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Efficient Energy Management
for
Manufacturing

Continuous rise in prices electricity costs in INDIA

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Source: PWC report 2011 for Maharashtra state (R-infra charges for LT)

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How do you answer these…

How do I improve productivity?

How do I reduce cost?

How do I execute projects faster?

Which fault is more frequent?

How do I avoid unplanned shutdowns?

SIEMENS answers the toughest questions with

ENERGY MANAGEMENT SYSTEM

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WHAT IS ENERGY MANAGEMENT

Energy management

is the foresighted, organizational and systematized **co-ordination** of the procurement, transformation, **distribution and use of energy** for the purpose of meeting requirements, taking **ecological and economic** objectives into consideration.

(Source: VDI 4602 „Energy management - Terms and definitions“)

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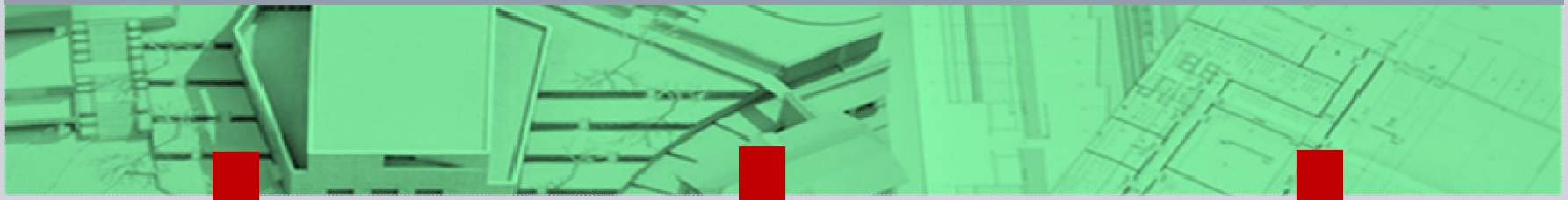
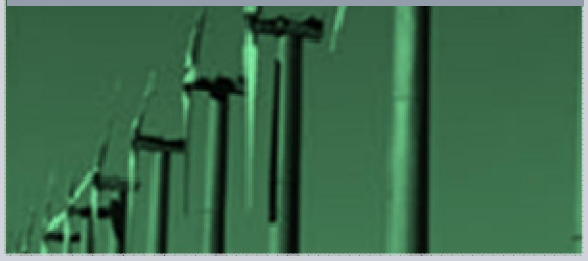
Solutions for a more efficient use of energy

Energy management



Decreasing of energy costs



- Using energy selectively and more efficiently

→ Better electricity contracts, optimized cost allocation

Decreasing of operating costs

- Supportive measures for maintenance and service

→ high plant availability
Energy efficiency through automation

Reducing CO_2 emissions

- Achieving operational environment targets

Companies which are more ecological are more economical


The Energy Dilemma

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Industry Norms

Energy Management according to DIN EN ISO 50001

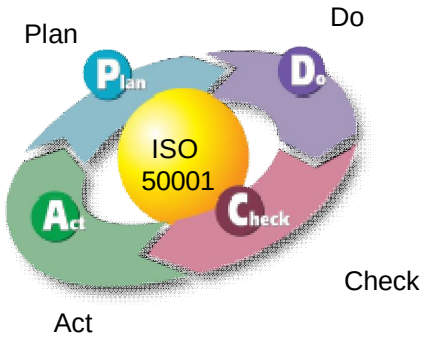
Objectives:

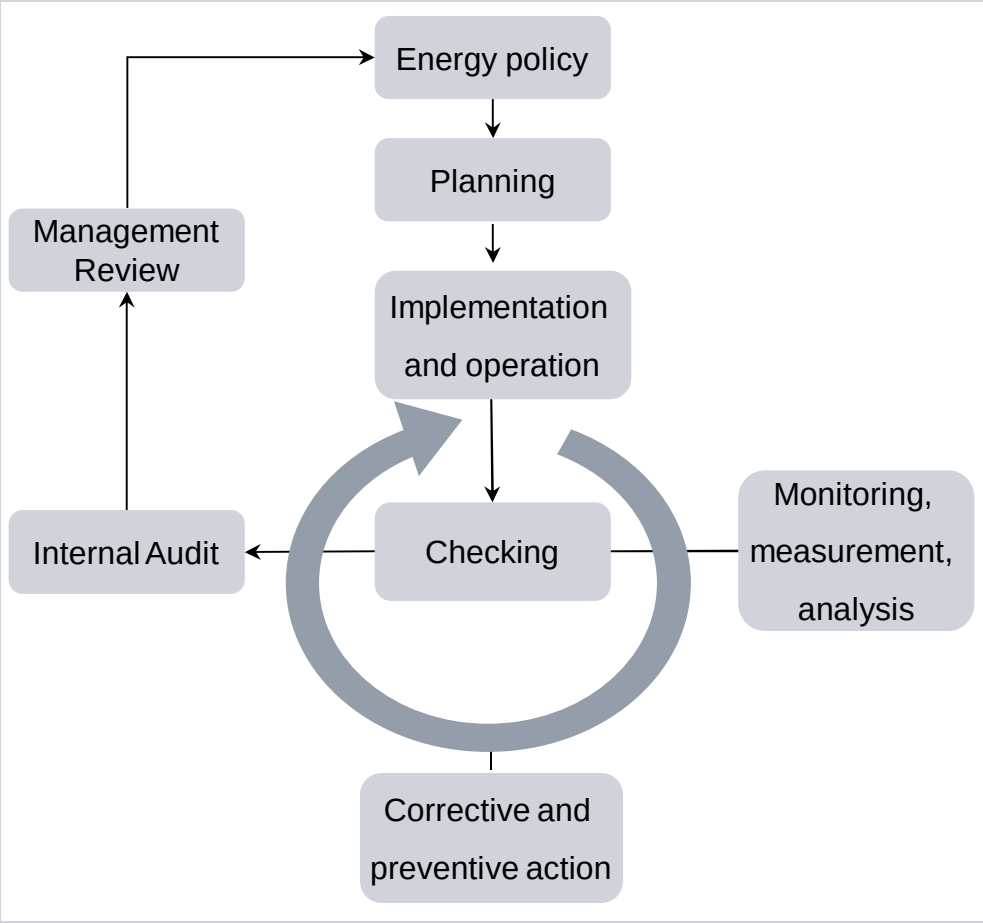
Continual improvement of energy consumption and reduce costs

Increase the profitability

Energy analysis

PDCA – Cycle





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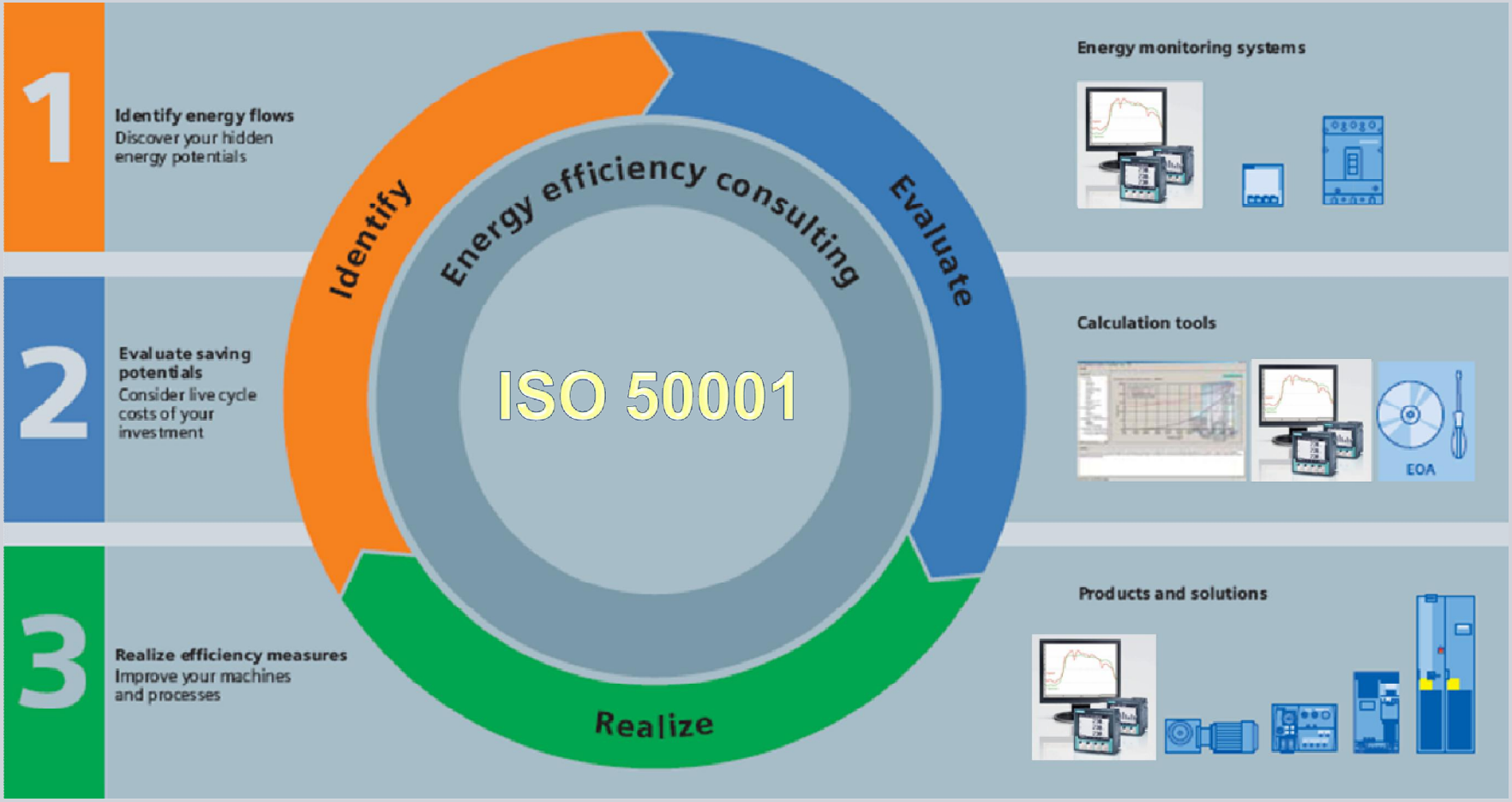
Energy Circle



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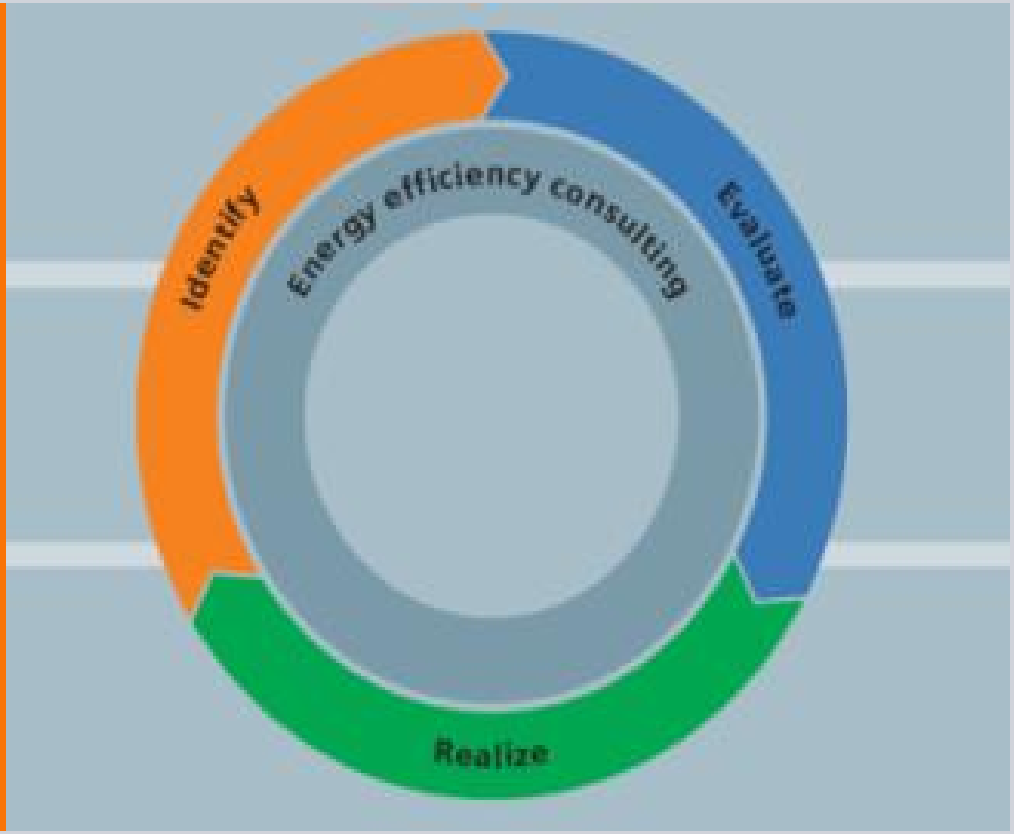
Identify

1



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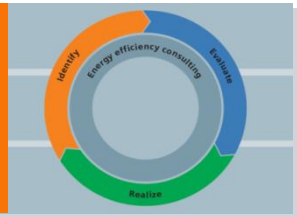
Why Identification is needed?

1



You cant manage what you cannot measure

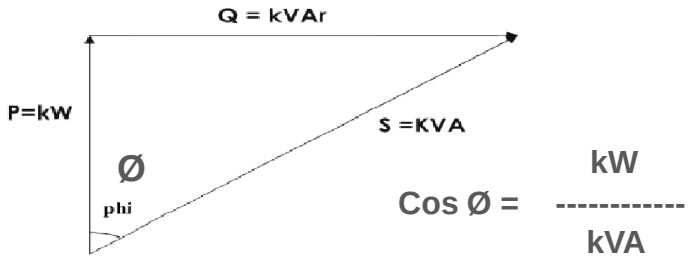
If you don‘t measure continuously, others will do that for you

⬇

This costs you a substantial amount of money!

Importance of Power Factor

Power factor is the cosine of the angle between the current phase and the voltage phase at any particular instant of time or it is the ratio of the active power (kW) to the apparent power (kVA). It is a measure of how effectively electrical power is being used.



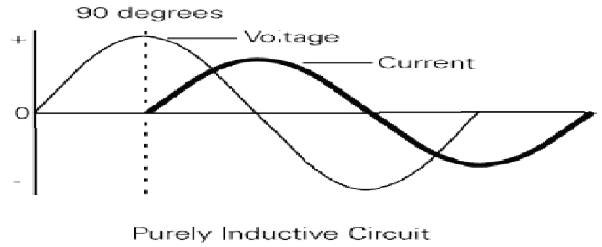
$$\text{Cos } Ø = \frac{kW}{kVA}$$

Phasor sum : kVA = kW + kVAR

kVA = Apparent power or total power supplied by source

kW = Active power or power used to drive the load

kVAR = Reactive power or negative power which is absorbed by Inductive load to set up magnetic field



Purely Inductive Circuit

Effect of poor power factor

- **Higher energy consumption to fulfill the same load requirement**
- **Higher line current requirement**
- **Higher transmission and distribution losses**
- **Higher voltage drop in the system**
- **Higher size of the cables, generators, transformers and switchgears**
- **Poor efficiency of the power transmission**
- **Loss of incentives / Levy of penalties**

3TS Capacitor Duty Contactor

Power factor improvement

kVA

Utility

Cos Ø = 1 (unity)

Active Power (kW)

Resistive Load

Resistive Load

kVA = kW; kVAR = 0

With resistive load, all supplied power is used by the load – no wastage of power.

3TS Capacitor Duty Contactor

Power factor improvement

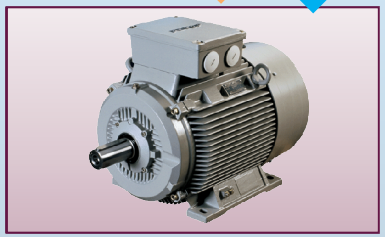
kVA

Utility

0 < cos Ø < 1

Reactive Power (kVAR)

Active Power (kW)



Motors

Welding M/c

kVA = kW + kVAR

With Inductive load, utility has to supply additional power to generate magnetic field. Some part of power is wasted

3TS Capacitor Duty Contactor

Power factor improvement

kVA

Utility

Cos Ø ⟶ 1

Reactive Power (kVAR)

Active Power (kW)

tive Power (kVAR

Motors

Welding M/c

Capacitor Bank

kW ~ kVA

Capacitor bank supply the required reactive power (kVAR). So, utility is free from this responsibility

Selection of Compensation

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1. Individual Compensation

2. Group Compensation

3. Central Compensation

Where to install Power Factor correction Equipment-1

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Individual Compensation

1. Directly at the Load terminals
2. Ex. Motors, Steady loads
3. Gives maximum benefit to user
4. Not recommended for Drives
5. Costly solution

Where to install Power Factor correction Equipment-2

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Group Compensation

1. Single compensation for Group of Load
2. Ex. Group of Motors
3. Gives moderate benefit to user
4. Few Capacitor Banks
5. Relatively easy to maintain

Where to install Power Factor correction Equipment-3

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Central Compensation

1. Directly connected at the incomer
2. Improves PF at the metering point
3. Line losses continue to prevail down stream
4. Least beneficial to user
5. Extremely easy to maintain

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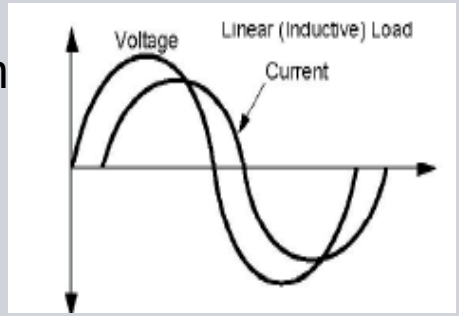
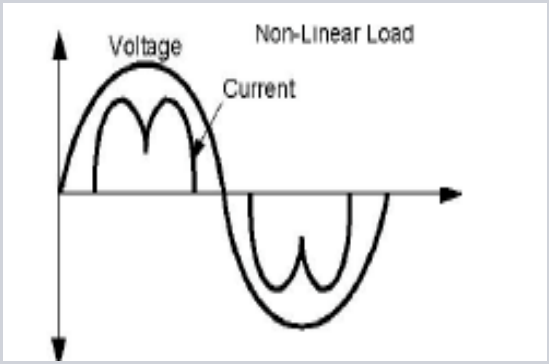
Linear and Non-linear Loads

A linear load is a load that opposes the applied voltage with constant Impedance resulting in a current waveform that changes in direct proportion to the change in the applied voltage

Example – resistance heating, incandescent lighting, motors



A nonlinear load, on the other hand, is a load that does not oppose the applied voltage with constant impedance. The result is a non-sinusoidal current waveform that does not conform to the waveform of the applied voltage.



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Harmonics

- What are harmonics ?

  Wave form distortion from generated supply waveform (normally pure sine wave)

- How they are created ?

  Electronic equipments have non linear impedance i.e. it's impedance varies during any time of supply voltage due to switch off-ons on many times or non sine pattern.

Harmonics - problem products

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Which products creates Harmonics ?

Arc Equipments
Audio & Video Recorders
Battery Chargers
Computers
DC drives
Discharge Lighting (fluorescent, mercury, sodium, etc.)
Electronic Dimmers
Elevators
Facsimiles (FAX)
Rectifiers
Telecommunication Equipment
Uninterrupted Power Supplies (UPS)
Variable Frequency Drives (VFD)
Video Display Units
Welding equipments






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Undesirable effects related with Harmonics

- What are the problems ? & Probable causes ?

1. Blinking of Incandescent Lights -	Transformer Saturation
2. **Capacitor Failure** -	Harmonic Resonance
3. **Circuit Breakers / Relays Tripping** -	Inductive Heating and Overload
4. Computer Malfunction or Lockup -	Voltage Distortion
5. Conductor Failure -	Inductive Heating
6. Electronic Equipment Shutting down -	Voltage Distortion
7. Flickering of Fluorescent Lights -	Transformer Saturation
8. **Fuses Blowing for No Apparent Reason** –	Inductive Heating and Overload
9. **Motor Failures** (overheating) -	Voltage Drop
10. Neutral Conductor and Terminal Failures –	Additive Triplen Currents
11. Electromagnetic Load Failures -	Inductive Heating
12. Overheating of Metal Enclosures -	Inductive Heating
13. Power Interference on Voice Communication –	Harmonic Noise
14. **Transformer Failures** -	Inductive Heating

A strong team for every measuring power & Harmonics

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1

Measuring devices for beginners

7KT PAC1500

Cost-effective devices for digital measurement

7KM PAC3100

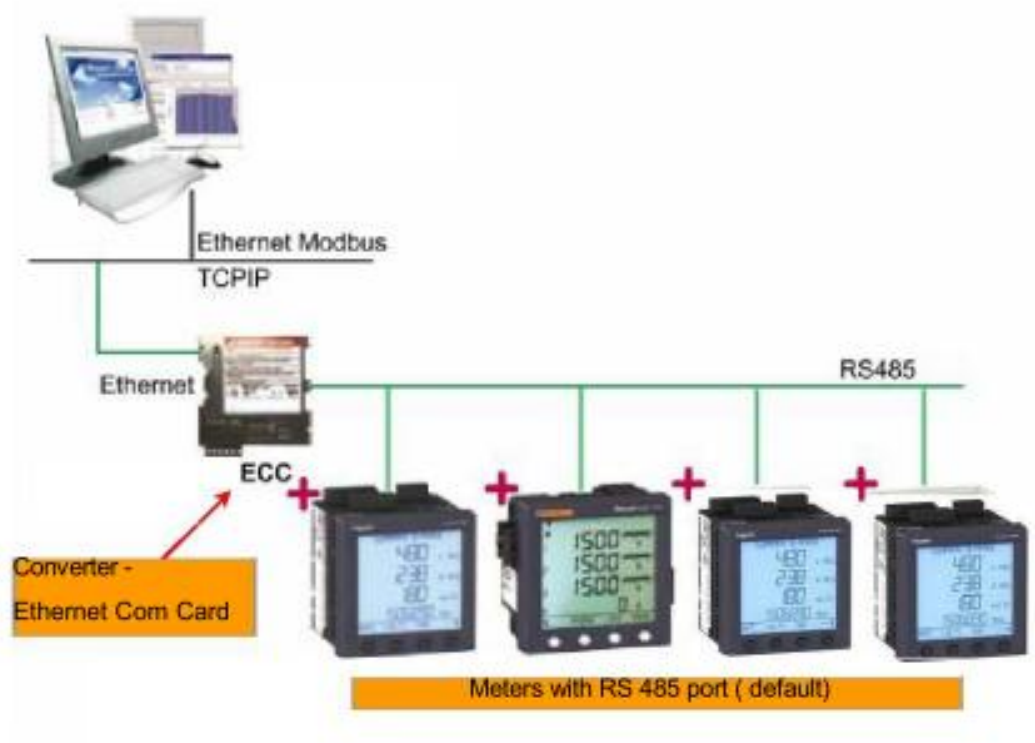
The specialist for precise power measurement

7KM PAC3200

The expert for communication and monitoring

7KM PAC4200

Conventional Communication System on RS485



Default Port is RS485

Required Converter Card to Communicate over Ethernet. Ethernet Card can be used 1x per device or 10-31x / device.

More variables and no of nodes leads to slower response on PC.

Speed Limitations of RS 485 Still a problem even after Ethernet conversion

Failure of Converter leads to data loss of all the devices in EMS

Compromise on Speed, Reliability & Performance of EMS System

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Ethernet

Ethernet

Ethernet is a local-area network architecture developed by Xerox, DEC, and Intel in 1976. It operates using a shared bus or star topology, and supports data transfer rates of 10 Mbps, 100 Mbps, and even 1000 Mbps formats.
Ethernet: 10 Mbps
Fast Ethernet : 100 Mbps
Gigabit Ethernet : 1 Gbps

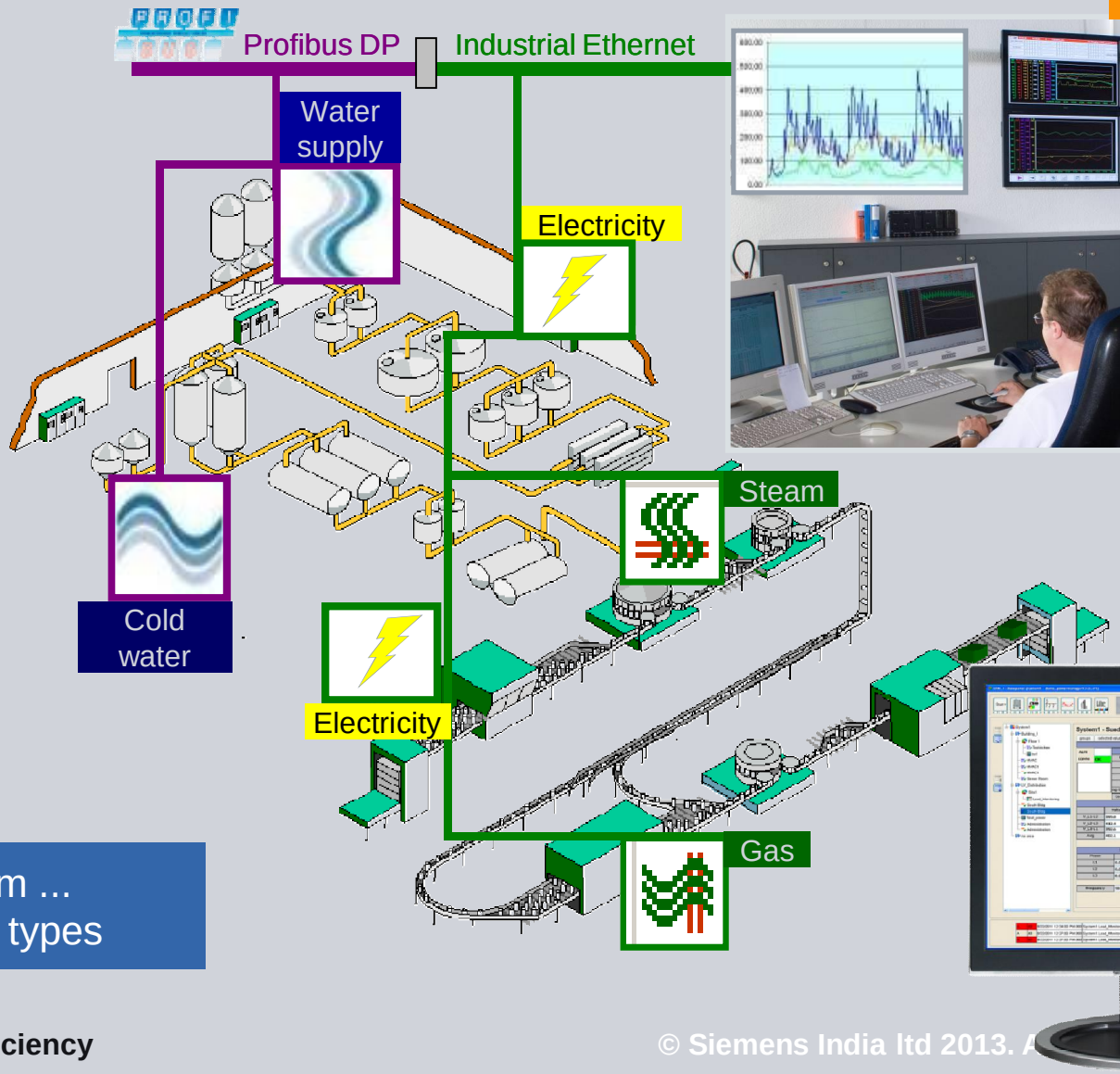
TCP/IP

The TCP/IP protocol suite refers to the family of network protocols used by most Ethernet networks, and by the Internet, to connect hosts.

Features

- Very high speed (10Mbit to 100Mbit/s).
- Very long distance, hundreds of feet can be achieved, more with hubs and switches.
- Immune to noise.
- Widely used in industrial automation due to noise Immunity.
- Commonality with other business level networks based on the same networking standards
- within a plant location.

Energy Circle: Identify – Overview



One (1) system ...
... for all energy types

Evaluate

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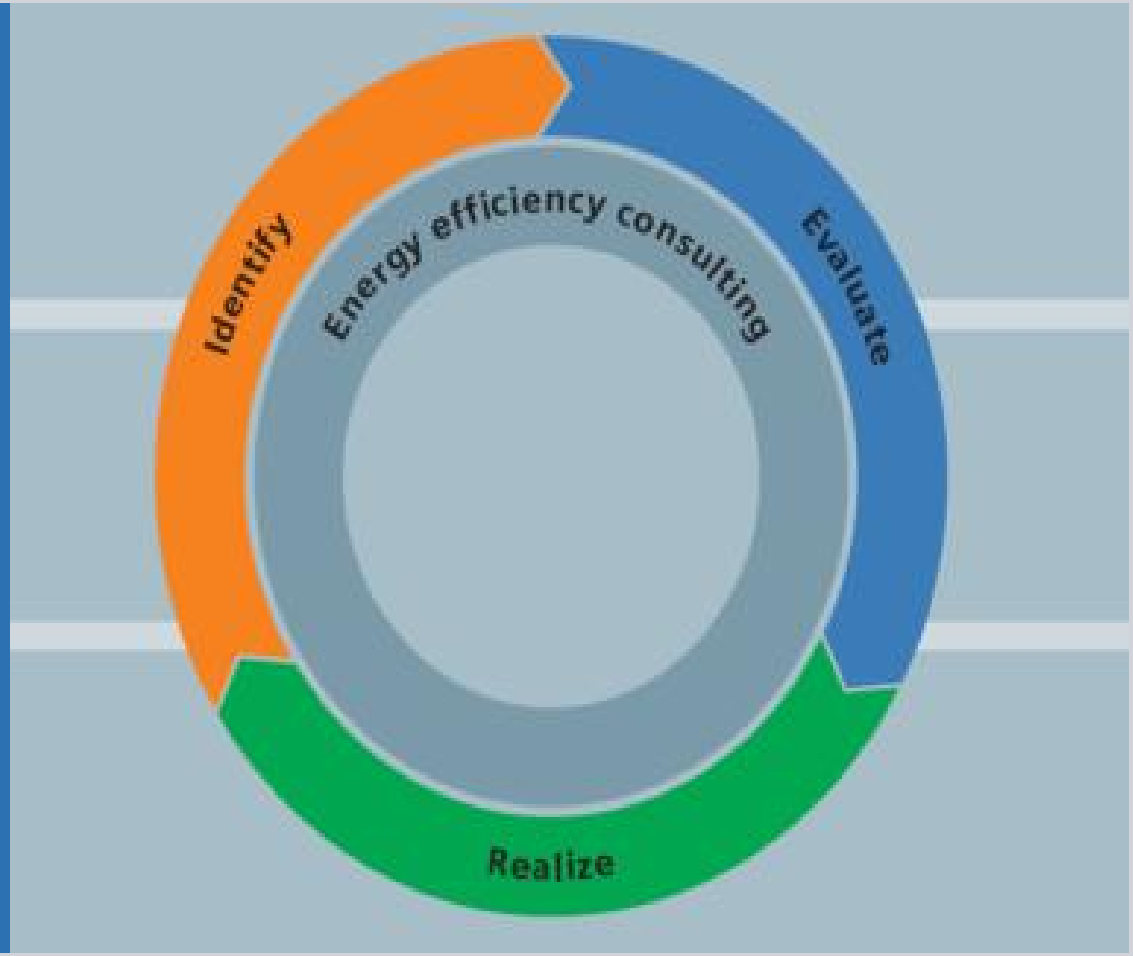
2



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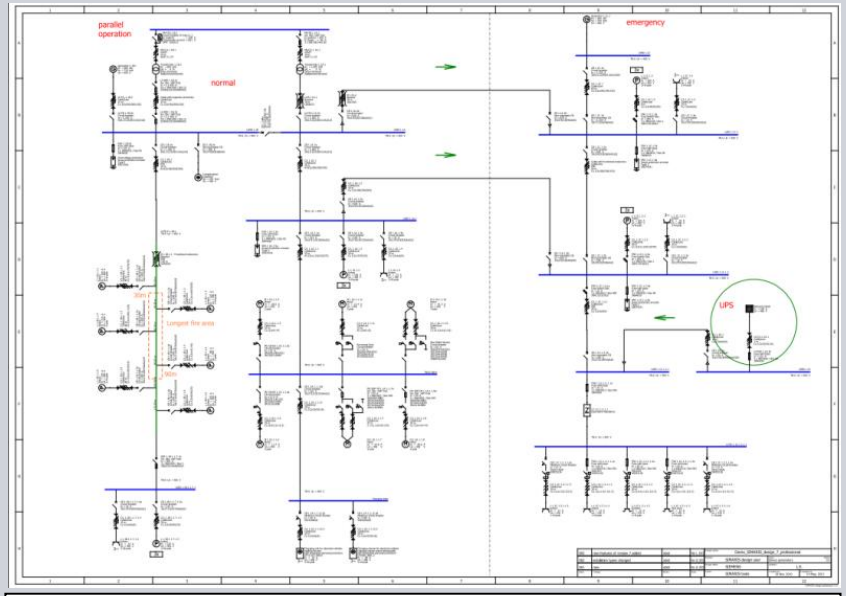
Basic steps for Power Distribution System design

Design Steps

- Load List
- Load segregation
- Energy Source (Transformer, DG etc.)
- Switchgear Selection
  - ✓ Load Current
- Cable Dimensioning
  - ✓ Current Carrying Capacity
  - ✓ Voltage Drop
- Fault Level Calculation
- Cable Dimensioning
  - ✓ Fault Level
- Switchgear Selection
  - ✓ Fault Level
- Capacitor Bank Sizing



Tender Documents

- Standard Specifications
- Specific Requirements
- Single Line Diagrams
- Cable Schedule
- Bill of Material
- Relay Co-ordination

SIMARIS Design

Enables **automatic calculation** of electric network parameters & **suitable equipment selection**

Inputs to SIMARIS design :

- Load List
- Load segregation
- Define Energy Source (Transformer, Diesel Generator etc.)

Change management ☺

Automatic calculations by SIMARIS

- Load flow
- Fault Level Calculation
- Switchgear Selection
- Cable Dimensioning
- Voltage Drop
- Capacitor Bank Sizing

Reports/Output from SIMARIS design

- Single Line Diagrams
- Bill of Material
- Cable Schedule
- Selectivity documentation

Economical and safe low-voltage power distribution

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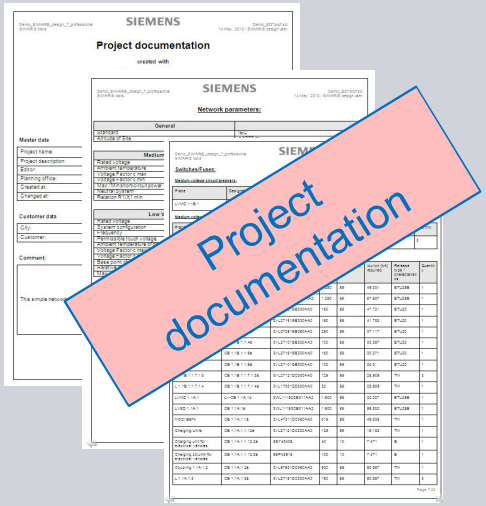
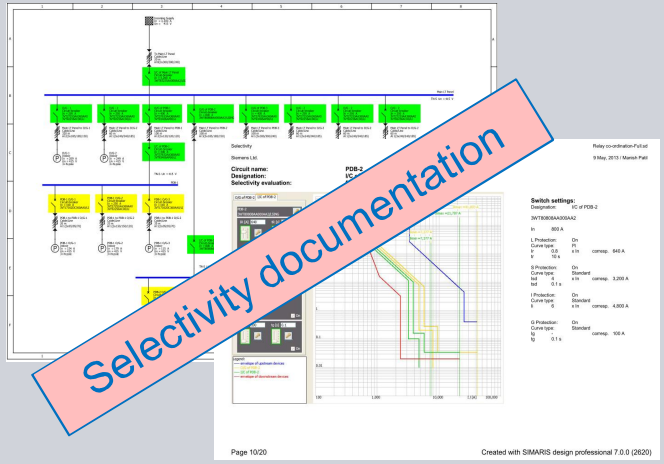
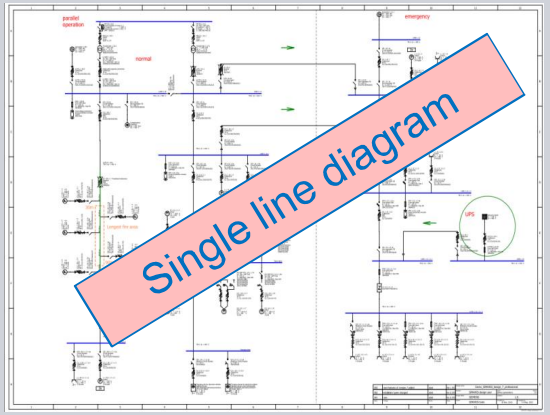
Dimensioning thru
SIMARIS

Save up to 5 % energy costs

Planning







Economical and safe low-voltage power distribution

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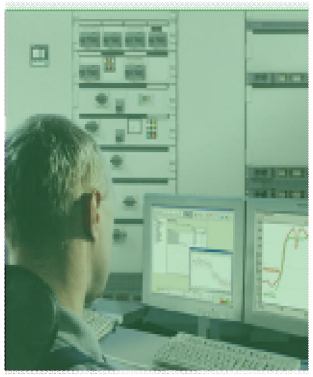
2

Operation



Measuring
+
Visualization
+
Actions

Power Manager

Save up to 20 % energy costs

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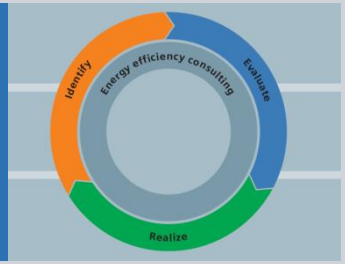
Energy Circle: Evaluate – Overview

2



SENTRON POWER MANAGER
Complete Energy Management Software for Industries

Evaluate – Power Quality Analysis

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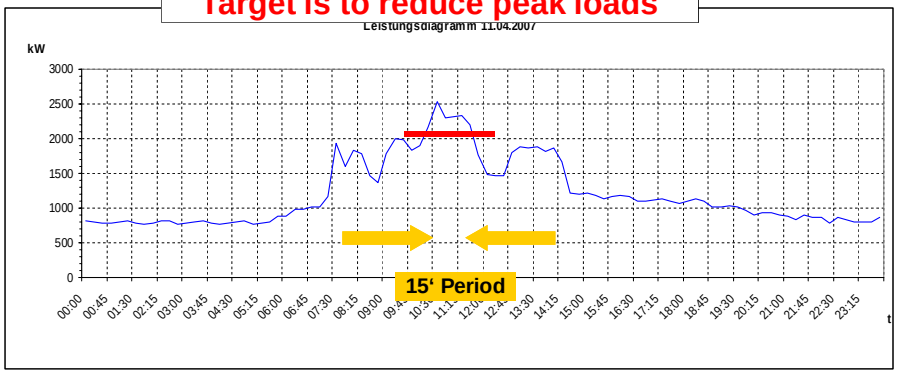
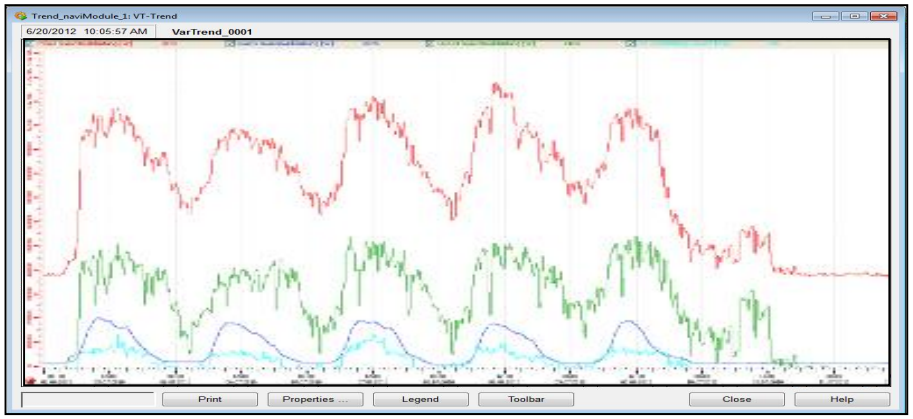
Load Curve

Target is to reduce peak loads





Benefit

- **Identification of**
- **Deviations that could be challenged**
- **Optimization potentials, e. g. domestic production of high loads**
- **Peak loads**
- **Energy consumption outside of production times**
- **Create “energy awareness”**

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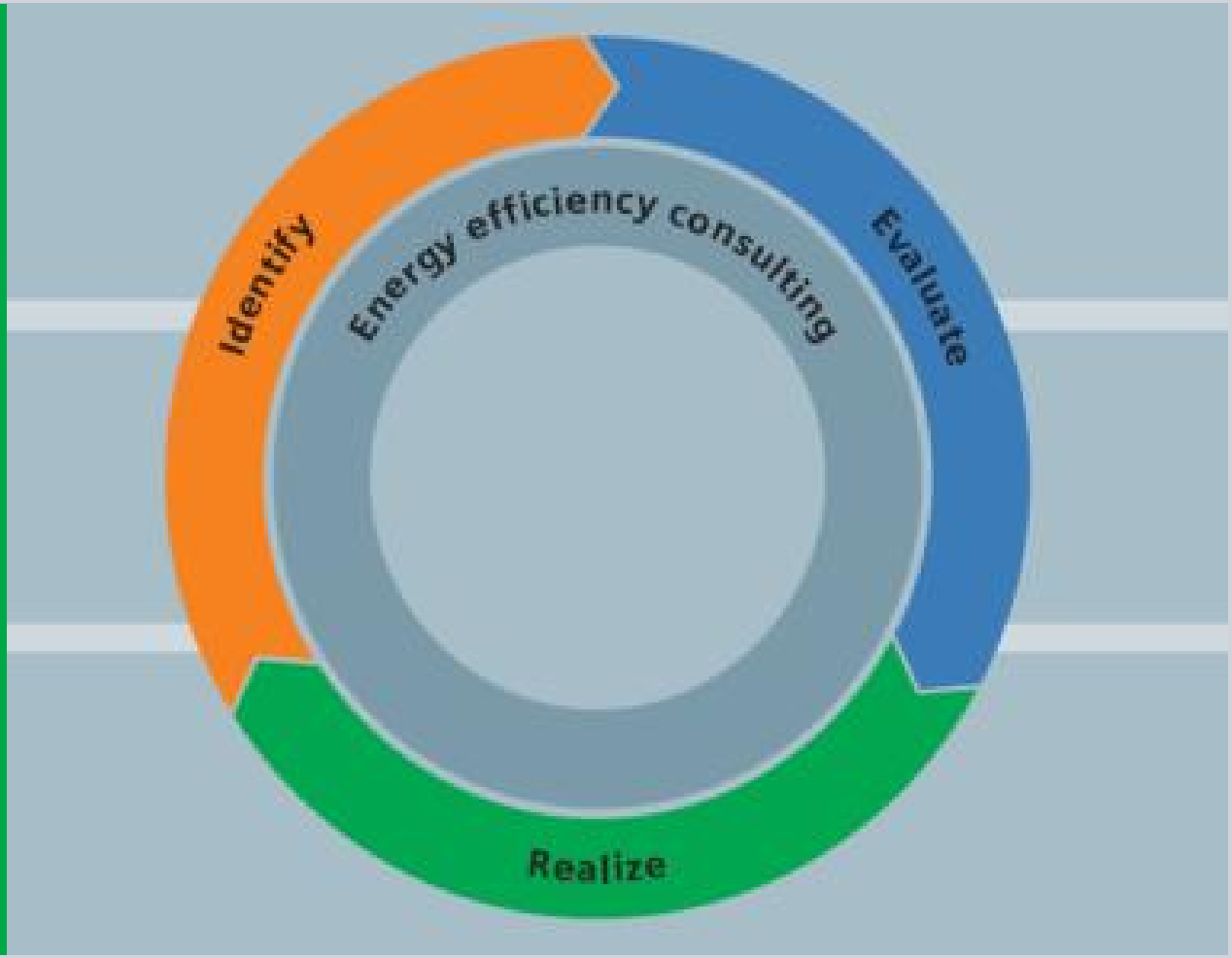
Energy Circle: Realize – Overview

3



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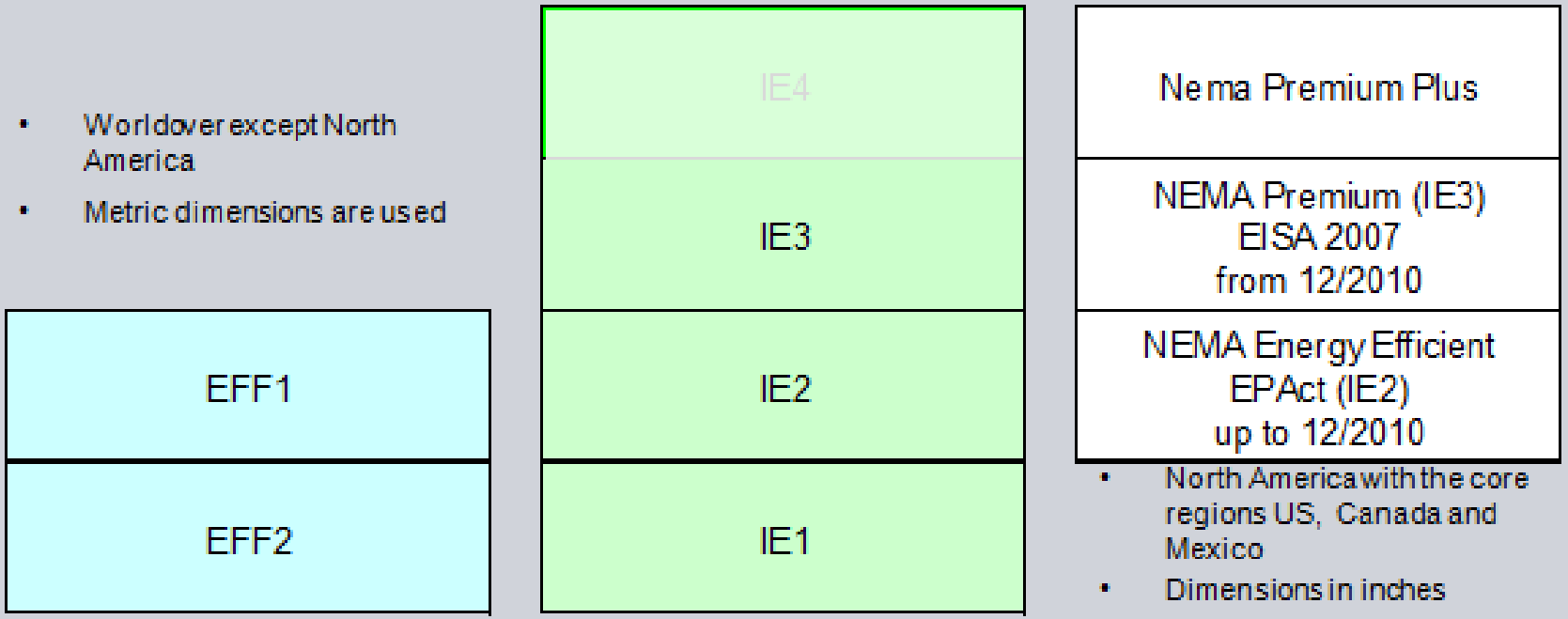
Towards a Worldwide Common Efficiency Standard

In 2008, IEC came up with a new standard - the IEC 60034-30

- **to eliminate differences in efficiency standards the world over**
- **to enable user to compare motor efficiency with a common reference**



IEC World

IEC 60034-30
Applicable the World over!

NEMA World

Towards a Worldwide Common Efficiency Standard

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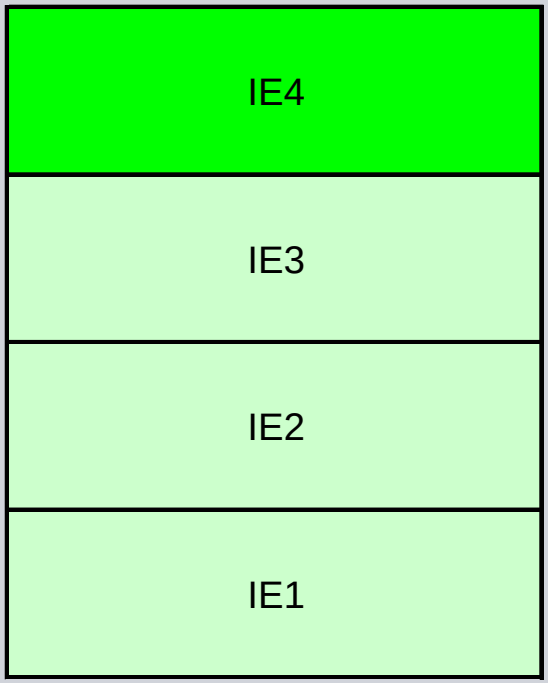

IEC 60034-30

Applicable the World over!

The New IS:12615-2011

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IS:12615-2011
Energy Efficient Induction Motors - Three Phase Squirrel Cage *(Second Revision)*

This new standard recommends that for motors to be classified as Energy Efficient, these must meet minimum efficiency class as *IE2*.
The standard also stipulates that by January 2014 the minimum class should be *IE3*.

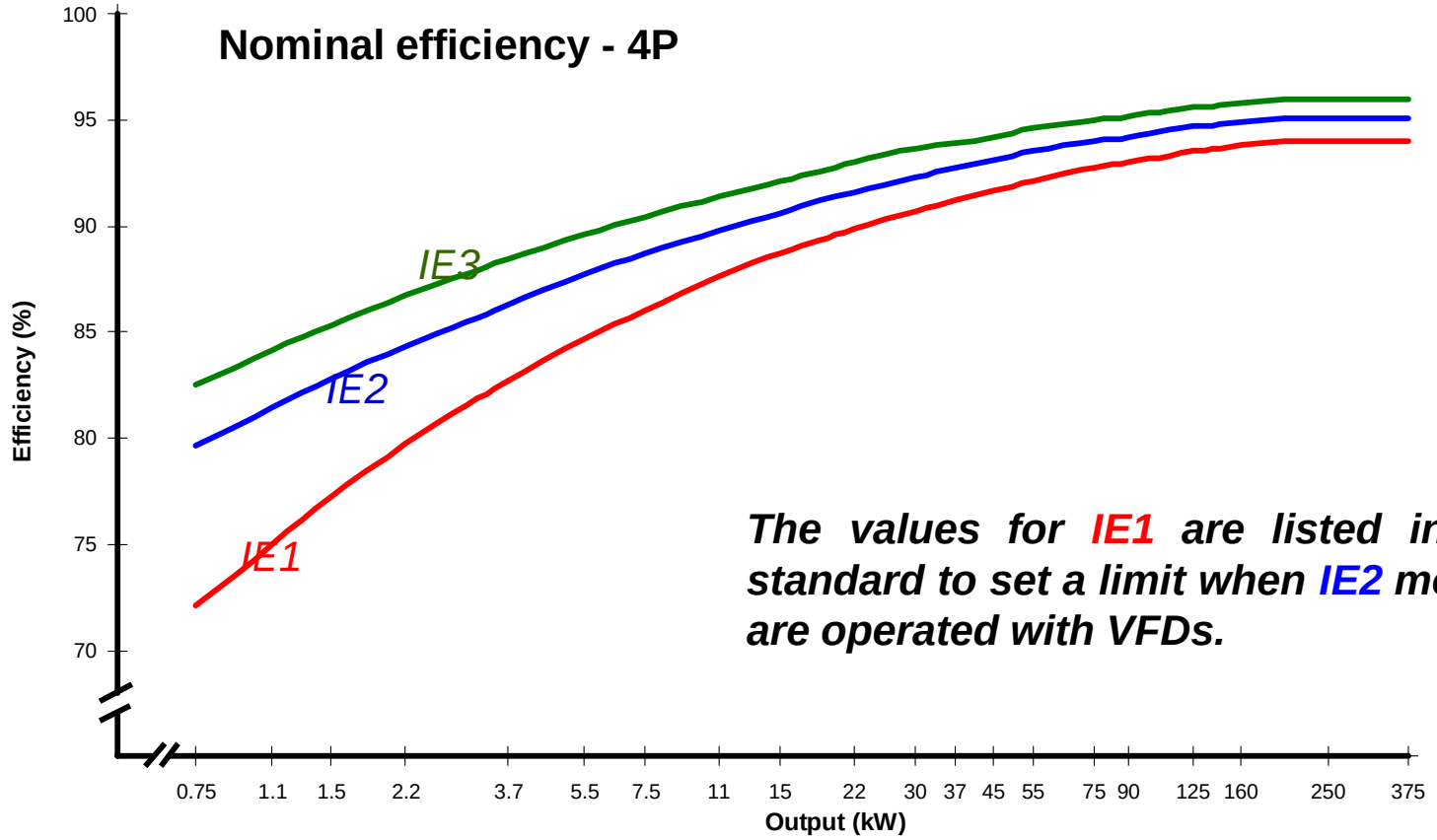
Keeping in view the threats to the exports to India and also complimenting the role of various Government initiatives like National Mission for Energy Efficiency, it is intended that the efficiency levels of the motors covered in this standard need to be upgraded in a phased manner as per the below schedule:

a) The second revision shall be implemented by 30 June 2011.

b) The efficiency performance values of the motors under the scope shall be IE2. However, when these motors are used with variable frequency drives, they shall conform to IE1 values of efficiency.

c) The efficiency performance values of the motors under the scope shall be IE3 and shall be effective by 31 January 2014. However, when these motors are used with variable frequency drives, they shall conform to IE2 values of efficiency.

The Efficiency Classes as per IS:12615-2011



The values for IE1 are listed in the standard to set a limit when IE2 motors are operated with VFDs.

The New IS:12615-2011

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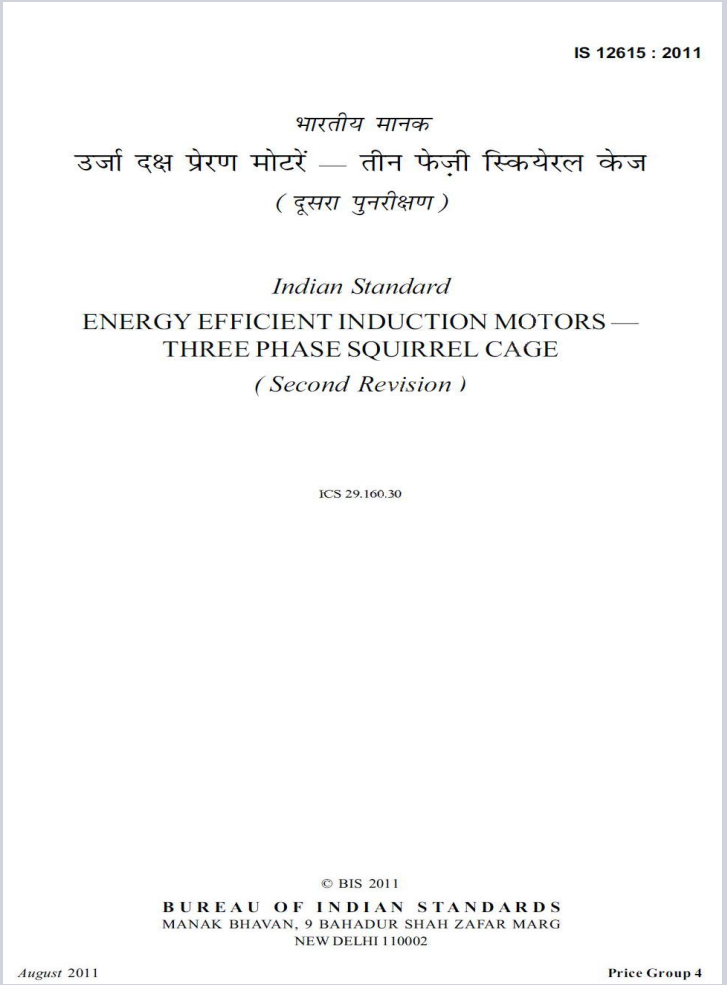
IS:12615-2011
Energy Efficient Induction Motors - Three Phase Squirrel Cage *(Second Revision)*

This revised standard based on IEC 60034-30 classifies efficiency into three classes:
***IE1* - Standard Efficiency**
***IE2* - High Efficiency**
***IE3* - Premium Efficiency**

This revised Standard defines nominal efficiency values for the 3 classes for:
0.37 - 375 kW in 2P, 4P and 6P



IS 12615 : 2011

भारतीय मानक

उर्जा दक्ष प्रेरण मोटरें — तीन फेज़ी स्कियेरल केज

(दूसरा पुनरीक्षण)

Indian Standard

ENERGY EFFICIENT INDUCTION MOTORS — THREE PHASE SQUIRREL CAGE

(Second Revision)

ICS 29.160.30

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

August 2011 Price Group 4

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How does it benefit to use IE3 motors?

It benefits to use IE3 motors because even when one does a conservative comparison w.r.t. IE2 motors….

Motor output	Price of an IE2 Motor	IE3 is costlier by	IE2 efficiency	IE3 efficiency	IE3 is higher by	Annual Energy Savings	Annual Savings in Energy Cost	Price Difference is recovered in
kW	`	`	%	%	% points	kWH	`	months
0.37	4,475	673	70.1	73	2.9	153.99	847	9.54
0.55	5,092	765	75.1	78	2.9	199.97	1,100	8.35
0.75	5,128	769	79.6	82.5	2.9	243.23	1,338	6.90
1.1	6,034	907	81.4	84.1	2.7	318.62	1,752	6.21
1.5	6,592	991	82.8	85.3	2.5	389.93	2,145	5.55
2.2	8,719	1,309	84.3	86.7	2.4	530.54	2,918	5.38
3.7	11,151	1,674	86.3	88.4	2.1	747.98	4,114	4.88
5.5	15,367	2,307	87.7	89.6	1.9	976.66	5,372	5.15
7.5	17,896	2,685	88.7	90.4	1.7	1,167.75	6,423	5.02
11	30,130	6,025	89.8	91.4	1.6	1,574.79	8,661	8.35
15	37,447	7,490	90.6	92.1	1.5	1,980.28	10,892	8.25
18.5	48,571	9,715	91.2	92.6	1.4	2,252.30	12,388	9.41
22	51,284	7,693	91.6	93	1.4	2,655.25	14,604	6.32
30	69,239	10,386	92.3	93.6	1.3	3,315.28	18,234	6.84

The incremental investment is recovered within 6 - 8 months.

Comparison between IE2 and IE3 efficiency values as per IS:12615-2011.

Note: kWH saving and Energy Costs calculated considering that the motor operates continuously at 85% load for 24 hours per day, 360 days per year, at a power tariff of ` 5.5 per kWH.

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How does it benefit to use IE3 motors?

It benefits to use *IE3* motors instead of *IE2* motors, even when the apparent efficiency difference is negligible.

Motor output	Price of an IE2 Motor	IE3 is costlier by	IE2 efficiency	IE3 efficiency	IE3 is higher by	Annual Energy Savings	Annual Savings in Energy Cost	Price Difference is recovered in
kW	`	`	%	%	% points	kWH	`	months
37	89,777	13,467	92.7	93.9	1.2	3,746.02	20,603	7.84
45	106,065	15,910	93.1	94.2	1.1	4,145.12	22,798	8.37
55	150,994	15,100	93.5	94.6	1.1	5,023.26	27,628	6.56
75	184,693	18,470	94	95	1	6,167.97	33,924	6.53
90	214,276	21,428	94.2	95.2	1	7,370.34	40,537	6.34
110	259,421	25,942	94.5	95.4	0.9	8,064.69	44,356	7.02
132	305,488	30,549	94.7	95.6	0.9	9,636.99	53,003	6.92
160	357,423	35,742	94.9	95.8	0.9	11,632.24	63,977	6.70
200	433,911	43,391	95.1	96	0.9	14,479.50	79,637	6.54
250	478,340	47,834	95.1	96	0.9	18,099.37	99,547	5.77
315	548,752	54,875	95.1	96	0.9	22,805.21	125,429	5.25

Average kWH saving of frame size 315 (110, 132, 160 and 200kW) is 10,953 kWh and considering that the amount of motors produced last year (IEEMA Statistics) in this frame being around 9,284, it translates into a National Saving Potential of around 1lakh (1,01,691) MWh.

Comparison between IE2 and IE3 efficiency values as per IS:12615-2011.

Note: kWH saving and Energy Costs calculated considering that the motor operates continuously at 85% load for 24 hours per day, 360 days per year, at a power tariff of ` 5.5 per kWH.

SIEMENS

The SIEMENS offering for IE efficiency class motors

and

IE2

2P	Frames	71 - 132	160 - 225	250 - 355
	Output	0.37 - 7.5kW	11 - 45kW	55 - 315kW
4P	Frames	71 - 132	160 - 225	250 - 355
	Output	0.37 - 7.5kW	11 - 45kW	55 - 315kW
6P	Frames	80 - 132	160 - 225	250 - 355
	Output	0.37 - 5.5kW	7.5 - 30kW	37 - 250kW

Energy Savings from ACBs & Fuses

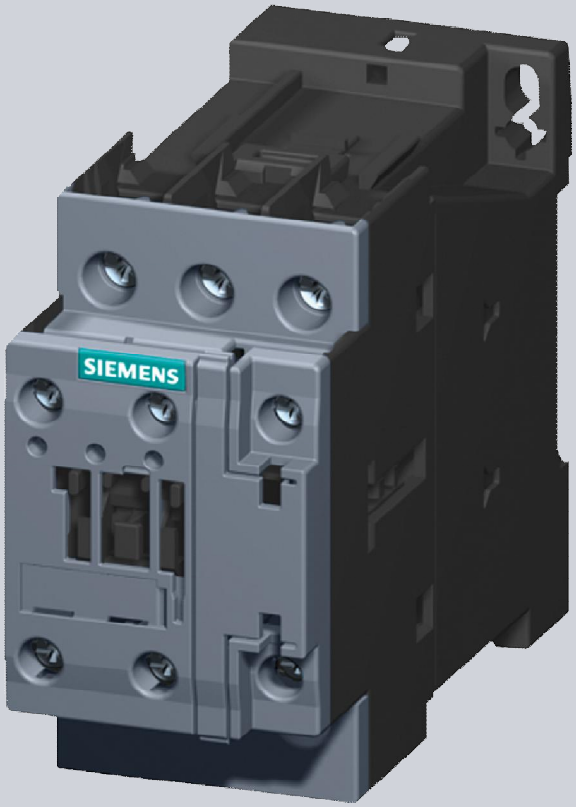
Energy Saving

- **Lowest Energy Consumption as per IS 13947**
- **85% less thermal stresses**
- **53% less dynamic stresses**

Energy Saving - Electronic Coil

SIEMENS

3



Holding power

AC operation

-87%

9.80 VA

1.26 VA

DC operation

-86%

5.9 W

0.8 W

Conventional drive

Electronic UC drive

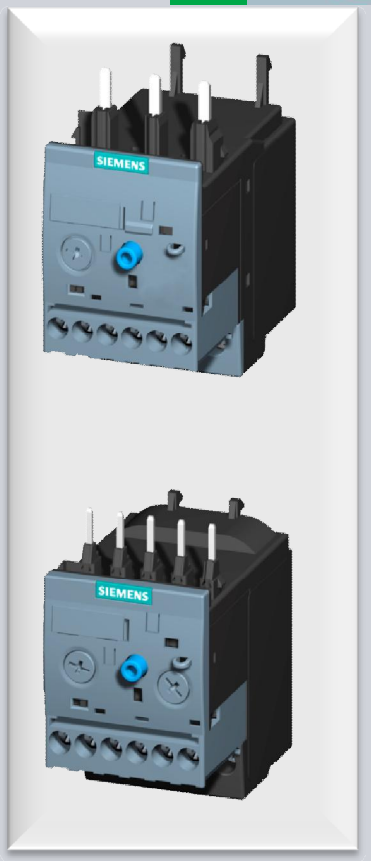
Energy Saving – Microprocessor Based Relay

SIEMENS

3

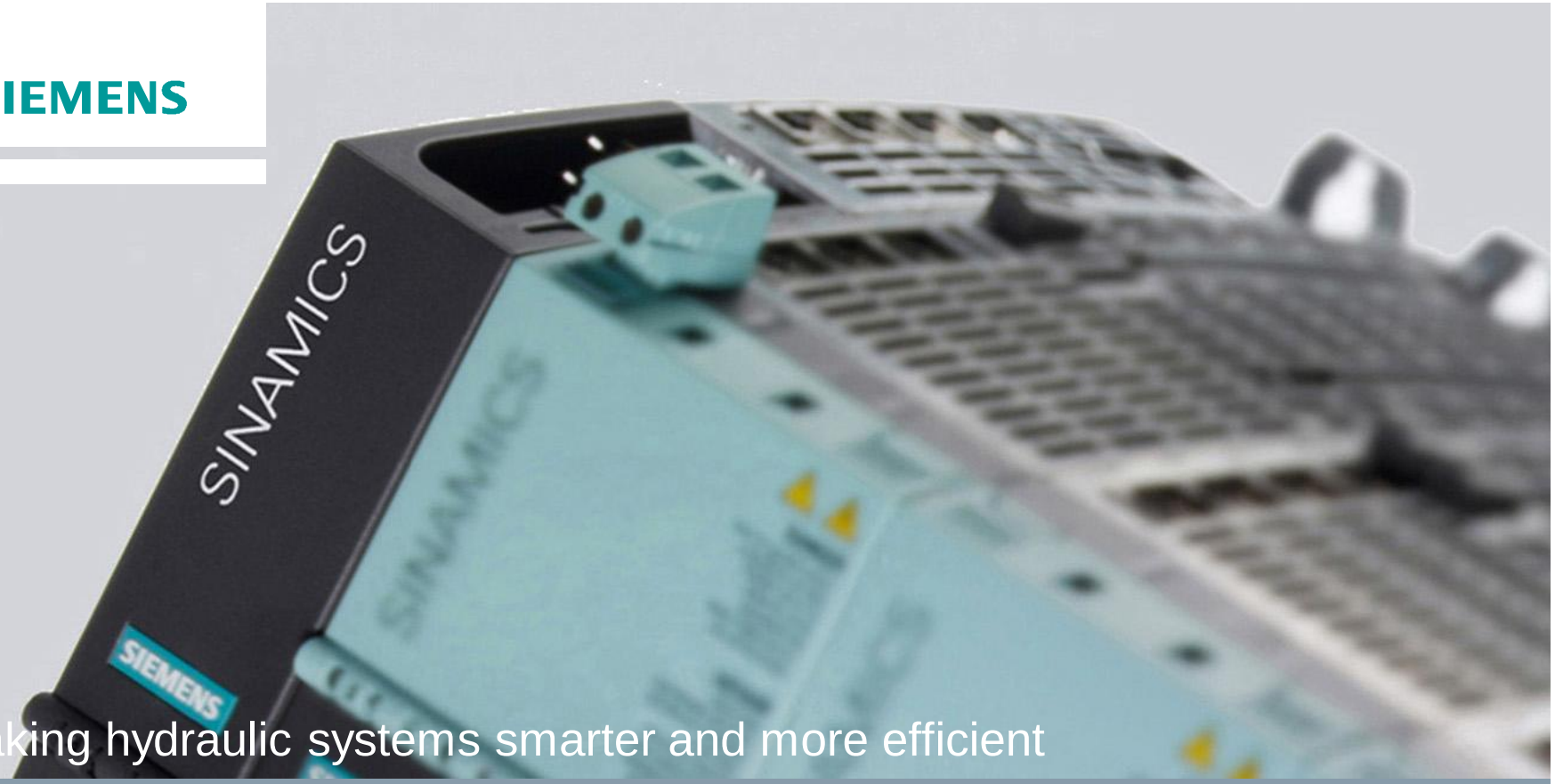
Product Characteristics

- Current rating 0.1 to 40 A
- Adjustable tripping CLASS 5 to 30
- Large setting ranges of 1:4
- Low power loss



Up to 98 % less power consumption than thermal solutions

SIEMENS



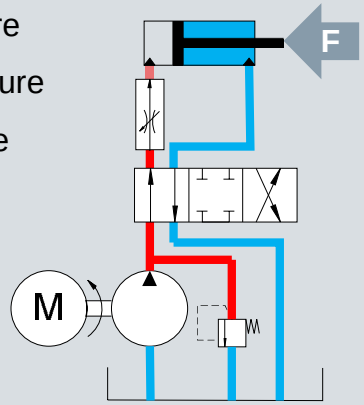
Making hydraulic systems smarter and more efficient

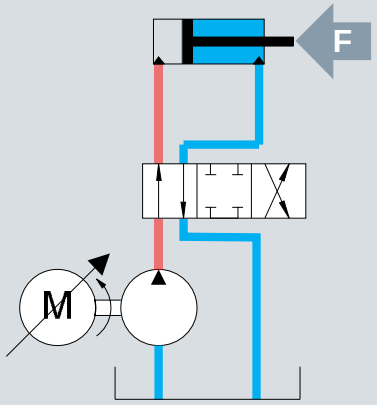
Drive Solutions for Hydraulic Systems

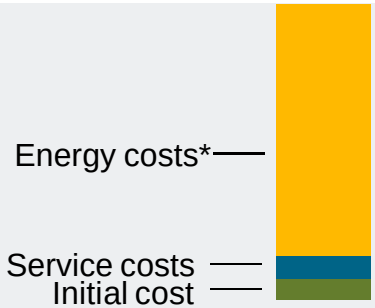
Life-cycle costs analysis of a system: Energy costs are reduced

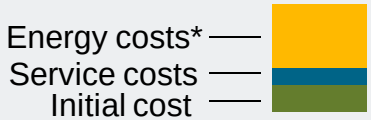
SIEMENS

Valve controlled system	Drive controlled system
Max. pressure Middle pressure Low pressure	









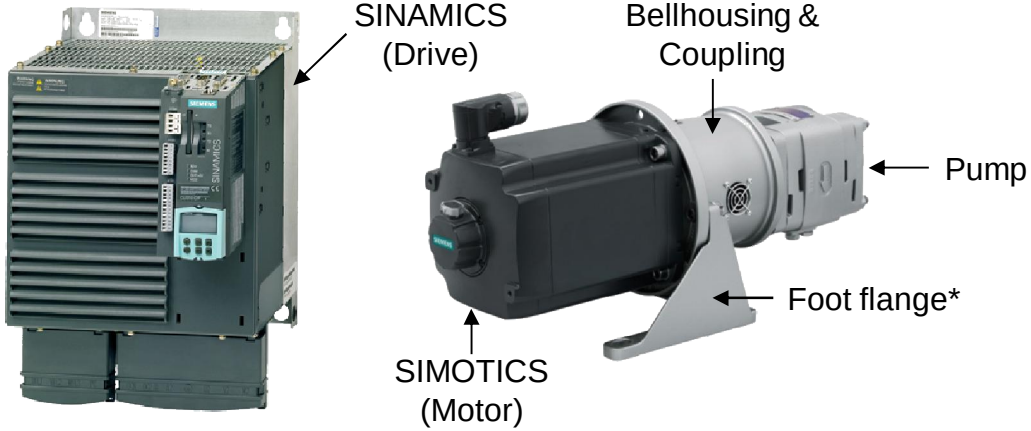
- **The life cycle costs of a system are much larger than the initial cost**
- **The ROI is usually reached before 2 years**
- **The drive emulates the functionality of valves and by-passes (and can replace them**)**

*Energy saving depends on application

*Some valves cannot be replaced due to safety reasons

Drive technology meets hydraulics: A new generation of hydraulic systems

SIEMENS



SIEMENS

- SINAMICS: S120, G120 or V20
- SIMOTICS: 1FK7, 1FT7, 1PH8 or 1LE1**
- Application: DCC or Technology controller

Pump provider of choice

- Pump (internal gear or axial piston pump)
- Bellhousing
- Coupling
- Foot flange*

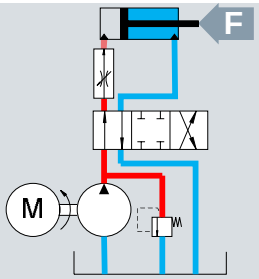
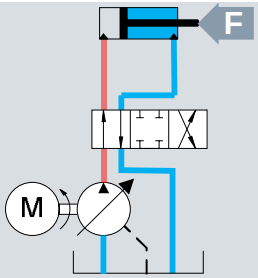
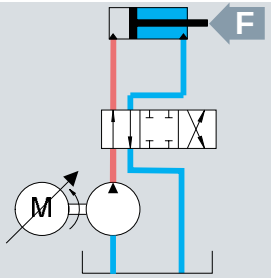
- **Customer can choose a suitable pump provider (Voith, Bosch-Rexroth, Eckerle, Bucher, etc.)**
- **SIEMENS can suggest the correct pump size**

*Only needed if construction type is not IM B35

**Norm-asynchronous motors require forced ventilation

Comparison of technologies: Possibilities for pressure and flow rate control

SIEMENS

	System with valves	System with variable displacement pump	System with drive
			
Actuating element	• Opening of flow control valve • Opening of pressure valve	• Displacement angle of pump	• Motor speed
Set point change during operation	• No / Yes* (auxiliary hydraulic system required)	• No / Yes* (auxiliary hydraulic system required)	• Yes
Motor type (efficiency)	• Norm-asynchronous (+)	• Norm-asynchronous (+)	• Norm-asynchronous (+) • Servo-asynchronous (+++) • Synchronous (++++) Depends on requirement
Main energy losses	• Flow control valve • Pressure valve • Directional valve • Recirculation of oil • Continuous motor rotation • *Auxiliary oil	• Directional valve • Continuous motor rotation • *Auxiliary oil	• Directional valve
Energy evaluation	☹	😐	☺

Abstract of our portfolio:
The optimal drive and motor for your system

SIEMENS

Drive controlled hydraulic pumps

- Movement of hydraulic actuators (cylinders or hydro-motors)
- Single or multiple hydraulic actuators per hydraulic system
- Different price optimized combinations for different dynamic, efficiency and precision

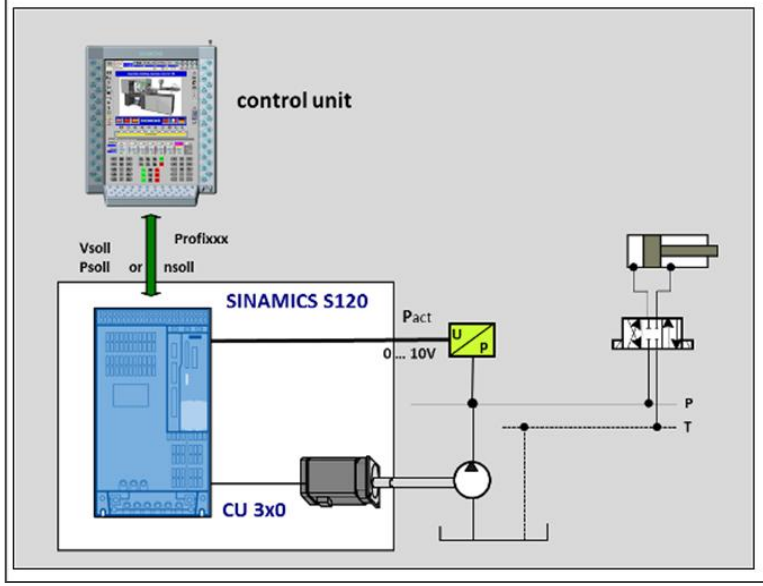
Configuration	A	B	C	D
Drives	• V20 • G120 (CU240) • G120 (CU250)	• G120 (CU250)	• S120 (CU310) • S120 (CU320)	• S120 (CU310) • S120 (CU320)
Motors	• 1LE1 (forced air ventilated)	• 1PH8 (asynchronous)	• 1PH8 (asynchronous)	• 1FK7 • 1FT7 • 1PH8 (synchronous)
Application examples	• General pressure sources • Bending machines	• Elevators	• Sand casting machines • Recycling presses	• Metal presses • Injection molding machines

Medium dynamic **High dynamic** **Very high dynamic**

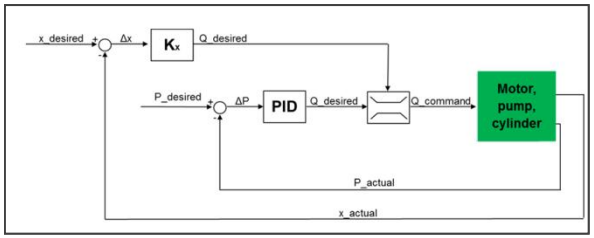
Ready-to-use application: DCC-Application

Task

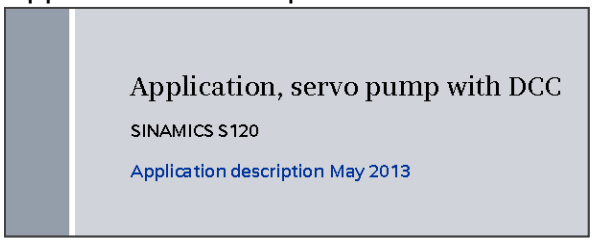
The standard application, servo pump for SINAMICS based on DCC, was developed with the objective of addressing a wide range of known servo pump applications with one single application configuration. As a result of the openness of the application, it is possible to configure or modify the application. The application can be used with different versions of the SINAMICS S120 and S150 series.
With the appropriate devices, servo pump for SINAMICS based on DCC, allows the variable-speed operation of an internal gear pump.
This document provides guidelines to optimize servo pumps with the corresponding devices.
Depending from your machine, this application can be used in the most different branches.



Application - Program



Application – Description



- **For S120: DCC (Drive Control Chart) application**
- **For the free application please contact SIEMENS**
- **Click here for ordering information**

Arguments for servo pumps: Much more than just energy efficiency

SIEMENS

Efficiency

- Energy reduction compared to conventional hydraulic solutions
- Less oil wear and leakage
- Less cooling
- The process is less dependent on oil temperature
- Less noise

Technology

- Hydraulic advantages (e.g. high energy density, own lubrication, own cooling)
- Electric advantages (configurable controller, high dynamic, monitoring)
- New possibilities to realize functionalities

Software

- Sinamics pool for all power ranges and applications
- Consistent software concept for commissioning
- Easy selection of components in SIZER
- Ready-to use application
- Pre-configuration of drives using macros

Components

- Wide portfolio of motors and drives
- Smaller and less components (e.g. no flow valves, no by-pass, no pressure accumulator, smaller pump)
- One servo pump replaces a large „conventional“ system

• The initial investment is easily compensated by the energy saving and further optimization possibilities

SINAMICS Technology for hydraulic pumps: A powerful combination

SIEMENS

- Advantages of electric drives and hydraulics are brought together
  - ✓ **High dynamic, high efficiency and high power density**
- Combination of SINAMICS drive, SIMOTICS motor and pump
  - ✓ **Wide portfolio to meet your needs**
- Integrated in software tools Starter and SIZER
  - ✓ **Easy configuration and selection of components**
  - ✓ **Commissioning as any SINAMICS drive**
- Ready-to-use control force, flow rate and position controllers
  - ✓ **The control algorithms are modular and can be adapted**
- Large range of pressures and flow rates possible
  - ✓ **Typical pressure range: 0…330 [bar]**
  - ✓ **Typical flow rate range: 0…600 [L/min]**
- New possibilities to optimize machines are opened
  - ✓ **Less or smaller components**

Retrofit of a plastic molding machine: Reference : 60 Ton / Single Pump

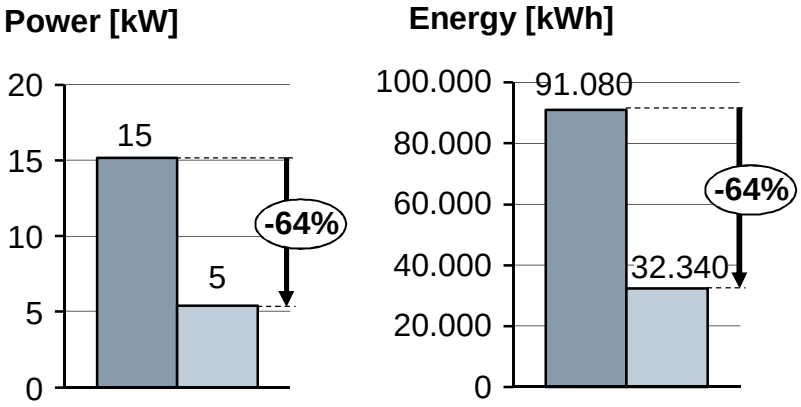
SIEMENS

Retrofit of a plastic molding machine:
- Before: valve controlled system
- Afterwards: drive controlled system

The power was reduced from 15,18 [kW] to 5,39 [kW]

Using the assumptions:
- Effective time = 6000 [hour/year]
  (=24 [hour/day] * 250 [day/year])

This results into:
- A reduction of the energy consumption of 64%
- A ROI before two years



Siemens scope

SIEMENS

1. Help propose correct solution

2. Conduct Site Survey

4. Implement

3. Submit Techno-Commercial offer

Why SIEMENS…..??

Siemens Ltd. is a Sustainable Plus Platinum Company in the CII Sustainability Rating

Siemens Ltd. has been ranked Number 1 in the Capital Goods Sector (as per BSE classification) and graded as a Sustainable Plus Platinum Company as part of the Confederation of Indian Industry's Sustainability Rating.

Dec 28, 2012


SIEMENS
Thank You