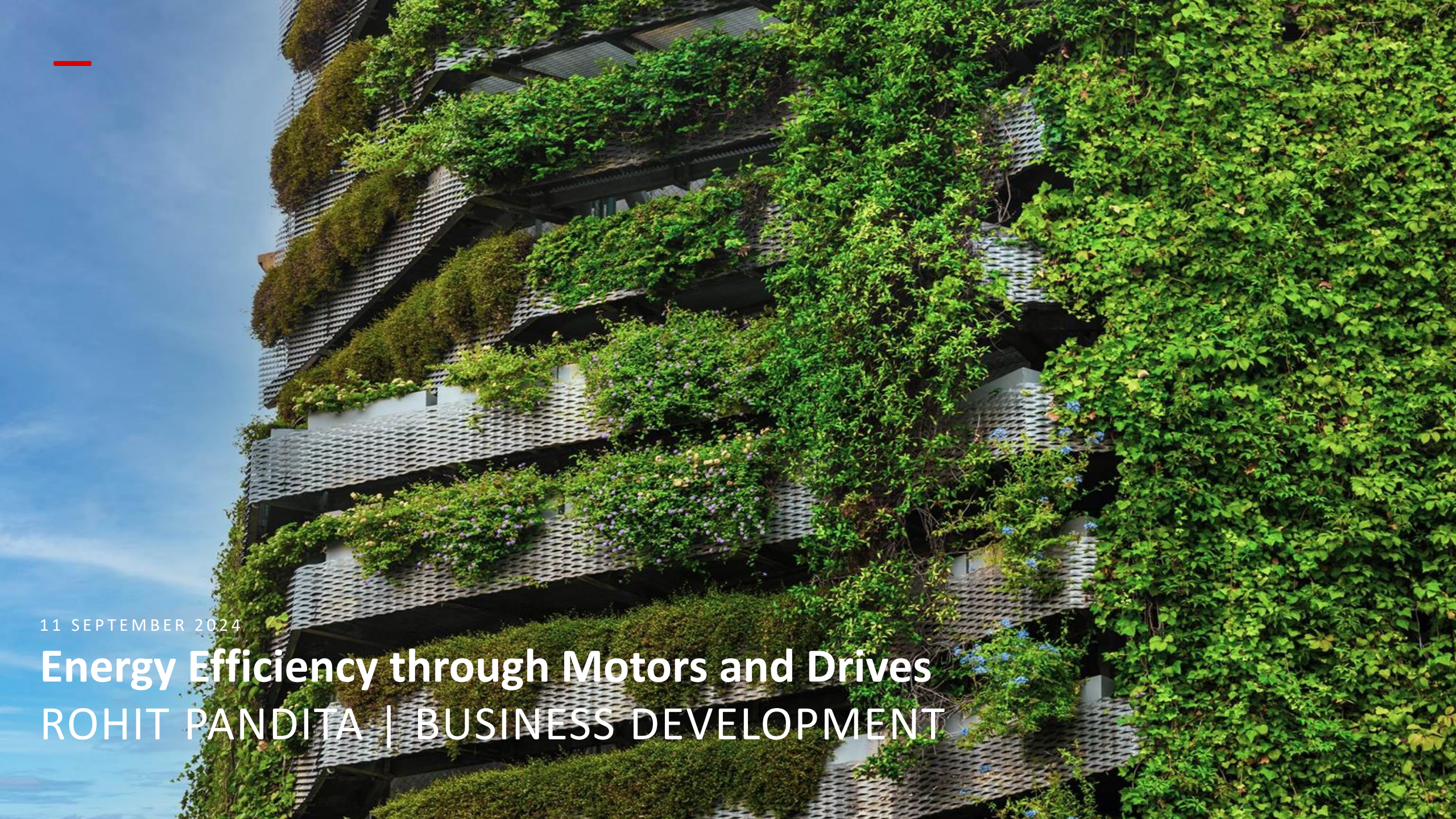


11 SEPTEMBER 2024

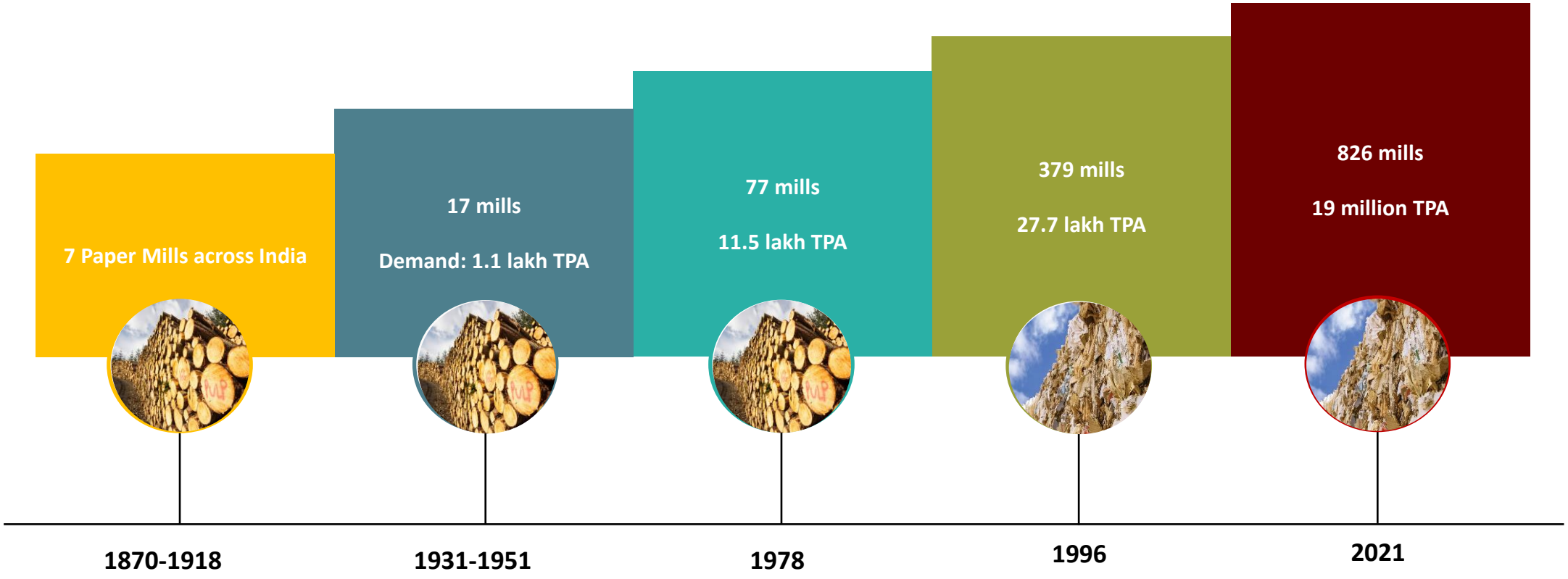
Energy Efficiency through Motors and Drives

ROHIT PANDITA | BUSINESS DEVELOPMENT

Agenda

1. Overview
2. Energy Efficiency Standards for Motor
3. VFD motors – latest IEC standards
4. IE5 efficiency and technologies
5. Role of Drives in energy saving
6. Energy appraisal of motor driven systems

Evolution of Paper Industry in India



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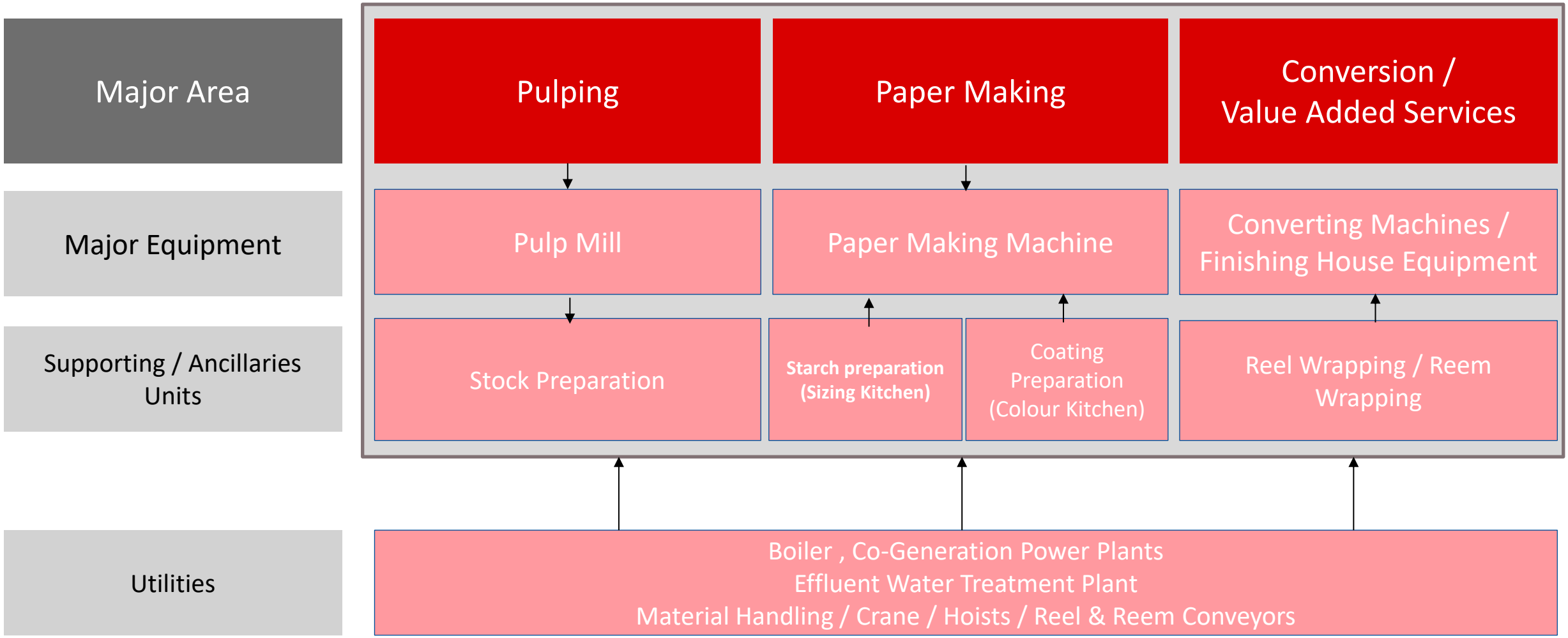
Source: IPMA

Major Areas of Typical Paper Plant



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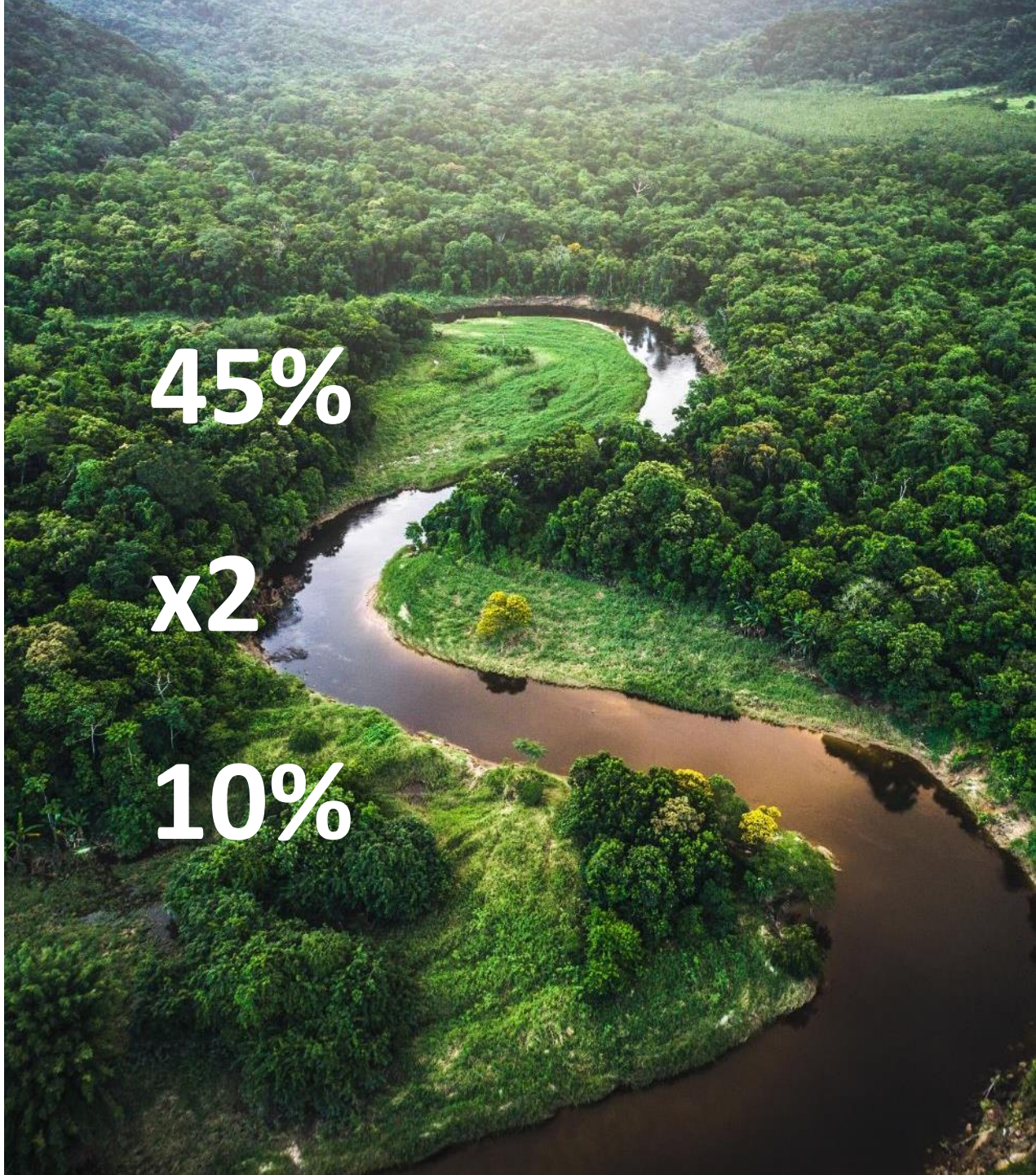
Our physical world depends on motors

Electric motors consume over 45% of the world's electricity

By 2040 the number of motors will double

It has been estimated that, If all the +300 million industrial electric motor-driven systems currently in operation were replaced with optimized, high-efficiency equipment, global electricity consumption could be reduced by up to 10 percent



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Efficiency standards
For Low Voltage motors

- IEC categorizes efficiency IE1 to IE5
- Efficiencies are primarily defined for DOL sinusoidal supply
- For each higher efficiency class, the losses are lower by 15% to 20%
- Motors with VFDs tend to have additional losses
- Rewinding tends to reduce the efficiency by 1% to 4% based on multiple factors
- Manufacturers offer guaranteed efficiency motors when specifications call for it (CE marking for supplies to EU MEPS)

Eco-design Directives on Efficiency for VFD driven motors at Partial load

Regulation EU 2019/1781 (Eco-design directive)

Manufacturers need to provide the losses at these points for the motor (1.7. 2022) and drive (1.7.2021)

This enables comparison of different motors in partial load conditions with VSD (variable speed drive) duty.

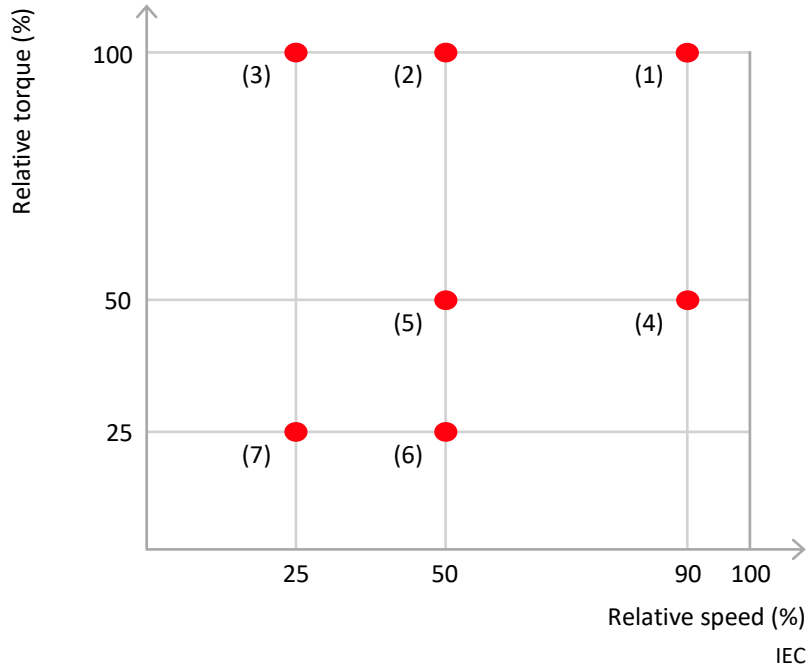
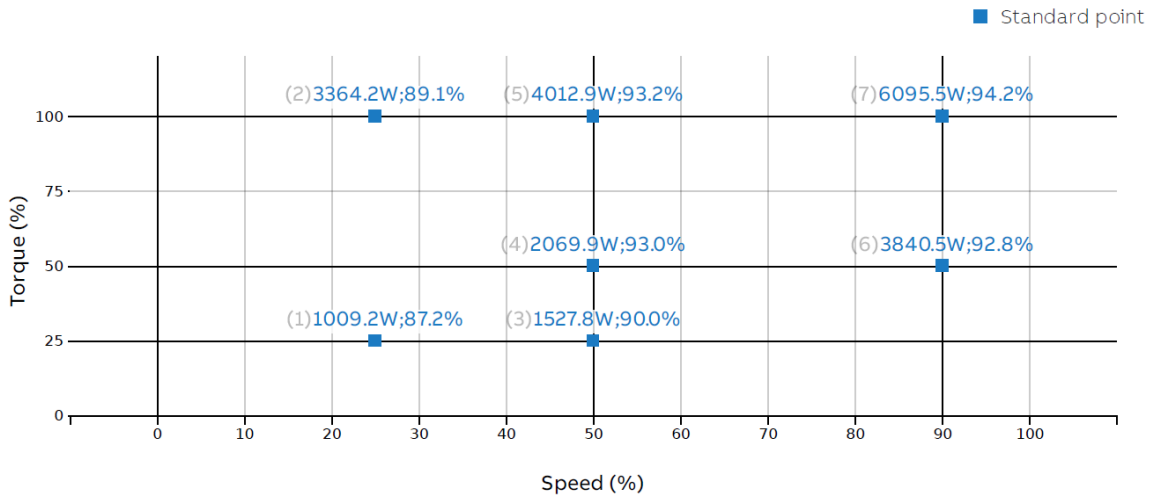


Fig-9: IEC 60034-2-3 [7]

Points (3), (2) and (1) are mostly relevant for constant torque applications (conveyor belts, lifts, hoist drives) at full load and test points (5) and (4) are relevant at half load.
Points (7), (6), (5), (4) and (1) are mostly relevant for quadratic torque applications like fans, pumps and compressors

Motor with 94.5% Efficiency at DOL – Motor losses and efficiency with VFD



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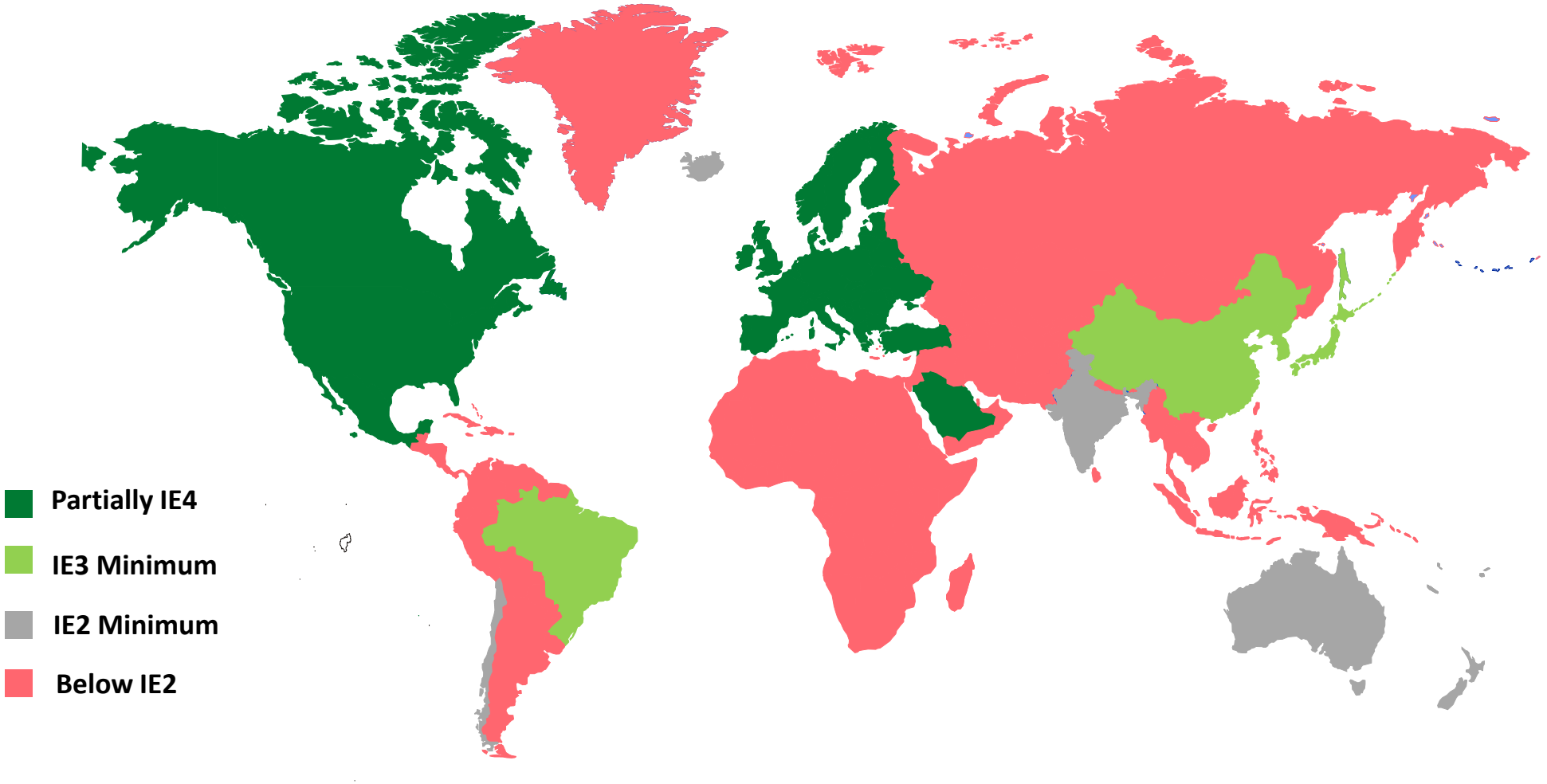
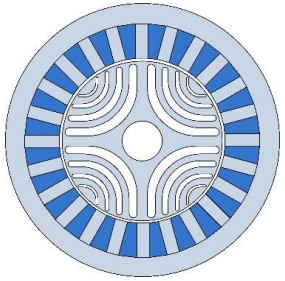
Legislating efficiency | Increasing mandates for IE3 as a minimum standard

Minimum Energy Performance Standard (MEPS) change markets



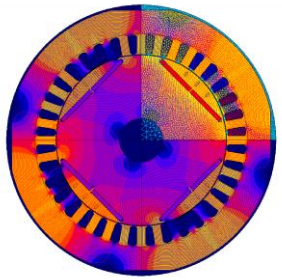
Motor technologies to reach IE5

Always compare actual product data! Same technology doesn’t mean same product characteristics



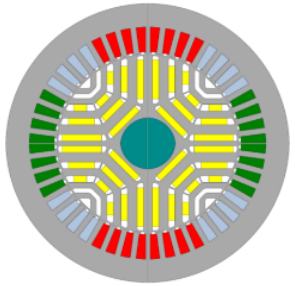
SynRM (Synchronous Reluctance)

- High energy efficiency
- High power density
- Accurate speed control even without sensors
- Low bearing temperatures and longer bearing lifetime
- **Easy to use and maintain**
- **Lower power factor and higher current demand (handled by VSD)**
- Only for VSD operation



Typical PM motor

- High energy efficiency
- **Highest power density**
- Accurate speed control even without sensors
- Low bearing temperatures and longer bearing lifetime
- **High cost**
- Only for VSD operation
- **Rare-earth magnets**
  - Uncertain cost variation
  - Demagnetization risk
  - More difficult service due to forces from magnets



Ferrite Assisted SynRM Motor

- **High Energy Efficiency: IE5+**
- Requires Variable Speed Drive
- Excellent Power Density
- Accurate speed control even without sensors
- Low bearing/winding temperatures
- **High PF and Maintains efficiency at low speeds**
- Tailored design performance
- **Uses Ferrite magnet (instead of rare earth magnet)**

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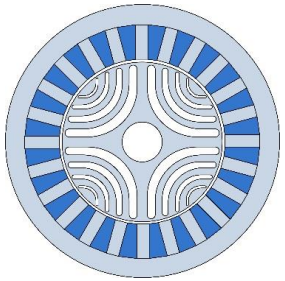
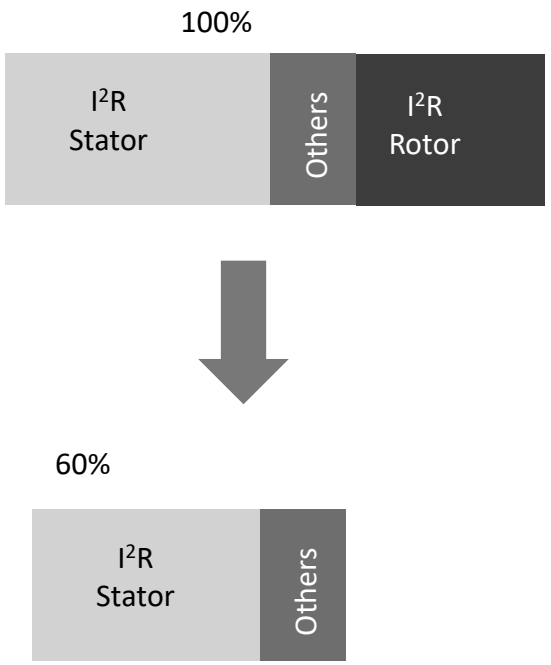
ABB IE5 synchronous reluctance motors

Elimination of rotor losses – Highly reliable and efficient



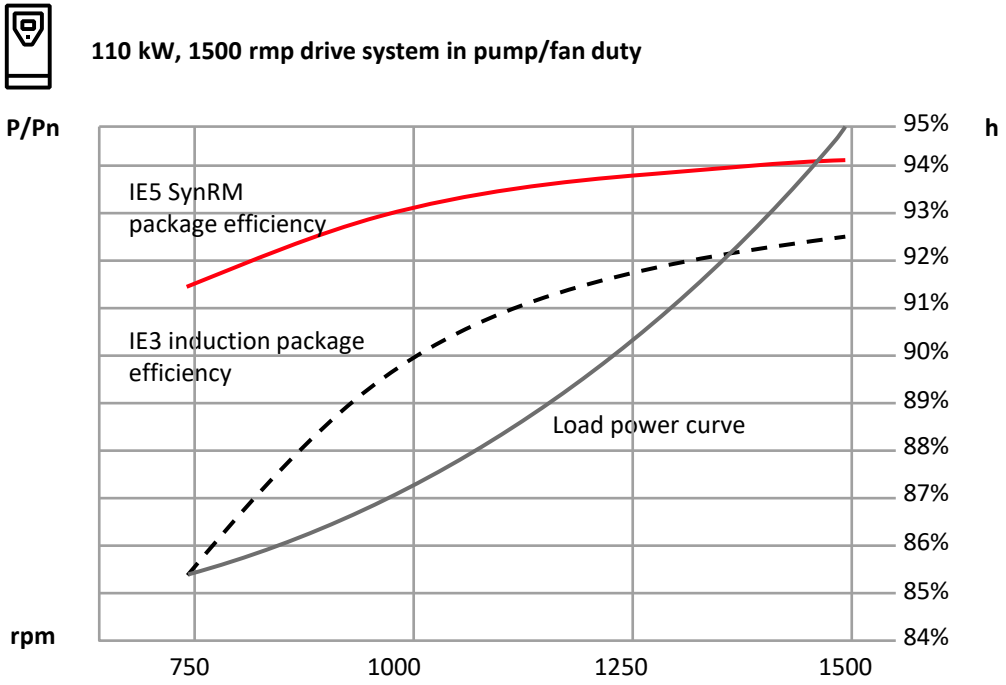
IE3 Induction motor

Losses



IE5 SynRM motor

SynRM are **highly efficient even at partial loads**



Example: For a 110 kW 1500 rpm drive system in pump/fan duty, with an IE3 induction motor the package efficiency is 92.5%, while for an IE5 SynRM motor the package efficiency is 94.2%.

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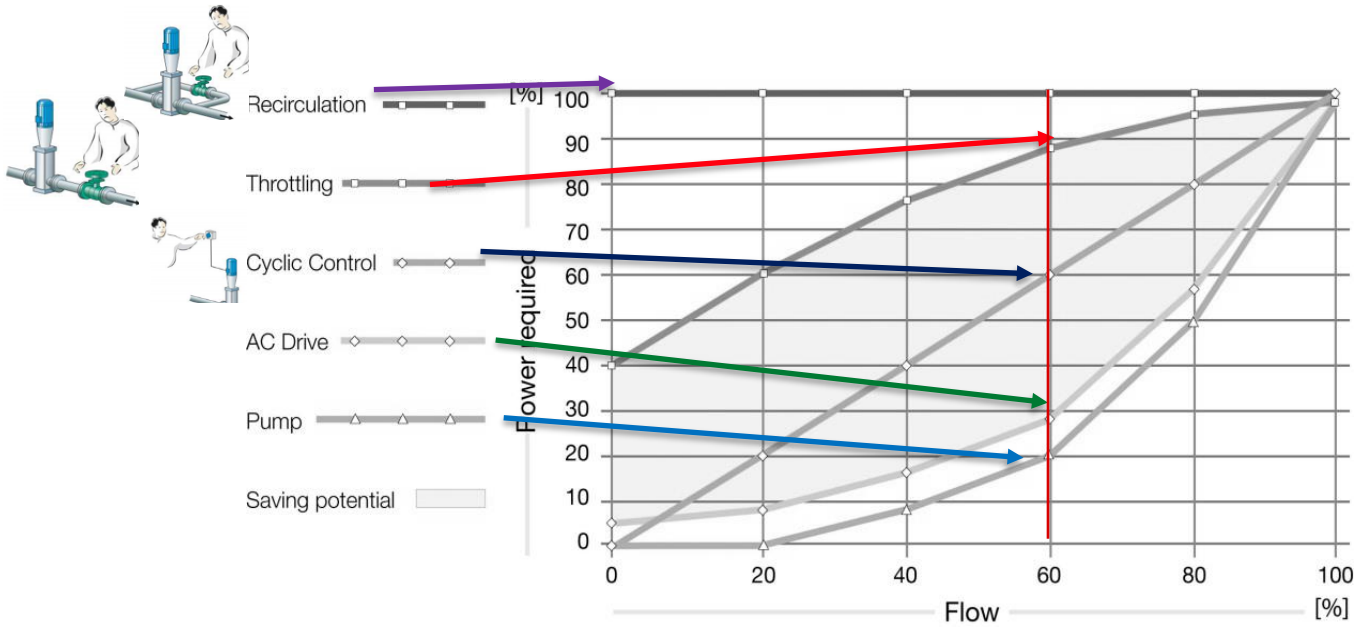
The underappreciated role of drives

With drive control
20% reduction
in speed only requires

51%

of the energy



- **Affinity Laws**

With Impeller Dia held constant

- Flow is proportional to shaft speed **Q1/Q2 = (N1/N2)**
- Pressure or Head is proportional to square of shaft speed **H1/H2 = (N1/N2)^2**
- Power is proportional to cube of shaft speed **P1/P2 = (N1/N2)^3**

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Domain expertise and energy efficiency

- **Customer:** Orchid Laminates Pvt. Ltd., a leading manufacturer of coated paper boards and laminate sheets in Bangalore, India
- **Solution:** Upgrade of existing **55KW 4P IE3 motor** for Pulper Mix Feed Pump run on direct on-line with **55KW 4P IE4 motor and ACS580 VFD**
- **Benefit:** **Energy saving of ~ 31%** resulting in **annual energy savings of 67MWh,** equivalent to providing enough charge for an **EV car to cover ~340,000 Kms**
- ROI **less than 2 years**

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The impact of ABB's high-efficiency motors in India

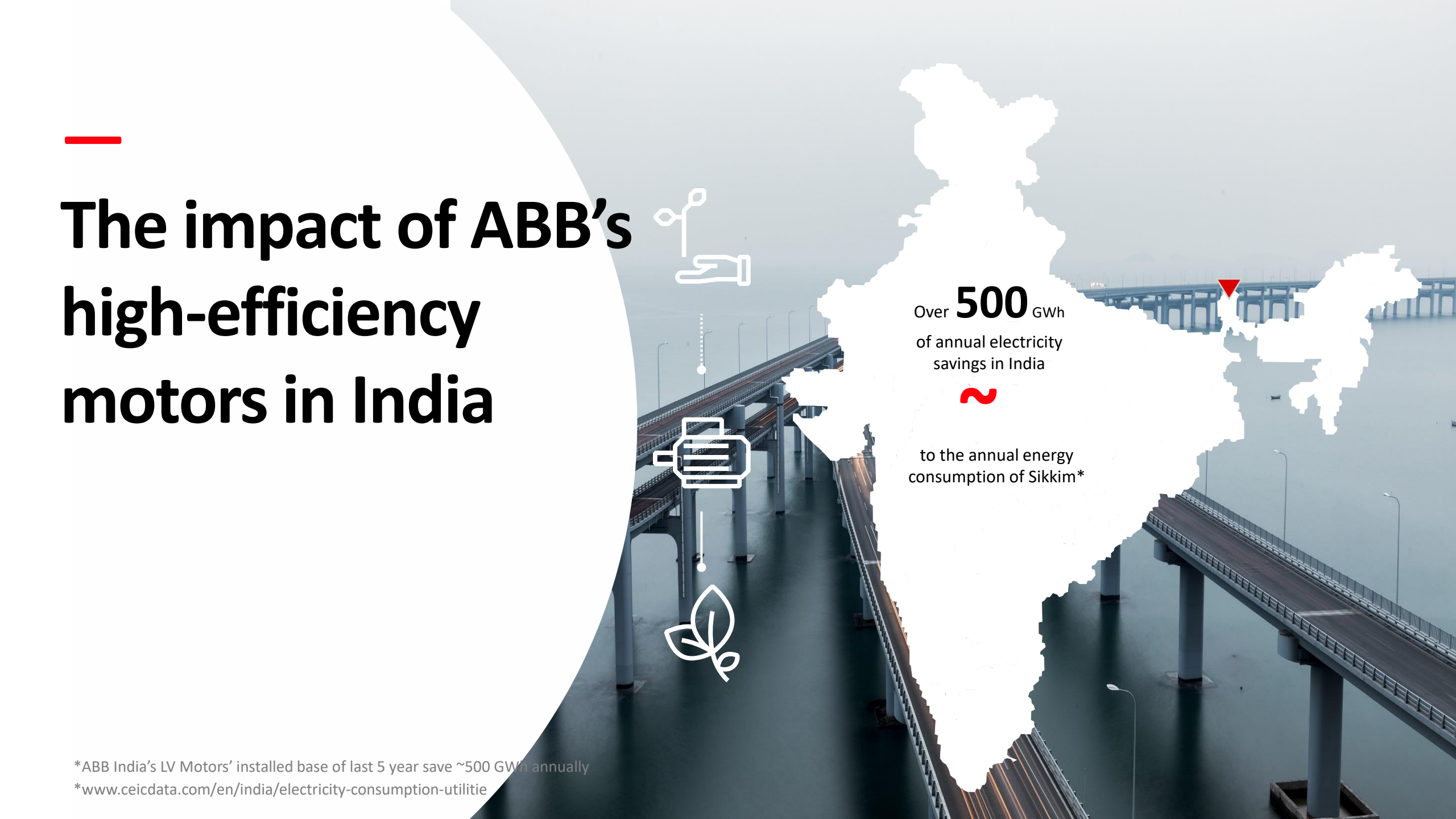


*ABB India's LV Motors' installed base of last 5 year save ~500 GWh annually

*www.ceicdata.com/en/india/electricity-consumption-utilitie

Role of energy appraisal and digitalization in energy saving

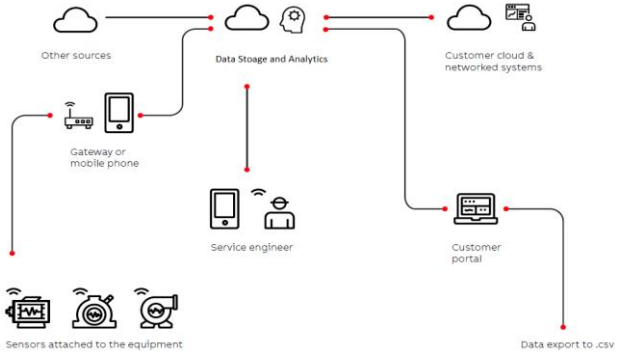
Get the facts straight

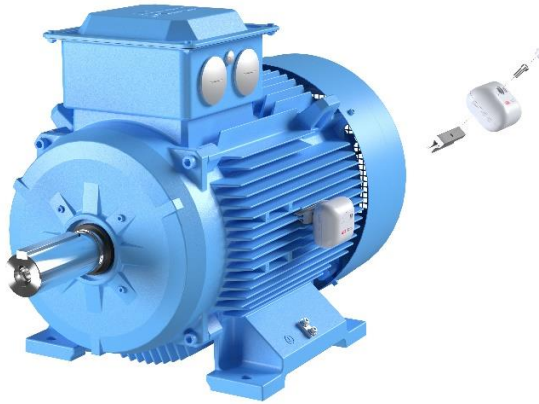
Audit

Analysis of historical energy consumption and the efficiency of equipment.

Connectivity

IIoT technologies can track energy flows show areas where energy can be saved





Data to the cloud

Moving data to the cloud and apply analytics to optimize how systems are operated and how much electricity they consume.

Health parameters

- Overall condition
- Overall vibration
- Bearing condition
- Skin temperature

Operating parameters

- Vibrations (radial, tangential, axial)
- Operating hours
- Number of starts

Additionally information for DOL motors

- Speed
- Operating power/ loading
- Energy consumption

Digital energy appraisal

Identifying saving potential in Waggeryd pulp mill

- ABB Ability™ Smart Sensors were installed in **93 motors** for digital energy assessment
- The results have helped Waggeryd to pinpoint places where additional energy savings can be made
- It identified those that have low operating efficiency, as well as others that are wrongly dimensioned and thus underutilized, contributing to waste of active and reactive energy.

September 15, 2023

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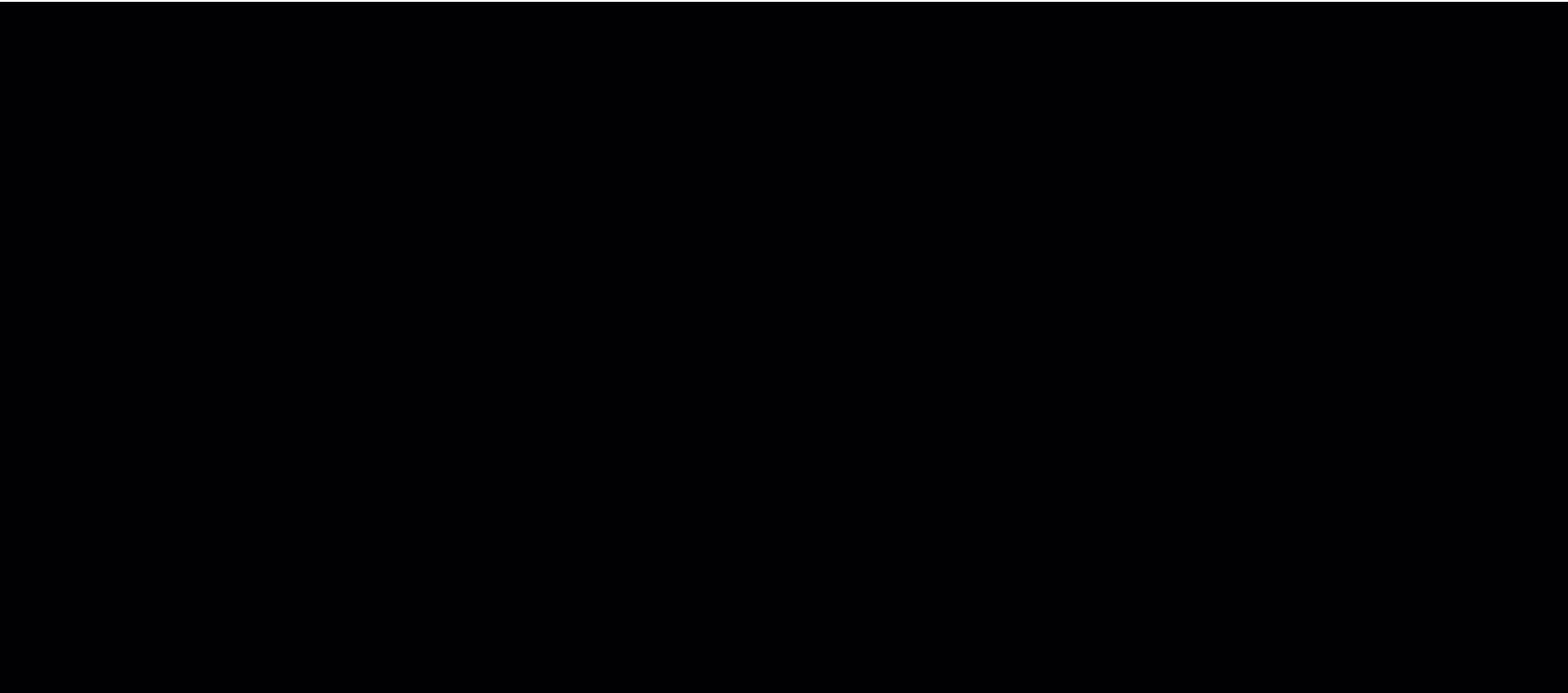
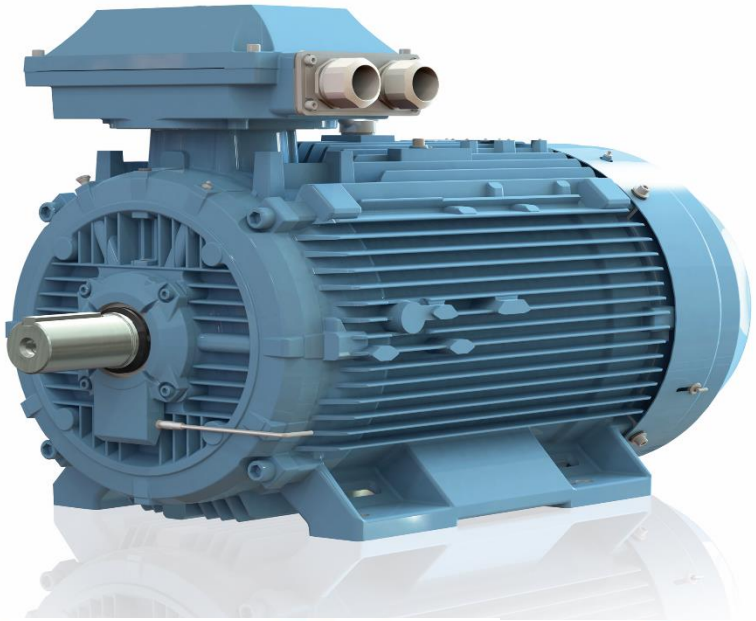
Digital energy appraisal

Identifying saving potential in Waggeryd pulp mill



Do larger motor ratings have better Energy Savings potential ?

Assume you have :
1 No. 75KW 4P IE1 motor **and 5 Nos** 15KW 4P IE1 motors
And you have budget to replace
either 1 No 75KW IE3 or 5 Nos 15KW IE3 motors



- 75KW 4P 50Hz motor – 1No

  IE1 92.7%, IE2 94%, **IE3 – 95%,** IE4 – 96%

- 15KW 4P 50Hz motor – 5 Nos

  IE1 88.7%, IE2 90.6%, **IE3 – 92.1%**, IE4 -93.9%

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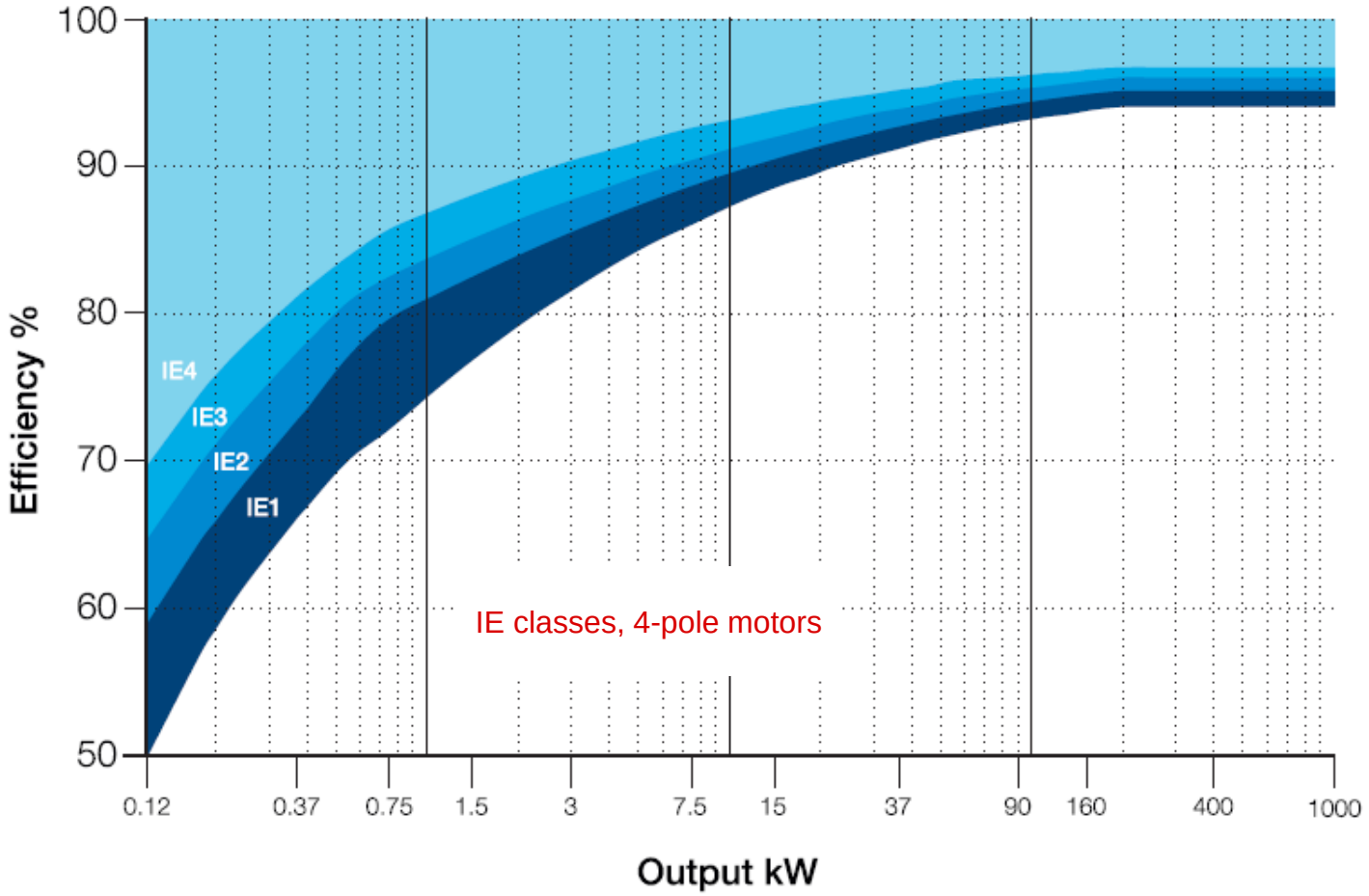
Do larger motor ratings have better Energy Savings potential ?



15KW 4P 50Hz motor

IE1 88.7%, IE2 90.6%, **IE3 91.5%,** IE4 93.9%

Savings IE1 to IE3 - 4530KWHr/Yr

5 Nos of 15KW – 22650 KWHr/Yr

Savings IE1 to IE4 - 8200 KWHr/Yr

5 Nos of 15KW – 41000 KWHr/Yr

75KW 4P 50Hz motor

IE1 92.7%, IE2 94%, **IE3 – 95%,** IE4 – 96%

Savings IE1 to IE3 - 17150 KWHr/Yr

Savings IE1 to IE4 - 24360 KWHr/Yr

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Join the Energy efficiency movement

Energy efficiency is not an if, it’s a must.
It is a simple and impactful solution to mitigate climate change. It’s the low-hanging fruit we need to bridge our path to a future where all energy is clean energy


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High efficiency brings more than just economic benefits

IE4 vs. IE2 -11kW 4-pole motor

3.5% efficiency increase

$P_{input\ 1}$ = 11kW/89.8% = 12.2 kW
$P_{input\ 2}$ = 11kW/93.3% = 11.7 kW

Losses reduced
12.2- 11.7=0.45 kW

P_{output} 11kW

11 kW motor application

Energy cost 10 INR per unit

Annual operating time, about of 7200 h

Annual energy savings:

0.45 kW x 7200 hrs = 3309 kWh

Annual electricity saving:

3309 kWh * 10 INR/ kWh = 33090 INR

Payback period of additional amount: **about 06 months**

Annual CO_2 reduction:

3309 *0.709= 2345 kg

Considering that over major cost of aoperating a industrial manufacturing setup comes from running machine, it makes good financial sense to make building energy efficient.

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