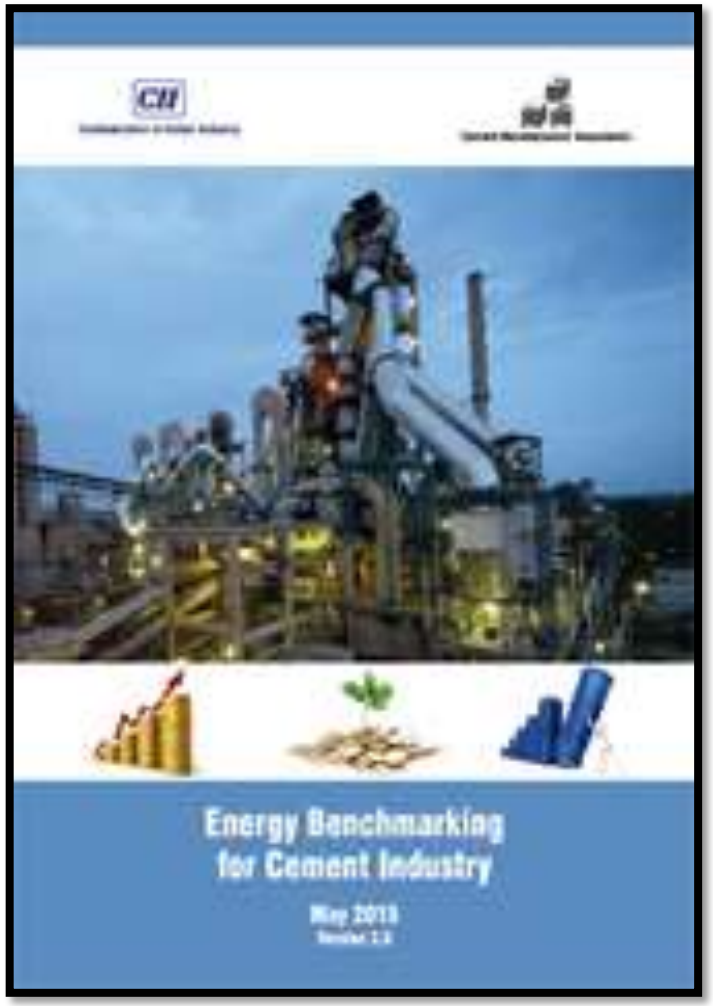
# Individual section performances

- PH fan lowest SEC – 3.88 kWh/MT clinker
- Lowest pressure drop in PH : 375 mmWc for 5 stage and 470 mmWc for 6 stage
- Fine coal phase density : 5.5 kg coal / kg air
- Lowest  RM Cyclone pressure drop : 50 mmwc
- Lowest false air across RM circuit : 11%
- Lowest compressed air generation pressure for plant air requirement : 4.5 bar
- Lowest CA fan power : 1.2 kWh/Mt cement
- Lowest APC in CPP : 5.36%

# Benchmarking in Cement Plants

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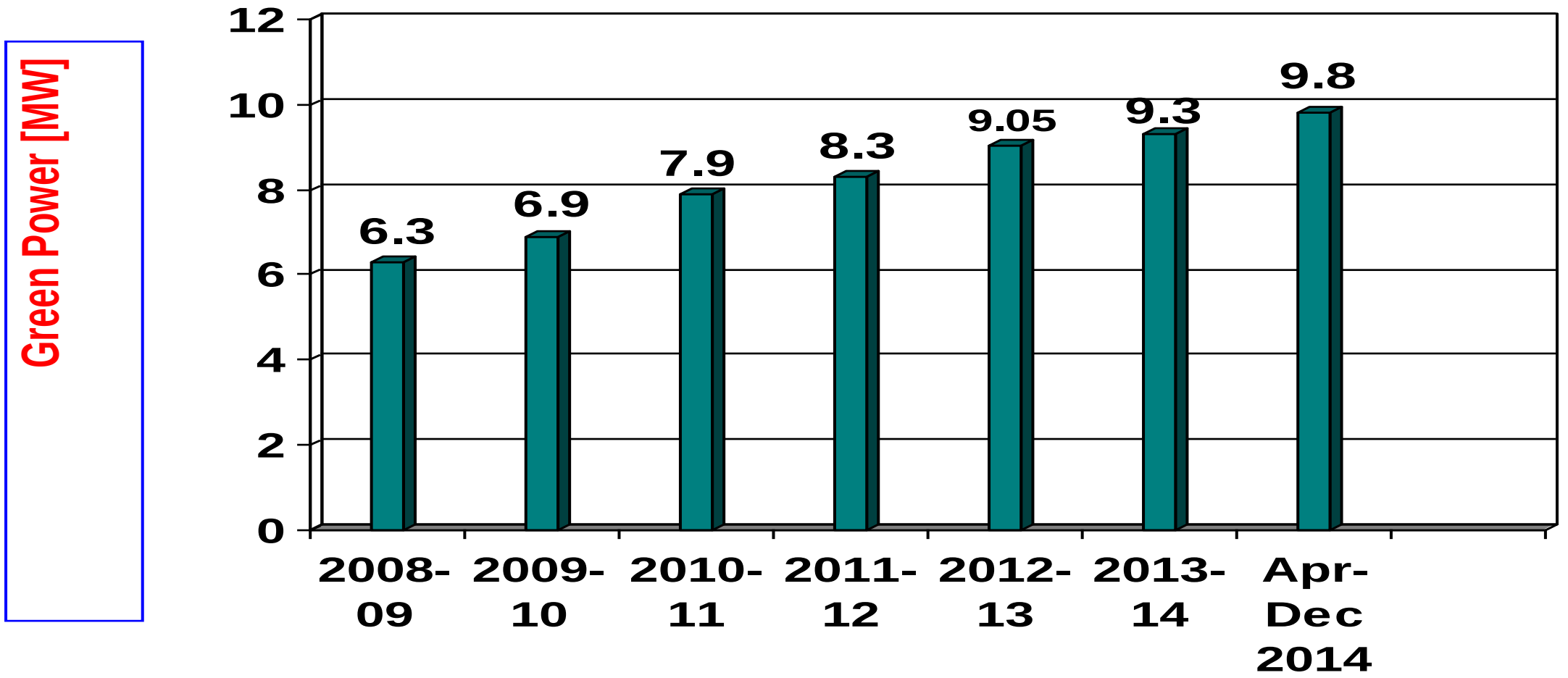
# Green Power generation – Paper Sector

- Black Liquor from paper process
  - Technique developed in paper plants
  - Firing in recovery boilers
    - Steam & power generation
      - Cogeneration
  - Contributes to lower fuel usage
    - GHG & effluent reduction

# Green Power generation



# CII's services for PAT sector..

- **Energy Audits in Cement, Paper & Pulp, Power, Fertilizer and Chemical sectors**
  - M&V studies & Mandatory Audits
  - In-plant training programs
  - Compressor Audits
  - PAT facilitation for the cement sector
  - Thermal Heat loss study in power plants

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# To Sum up…

- **Refinery Sector**
  - Great opportunity to attain world class standards
    - Cross sectoral projects – Good Example
      - Sharing & Understanding
      - Discussions
  - Energy conservation – continued approach
    - Priority for the projects – Time & Target setting
    - Proper Work Plan
  - CII – Will be glad to extend all possible assistance

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# 16th Energy Efficiency SUMMIT 2017

30, 31 Aug & 1 Sep 2017, Hyderabad

**Highlights:**

- Facilitate sharing of best practices, introduce latest technologies & usher in international experience
- Enhance the National EnCon Movement

**Concurrent Events:**

- National Award for Excellence in Energy Management 2017
- PaperTech 2017
- Power Plant Summit 2017
- Green Sugar Summt 2017

## Exposition

The summit hosts an exposition showcasing the latest trends, technologies, equipment and products on energy conservation and process optimisation.

## Snapshot of Energy Efficiency Summit 2016

**141** Energy Efficient Companies Awarded

**7** Innovative Products/ Services Awarded

**700+** Participants

**8** Energy Intensive sectors Awarded


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