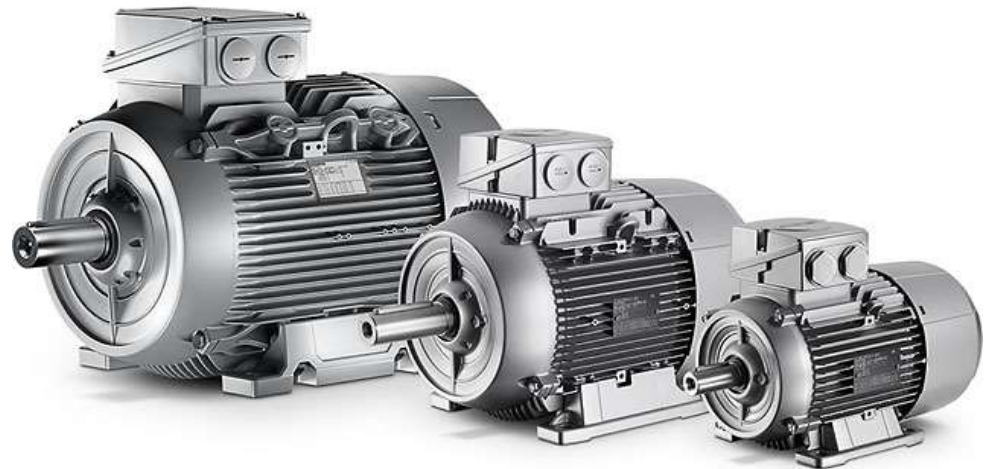


# Energy Efficient Motors

- Lokesh Sharma

at Spandan Hall, IOCL Township, Vadodara  
June 07, 2017



# International Copper Association & Copper Alliance

Cu

- Leading non profit organization for promoting the sustainable use of copper worldwide
- 26 Copper Alliance Centres World Wide
- 36 global-level member companies



COPPER ALLIANCE IS ACTIVE IN NEARLY 60 COUNTRIES

- |                    |                                  |
|--------------------|----------------------------------|
| Asia:              | Ghana:                           |
| Australia          | Greece                           |
| Bangladesh         | Hungary                          |
| Brazil, Durruti    | Italy                            |
| Canada             | Luemburg                         |
| China              | Netherlands                      |
| India              | Nigeria                          |
| Indonesia          | Poland                           |
| Japan              | Romania                          |
| Korea              | Russia                           |
| Malaysia           | Senegal                          |
| New Zealand        | Slovakia                         |
| Papua New Guinea   | South Africa                     |
| the Philippines    | Spain                            |
| Saudi Arabia       | Sweden                           |
| Singapore          | Ukraine                          |
| South Korea        | United Kingdom                   |
| Sri Lanka          |                                  |
| Taiwan             | Latin America and the Caribbean: |
| Thailand           | Argentina                        |
| The UAE            | Brazil                           |
| Vietnam            | Chile                            |
|                    | Colombia                         |
| Europe and Africa: | Dominican Republic               |
| Belgium            | El Salvador                      |
| Bulgaria           | Mexico                           |
| Spain              | Peru                             |
| Czech Republic     |                                  |
| Finland            | North America:                   |
| France             | Canada                           |
| Germany            | United States of America         |

# Indian Standards - Overview

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Indian government is actively doing energy conservation with the help of Indian Standards as under:

- A) IS 325 - Implemented in 1978
- B) IS 8789 - 3 phase Induction Motors efficiency
- C) IS 12615:2004 - Eff2: Improved Efficiency & Eff1: High Efficiency levels
- D) IS 12615:2011 - IE1 as standard efficiency  
IE2 as High efficiency  
IE3 as Premium efficiency

# QUALITY CONTROL ORDER

रजिस्ट्री सं० डी० एल०-33004/99

REGD. NO. D. L.-33004/99

  
**भारत का राजपत्र**  
**The Gazette of India**

असाधारण

EXTRAORDINARY

भाग II—खण्ड 3—उप-खण्ड (ii)

PART II—Section 3—Sub-section (ii)

प्राधिकार से प्रकाशित

PUBLISHED BY AUTHORITY

सं. 165]

नई दिल्ली, बुधवार, जनवरी 19, 2017/पौष 29, 1938

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**वाणिज्य और उद्योग मंत्रालय**

**(औद्योगिक नीति एवं संवर्धन विभाग)**

**आदेश**

नई दिल्ली, 18 जनवरी, 2017

**का.जा. 178(अ).**—भारतीय मानक ब्यूरो अधिनियम, 1986 (1986 का 63) की धारा 14 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए, केंद्र सरकार का भारतीय मानक ब्यूरो के साथ परामर्श करने के बाद यह मत है कि यह जनहित में आवश्यक एवं हितकर है, अतः एतद्वारा निम्नलिखित आदेश करती है, नामतः—

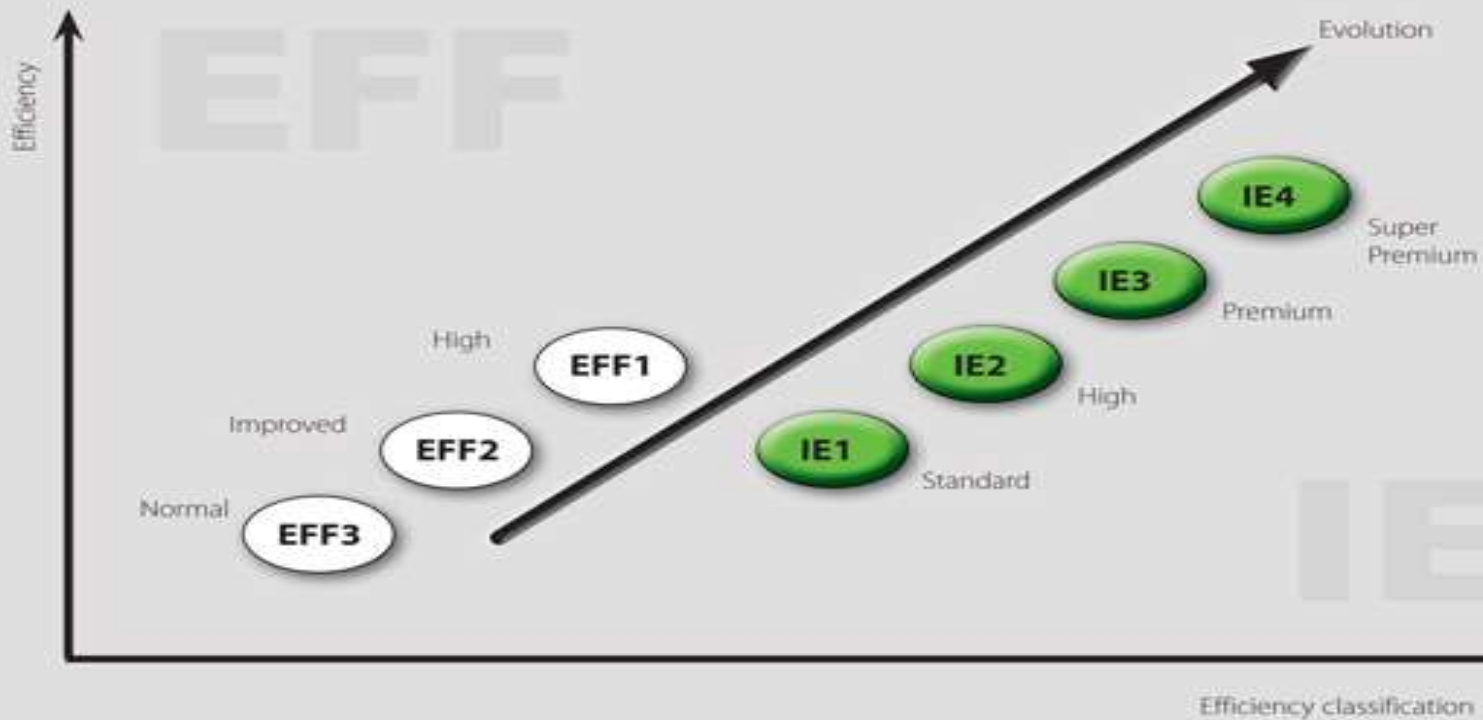
1. **संक्षिप्त शीर्षक एवं प्रारंभ-** (i) इस आदेश को ऊर्जा दक्ष इंडकेशन मोटर्स-श्री फेज स्क्वैरेल केज (गुणवत्ता नियंत्रण) आदेश, 2017 कहा जाएगा।  
(ii) यह आदेश दिनांक 01.10.2017 से लागू होगा।
2. **परिभाषा-** इस आदेश में जब तक कि संदर्भ के लिए अन्यथा अपेक्षा न हो—

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**As per this Quality control order by Gov. of India, Minimum energy performance standards for line operated 3phase induction motors in India shall be IE2 class applicable from 01<sup>st</sup> Oct 2017**

# EFFICIENCY CLASS OVERVIEW

## Efficiency class comparison



# Latest Developments in Indian Standards



- IS325 is withdrawn & has adopted IS/IEC60034-1
- For all S1 duty motors IS12615 is adopted i.e. IE2, IE3



IS12615:2011

Motor Technology Changes  
IE3 → IE4

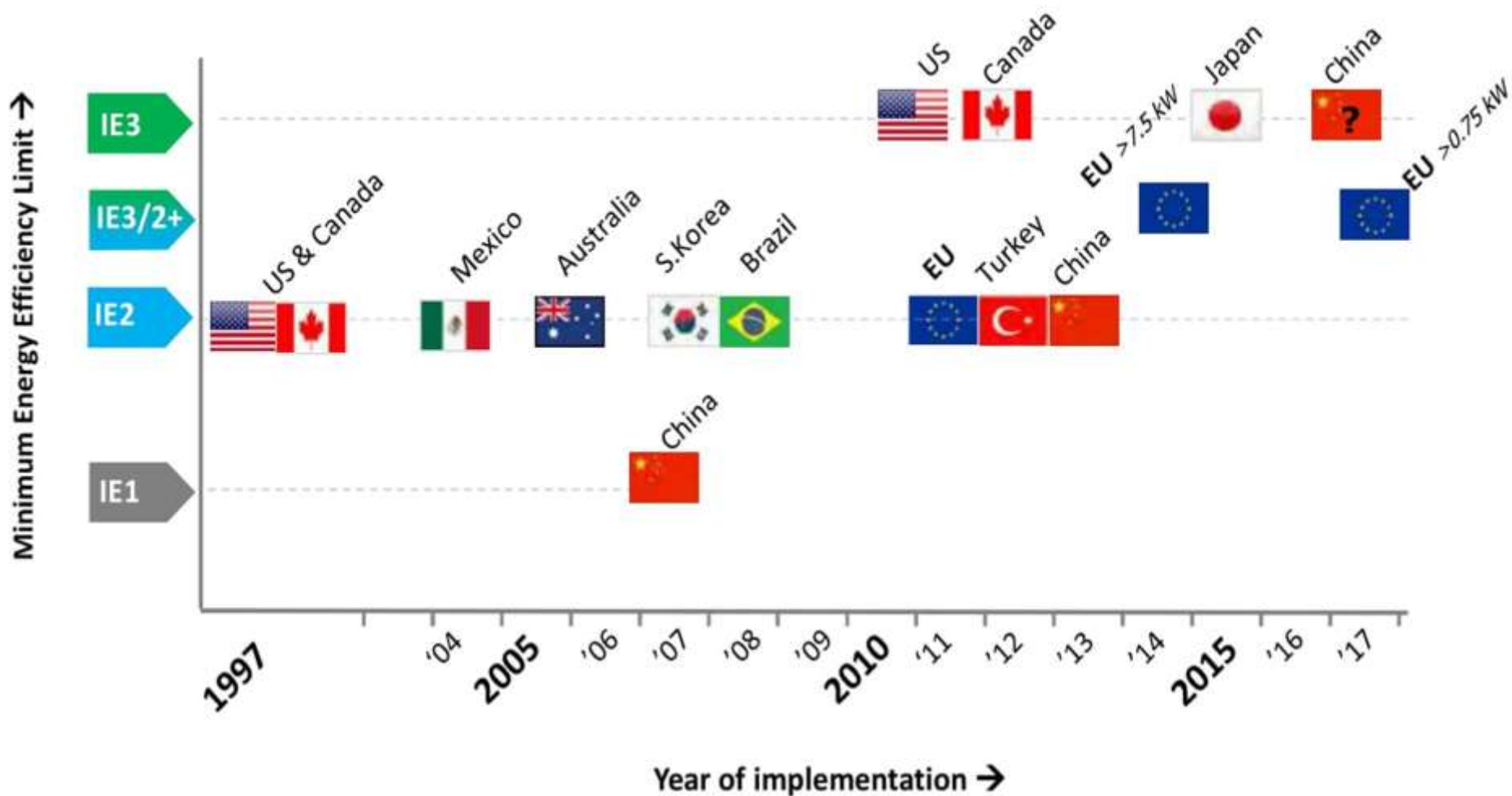
IEC 60034-30-1: 2014



PM Motor  
Or SRM –SynR  
Motor

IEC Commercial Motor Technology  
for IE4

# Industrial Motors, Minimum Energy Efficiency Legislation Worldwide





# LIFE CYCLE COST

## RUNNING COST VS PURCHASE COST

The cost of buying an electric motor can be deceptive;  
in a single year the cost of energy can  
be up to 10 times the purchase cost.  
Over the life of the motor it is by far the most significant cost.



# BENEFITS OF ENERGY EFFICIENT MOTORS

---

Cu

- Lower electricity consumption, leading to reduced electricity bills
- Almost constant efficiency between 65% to 100% load.
- Attractive low payback period
- Better tolerance to thermal and electrical stresses
- Better performance at higher temperature.
- Reduction of 'Greenhouse Gas' emissions



**Green Energy**

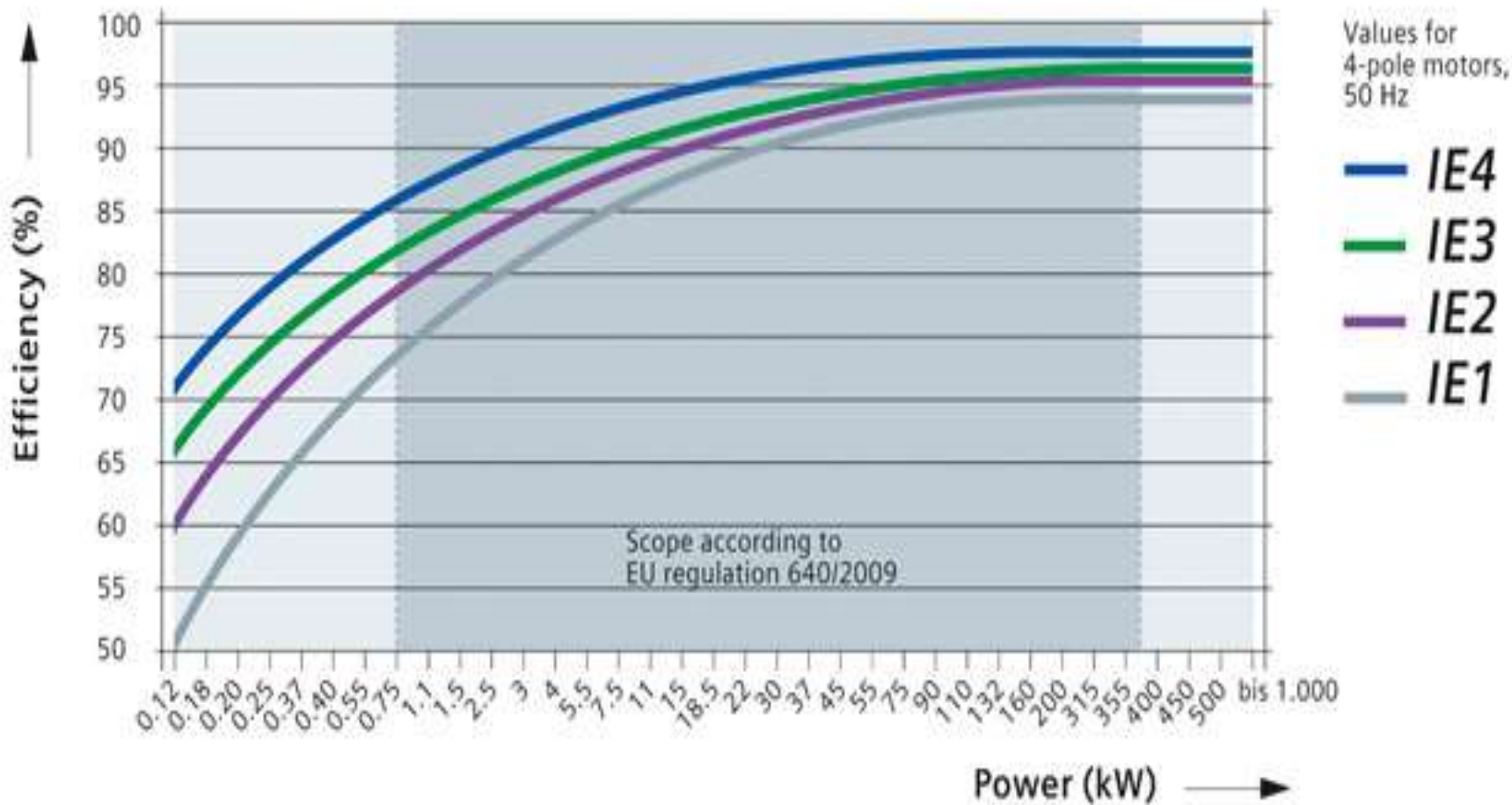


**IE3 PREMIUM MOTORS  
IE4 SUPER PREMIUM MOTORS**

# EFFICIENCY VALUES COMPARISON

Cu

kW	IE1 – Standard Efficiency			IE2 – High Efficiency			IE3 – Premium Efficiency		
	2-pole	4-pole	6-pole	2-pole	4-pole	6-pole	2-pole	4-pole	6-pole
0.75	72.1	72.1	70.0	77.4	79.6	75.9	80.7	82.5	78.9
1.1	75.0	75.0	72.9	79.6	81.4	78.1	82.7	84.1	81.0
1.5	77.2	77.2	75.2	81.3	82.8	79.8	84.2	85.3	82.5
2.2	79.7	79.7	77.7	83.2	84.3	81.8	85.9	86.7	84.3
3	81.5	81.5	79.7	84.6	85.5	83.3	87.1	87.7	85.6
4	83.1	83.1	81.4	85.8	86.6	84.6	88.1	88.6	86.8
5.5	84.7	84.7	83.1	87.0	87.7	86.0	89.2	89.6	88.0
7.5	86.0	86.0	84.7	88.1	88.7	87.2	90.1	90.4	89.1
11	87.6	87.6	86.4	89.4	89.8	88.7	91.2	91.4	90.3
15	88.7	88.7	87.7	90.3	90.6	89.7	91.9	92.1	91.2
18.5	89.3	89.3	88.6	90.9	91.2	90.4	92.4	92.6	91.7
22	89.9	89.9	89.2	91.3	91.6	90.9	92.7	93.0	92.2
30	90.7	90.7	90.2	92.0	92.3	91.7	93.3	93.6	92.9
37	91.2	91.2	90.8	92.5	92.7	92.2	93.7	93.9	93.3
45	91.7	91.7	91.4	92.9	93.1	92.7	94.0	94.2	93.7
55	92.1	92.1	91.9	93.2	93.5	93.1	94.3	94.6	94.1
75	92.7	92.7	92.6	93.8	94.0	93.7	94.7	95.0	94.6
90	93.0	93.0	92.9	94.1	94.2	94.0	95.0	95.2	94.9
110	93.3	93.3	93.3	94.3	94.5	94.3	95.2	95.4	95.1
132	93.5	93.5	93.5	94.6	94.7	94.6	95.4	95.6	95.4
160	93.8	93.8	93.8	94.8	94.9	94.8	95.6	95.8	95.6



# SAVINGS & PAYBACK CALCULATOR

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[cost benefit analysis.xlsx](#)

[Motor Calculator\motorsoft.exe](#)



# APPROACH TO AUDIT

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- ❖ Considering the importance to volume in lower ratings and higher efficiency increment, all old lower rating motors can be replaced based on “Desk-top audit”
- ❖ Considering the larger volumes and moderate increase in efficiency, the medium rating motors can be audited and replaced based on “ Field efficiency testing”
- ❖ Once the purchase decision is made and the new IE2 or IE3 motors are procured, then “Beta testing” for energy efficiency can be carried out to compare the old & new efficiencies on a uniform load









# Efficiency Correction & Estimated savings



## Revised motor efficiency with Stray loss loader as per IEC: 60034-2-1

Rated kW	Name plate efficiency (%)	Stary loss at 0.5% (kW)	Total loss (kW)	New stray loss SLL	Revised stray loss (kW)	Revised total loss (kW)	Revised Efficiency %
7.5	<b>87</b>	0.0375	1.121	2.20%	0.165	1.248	<b>85.73</b>

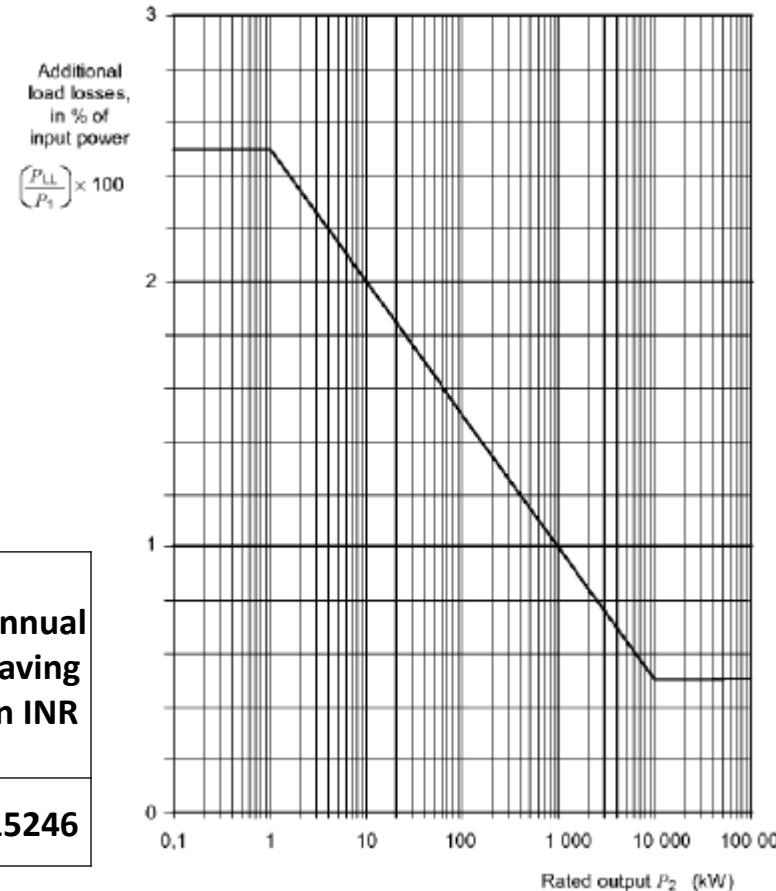
### How to calculate the savings from reduction in input power ?

The formula for calculating the savings in terms of units/hour is

$$\text{Rated output} \times \text{Load Factor} \times \left[ \frac{1}{\text{old Eff}} - \frac{1}{\text{new eff}} \right]$$

Example  $15 \times 75\% \times (1/0.89 - 1/0.925) = 0.85$  Units/hour

Annual savings  $0.85 \times 24 \text{ hours} \times 360 \text{ days} \times \text{Rs.}3.50 = \text{Rs}25704/-$



## Estimated energy saving with new IE3 motors

Rated power kW	Old Efficiency	New Efficiency	Load factor %	Energy saved- kWh	No of hours/ year	Annual saving in energy kWh	Tariff/ unit	Annual saving in INR
7.5	<b>85.73</b>	90.4	0.75	0.34	7500	2541	6	15246

# CASE STUDY

---

[IE3 motor- Energy Saving- HUL Pandy.pdf](#)

## Motor Energy Saving Calculator

Export

Reset All

## Motor Input

Enter the Parameters of the motor:

No. of Poles: 4

Rated RPM: 1,410

Power tariff (Rs/kwh): Rs.6

Rated output in kw: 15.0

Loading Factor: 80.00%

Name plate efficiency %: 88.70%

Frame Size: 160L

Utilization (Hrs/Year): 8,000

Estimated efficiency % Approx  
(As per IS15999) 88.70%

## Savings

Select star rating for the motor:  Star 1  Star 2  Star 3  Star 4  Star 5

Calculate Savings

4 Pole, 15.0 KW Motor, Star 3 with 92.1% efficiency

	Existing Motor	Star 3 Motor
Energy Used (kwh/yr)	108230	104235
Energy cost (INR/yr)	649380	625410

## Energy Savings

Energy savings (kwh/year): 3995

Energy cost savings (INR/year): 23970

## Lifecycle Savings

4 Pole, 15.0 KW Motor, Star 3 with 92.1% efficiency

	10 yrs	15 yrs
Energy savings (kwh)	39950	59925
Energy cost savings (INR)	239700	359550

## Payback Calculator

Approx. Price for 4 Pole, 15.0 KW Motor with Star 3 rating (INR) Rs.44,000

Simple Payback in Months 22

Calculate

Greenhouse (considering Approx. 850 grams CO2 per kWh)

Greenhouse gas emission reduced by 3.4 tonnes CO2/yr

# Inputs

Cu

## Motor Input

Enter the Parameters of the motor:

No. of Poles:

Rated RPM:

Power tariff (Rs/kwh):

Rated output in kw:

Loading Factor:

Name plate efficiency %:

Frame Size:

Utilization (Hrs/Year):

Estimated efficiency % Approx  
(As per IS15999)

## Input with Values

## Motor Input

Enter the Parameters of the motor:

No. of Poles:

Rated RPM:

Power tariff (Rs/kwh):

Rated output in kw:

Loading Factor:

Name plate efficiency %:

Frame Size:

Utilization (Hrs/Year):

Estimated efficiency % Approx  
(As per IS15999)

# SAVINGS

Cu

## Savings

Select star rating for the motor:  Star 1  Star 2  Star 3  Star 4  Star 5

[Calculate Savings](#)

4 Pole, 15.0 KW Motor, Star 3 with 92.1% efficiency

	Existing Motor	Star 3 Motor
Energy Used (kwh/yr)	108230	104235
Energy cost (INR/yr)	649380	625410

### Energy Savings

Energy savings (kwh/year):

Energy cost savings (INR/year):

## Lifecycle Savings

4 Pole, 15.0 KW Motor, Star 3 with 92.1% efficiency

	10 yrs	15 yrs
Energy savings (kwh)	39950	59925
Energy cost savings (INR)	239700	359550

# Payback Calculations

Cu

## Payback Calculator

Approx. Price for 4 Pole, 15.0 KW Motor with Star 3 rating (INR)

Simple Payback in Months

Calculate

## Greenhouse gas(GHG) emissions reduction

Greenhouse (considering Approx. 850 grams CO<sub>2</sub> per kWh)

Greenhouse gas emission reduced by 3.4 tonnes CO<sub>2</sub>/yr

# Motor Energy Saving Calculator

Export Reset All

## Motor Input

Enter the Parameters of the motor:

No. of Poles: 2

Rated RPM:

Power tariff (Rs/kwh):

Rated output in kw: 0.37

Loading Factor:

Name plate efficiency %:

Frame Size: 71

Utilization (Hrs/Year):

Estimated efficiency % Approx (As per IS15999)

## Savings

Select star rating for the motor:  Star 1  Star 2  Star 3  Star 4  Star 5

Calculate Savings

	Existing Motor	Star 1 Motor
Energy Used (kwh/yr)		
Energy cost (INR/yr)		

## Energy Savings

Energy savings (kwh/year):

Energy cost savings (INR/year):

## Lifecycle Savings

	10 yrs	15 yrs
Energy savings (kwh)		
Energy cost savings (INR)		

## Payback Calculator

Apply for Cu for 24 hrs, 0.37 kW Motor with star rating of

Simple Payback in Months

Calculate

Greenhouse (considering Approx. 850 grams CO<sub>2</sub> per kWh)

Can be Downloaded at [www.copperindia.org](http://www.copperindia.org)



# Adoption of Energy Efficient Motors

Saves

" Energy & Environment"



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# Thank you

For more information please contact

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**Email: [patoicpci@gmail.com](mailto:patoicpci@gmail.com)**