

11TH SEP 2024, POWER PLANT SUMMIT 2024 (20TH EDITION), HICC, HYDERABAD

Enhancing System Efficiency with Drives & Motors

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Agenda

1. Why Energy Efficiency in Power Plants ?
2. Energy Efficiency through optimizing auxiliary power
3. Energy Efficiency through motors
4. Improved System Efficiency with Drive Systems

Why Energy Efficiency in Power Plants

- Power sector is the single largest GHG emitter, contributing 40% to the total CO₂ equivalent emissions (1)
- The Energy Conservation Act 2001, with the objective of conservation and the efficient use of energy
- Efficiency percent = $(\text{Useful Power Out (kW)} / \text{Power In (kW)}) \times 100$
- Adoption of energy efficiency schemes/ program's
 - PAT I : Saved 31 MtCO₂ &
 - PAT II : Saved 61.34 MtCO₂ &

Note :

- 1) Source :Third Biennial Update Report to The United Nations Framework Convention on Climate Change (2021)
- 2) Initiatives under PAT :Auxiliary Power Consumption (APC) optimization using efficient motors, Variable frequency drives (VFDs) and stage reduction in pumps , Utilization of low-temperature waste heat from flue gas for generating chilled water, desalinating water & Micro Oil ignition system (MOIS)

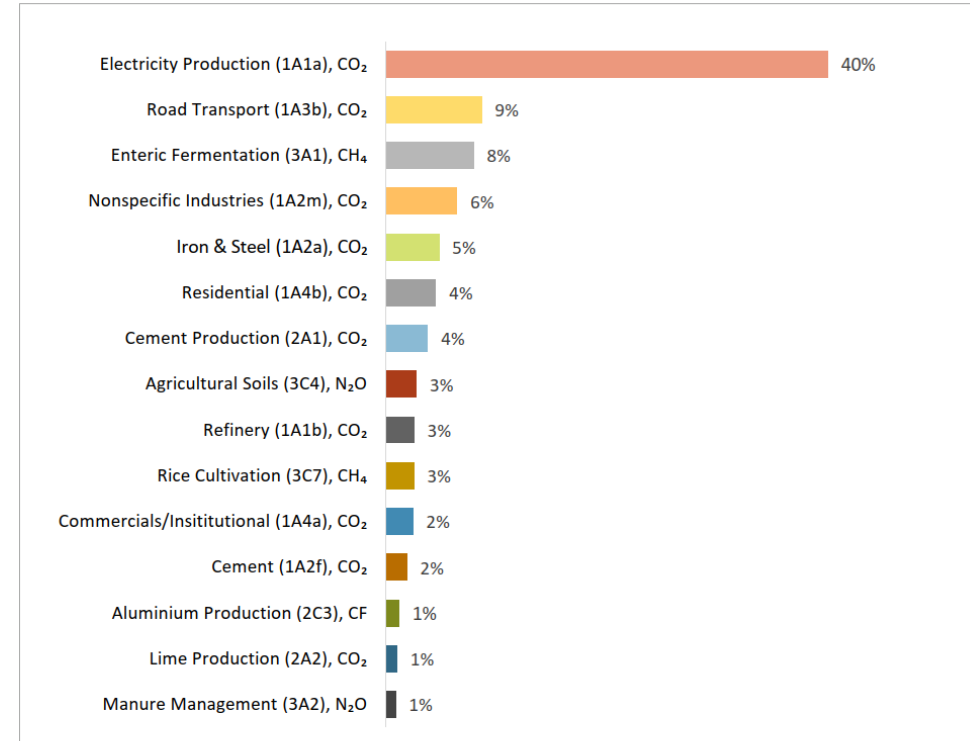


Figure ES2: Greenhouse gas emissions by category, GgCO₂e, 2016.

Energy Efficiency through optimizing auxiliary power

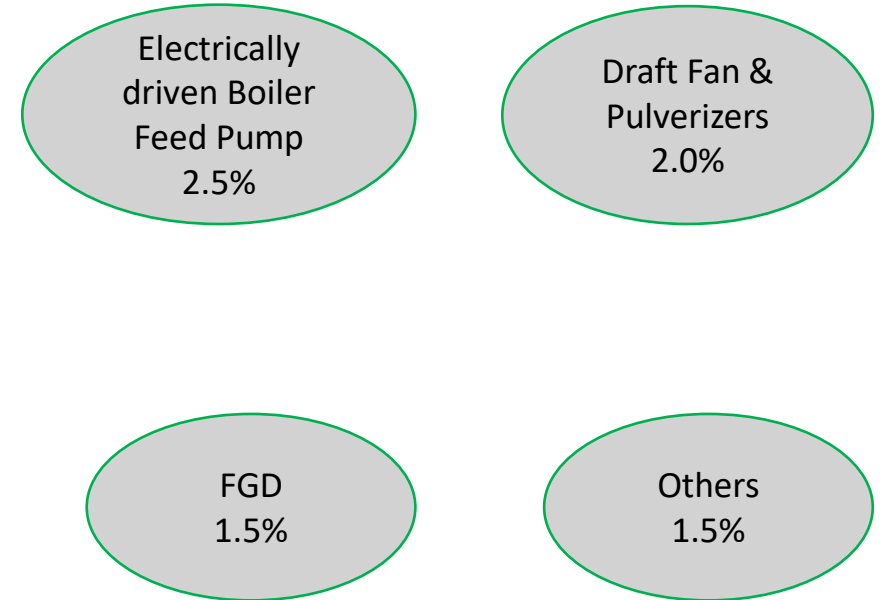
Role of VFDs and Energy efficient motors

*The coal-based thermal generation is responsible for meeting more than 74% of India's electricity energy demand and this share is expected to stay near 50% by 2030.

Thermal units would experience lower minimum loads as the share of renewable resources in the energy mix increases

Auxiliary power in power plant varies from 7% to 15% of the gross generated power - with environmental norms becoming stringent - there is need for additional auxiliary equipment

Reducing auxiliary power requirement and especially during varying demand is important contributor to energy efficiency in power plant



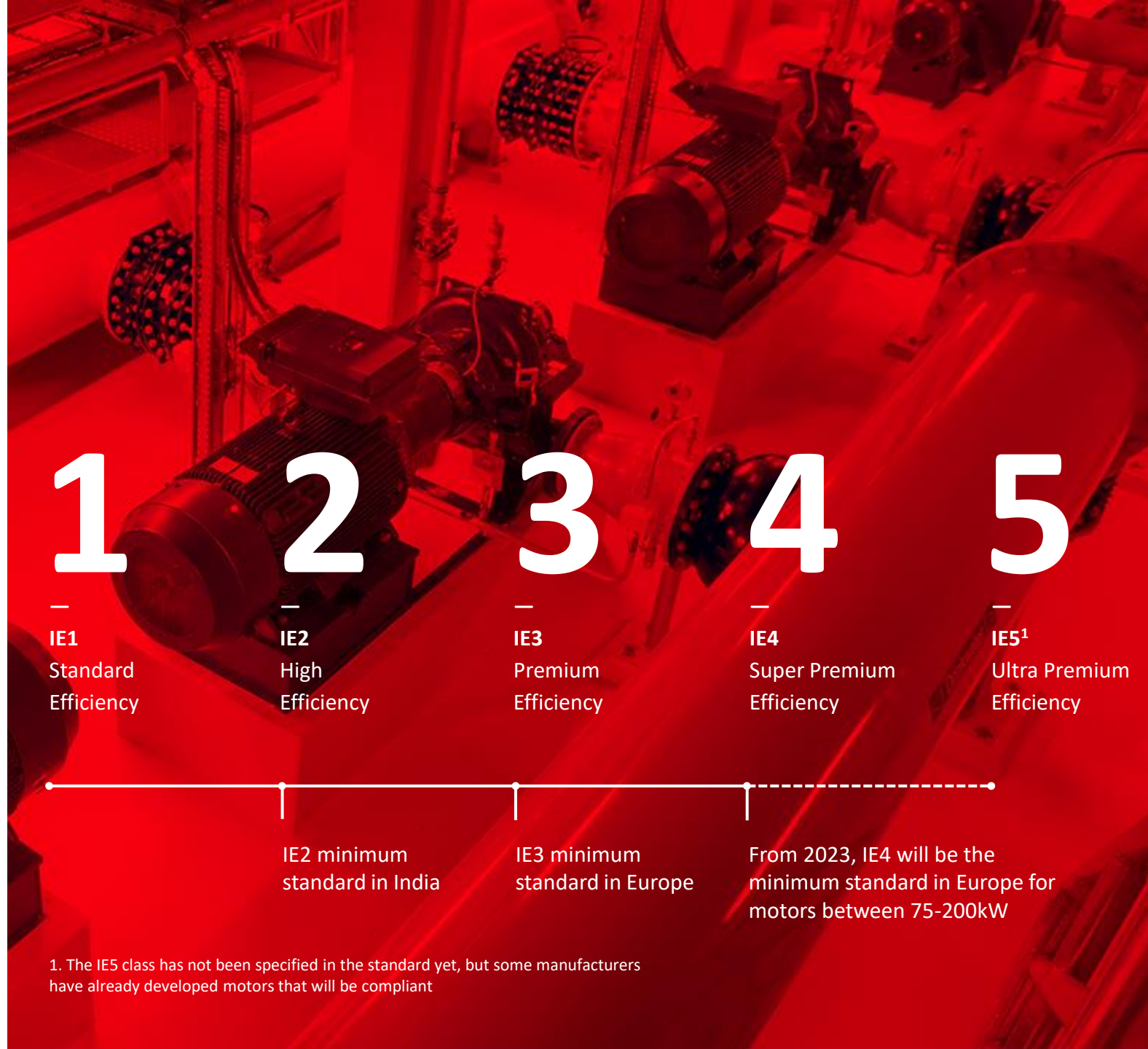
* Source - CEA report on Flexibilisation of coal fired power plant - 2023

Energy Efficiency through motors

Efficiency standards

For Low Voltage motors

- IEC categorizes efficiency IE1 to IE5
- BIS (IS 12615) categorizes efficiency IE2 to IE4
- Efficiencies are primarily defined for DOL sinusoidal supply
- The IE3 motors have energy losses 15%-20% lower than IE2 motors
- The IE4 motors have energy losses 15%-20% lower than IE3 motors
- The IE5 motors have energy losses 15%-20% lower than IE4 motors



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IE1
Standard
Efficiency

2

—
IE2
High
Efficiency

3

—
IE3
Premium
Efficiency

4

—
IE4
Super Premium
Efficiency

5

—
IE5¹
Ultra Premium
Efficiency

IE2 minimum
standard in India

IE3 minimum
standard in Europe

From 2023, IE4 will be the
minimum standard in Europe for
motors between 75-200kW

1. The IE5 class has not been specified in the standard yet, but some manufacturers have already developed motors that will be compliant

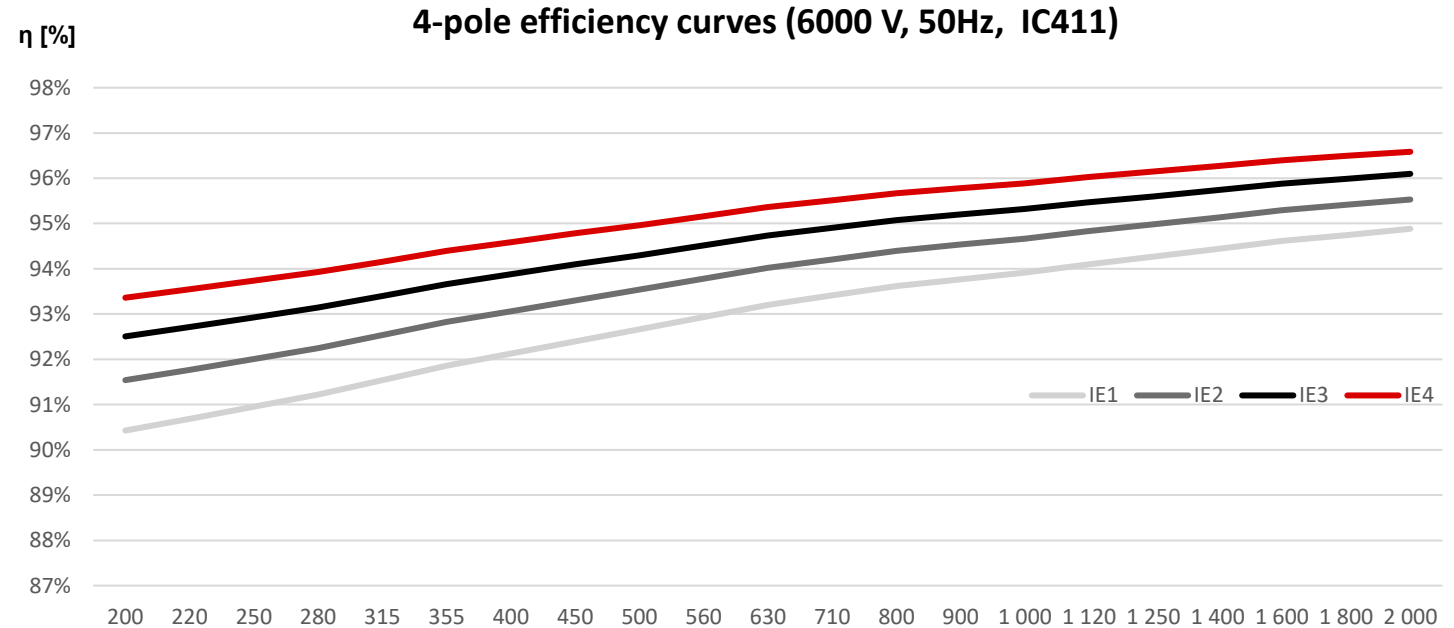
Efficiency Class – High Voltage Motors

IEC 60034-30-3 standard on efficiency classes for HV AC motors



The coverage of the new standard includes the following DOL Induction motors:

- Are intended for direct-on-line starting at rated or at reduced voltage and rated frequency
- Are line-operated single-speed
- **2, 4 and 6 poles**
- Rated output : **200 kW to 2000 kW**
- Rated voltage **1kV to 11 kV**
- Ambient temperature : -20°C to +60°C
- Altitude up to 2000 m above sea level
- Designed for cooling methods IC411, IC511, IC611, IC01 or IC81W



Innovation, the way forward from ABB

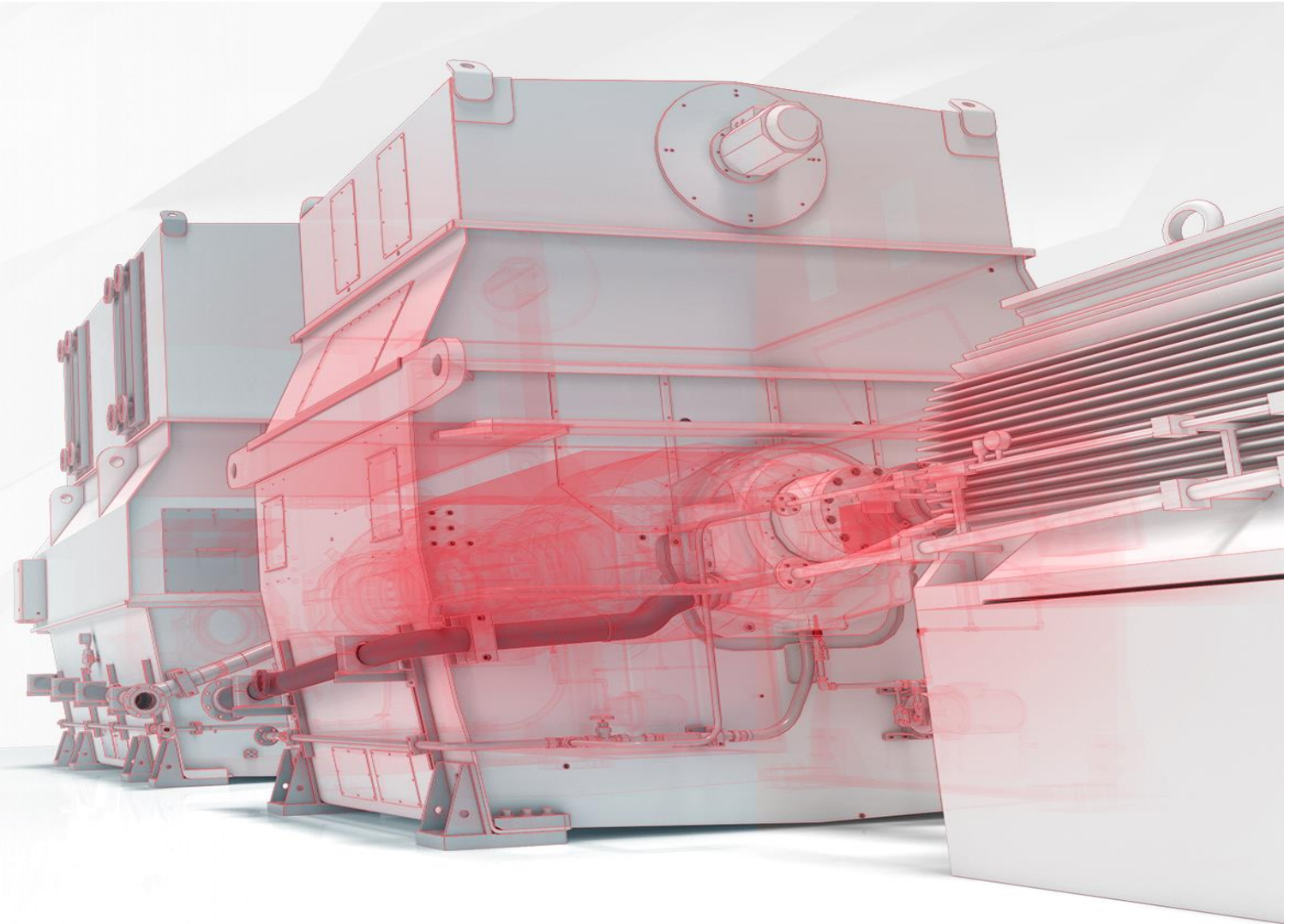
One motor can make a big difference

Our Large Motor technologies provide the powerful solutions the world needs

99.05% efficiency

(Eff achieved with one of the Synchronous motor)

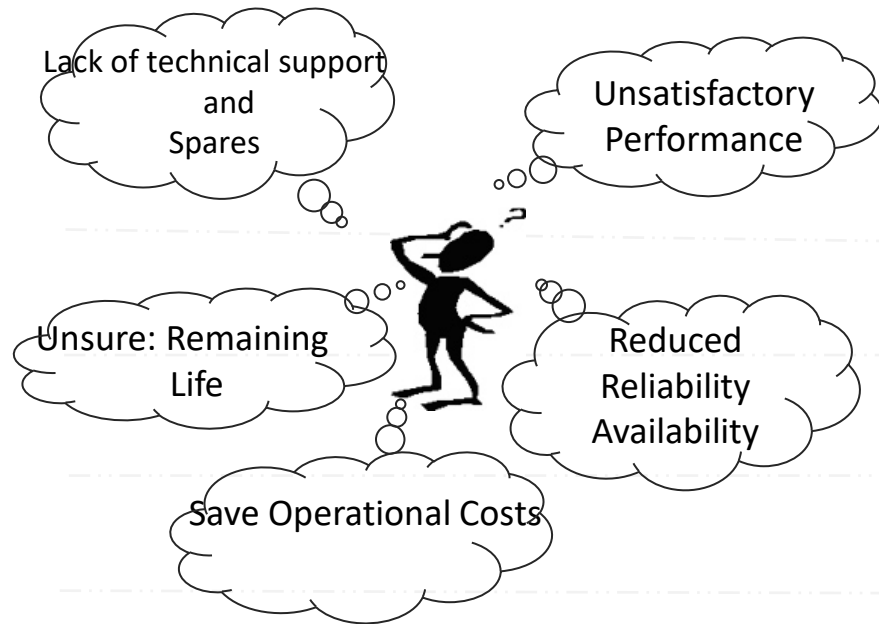
With such high-efficiency ratings, they are capable of producing massive energy savings



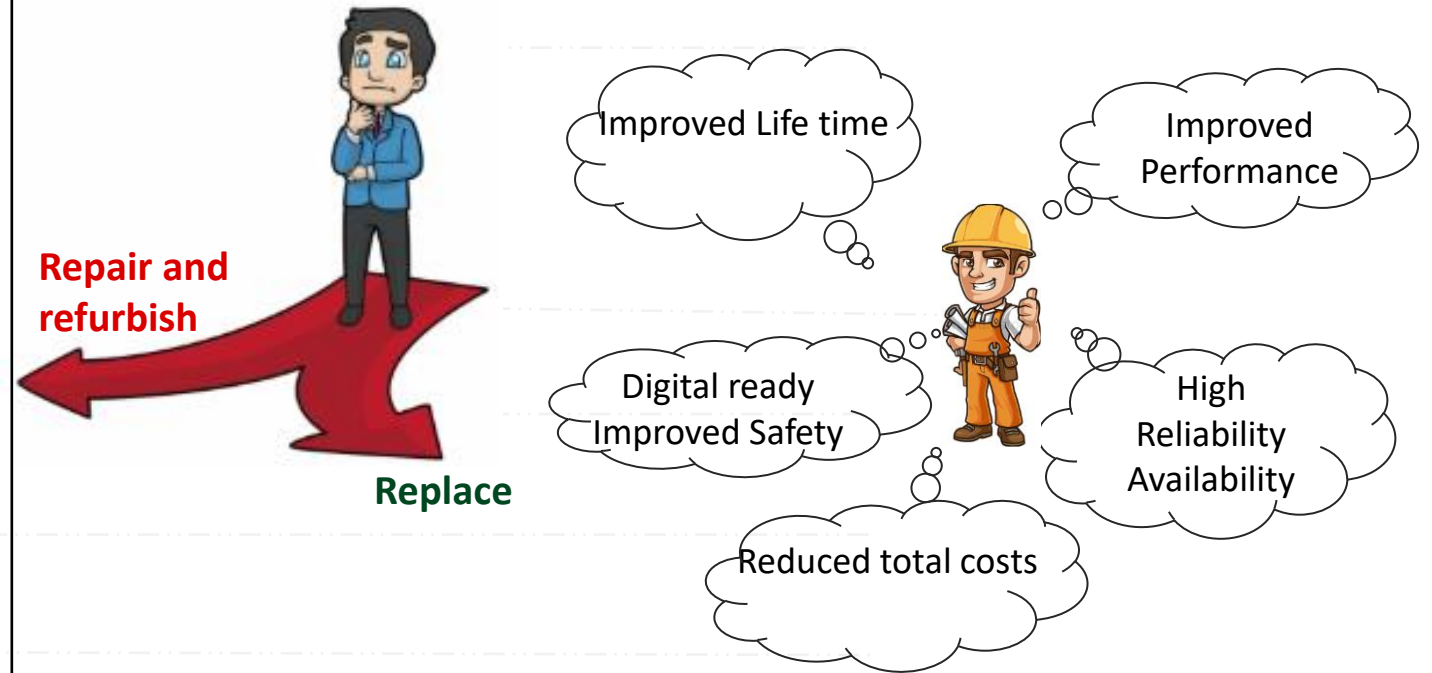
Replacement motors

Things that really count

Key issues bothering operations and maintenance teams



Benefits from Replacements

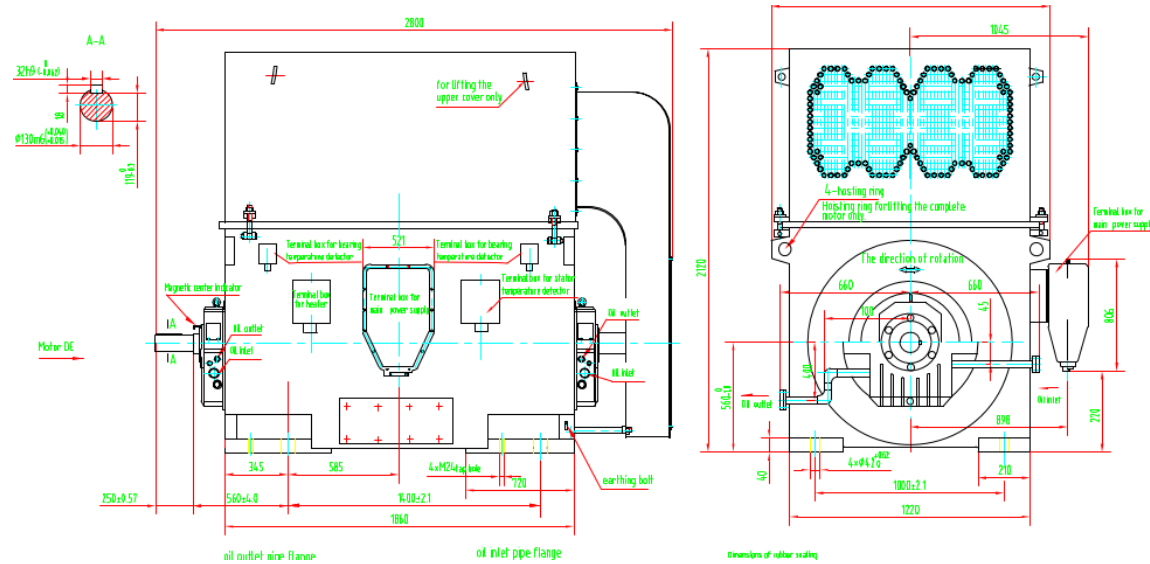


Replacement : Any motor sold for installation on an existing foundation

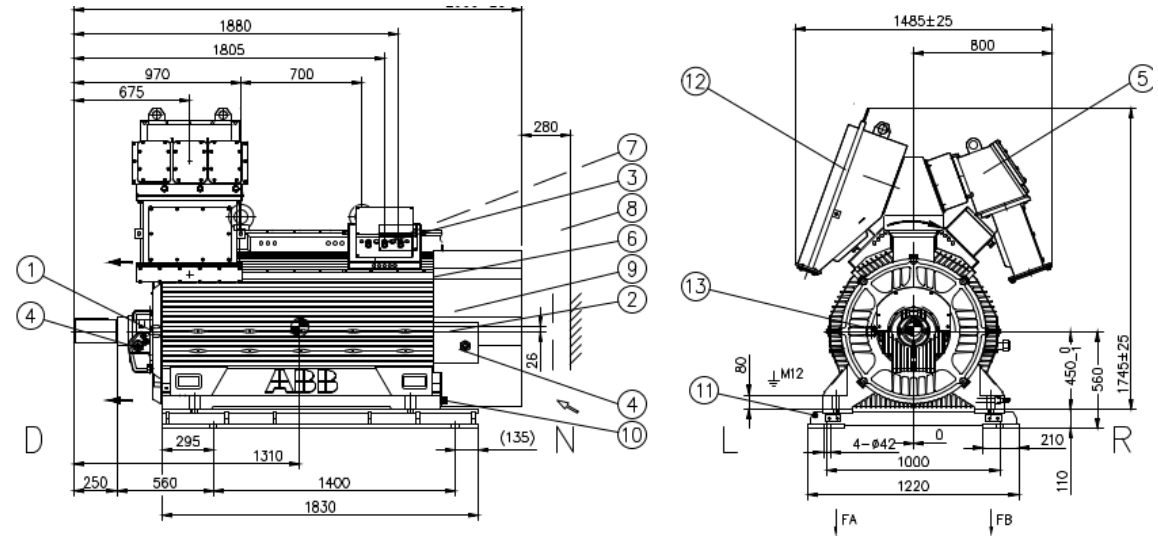
Replacement Case Study

Annual Energy saving of ~ 130MWh

Existing motor



New motor with modification



Customer was implementing efficiency improvement program

- Chinese Motor - 900kW 2P 11kV with efficiency of 95%.

ABB replaced the existing motor with efficiency of 97% which resulted in saving of 128,900 kWhrs / year

Pay back period of 3 years for new motor.

CO2 savings/ year per motor – 81 Tons (approx.)

Direct drive cooling tower

Eliminate the gearbox

Synchronous AC salient pole permanent magnet (PM) motor designed for cooling tower applications

- Eliminates gear boxes and belt solutions
- Improves system reliability, safety, efficiency and noise reduction
- Less parts = less maintenance = less cost

Increased system reliability and efficiency

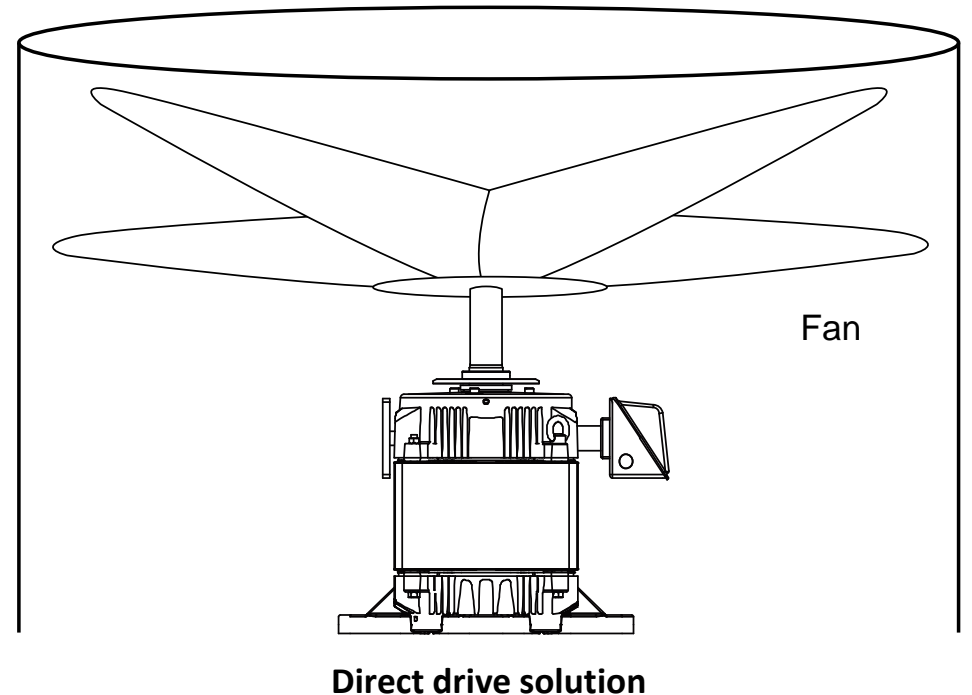
- AC drive controls motor speed to match process demand
- Permanent magnet (PM) motor for greater efficiency

Lower speeds, high torque motor design

Lower vibration & operating noise levels

Safety & environmental issues decreased

Availability: 10 – 300 Hp (7.5 – 250 kW)



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Medium Voltage Drives

ABB supplies drives products and systems for various kinds of processes and applications in the power generation industry:

Gas turbine power plants	GT starters, drives for fuel gas booster compressors, boiler (HRSG) feed-water pumps and cooling water pumps
Steam generating boilers, waste incinerators	Drives for boiler feed-water-, cooling water-, circulation water pumps, FD and ID fans
District heating, Combined Heat and Power	Drives for water circulation pumps in industrial and municipal combined heat and power (CHP) plants
Fuel handling	Drives for conveyors and coal mills
Selective Catalytic Reduction, Flue Gas Desulphurization	Drives for ID booster fans, limestone slurry feed- and absorbent circulation pumps and oxidation air compressors
Pumped storage hydro power plants	Soft starters for hydro turbines
Renewable energy	Drives for geothermal power plants and soft starters for synchronous condensers
Nuclear power plants	Drives for feed-water, condensate recirculation and cooling-water pumps

Various processes and applications in the power industry benefit from the implementation of variable speed drives.

Pumps

- Boiler feed-water pump
- Condensate extraction pump
- Cooling water pump
- District heating circulation pump
- Limestone slurry feed- and absorbent circulation pump

Fans

- Primary air fan
- Secondary air fan
- ID fan
- ID booster fan

Other

- Conveyor
- Coal mill
- Oxidation air compressor
- Gas turbine starter
- Fuel gas booster compressor

ABB Drive Product Portfolio

Choosing The Right Technology

Energy efficiency – Emission Reduction

ACS580MV



200 kW to 6.3 MW (3.3/6/6.6/10/11 kV)

Applications

- Pumps, fans

Segments

- Water, HVAC, Power, Mining, Cement

Focus

- Simple to select, order, commission and use
- Affordable energy saving solution

ACS5000 / MEGADRIVE-LCI



2 to 36 MW (6.6kV)

Applications

- Large compressors, pumps, fans, gas turbine starters

Segments

- Oil and gas, power generation, water

Focus

- Flexible to configure for specific needs
- Medium to high power applications
- High reliability and availability
- Highest level of personal safety

Process control

ACS1000/ACS880 ULH Drives



250 kW to 5 MW (3.3kV) 0.55kW to 6MW

(415V / 690V)

Applications

- Pumps, fans, mills, conveyors, extruders, mixers, hoists

Segments

- Mining, cement, oil and gas, water petrochemical, power generation

Focus

- Flexible to configure for specific needs
- Small footprint
- High reliability and availability
- Highest level for personal safety

ACS6080



5 to 36 MW (3.3kV)

Applications

- Mills, conveyors, propulsion, hoists, test stands, special applications

Segments

- Metals, mining, marine

Focus

- Flexible to configure for specific needs
- High performance
- High reliability and availability

ACS580MV technical overview

Voltage range:

3.3 to 13.8 kV (supply)
3.3 to 11 kV (output)

Power range:

3.3 kV: 315 to ~2000 kW
4.16 kV: 300 to ~2500 kW
6/6.3/6.6 kV: 200 to ~4000 kW
10/10.5/11 kV: 200 to ~6300 kW

Supply frequency:
50/60 Hz

Power factor:
> 0.96



Induction motor

Scalar and vector control

Output frequency:
0 ~ 120 Hz

2Q operation

Motor cables up to 1000 m as standard

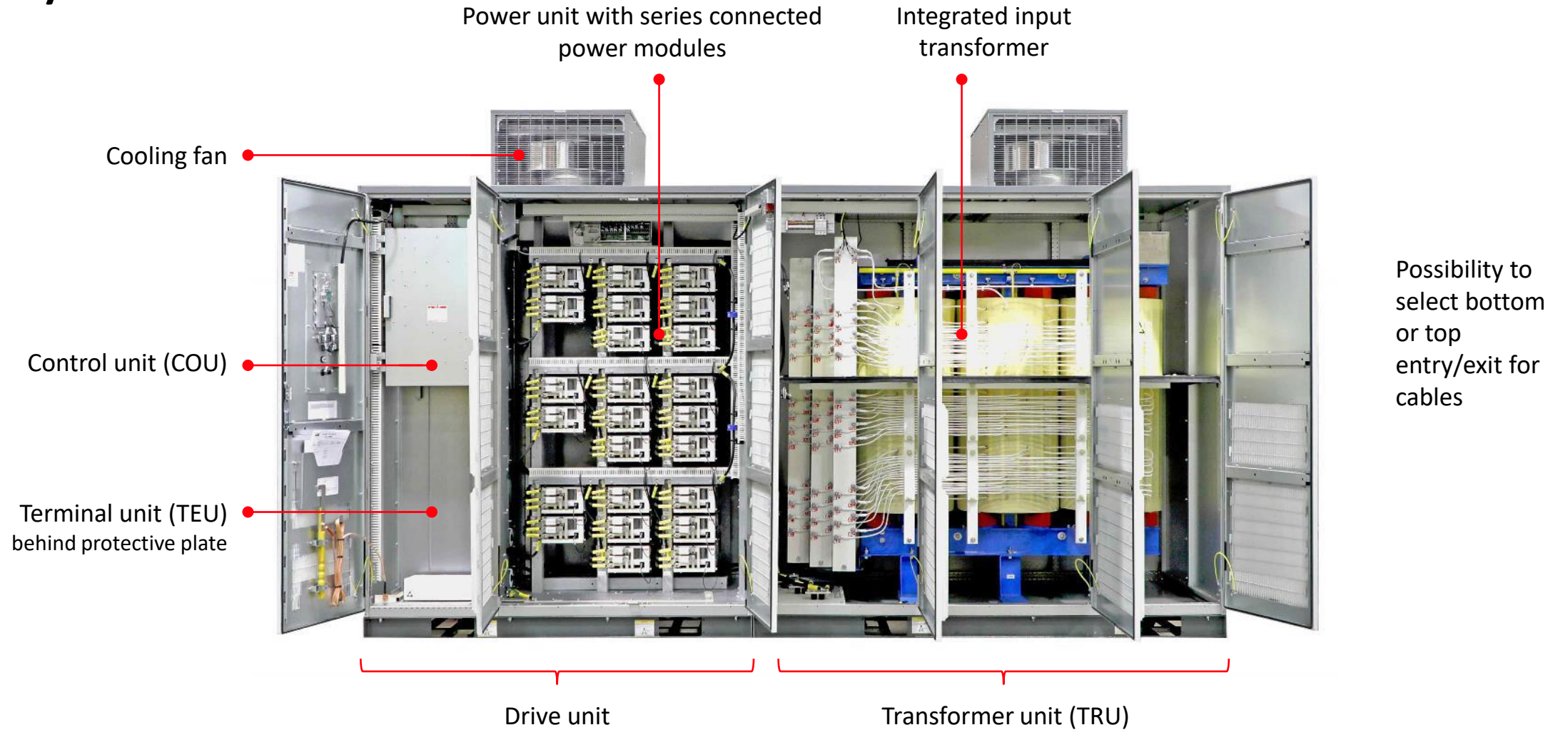
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Total efficiency:
 $\eta > 96\%$

Protection class:
IP21 or IP42

Output current THD:
< 2%

Cabinet layout



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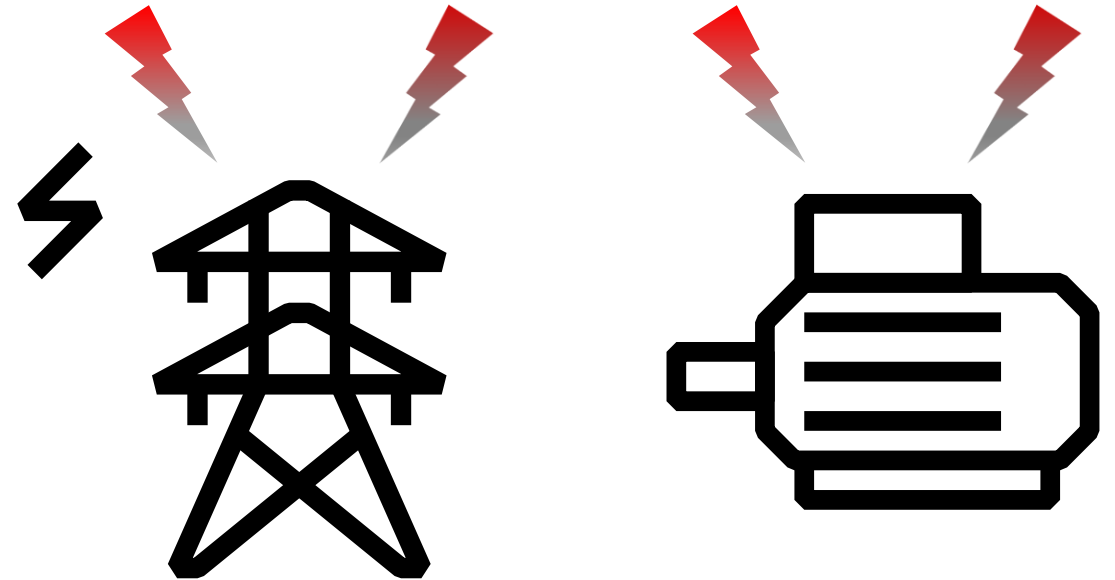
Improved System Efficiency with Ultra Low Harmonic (ULH) VFD

Ultra-low harmonic drives

Disturbances caused by harmonics

Harmonics pollute the electrical supply and can cause negative disturbances to equipment connected to the grid

- Motors, transformers, cables and other equipment can overheat
- communications equipment can experience interference
- sensitive electronic equipment can be damaged
- measurement devices can give false readings
- capacitor can fail due to resonances
- displays and lighting can flicker
- circuit breakers can trip
- fuses can blow



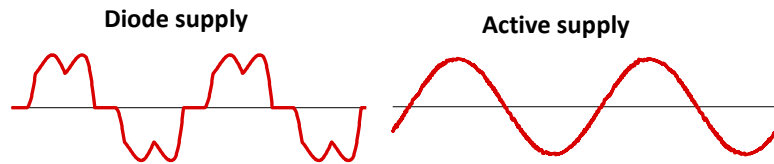
These can cause major trouble like equipment failure and disrupt your operation!

Ultra-low harmonic drives

Features & Benefits

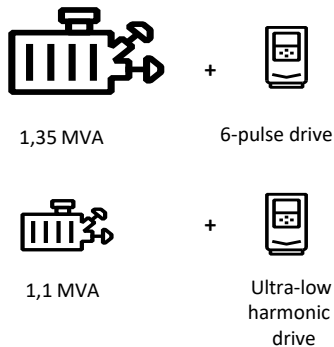
Low Harmonic content, <3% THDi

The drive produces exceptionally low harmonic content and exceeds the requirements of harmonic recommendations, such as IEEE 519 and G5/4. The total harmonic current distortion is typically <3% in nominal situation and undistorted network.



Reduced Demand ~25%

ABB's ultra-low Harmonic drives kills the cause for the harmonics at the source and hence the demand for the network also reduces by 25%



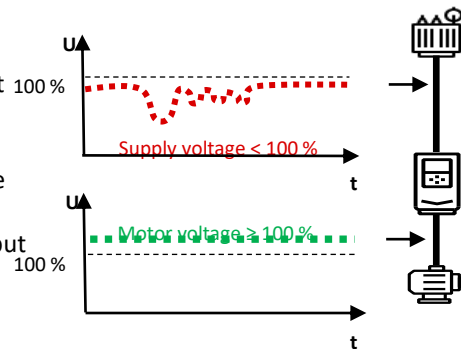
Unity Power Factor, at all loads

ABB's ultra-low harmonic drives have been designed to be neutral from the network point of view. Drive reaches unity power factor. This high power-factor indicates that electrical energy is used efficiently.



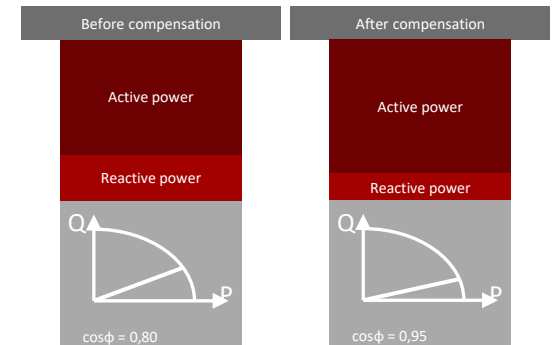
Immunity to network variations

The voltage stabilization feature in the ultra-low harmonic drives can boost the output voltage more than the source voltage. And ensures 100% voltage at motor terminals consistently despite of input fluctuations.

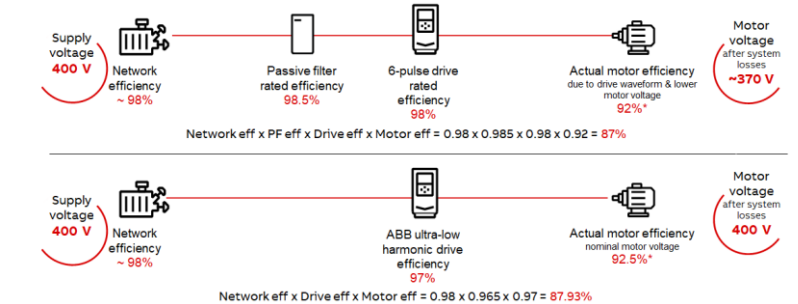


Reactive Power Control

ABB's ultra-low harmonic drives have the built-in feature for reactive power compensation, without any additional components

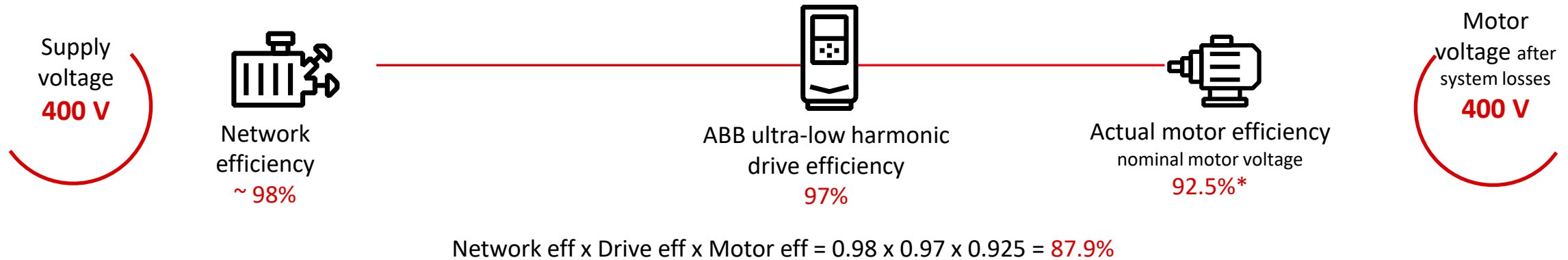
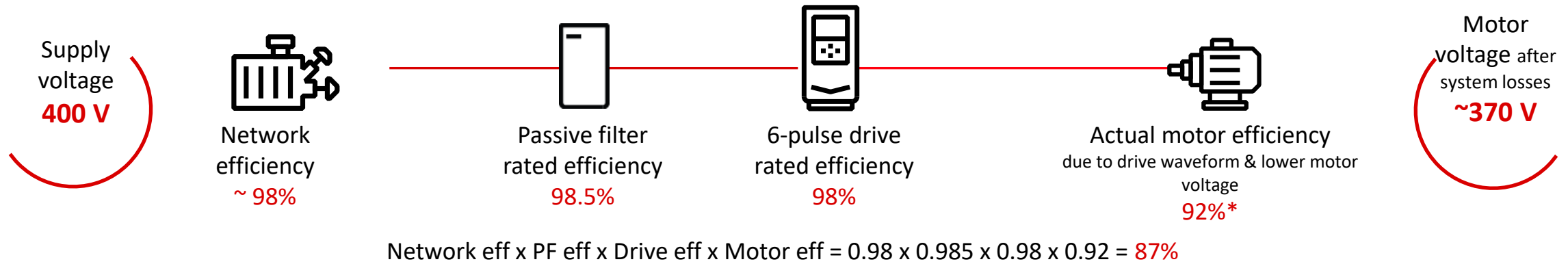


Improve System Efficiency



Ultra-low harmonic drives

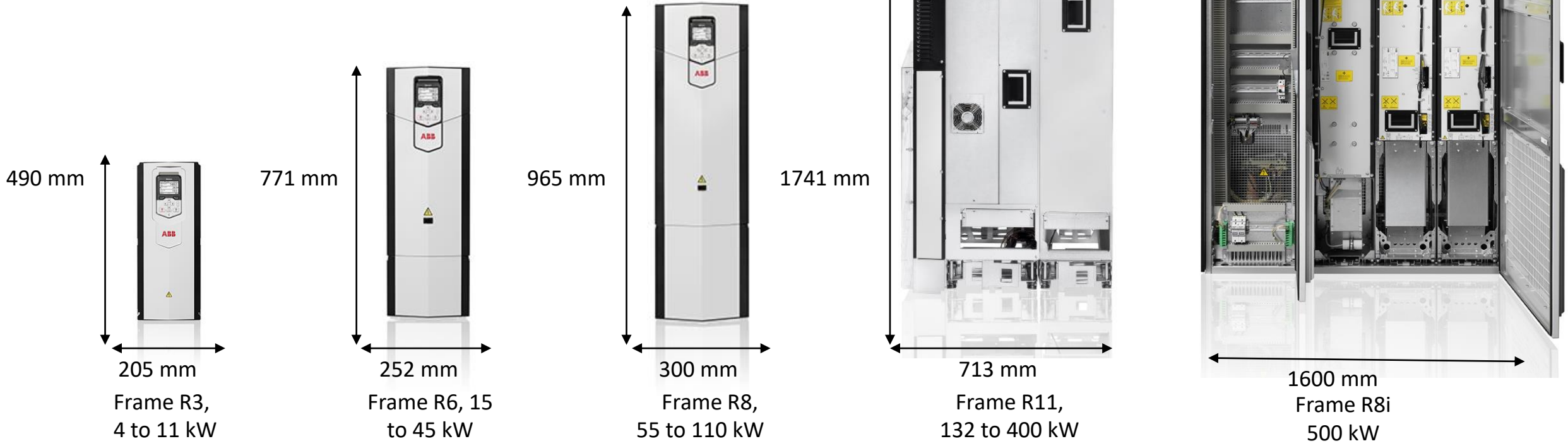
System efficiency



* Standard IEC motor rated efficiency 93%

Ultra-low harmonic drives

Low voltage 415/690V



Compact solution.
Everything in one integrated package.

ABB Ability™ Digital Powertrain

Powertrain

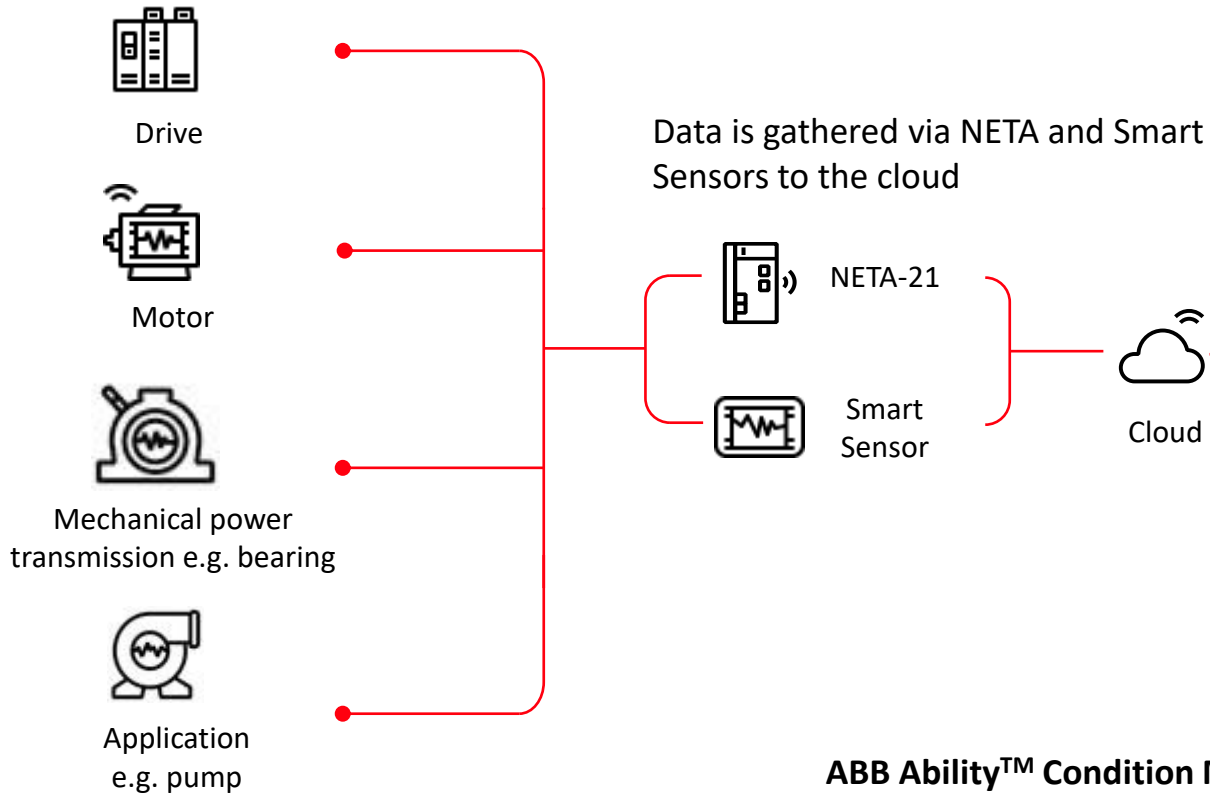


ABB Ability™ Condition Monitoring

Talwandi Sabo Power Limited (now Vedanta Limited)



WHO?

TSPL, SPV by Punjab State Electricity Board (PSEB) and now transferred to Vedanta Limited.

Installed Capacity: 3x660 MW Thermal Power Plant



WHAT?

2x ACS2000 driving 2200KW motors

APPLICATION: Condensation Extraction Pump (CEP) in Super Critical Thermal Power Plant

By using ABB drive customer is able to save about 20% of Energy



WHY?



Complete Turnkey solution of electrical, instrumentation through our system Integrator



ABB