1Measure
2Detect
3Control

Energy Management and
Conservation in Industries

CONZERV
Smart Energy Management

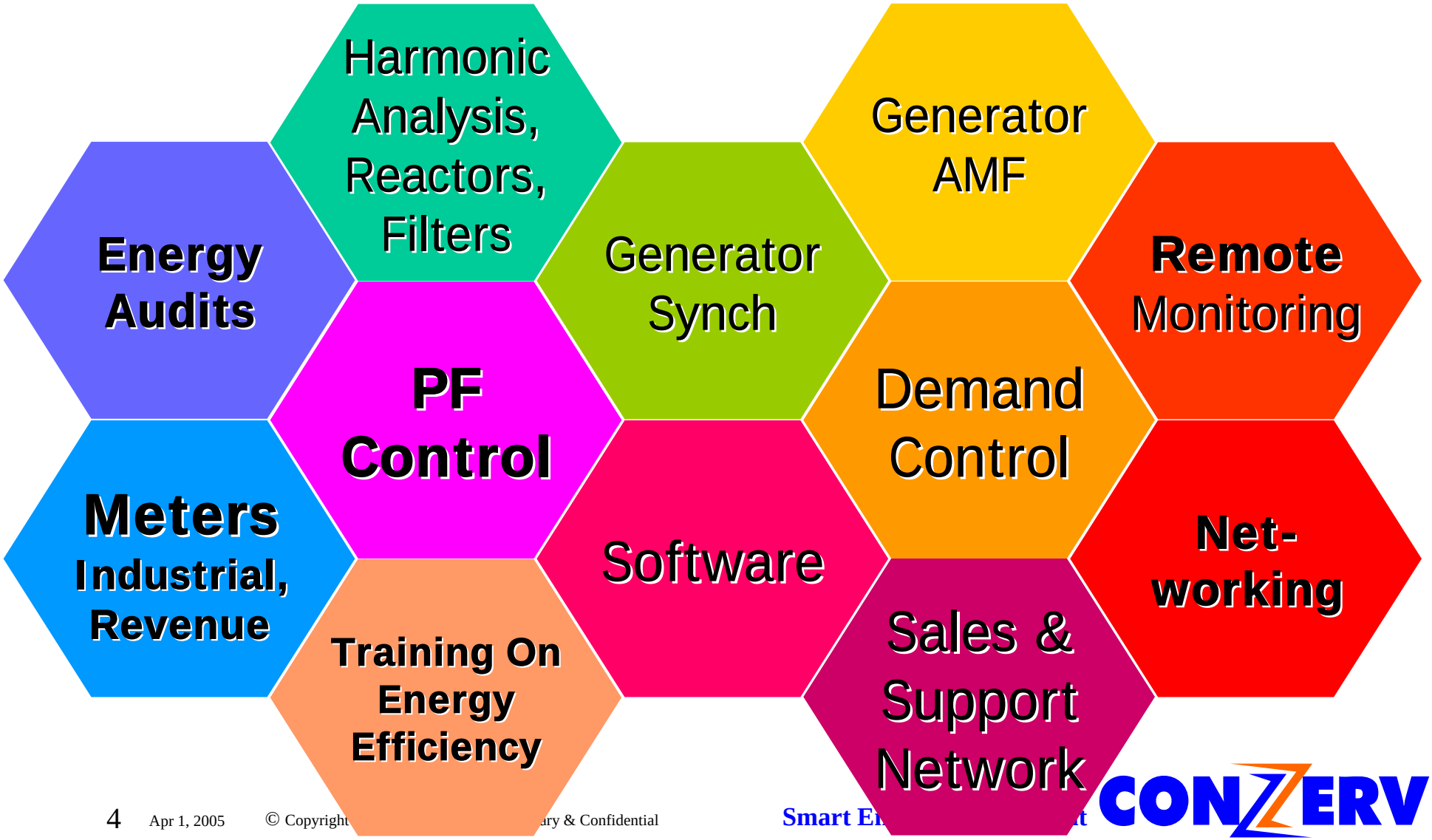
Conzerv – Profile

- A Board of Directors with Global vision
- Chairman Mr. T. Thomas
  - Ex - Chairman, Hindustan Lever
  - Board of Directors – Unilever UK
- Hema – MBA Marketing – IIM Calcutta Managing Director
- Ashok – MS Electrical Engg., University of Texas at Austin
  Director Technology Development
- Managed by a team of young, qualified professionals

Global Network

- 27,000 sq M premises, 2000 Sq M facility at Electronic City, Bangalore
- 4100 sq M premises with 1800 sq M facility at Yelahanka, Bangalore
- Regional offices at Delhi, Mumbai, Kolkata and Bangalore and Branch offices
- Overseas offices at Dubai, Bangkok, Kuala Lumpur and Boston
- Network of Engineers

Conzerv Spectrum of Activities



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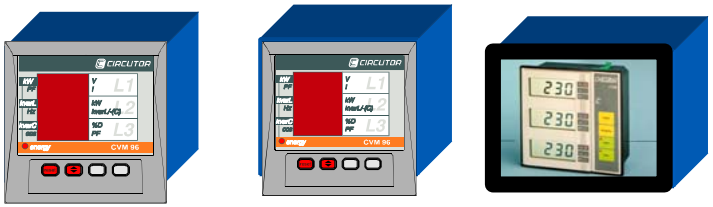
Energy Management Systems

Instrumentation for Monitoring

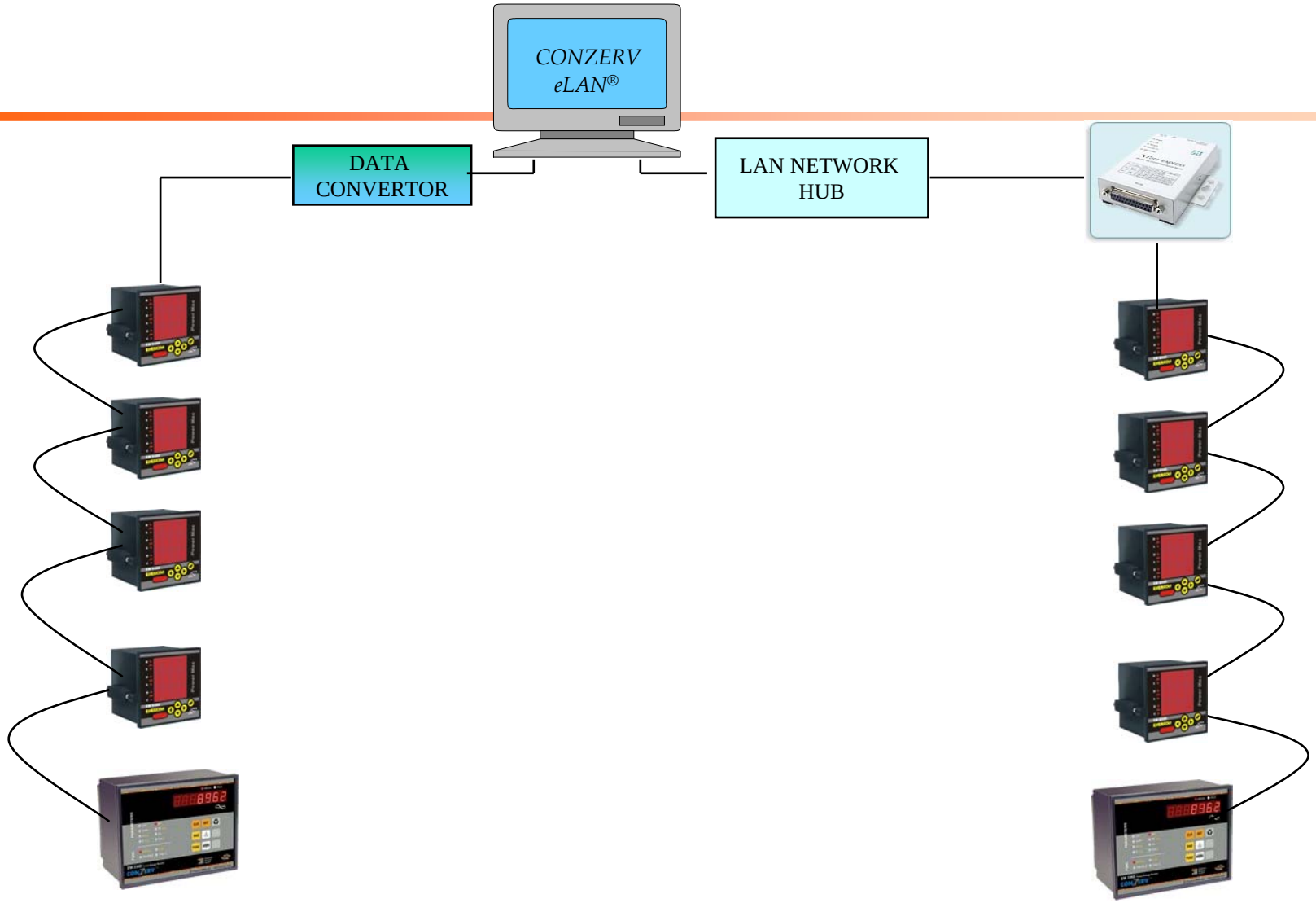


EM3000 Multi Function Meter
DM52 Energy Meter

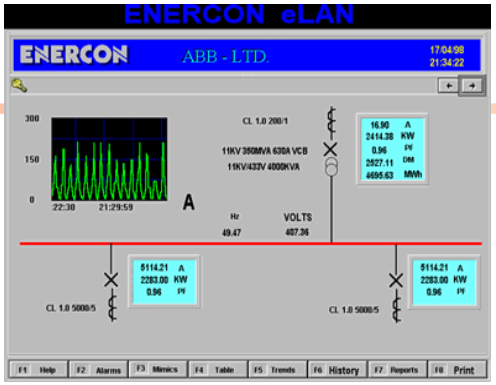
Smart Energy Management

CONZERV

EMS SYSTEM



Networked into Centralized System



Central Computer

Data Convertor

Concen -trator

EM3000 Multi Function Meter
: DM52 Energy Meter

Smart Energy Management

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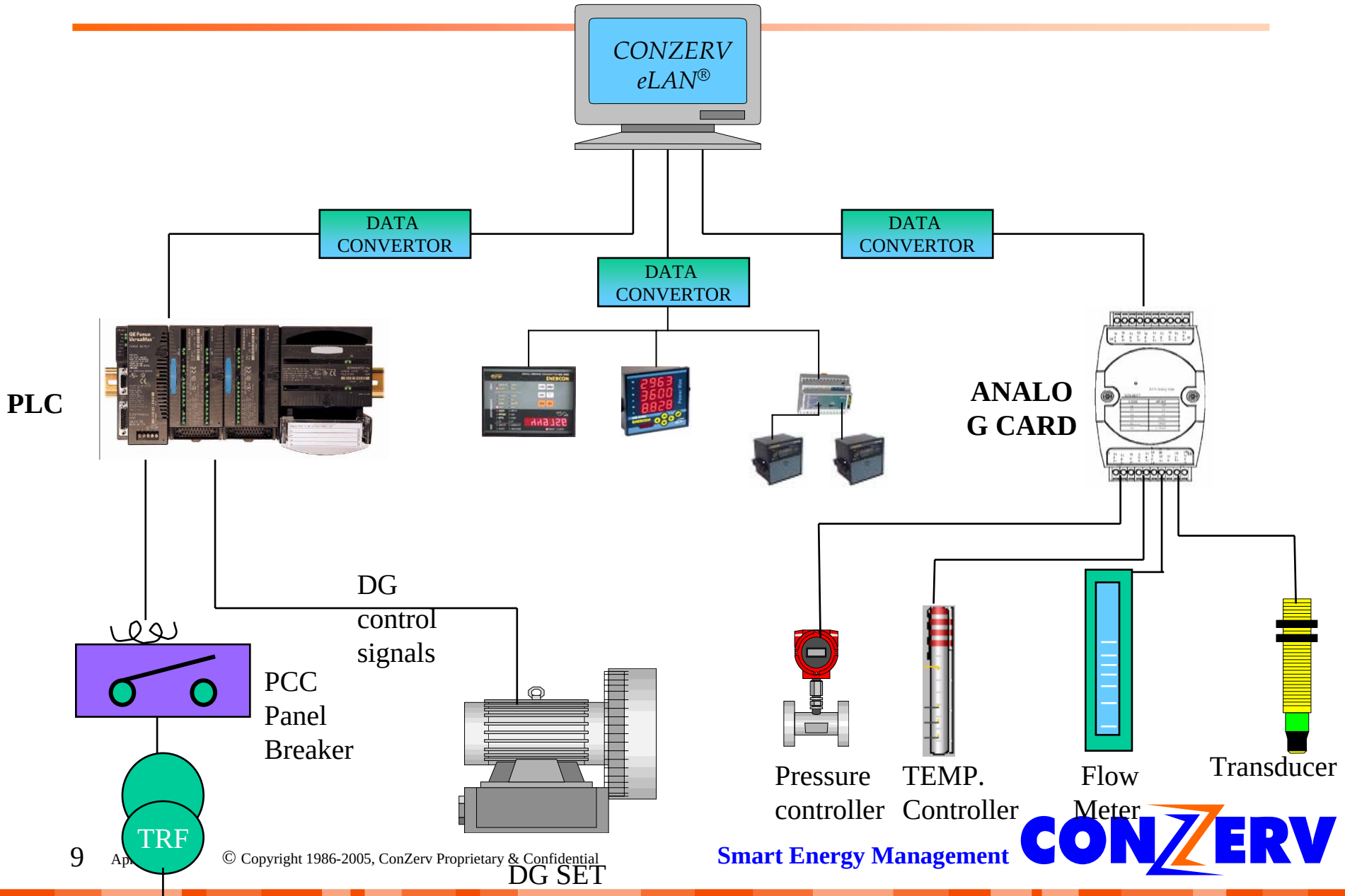
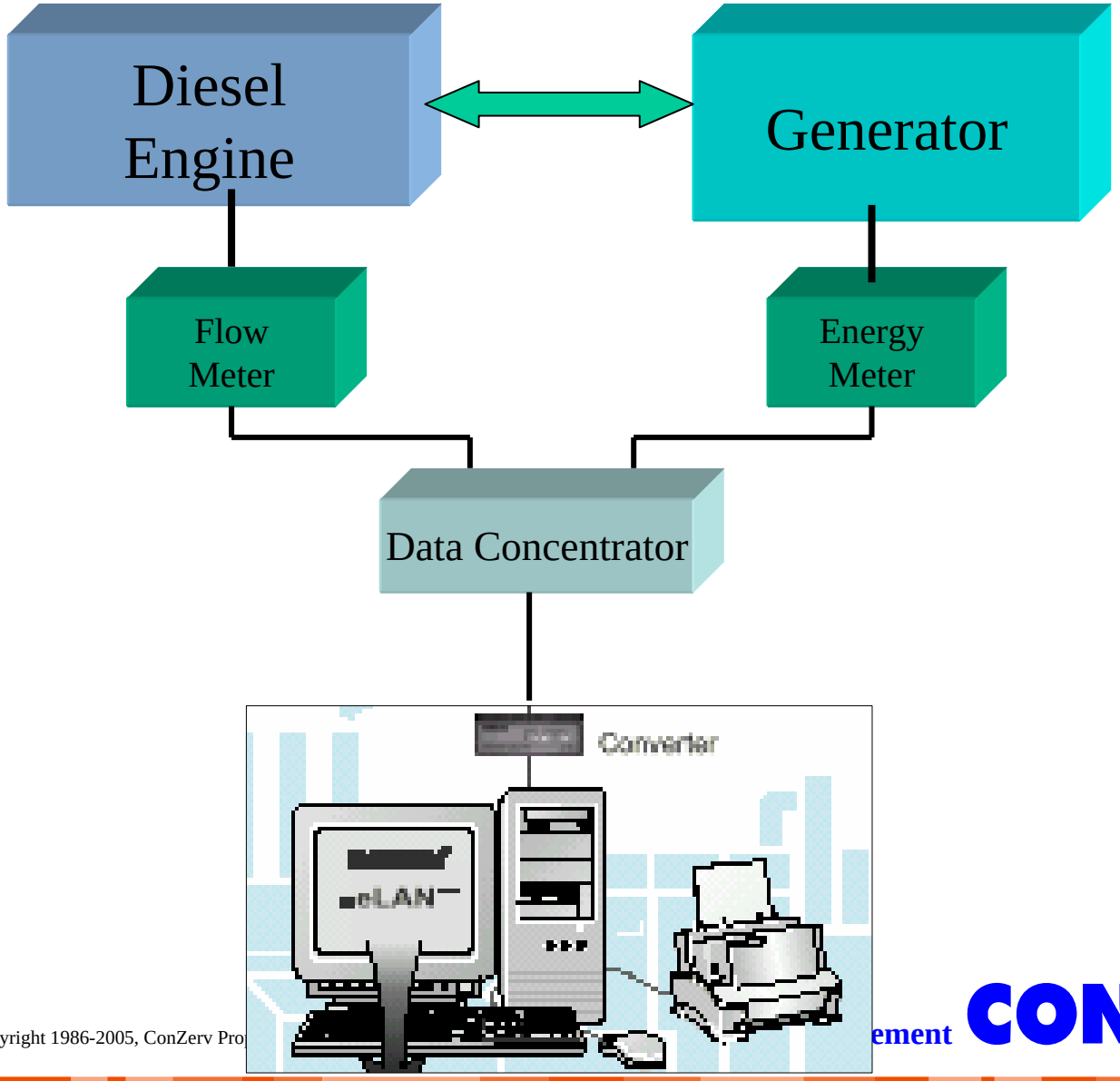
Conzerv eLAN® for Process Optimisation

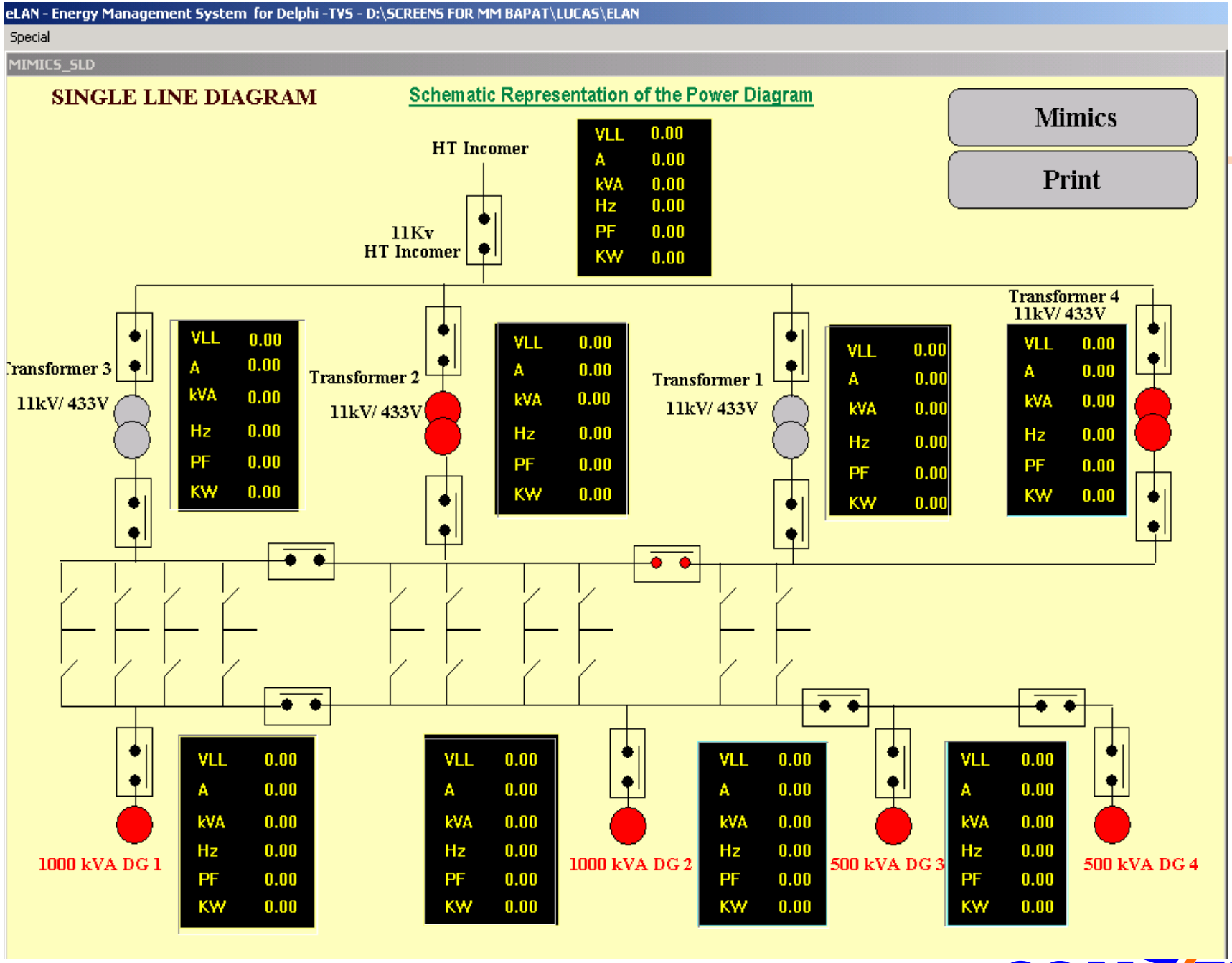


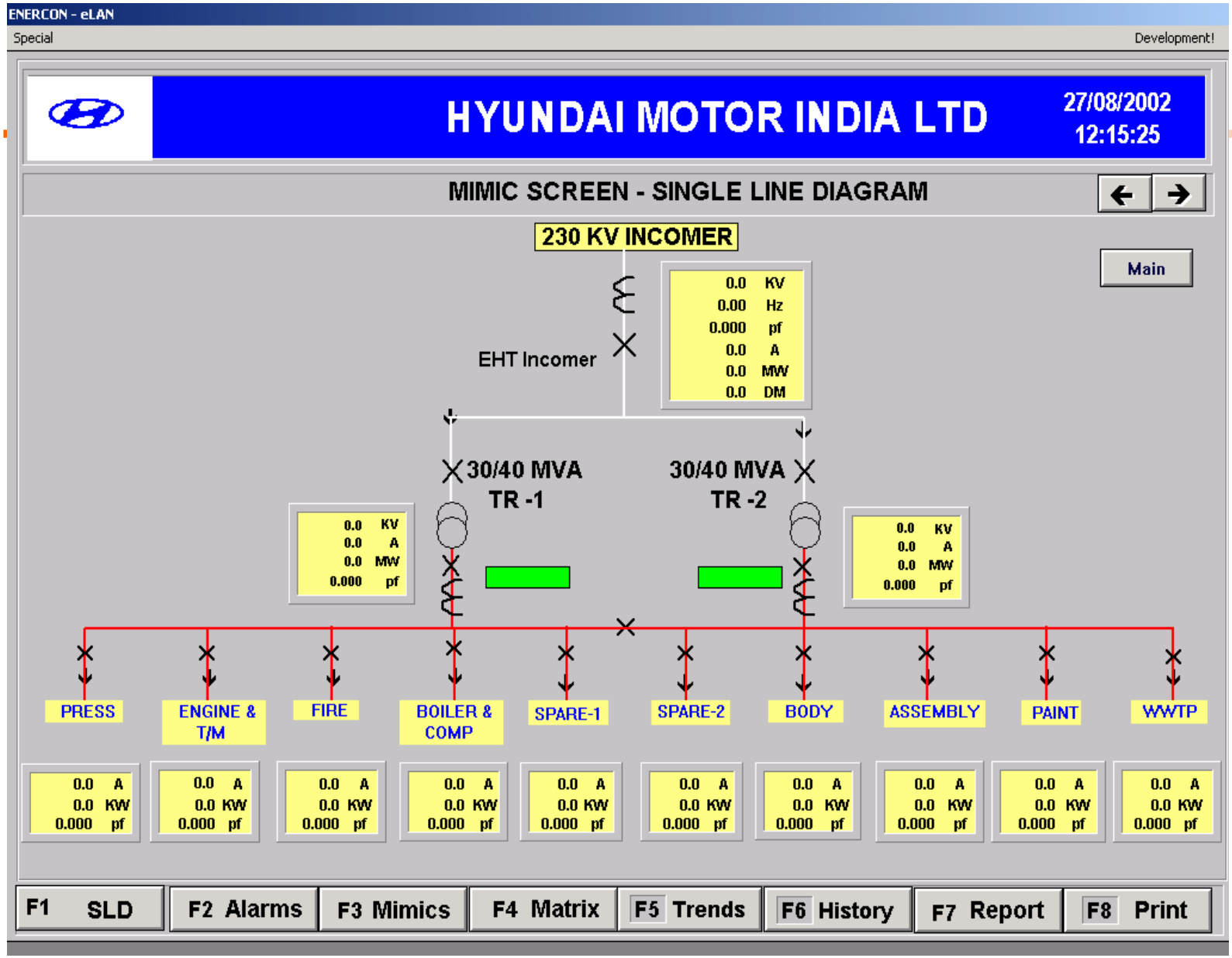
Generator Optimisation



Energy Management System Applications

- Benchmarking of Production
- Predictive Maintenance
- Root Cause Analysis
- Power Quality
- Measurement and Verification
- Cost Allocation
- Smart Power Management
- Energy Resource Planning
- Energy Balancing
- Breaker Status – remote monitoring
- Automated Energy Billing System for Townships





Audit Capability

ACCREDITATION

CONZERV is accredited for Energy Audit by Bureau of Energy Efficiency, Ministry of Power,Govt of India under Energy Conservation Act 2001

Menu of Services

- Comprehensive Energy Audits
- Post Audit Assistance
- Training in Energy Efficiency
- Power Factor Correction
- Harmonic Analysis
- Specific Projects

The Team

- Multi-disciplinary team of Auditors
- 9 Full time Energy Auditors
- Panel of Experts for Specialized Processes
- Advisory panel comprising renowned technocrats

Major Clients

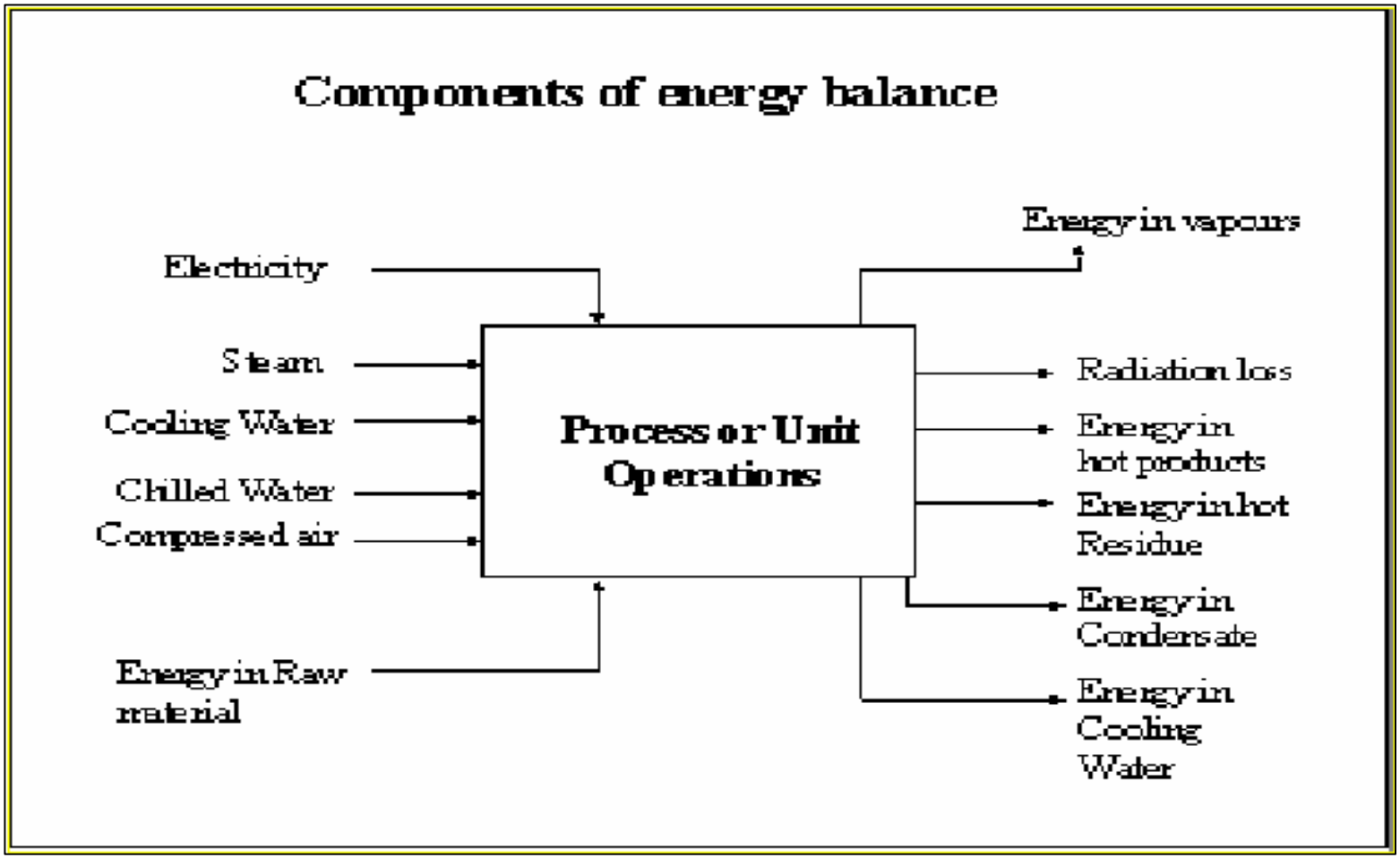
- Ashok Leyland - Automobile
- Taj Group of hotels - Hospitality
- Oberoi and ITC group - Hospitality
- Hyundai Motors - Automobile
- HLL group - FMCG
- Tata Chemicals - Chemicals
- ACC – Gagal,Kymore,Tikaria - Cement
- NTPC,Singrauli,Tanda, Dadri - Power plant
- HEG Mandideep -Graphite
- Kwality Ice Cream, Delhi - FMCG
- NDDB,Anand -Dairy
- Ranbaxy – Mohali, Tonsa - Pharma
- Liberty Shoes – Gharaunda, Karnal - Shoes

Major Clients – Punjab, Haryana and UT Chandigarh

- Ranbaxy Mohali / Tonsa / Ponta Sahib
- Nestle Moga
- Steel Strips Wheels
- Indian Acrylics
- Hero Motors
- ICI Paints
- Aarti Spinning
- Abhishek Industries
- Jagatjit Industries
- Liberty Shoes

Energy Efficiency In Industries

Components of Energy Balance



Purpose of material and energy balance

- To Assess the input, conversion efficiency, output and losses
- To quantify all material, energy and waste streams in a process or a system
- To find out the difference between calculated/designed values and measured/actual values thereby making it possible to identify previously unknown losses and emissions
- Powerful tool for establishing basis for improvement and potential savings

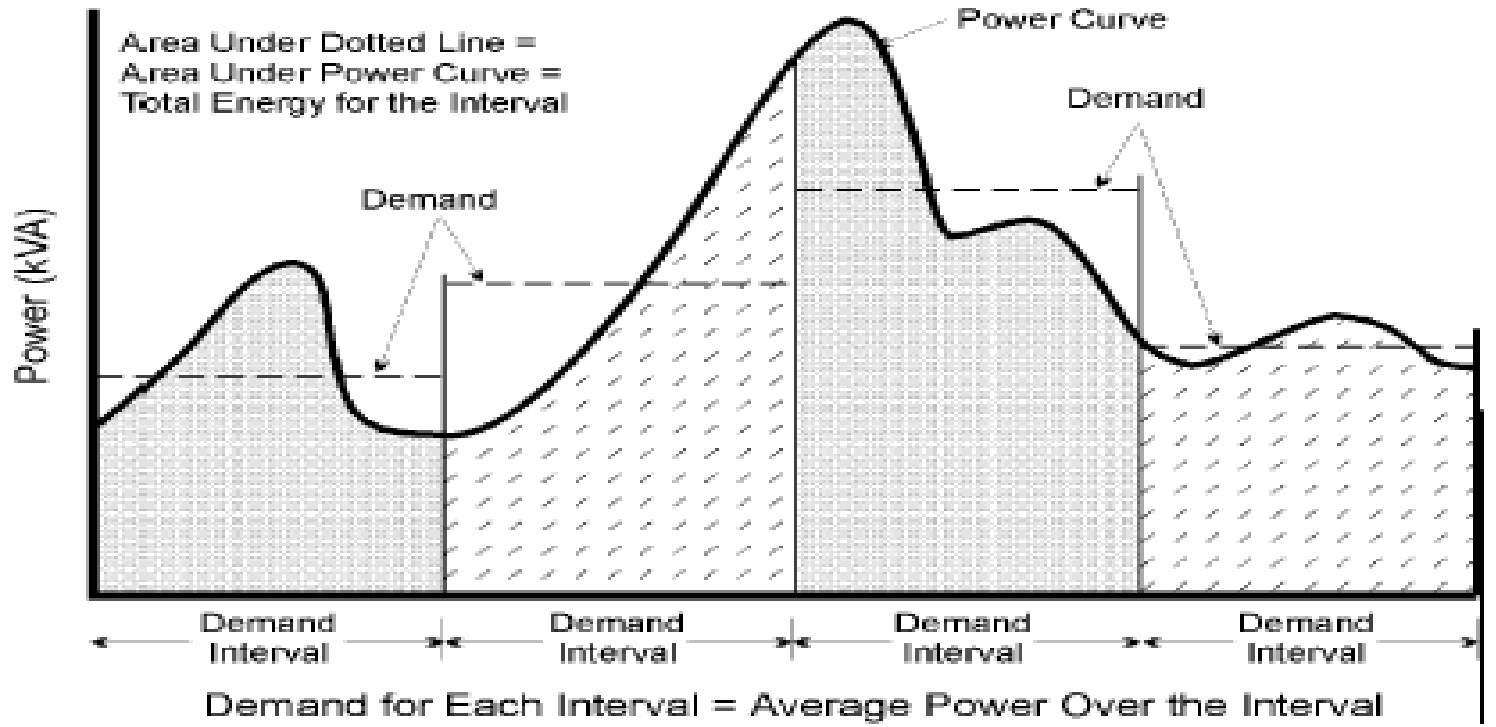
Electrical Network

Electricity Billing

The consumer pays for two components.

- For the energy kWh consumed
- For the maximum demand (kVA) registered

Maximum Demand



As can be seen from the figure above the demand varies from time to time. The demand is measured over predetermined time interval and averaged out for that interval as shown by the horizontal dotted line.

Smart Demand Controller EM 3460

- TOU Demand Control
- User Programmable Upper Limit, Lower Limit,
- Essential Load and Prediction Interval for sophisticated Demand Control
- Demand Control through Unique Predictive technique and Sliding Window Integration Leads to : Reduced Energy Losses, Improved Load Factor &
- Minimal disruption in operations
- 3 Change Over Potential free control outputs for: Predicted Demand exceeding Target, Demand exceeds Target & Restore Load

Power Factor

- EB Billing – Unity
- D G / T G Sets – ?

kVAR = kW (tan Ø 1 - tan Ø 2)

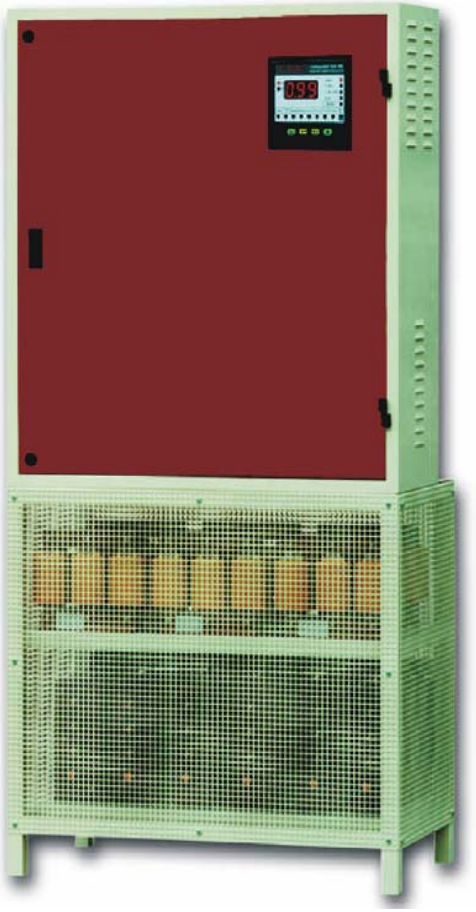
Or use the capacitor selection chart

Location of capacitors

- Main distribution boards (Unity)
- Sub distribution boards (o.95)
- Load ends (0.85)

Power Factor Improvement Panel

- Compact modular stand alone unit
- Comprises of capacitors, Contactors, isolating switch, HRC fuses, Power factor Controller
- Models from 35kVAr to 200kVAr



Benefits of PF Improvement

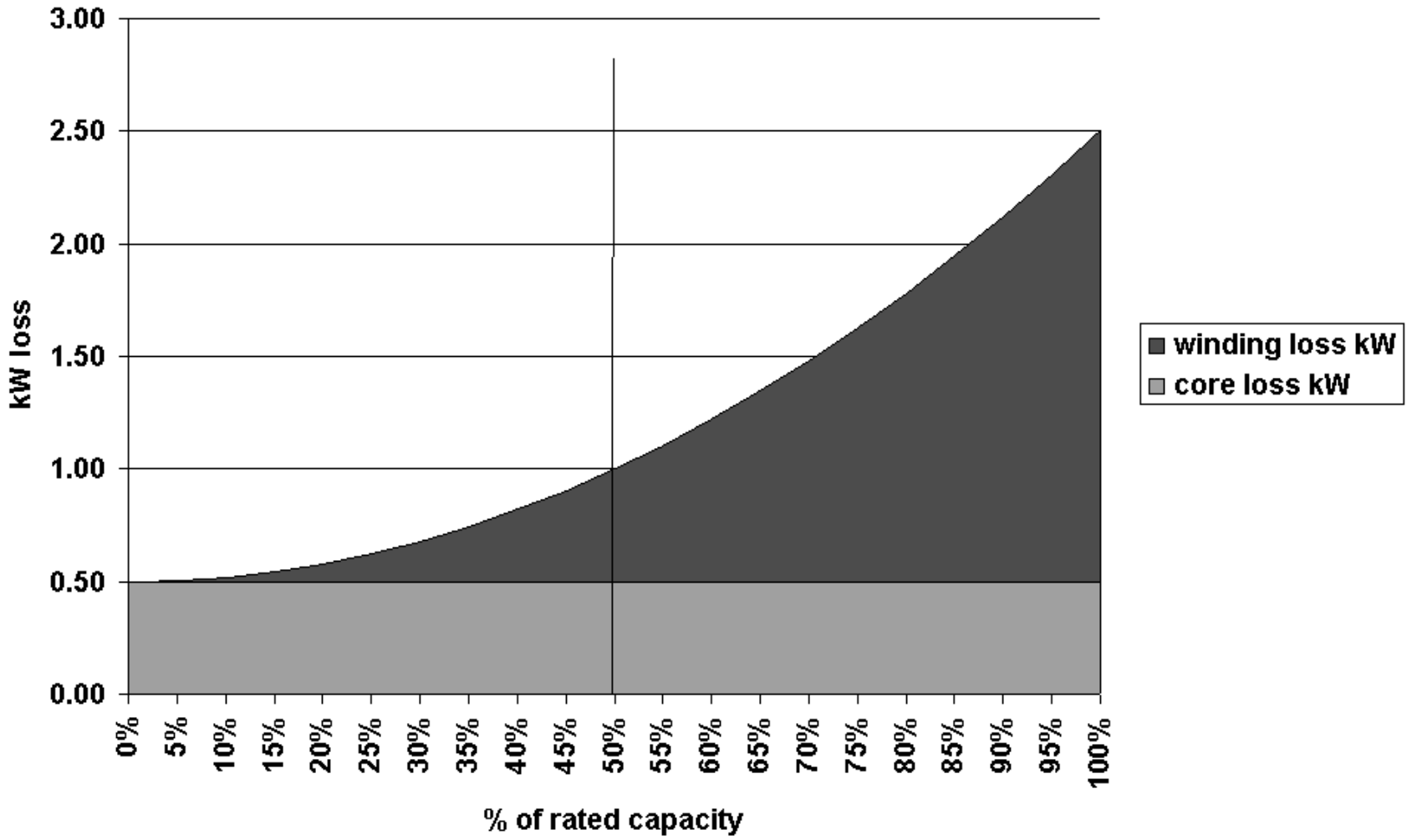
- Avail rebates from SEB
- Reduced heat loss of network
- Voltage improvement
- Reduced maximum demand charges

Transformers

Transformers

- Load loss or copper loss.
- No load loss or iron loss .
- Amorphous iron is expensive but reduces core loss to less than 30% those of conventional steel cores. An alternative, less expensive core material is silicone steel, which has losses higher than amorphous iron, but less than standard carbon steel.

Transformers



Harmonics

Harmonics

WHAT ARE HARMONICS ?

- **HARMONIC IS DEFINED AS A COMPONENT OF PERIODIC WAVE (OR A SIGNAL) WHOSE FREQUENCY IS INTEGER MULTIPLE OF THE FUNDAMENTAL FREQUENCY.**
- **CURRENT HARMONICS**
- **VOLTAGE HARMONICS**

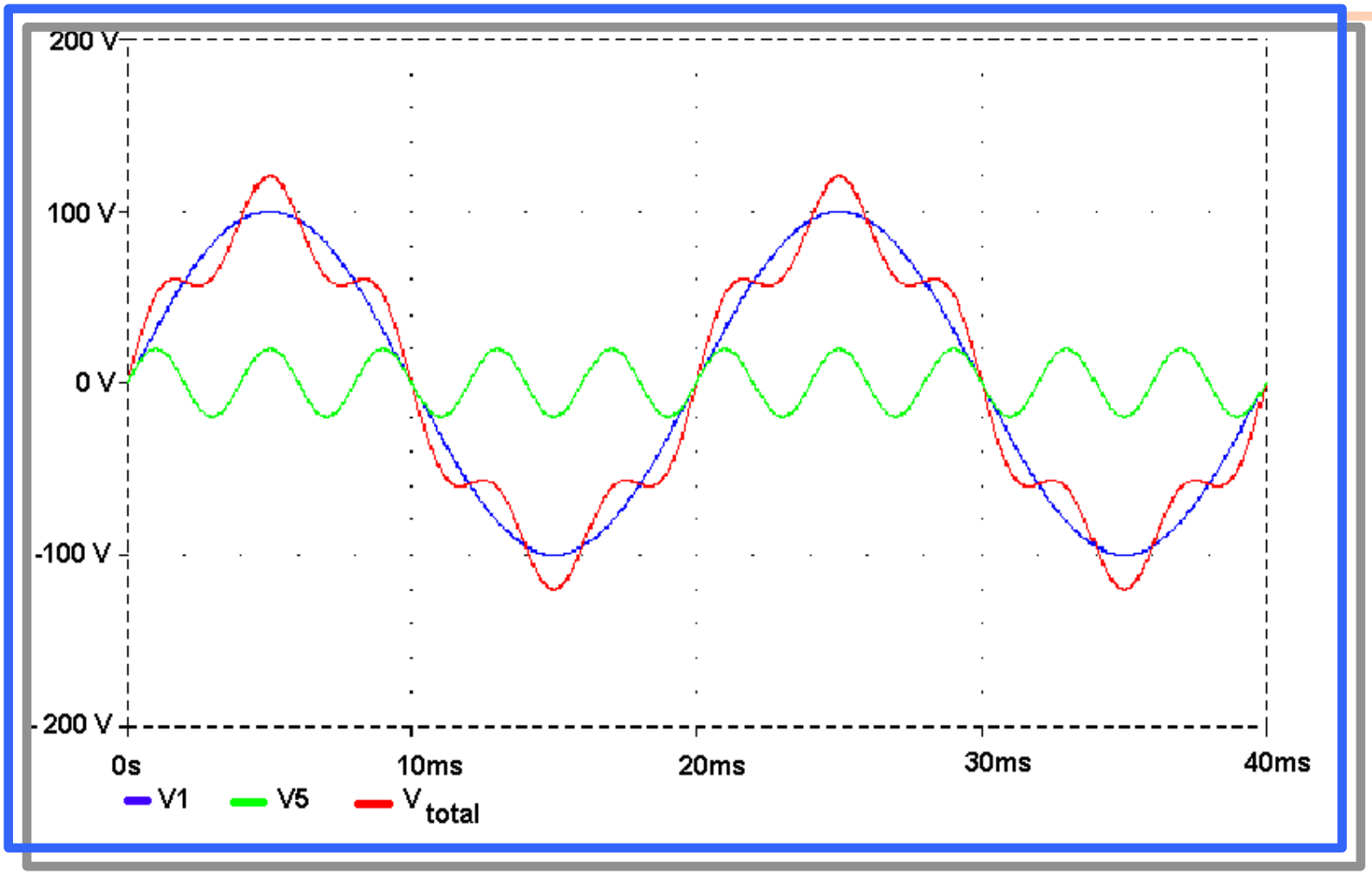
SOURCES OF HARMONICS

- NON LINEAR LOADS ARE MAJOR HARMONICS GENERATORS
- SOURCES:
- TRANSFORMER UNDER NO LOAD & LIGHT LOADS
- SATURATED REACTORS
- THYRISTOR-CONTROLLED MOTOR DRIVES
- ARC FURNACES

SOURCES OF HARMONICS – CONT'D

- INDUCTION FURNACES
- GAS-DISCHARGE LIGHTING REACTORS
- ELECTROLYSIS PLANTS
- ENERGY CONSERVATION DEVICES
- Eg: SOFT STARTERS, ELECTRONIC BALLASTS & FAN REGULATORS
- EQUIPMENT WITH SMPS, Eg., T.V. RECEIVERS, PCs
- CVTs , Inverters

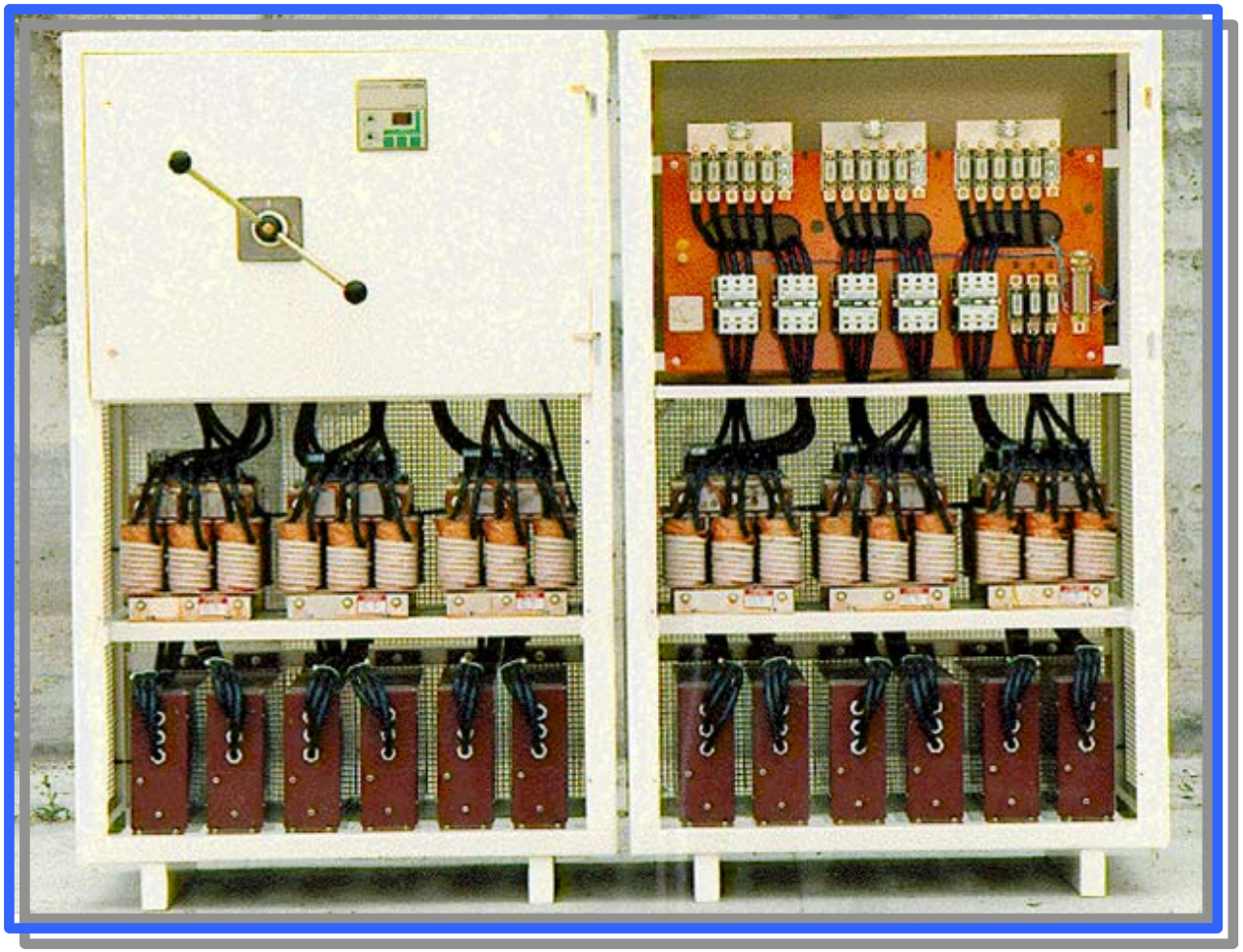
HARMONIC COMPONENTS



Power Quality Audits

- Excess harmonics in network can lead to:-
- Excess energy consumption
- Poor capacity utilisation of network
- Damages to components like capacitors, D G sets, computers etc.
- Nuisance tripping of circuits leading to production loss
- And many more associated problems

REJECTION FILTER BANK



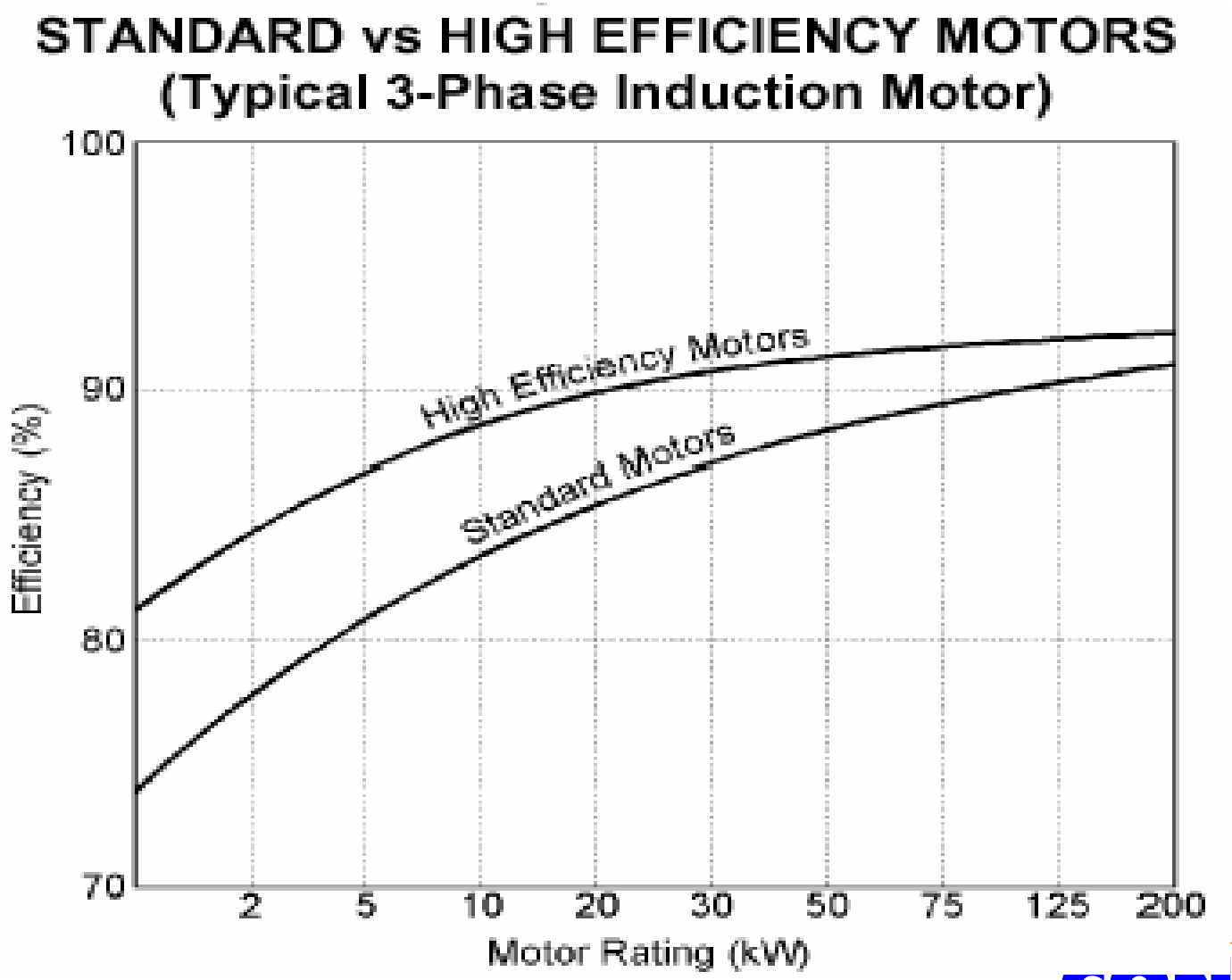
REJECTION FILTERS UP TO 15kV

Motors

Motors

- Energy efficiency strategies
- Switch off equipment when not needed
- Provide better controls (VSD instead of throttling)
- Process re-engineering
- Maintain voltage levels
- Minimise phase unbalance
- Minimise rewound motor losses (no load pf 0.2, amp 40%)
- Avoid over / under capacity
- Use energy efficient motors (92%)

High Efficiency Motors



Air Compressors

Air Compressors

Compressed Air Efficiency:

60 to 80% of the power of the prime mover is converted into an unusable form of energy (HEAT)

And to a lesser extent, into friction, misuse and noise

To the extent possible, use of compressed air in production should be minimised

Air Compressors – Intake Temperature

Inlet Temperature (^{0}C)	Relative Air Delivery (%)	Power Saved (%)
10.0	102.0	+ 1.4
15.5	100.0	Nil
21.1	98.1	- 1.3
26.6	96.3	- 2.5
32.2	94.1	- 4.0
37.7	92.8	- 5.0
43.3	91.2	- 5.8

Every 40C rise in inlet air temperature results in a higher energy consumption by 1 % to achieve equivalent output. Hence, cool air intake leads to a more efficient compression.

Air Compressors - Leaks

Orifice Size mm	KW Wasted	* Energy Waste (Rs/Year)
0.8	0.2	8000
1.6	0.8	32000
3.1	3.0	120000
6.4	12.0	480000

* based on Rs. 5 / kWh ; 8000 operating hours; air at 7.0 bar

Air-conditioning

COP

- COP_{Carnot} is only a ratio of temperatures, and does not take into account the type of compressor. Hence the COP normally used in the industry is given by

$$COP = \frac{\text{Cooling Effect (kW)}}{\text{Power input to compressor (kW)}}$$

where the cooling effect is the difference in enthalpy across the evaporator and expressed as kW.

Chiller Performance

Basic Calculation:

- Compressor kW
- Chilled water pump kW
- Condenser water pump kW
- Cooling tower fan kW

Overall kW/TR = sum of all above kW/ TR

Energy Performance Of Chillers

- *Reciprocating Chiller (>50 TR)*

  KW/TR - 0.66 - 0.67 kW/TR
  COP - 5.32
  EER - 18-19 BTU/hour/W

- *Centrifugal Chiller (>150 TR)*

  KW/TR - 0.59 - 0.65 kW/TR
  COP - 6
  EER - 20-25 BTU/hour/W

- *Screw Chiller (>150 TR)*

  KW/TR - 0.55 - 0.60 kW/TR
  COP - 6
  EER - 20-25 BTU/hour/W

Energy performance – Vapor Absorption Chillers

(chilled Water @ 8 Deg C)

- **Single Effect Chiller**

COP - 0.6-0.65
EER - 2.0-2.25 BTU/hour/W
Steam Consumption - 8 – 8.5 kg/hr (3.0 kg/cm2)

- **Double Effect Chiller**

COP - 1.0-1.2
EER - 3.5-4.0 BTU/hour/W
Steam Consumption - 4.5 – 5.5 kg/hr/TR (8.0-8.5 kg/cm2)

Effect of Poor Maintenance on Compressor Power Consumption

Condition	Evap. Temp (^{0}C)	Cond. Temp (^{0}C)	Refrigeration Capacity (tons)	Specific Power Consumption (kW/ton)	Increase in kW/Ton (%)
Normal	7.2	40.5	17.0	0.69	-
Dirty condenser	7.2	46.1	15.6	0.84	20.4
Dirty evaporator	1.7	40.5	13.8	0.82	18.3
Dirty condenser and evaporator	1.7	46.1	12.7	0.96	38.7

Energy Performance – Down Side Equipments

- Chilled Water Pump - 0.10 – 0.12 kW/TR
- Condenser Water - 0.085 – 0.12 kW/TR
- Cooling Tower - 0.03 – 0.1 kW/TR
- AHU - 3000 – 6000 CFM/kW
- FCU - 8000 - 10000 CFM/kW

Energy Savings Opportunities in Air Conditioning

- Use double glass in windows, sun screens etc.
- Optimise air flow / air changes.
- Minimise artificial lighting, use natural light.
- Air tight building envelope.
- Use thermostatic controls and VSDs for AHUs.
- Avoid placing heat producing devices in AC spaces.

Solutions for Efficiency in Air Conditioning

- Energy Audit can indicate where efficiency is low or where energy consumption is excessive. It will also assess losses and wastages in the system.
- EMS can provide running efficiency of the system by monitoring energy efficiency of chillers and other components on a continuos basis.
- BMS can control HVAC to provide maximum efficiency without compromising comfort conditions

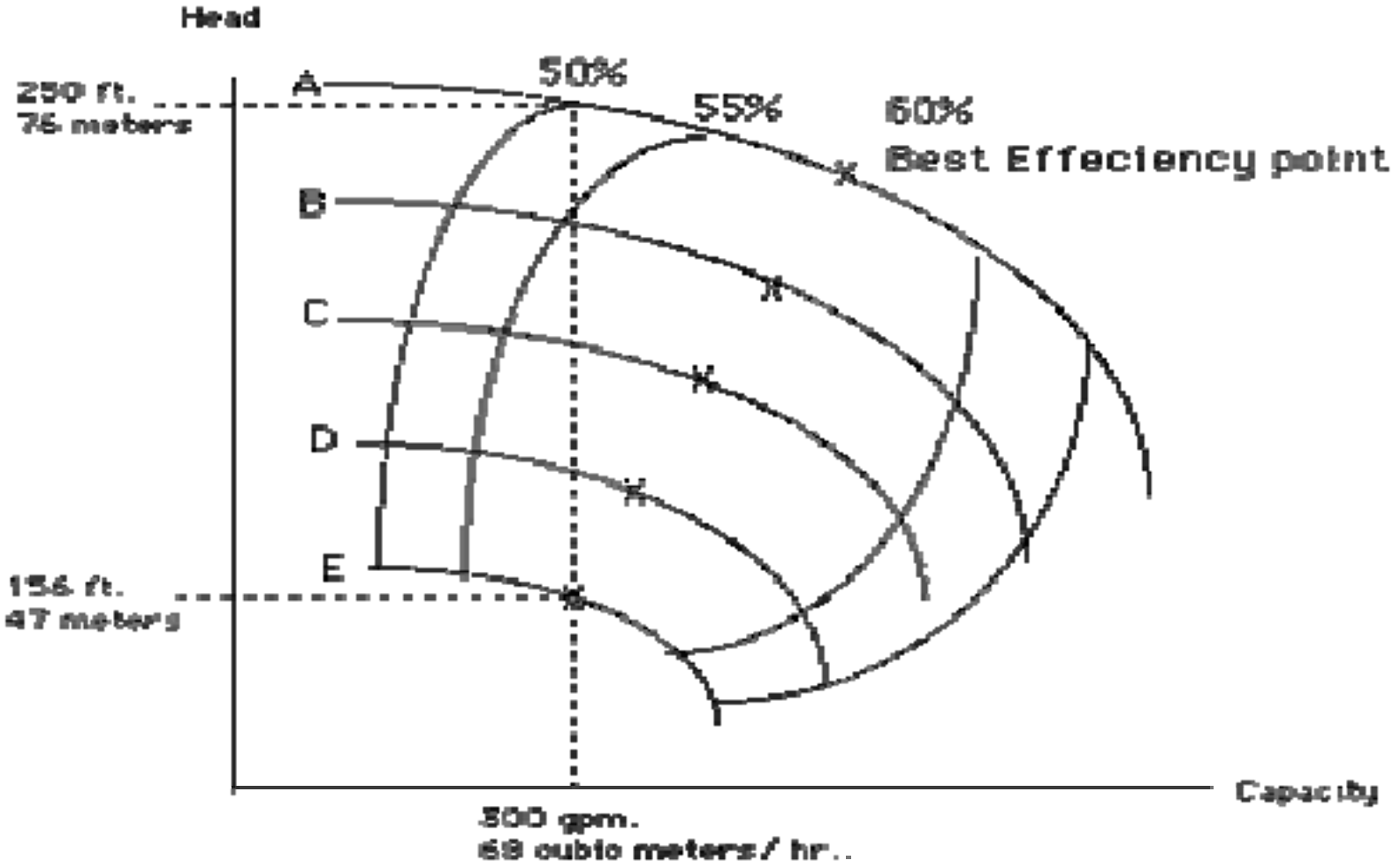
Fans / Blowers

Speed vs Power

% Speed	% Power
100	100
90	73
80	51
70	34
60	22
50	13

Pumps

Efficiency Curves

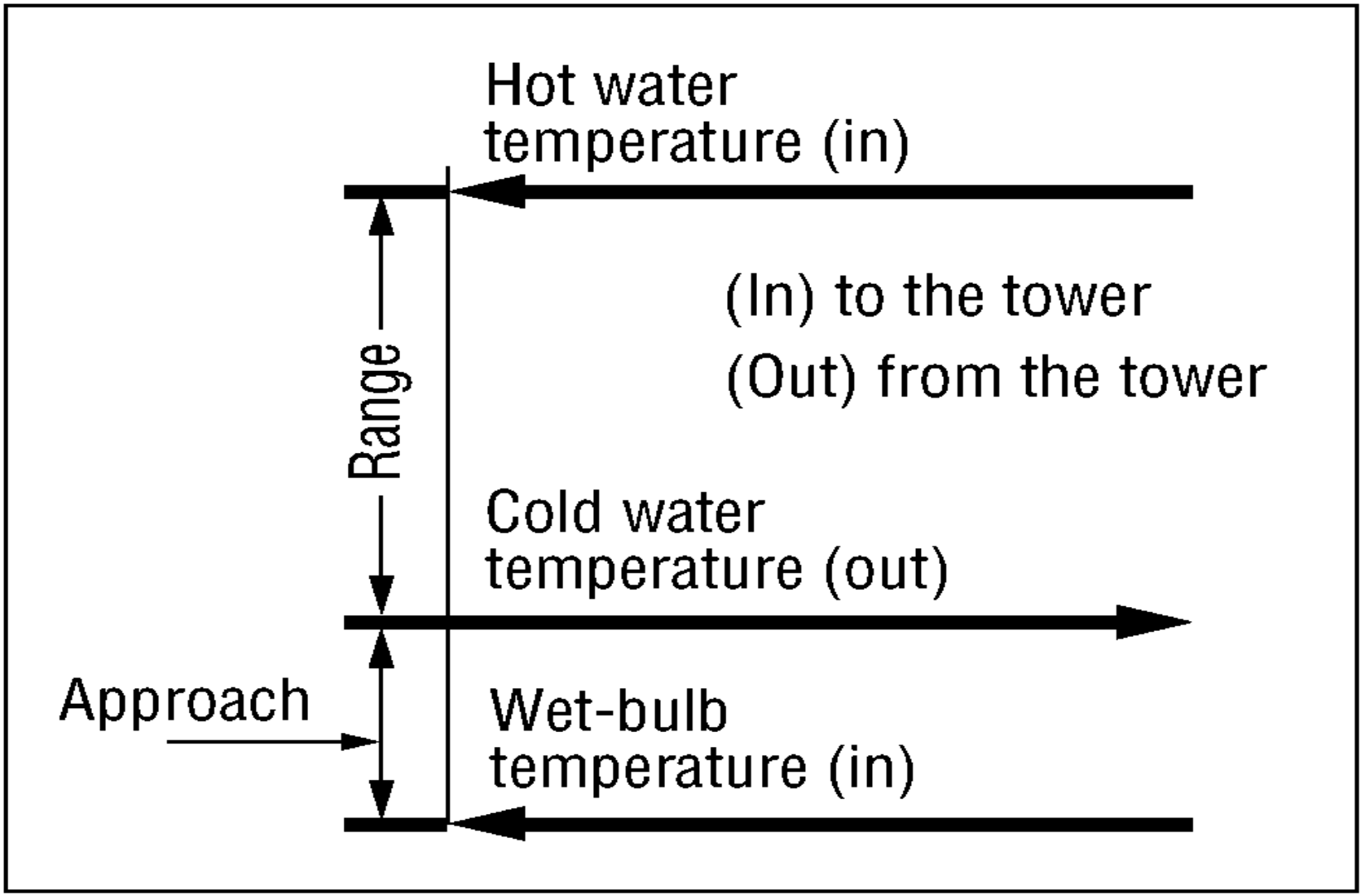


Opportunities in Pumping System

- **Operate pumps near best efficiency point.**
- **Modify pumping system and pumps losses to minimize throttling.**
- **Adapt to wide load variation with variable speed drives.**
- **Repair seals and packing to minimize water loss by dripping.**
- **Balance the system to minimize flows and reduce pump power requirements.**

Cooling Towers

Cooling Tower Performance



Cooling Towers – Energy Saving

- Maintain clearances around the tower.
- Replace old nozzles with non clogging ones.
- Optimise cooling tower fan blades periodically for seasonal or load conditions.
- Correct fan balance and tip clearances.

Boilers

Boiler Efficiency

- **What are the factors for poor efficiency?**
- Efficiency reduces with time, due to poor combustion, heat transfer fouling and poor operation and maintenance.Deterioration of fuel and water quality also leads to poor performance of boiler.

- **How Efficiency testing helps to improve performance?**
- Helps us to find out how far the boiler efficiency drifts away from the best efficiency. Any observed abnormal deviations could therefore be investigated to pinpoint the problem area for necessary corrective action.

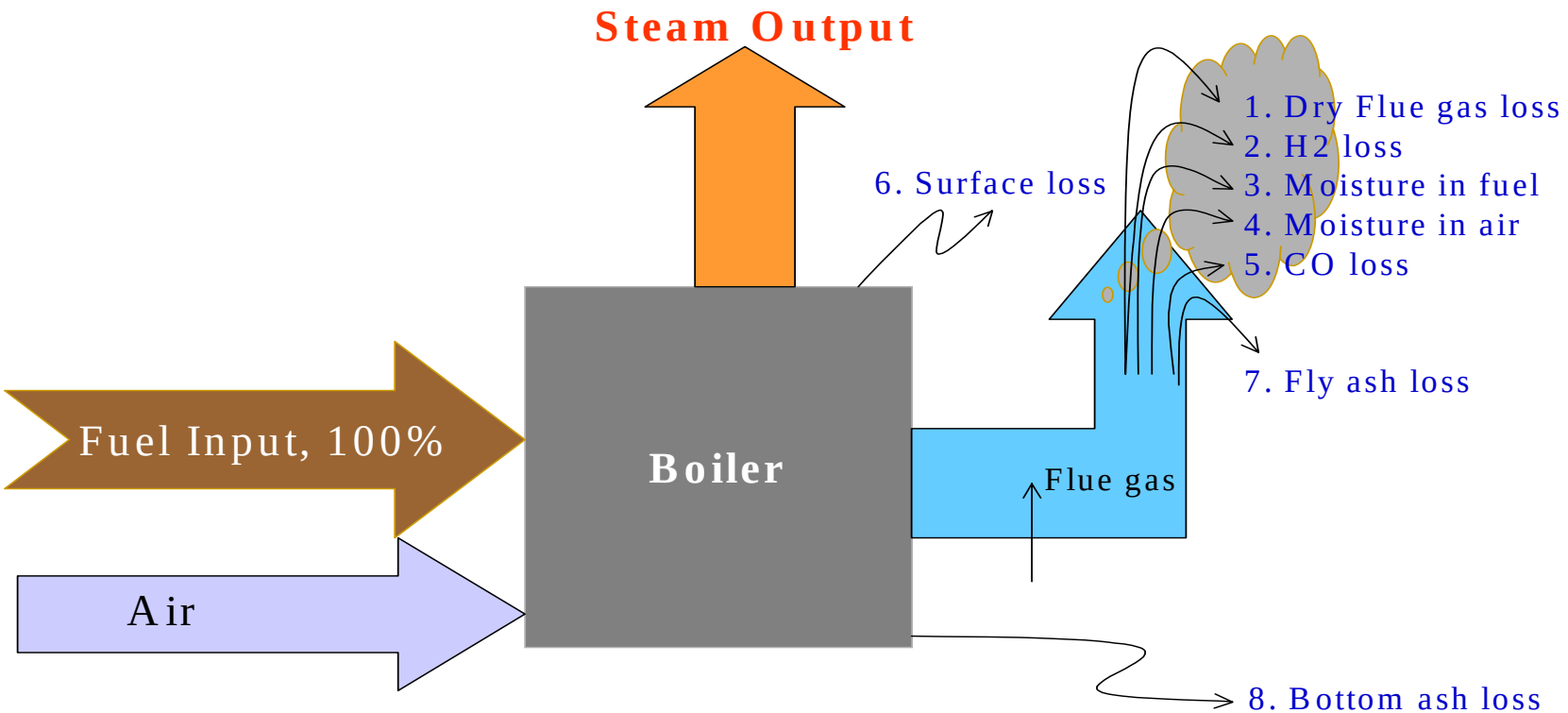
Boiler Efficiency

- Thermal efficiency of boiler is defined as the percentage of heat input that is effectively utilised to generate steam. There are two methods of assessing boiler efficiency.
- **1) The Direct Method:** Where the energy gain of the working fluid (water and steam) is compared with the energy content of the boiler fuel.
- **2) The Indirect Method:** Where the efficiency is the difference between the losses and the energy input.

Boiler efficiency – Direct Method

- Boiler efficiency (η): = $\frac{\mathbf{Q \times (H - h)}}{\mathbf{(q \times GCV)}} \times \mathbf{100}$
- Where **Q** = Quantity of steam generated per hour (kg/hr)
- **H** = Enthalpy of saturated steam (kcal/kg)
- **h** = Enthalpy of feed water (kcal/kg)
- **q** = Quantity of fuel used per hour (kg/hr)
- **GCV** = Gross calorific value of the fuel (kcal/kg)
- **Boiler efficiency (η)=** $\frac{8 \text{ TPH x1000Kg/Tx (665–85) x 100}}{1.8 \text{ TPH x 1000Kg/T x 3200}}$
- **= 80.0%**
- **Evaporation Ratio** = 8 Tonne of steam/1.8 Ton of coal
- **= 4.4**

Boiler Efficiency – Indirect Method



Efficiency = 100 – (1+2+3+4+5+6+7+8)

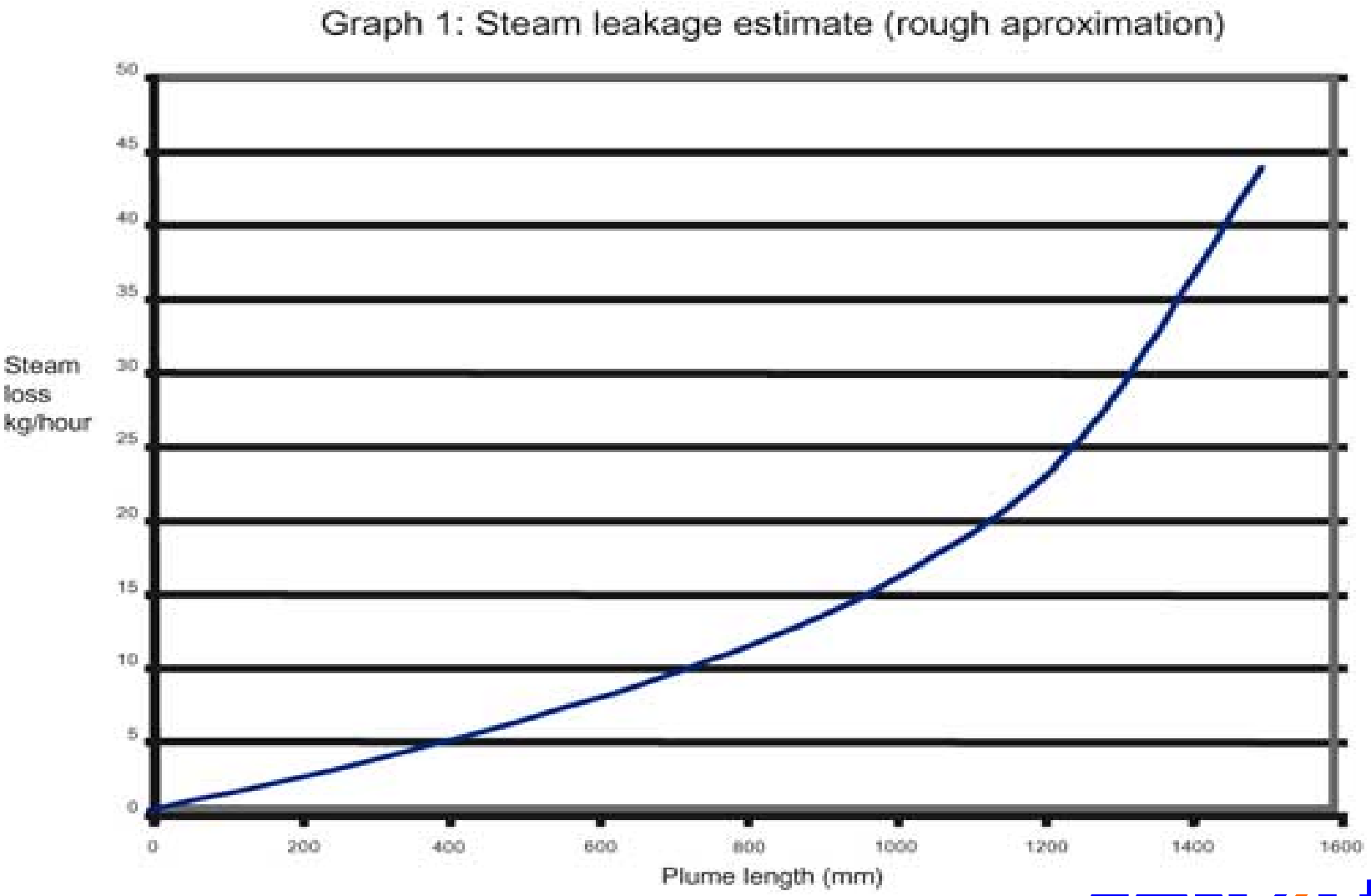
(by In Direct Method)

Steam Traps

A steam trap is a valve device that discharges condensate and air from the line or piece of equipment without discharging the steam.

- The purpose of installing the steam traps is to obtain fast heating of the product and equipment by keeping the steam lines and equipment free of condensate, air and non-condensable gases.
- **Functions**
  - To discharge condensate as soon as it is formed
  - Not to allow steam to escape.
  - To be capable of discharging air and other incondensable gases

Avoiding Steam Leakages



Specific Steam Generation

- Specific Steam

- 12.5 to 13 kg of steam /kg of HSD/LDO
- 10.8 to11.3 kg of steam/ Lit. of HSD/LDO

Lighting

Types of Lighting

- Fluorescent lamps (FTL)
- Compact Fluorescent Lamps (CFL)
- Mercury Vapour Lamps
- Sodium Vapour Lamps
- Metal Halide Lamps

Luminous Performance Characteristics of Commonly Used Luminaries

Type of Lamp	Lum / Watt		Color Rendering Index	Typical Application	Life (Hours)
	Range	Avg.			
Incandescent	8-18	14	Excellent	Homes, restaurants, general lighting, emergency lighting	1000
Fluorescent Lamps	46-60	50	Good w.r.t. coating	Offices, shops, hospitals, homes	5000
Compact fluorescent lamps (CFL)	40-70	60	Very good	Hotels, shops, homes, offices	8000-10000
High pressure mercury (HPMV)	44-57	50	Fair	General lighting in factories, garages, car parking, flood lighting	5000
Halogen lamps	18-24	20	Excellent	Display, flood lighting, stadium exhibition grounds, construction areas	2000-4000
High pressure sodium (HPSV) SON	67-121	90	Fair	General lighting in factories, ware houses, street lighting	6000-12000
Low pressure sodium (LPSV) SOX	101-175	150	Poor	Roadways, tunnels, canals, street lighting	6000-12000

Lighting Controls

- On/off flip switches
- Timer control & auto timed switch off
- Presence detection
- Luminary grouping / Group Switching
- Day light linking, blinders, corrugated roof sheets
- Dimmers , Lighting voltage controllers
- Photo sensors

D G Sets

Energy Balance in DG Sets

- A typical energy balance in a DG set indicates following break-up:

Input	:	100%	Thermal Energy
Outputs	:	35%	Electrical Output
	:	4%	Alternator Losses
	:	33%	Stack Loss through Flue Gases
	:	24%	Coolant Losses
	:	4%	Radiation Losses

Waste Heat Recovery in DG sets

- Use flue gas for generating hot water or steam.
- Provide heat for vapour absorption.
- Jacket water heat recovery for hot water requirements.

Training Capability

Energy Efficiency Training Modules

- Air Compressor/Pumps/Fans
- Water Treatment
- Energy Efficient Equipments
- Maintenance
- Industrial Process

Initiatives By Government

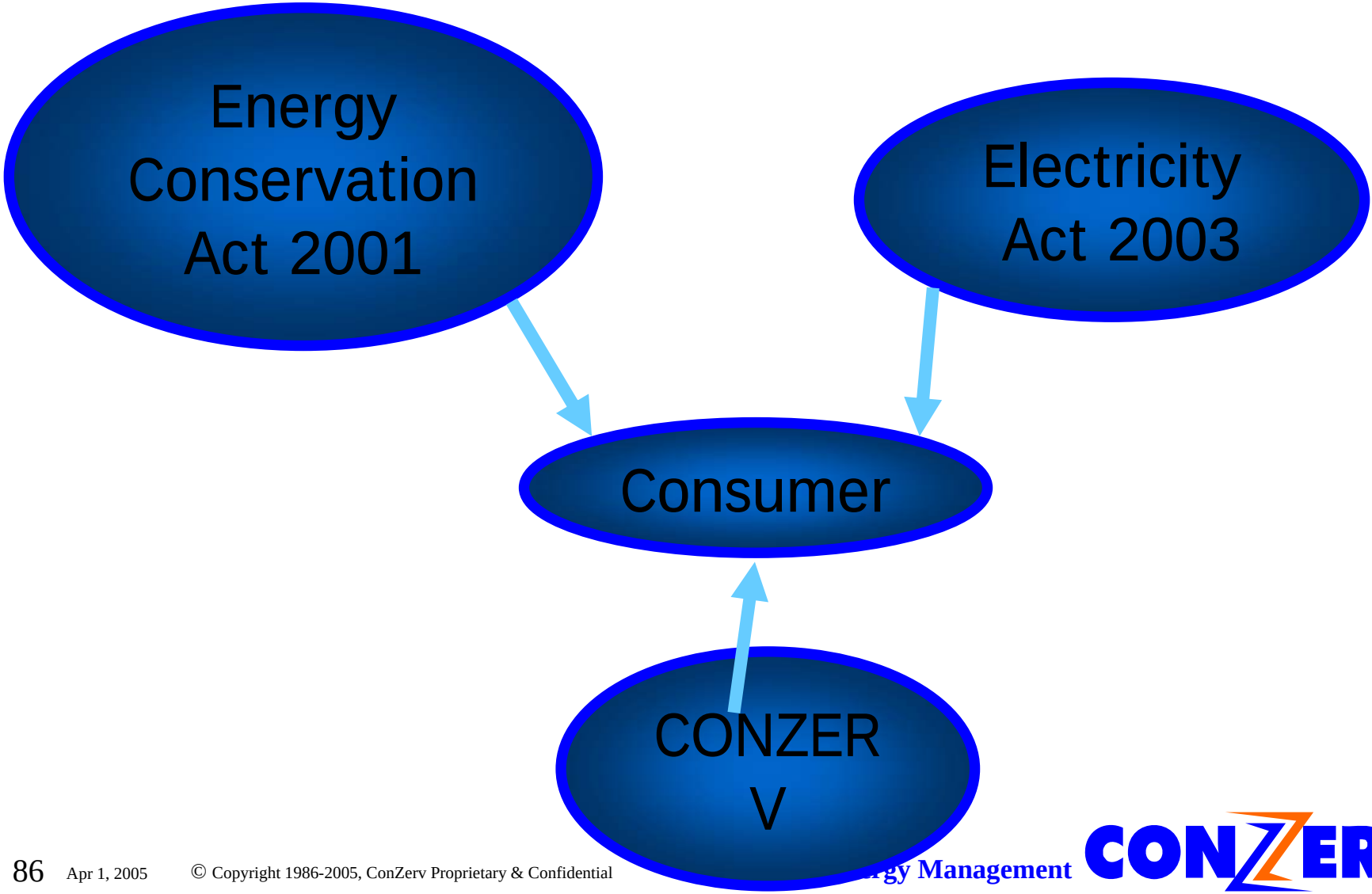
Initiatives By Government

- Energy Conservation Act, 2001
- Amendments In Electricity Act, 2003
- Both Acts Aimed At Promoting Energy Efficiency in India
- 25000 MW saving potential to be achieved by year 2012 as per MOP plan

Designated Industries

1. Aluminium
2. Fertilizers
3. Iron and Steel
4. Cement;
5. Pulp and paper
6. Chlor Akali;
7. Sugar
8. Textile;
9. Chemicals
10. Railways;
11. Port Trust
12. Transport
13. Petrochemicals & Refineries
14. Power Stations, T & D companies
15. Commercial buildings >500 kW

Conzerv-Link Between Industry and The Acts



Energy Conservation Act, 2001

- Major Provisions
- Norms of processes and standards
- Identified Designated Industries
- Accredited Energy Auditors
- Mandatory Energy Audits
- Building codes
- Energy Managers
- Comply with norms and standards
- Submit Status Report on Energy Consumption
- Penalty for non-compliance

Thank you