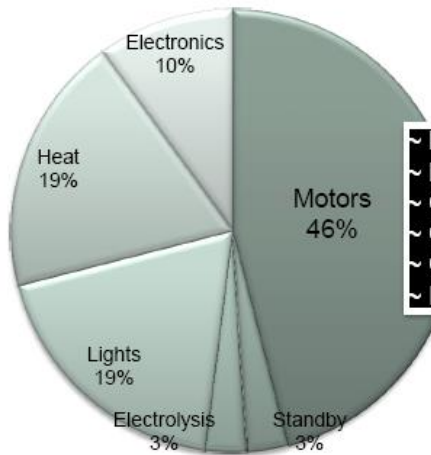


Super Premium Energy Efficient Motors – IE4 SynchroVERT - Permanent Magnet Synchronous Motors

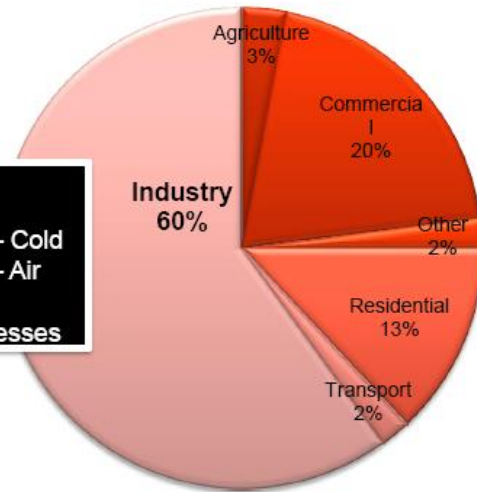
Global end use of Electricity



Global Electricity Usage by application



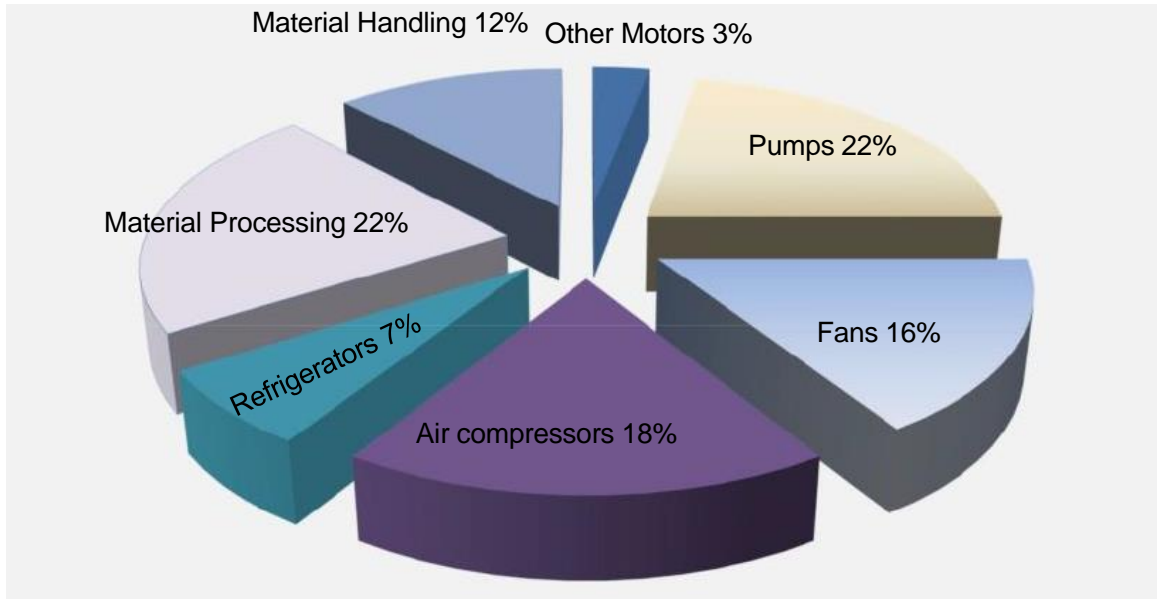
Electricity Usage By Sector



- ~ Pumps
- ~ Fans
- ~ Compressors – Cold
- ~ Compressors – Air
- ~ Conveyors
- ~ Industrial Processes

Motor Use 46% of Global Electricity


Motor Electricity consumption by End Use



Superiority of SynchroVERT Motor Over induction Motor

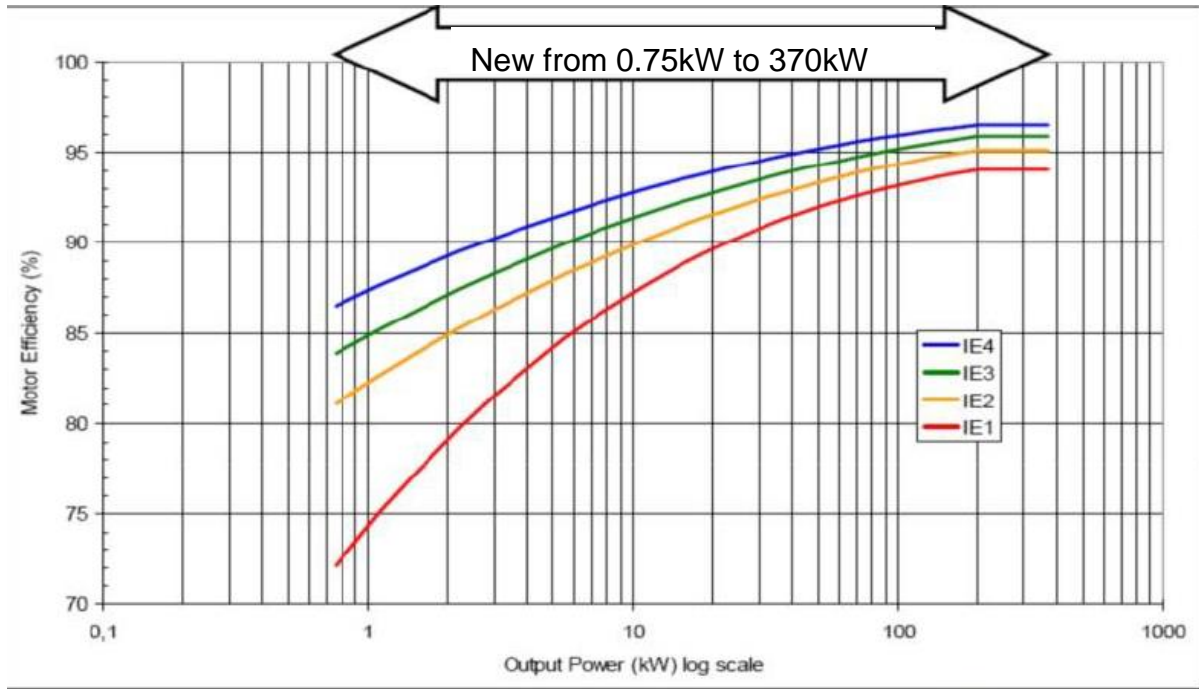
1. Line start PMSM motor also suitable for star delta & VFD Starting
2. Efficiency improvement up to 14%.
3. Temperature rise reduced up to 30deg C at full load which helps to sustain short time over load or at marginal drop in voltage
4. Motor full load current & Starting current is lower than IE1/IE2/IE3
5. Motor runs at 1500RPM which can give higher output with the same equipment
6. Efficiency drop nominal on partial load of 75% & 50%
7. Wide speed range suitability from 500RPM to 3000RPM at constant torque below rated KW & Constant HP above rated KW
8. With constant Speed operation even at lower voltage , head and discharge of pump/Air Quantity of air will be maintained unlike induction motor.

IE Efficiencies as per IEC 60034-30-1:2014

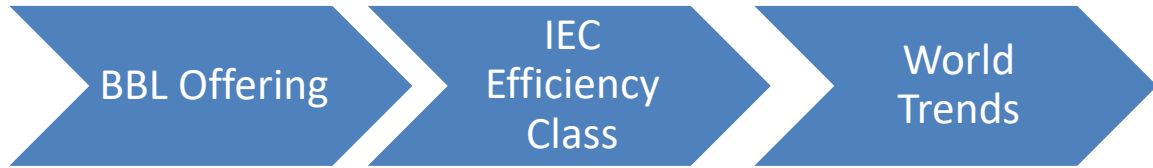


kW	Pole	Frame Size	IE1 Eff.	IE2 Eff.	IE3 Eff.	IE4 Eff .
1.5	4	112M	77.2	82.8	85.3	88.2
2.2		112M	79.7	84.3	86.7	89.5
3.0		112M	81.5	85.5	87.7	90.4
3.7		112M	82.6	86.3	88.4	90.9
5.5		132S	84.7	87.7	89.6	91.9
7.5		132M	86	88.7	90.4	92.6
11.0		160M	87.6	89.8	91.4	93.3
15.0		160L	88.7	90.6	92.1	93.9
18.5		180M	89.3	91.2	92.6	94.2
22.0		180L	89.9	91.6	93	94.5

IE Efficiencies as per IEC 60034-30-1:2014



Global Scenario



LSPM Super Premium
Efficiency 1.5kW to
22.0kW

PMSM with VFD
start being offered

IE4

Premium Efficiency Motors
0.75kW to 355kW

2010- USA, Canada
2015 – EU, Japan
2016 – China(PROC)

IE3

High Efficiency
0.37kW to 375kW

2010- KOREA
2011 – China(PROC)

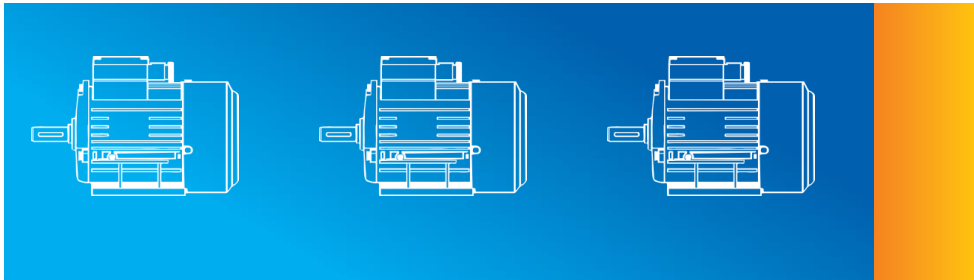
**High Efficiency
(IE2)**

Standard Motor
0.18kW to 315kW

**Standard Efficiency
(IE1)**



BBL's way for SynchroVERT Motors



- Bharat Bijlee has developed technology and designs for this type of motors (**Line start PM**)
 - Our motors use the Interior mounted magnets approach since these motors can operate at high speeds, whereas surface mounted magnets have limited speed range due to high centrifugal forces which can cause the magnets to fly off
 - There is no increase in frame size, and mounting dimensions are identical to standard IE1 or IE2 motors. Foot mounted (B3) and Flange mounted (B5) motors are available. 132 Frame can also be offered in Face mounting (B14)
 - Existing motors can be directly replaced by the new SynchroVERT motors
-

Types of PMSM: Surface Mounted V/s Interior Mounted

- Surface permanent magnet motors have the potential to have the highest torque density but you pay more because of the additional permanent magnet material, whereas one can get almost the same torque density with an IPM machine at a lower cost because you don't have to use permanent magnets get all your torque
- IPM configuration allows more control over the magnetization of the magnetic circuit



Selection of Magnets : Ferrite V/s Rare Earth

★★★★ = good

★★★ = medium

★ = poor

	Ferrite	Rare Earth
Adhesive force per volume	★	★★★★
Price	★★★	★
Price stability	★★★★	★
Temperature resistance	★★★★	★
Outdoor use/rust resistance	★★★★	★
Break resistance	★★★	★
Loss of adhesive force over time	★★★★	★★★★
Standard tolerances	★	★★★★
Uncomplicated transport	★★★★	★
Coercive field strength	★	★★★★
Aesthetics	★	★★★★



BBL's way for SynchroVERT Motors – Selection of Magnets

Temperature resistance

Ferrite magnets can be used at temperatures between $-40\text{ }^{\circ}\text{C}$ and $250\text{ }^{\circ}\text{C}$, while most neodymium magnets lose their magnetization permanently at a temperature of $80\text{ }^{\circ}\text{C}$. However, temperatures under $-40\text{ }^{\circ}\text{C}$ are no problem for neodymium magnets

Adhesive force per volume

Ferrite magnets are much weaker than neodymium magnets of the same volume. Neodymium is therefore the preferred material when you have little space available and the end product needs to be fairly light

Price

On the one hand, ferrite material only costs a fraction of the NdFeB material. On the other hand, a neodymium magnet has an adhesive force that is about 8 to 10 times higher than that of a comparable ferrite magnet, Ferrite magnets are about 2 to 3 times cheaper than neodymium magnets. This is especially true for block or ring magnets and for larger quantities. The cost advantage is only then relevant, however, if weight and size do not matter, because the ferrite magnet is much heavier and larger than a neodymium magnets with the same adhesive force.

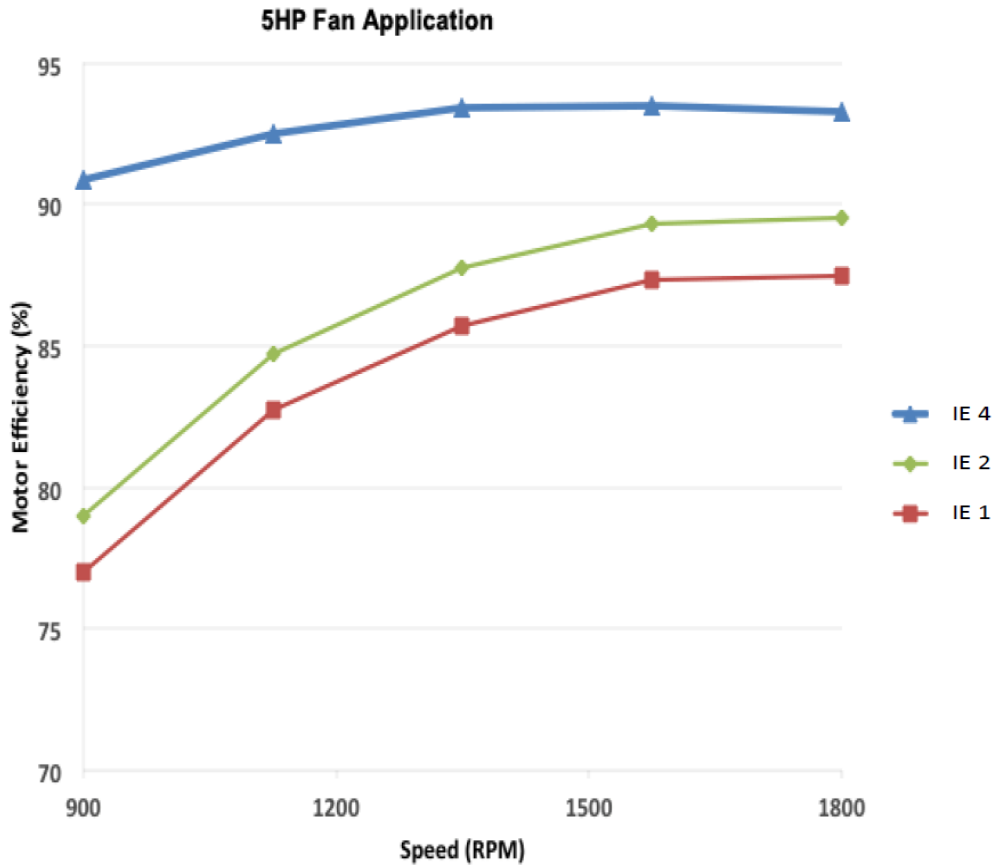


Efficiency Improvement Measures

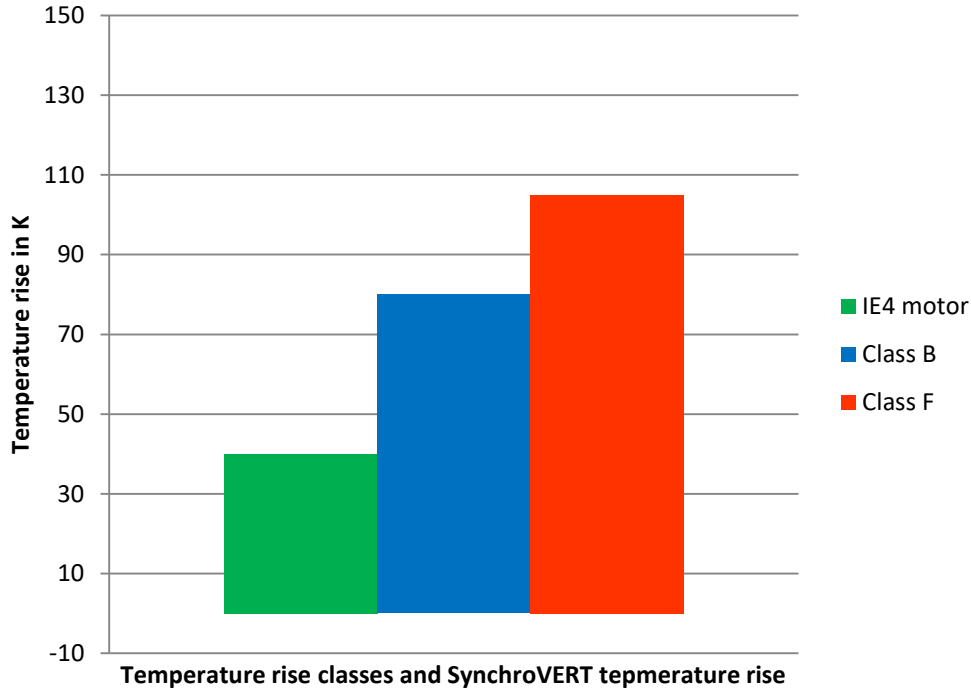
- Stator & Rotor Stamping:
 - Improved Slot design, Slot Combination and optimum ID/OD ratio
 - Better Quality Laminations for Low watt loss
 - Thin Laminations
 - More steel for core by using longer core lengths
 - More copper for the conductor
- Change in Fan:
 - Fan and fan cover designed for maximum cooling
 - Smaller Fans- Takes less power
 - Lower Temperature rise(60 °C)
- Use of Magnets in rotors:
 - Loss less excitation
 - Nickel Plated magnets to avoid corrosion problems
 - High Temp magnets selected
- Process Improvement:
 - Grinding process implemented for Rotors
 - VPI Done for all windings
 - DC wire for all windings



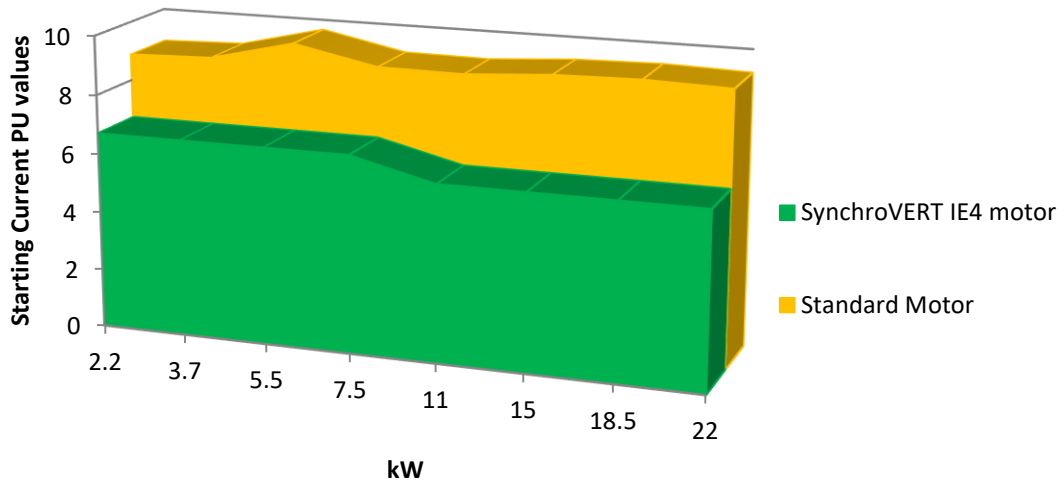
Advantages of our LSPM SynchroVERT Motor



Advantages of our LSPM SynchroVERT Motor



Advantages of our LSPM SynchroVERT Motor



Performance Comparison of 15kW/4 Pole motor



	IE1	IE2	SynchroVERT
Frame	160L		
Speed	1450	1465	1500
Current	27.6	27.1	25.4
Rated Torque	10.08	9.97	9.74
Power Factor	0.84	0.85	0.88
Efficiency	88.7	90.6	93.9
Starting current	600%	700%	600%
Starting torque	210%	240%	240%
Temperature Rise	68	68	51

Payback

Payback Period calculation SynchroVERT v/s IE1

kW	3.7	5.5	7.5	11.0	15.0	18.5	22.0
IE1 % Nominal Efficiency	82.7	84.7	86.0	87.6	88.7	89.3	89.9
SynchroVERT Motor % Nominal Efficiency	90.9	91.9	92.6	93.3	93.9	94.2	94.5
Selling Price for IE1. in Rs.	8,224	11,332	13,230	21,183	26,324	35,482	39,560
Selling Price for SynchroVERT Motor in Rs.	23,925	30,906	36,081	53,925	67,005	83,865	93,510
Working hours per year (H)	6000	6000	6000	6000	6000	6000	6000
Tariff (T) in Rs/kWh	9.0	9.0	9.0	9.0	9.0	9.0	9.0

Calculation of Payback if SynchroVERT motor is used instead IE1 motor (Based on nominal Eff)

Energy Saving per year in kWh	2428	3052	3729	4603	5619	6466	7147
Energy Saving per year in Rs.	21,853	27,472	33,565	41,426	50,571	58,191	64,325
Additional Purchase Price in Rs.	15,701	19,574	22,851	32,742	40,681	48,383	53950
No. of years	0.72	0.71	0.68	0.79	0.80	0.8 3	0.84
No. of months	8.6	8.6	8.2	9.5	9.7	10.0	10.1



Payback

Payback Period calculation SynchroVERT v/s IE2

kW	3.7	5.5	7.5	11.0	15.0	18.5	22.0
IE2% Nominal Efficiency	86.3	87.7	88.7	89.8	90.6	91.2	91.6
SynchroVERT Motor % Nominal Efficiency	90.9	91.9	92.6	93.3	93.9	94.2	94.5
Selling Price for IE2 in Rs.	9,497	13,137	15,355	25,031	31,109	40,531	44,751
Selling Price for SynchroVERT Motor in Rs.	23,925	30,906	36,081	53,925	67,005	83,865	93,510
Working hours per year (H)	6000	6000	6000	6000	6000	6000	6000
Tariff (T) in Rs/kWh	9.0	9.0	9.0	9.0	9.0	9.0	9.0

Calculation of Payback if SynchroVERT motor is used instead IE2 motor (Based on nominal Eff)

Energy Saving per year in kWh	1,302	1,720	2,137	2,757	3,491	3,876	4,422
Energy Saving per year in Rs.	11,716	15,477	19,230	24,814	31,420	34,885	39,800
Additional Purchase Price in Rs.	14,428	17,769	20,726	28,894	35,896	43,334	48,759
No. of years	1.23	1.15	1.08	1.16	1.14	1.24	1.23
No. of months	14.8	13.8	12.9	14.0	13.7	14.9	14.7



Criteria for SynchroVERT Motor consideration

1. Annual motor running over 4000 hrs.
2. Motor already rewind once
3. Age of motors > 10 Years
4. If O/P is controlled by mechanical equipment such as dampener
5. If used on constant torque load then 3% extra output with synchronous speed can be achieved
6. If Power tariff rate is above Rs: 7/- and partial usage on DG-Set
7. In air-conditioned areas to reduce load on system as these motors run with 10 Deg lower temp rise
8. Multiple motors without encoder in open loop can be used

CASE STUDY TAJ HOTEL-MUMBAI



Application-GD Exhaust
Motor Rating-22kW-4Pole-415V-TEFC-B3
Coupling-Pulley Driven
Change over from IE1 to IE4

CASE STUDY TAJ HOTEL-MUMBAI

GD exhaust		
	Existing motor	BBL SynchroVERT IE4 motor
kW	22kW	22kW
RPM	1475	1500
Site Voltage	~400V	~400V
Efficiency	92	94.5
Power Factor	0.84	0.86
Actual current (R phase)	18.5	16.8
Actual current (Y phase)	18.8	17.2
Actual current (B phase)	18.8	17.7
Average phase current	18.7	17.2
Line current	32.4	29.8
Reduction in line current	2.5Amps	
Calculated Power	18.8	17.8
Reduction in power kW	1.065	
Energy saving for 8760Hrs running kWh	9327	

CASE STUDY TAJ HOTEL-MUMBAI

Payback Period calculation	
Application	GD Exhaust
Rating (kW)	22
Existing motor Nom Eff	92
IE4 % Nom Eff	94.5
Buyback of existing motor	0
Selling Price for IE4	93,500
Working hours per year (H)	8760
Tariff (T) in Rs/kWh	11
Tariff (T) in Rs/kWh with CAGR	22.9
Energy Saving per year in kW	9,327
Energy Saving per year in Rs.	102,597
Energy Saving in life time in kW	139,905
Energy saving in life time in Rs Lac	15.39
Enewrgy saving in life time with annual increase in tariff rate in Rs	32
IE4 Incremental cost over IE1	93,500
Pay Back in No. of years	0.91
Pay Back in No. No. of months	10.9
CAGR-Compound Annual Growth Rate	

CASE STUDY –GODREJ-3.7kw

Energy Study details at Godrej Industries Limited

Date of Visit: 10th and 11th Sept.2015

Place of Visit: Godrej Industries Ltd.,

Burjorjinagar, Plot No. 3, Village Kanerao,

Taluka - Valia, Dist. Bharuch, Gujarat - 393 135

Motor Name Plate Details

Sl No.	Description	STANDARD MOTOR	IE4 MOTOR
1	Make	Kirloskar	BBL
2	kW, Rating	3.70	3.70
3	Machine No	91PC98-4	K1515987
4	Frame	ekh1325.	1325
5	Full Load Current	7.60	6.50
6	Line Voltage	415	415
7	Efficiency	80.00%	90.90%
8	Power Factor	--	0.87
9	Speed/Hz/Amb.	1440/50/45	1500/50/50
10	Conn / End	Δ / IP:55	Δ / IP:55

Sl No.	Time	STANDARD MOTOR					IE4 MOTOR					
		C & S Energy Meter Reading	Line Current in amps	Line Voltage in Volts	Energy in kWh	As per basic formula kWh	Time	C & S Energy Meter Reading	Line Current in amps	Line Voltage in Volts	Energy in kWh	As per basic formula kWh
1	11.40 am	5.327	6.52	433	--	--	11.43 am	21.07	3.58	432	--	--
2	12.40 pm	9.449	6.46	427	4.122	3.918	11.48 am	21.28	3.59	432	2.520	2.444
3	01.40 pm	13.480	6.35	431	4.031	3.887	12.13 pm	22.34	3.50	432	2.544	2.383
4	02.40 pm	17.600	6.50	430	4.120	3.970	12.43 pm	23.66	3.52	431	2.640	2.391
5							01.13 pm	24.95	3.49	430	2.580	2.365
6							02.13 pm	27.53	3.55	431	2.580	2.412
7							02.43 pm	28.81	3.50	431	2.560	2.378
	Average Reading		6.46	430	4.091	3.925	--	--	3.533	431	2.571	2.396
	Reading Taken by NANOVIP Harmonic analyser											

CASE STUDY –GODREJ-3.7kw

SI No.	Description	STANDARD MOTOR	IE4 MOTOR
1	Line Current in Amps	6.50	3.65
2	Line Voltage	432	432.00
3	Power in kW.	4.01	2.48
4	Power factor	0.82	0.91
5	kVAR.	2.76	1.12
6	kVA.	4.85	2.67
7	Hz	49.8	49.9
8	Temperatur Details		
9	DE Side	52.0 Deg C	42.0 Deg C
10	Middle	50.8 Deg C	44.0 Deg C
11	NDE Side	34.6 Deg C	35.0 Deg C
12	Amb.	34.1 Deg C	34.0 Deg C
13	Starting Method	DOL	DOL
14	Application:	Cooling Tower Water Pump.	Cooling Tower Water Pump.
15	Line No:	5G6B 4RB	5G6A 7FB
Pay Back Period Calculation:			
SI No.	Description	STANDARD MOTOR	IE4 MOTOR
1	Energy Consumption Per Hour	4.091	2.571
2	Working Hours per Year	8760	8760
3	Tariff in Rs/kWh	7.00	7.00
4	Energy Cost per Year	250860.12	157633.28
5	Energy Cost Saving per Year by using IE4 Motor	--	93226.84
6	STD Motor Cost in Rs.	7725.00	
7	IE4 Motor Cost in Rs.	23800.00	
8	Pay Back Period in Months	2.1	

CASE STUDY –GODREJ-5.5kw

Sl No.	Description	STANDARD MOTOR	IE4 MOTOR
1	Line Current in Amps	7.40	Not taken due to meter faulty
2	Line Voltage	433	
3	Power in kW.	3.98	
4	Power factor	0.72	
5	kVAR.	3.84	
6	kVA.	5.53	
7	Hz	49.8	
8	Temperatur Details	--	--
9	DE Side	--	--
10	Middle	--	--
11	NDE Side	--	--
12	Amb.	--	--
13	Starting Method	DOL	DOL
14	Application:	Glycerin Pumping	Glycerin Pumping
15	Line No:	4G3A 5FA	4G3B 6RB
Pay Back Period Calculation:			
Sl No.	Description	STANDARD MOTOR	IE4 MOTOR
1	Energy Consumption Per Hour	4.235	3.950
2	Working Hours per Year	8760	8760
3	Tariff in Rs/kWh	7.00	7.00
4	Energy Cost per Year	259690.20	242214.00
5	Energy Cost Saving per Year by using IE4 Motor	--	17476.20
6	STD Motor Cost in Rs.	9810	
7	IE4 Motor Cost in Rs.	28433	
8	Pay Back Period in Months	12.8	

CASE STUDY –ADITYA BIRLA

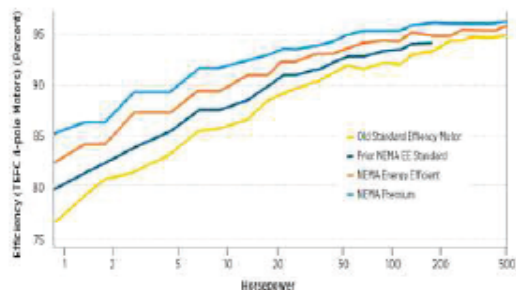


Success with IE-4 Motors



Cooling Water Pump C: IE 4 Motor

Power Before @ 1440 RPM(KW)	92.6
Power After @ 1440 RPM(KW)	82.4
Saving (KW)	10.2
Saving Per Day Units	244.8
Savings Per Annum @ 360 Days	88128
Savings Per Annum @ Rs 6.3 Per unit	555206.4



Catholyte Pump C: IE 4 Motor

Power Before	18.5
Power After	16.9
Saving (KW)	1.6
Saving Per Day Units	38.4
Savings Per Annum @ 360 Days	13824
Savings Per Annum @ Rs 6.3 Per unit	87091.2

CASE STUDY –GAJJAR HOTELS

N. M. GAJJAR HOTELS PVT. LTD.

Ref. No.

Date :

06/05/2016

To,

Sunrise Marketing & Services

Surat.

Sub: Appreciation Letter.

Dear Sir,

We are happy to inform you that we have 8 nos. BBL make IE 4 Efficiency level motors of rating 5.5 k.w are installed in our factory from last Four Months. With installation of these motors we have been able to get good energy Savings.

These all motors are running with L & T make VFD. At present we don't have any performance related issues and the motors are in operation and running satisfactorily.

For N.M. GAJJAR HOTELS PVT. LTD.

સુરત મોટર્સ સર્વિસ

TFO APPLICATION



Application-TFO

Sector-Textile Surat

Motors Rating
3.7KW to 7.5KW

Qty-700Nos

Payback Period
Reported 8-9months

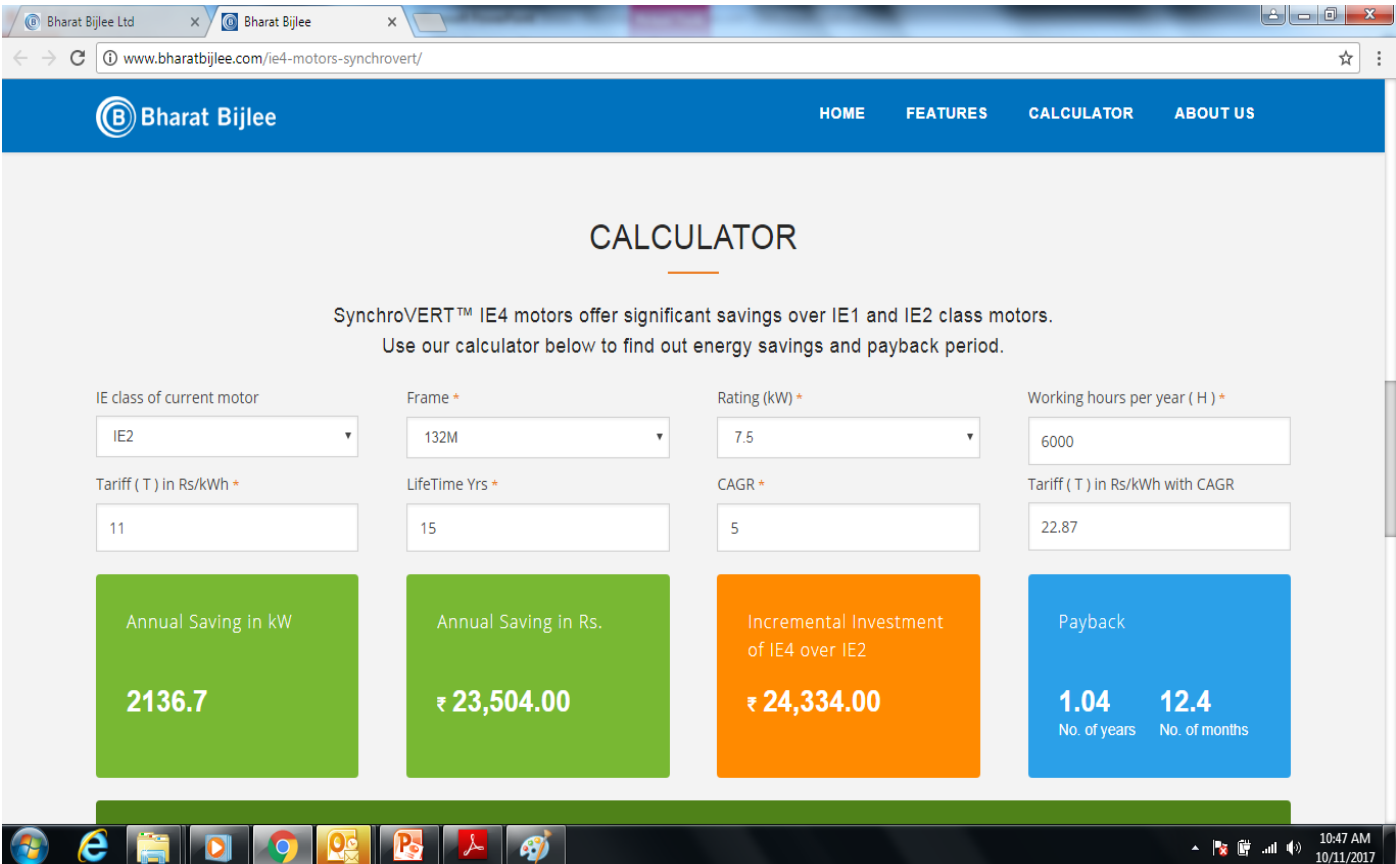
EXECUTED PROJECTS LIST



ONLINE-CALCULATOR

<http://www.bharatbijlee.com/ie4-motors-synchrovert/>

SAMPLE-CALCULATOR



The screenshot shows a web browser window with the URL www.bharatbijlee.com/ie4-motors-synchrovert/. The page features a blue navigation bar with the Bharat Bijlee logo and links for HOME, FEATURES, CALCULATOR, and ABOUT US. The main heading is "CALCULATOR". Below it, a text block states: "SynchroVERT™ IE4 motors offer significant savings over IE1 and IE2 class motors. Use our calculator below to find out energy savings and payback period." The calculator interface consists of several input fields and four result boxes. The input fields are: "IE class of current motor" (IE2), "Frame" (132M), "Rating (kW)" (7.5), "Working hours per year (H)" (6000), "Tariff (T) in Rs/kWh" (11), "LifeTime Yrs" (15), "CAGR" (5), and "Tariff (T) in Rs/kWh with CAGR" (22.87). The result boxes are: "Annual Saving in kW" (2136.7), "Annual Saving in Rs." (₹ 23,504.00), "Incremental Investment of IE4 over IE2" (₹ 24,334.00), and "Payback" (1.04 No. of years, 12.4 No. of months). The Windows taskbar at the bottom shows the time as 10:47 AM on 10/11/2017.

Input	Value
IE class of current motor	IE2
Frame	132M
Rating (kW)	7.5
Working hours per year (H)	6000
Tariff (T) in Rs/kWh	11
LifeTime Yrs	15
CAGR	5
Tariff (T) in Rs/kWh with CAGR	22.87

Result	Value
Annual Saving in kW	2136.7
Annual Saving in Rs.	₹ 23,504.00
Incremental Investment of IE4 over IE2	₹ 24,334.00
Payback	1.04 No. of years, 12.4 No. of months

CII-CERTIFICATE



Confederation of Indian Industry

**17th National Award for
Excellence in Energy Management 2016**

This is to certify that product

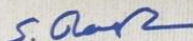
3 PHASE LINE START PERMANENT MAGNET MOTOR - 1e4

offered by

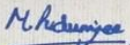
BHARAT BIJLEE, MUMBAI

Has been rated as "Most Innovative Energy Saving Product"

*This is based on the feedback of participants at the National Competition for
Excellence in Energy Management held on 22,23 & 24 August 2016 at Hyderabad*



S RAGHUPATHY
Deputy Director General
Confederation of Indian Industry



MEHER PUDUMJEE
Chairperson - Energy Efficiency Council
CII - Godrej GBC



Dr A R K RAO
Co-Chairman
National Award for Excellence
in Energy Management 2016

CII-TROPHY



CII-SUMMIT-2016





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