

Session: Motors , Drives & Lighting



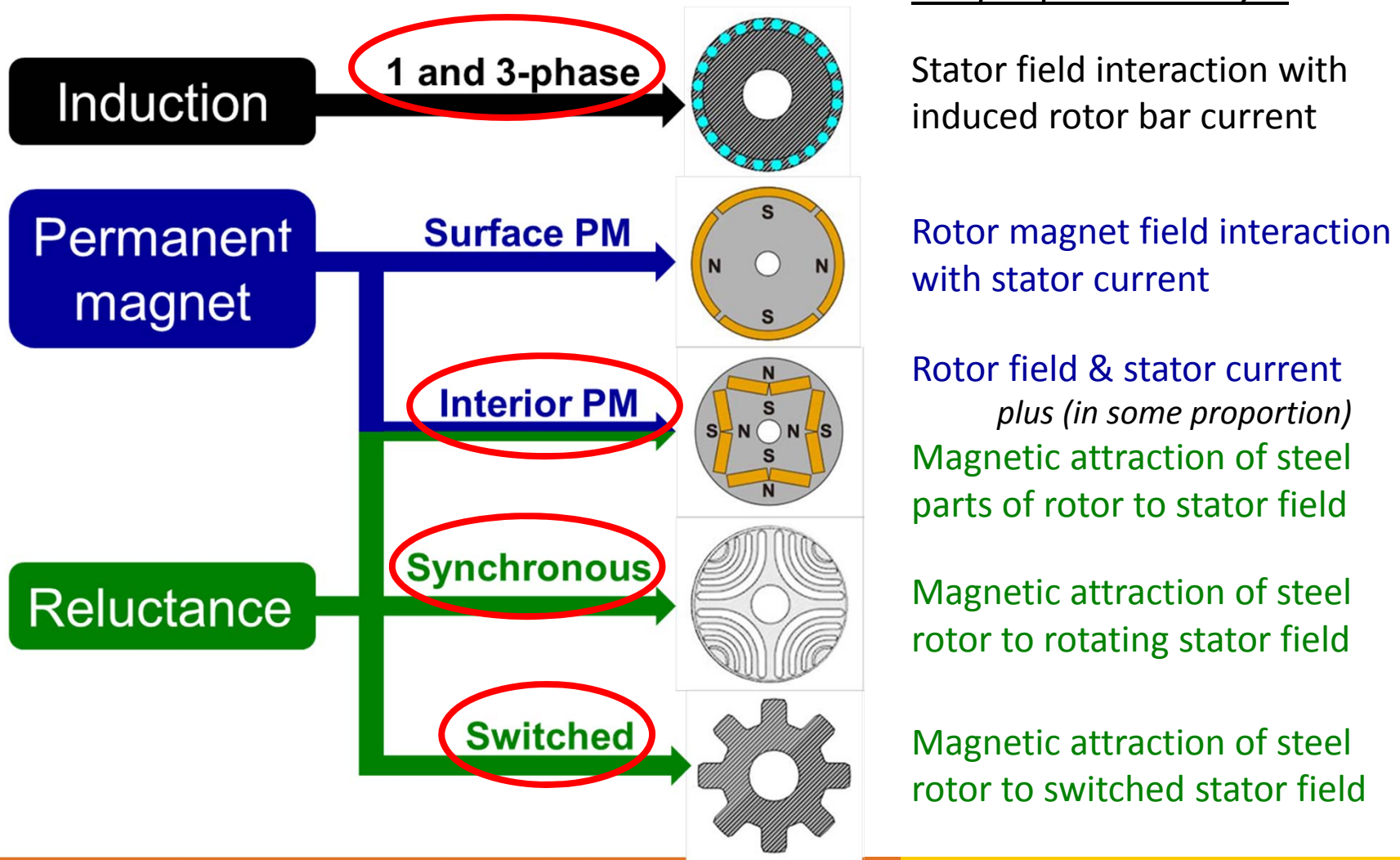
Commercial-Industrial Electric Motors

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Nidec Motor Corporation
August 9, 2016

Key topics

- Basic Types of Electric Motors (AC Induction, DC, ECM, Switched Reluctance, Synchronous Reluctance.)
- Motor use and energy saving opportunity
- How to Read a Nameplate
- Motor Efficiency Terms (Standard Efficiency, Nominal, Premium, etc.) Motor Slip
- Relationship of Efficiency, Speed & Load
 - Efficiency vs energy savings
- Motor Performance vs Motor with drive system performance
- Current motor regulations summary
- Actions you can take to save energy * Repair, retro-fit, replace, or convert?

Principal classes of motor types for commercial and industrial applications



STEEL

ALUMINIUM

MAGNET

Energy Exchange: Federal Sustainability for the Next Decade

What can you do to save energy ?

- Motors are what?
 - Typical motors in use
 - Electrical considerations
 - Mechanical considerations
- What's important –what's not ?
- Making good decisions
- What could I expect save?
 - Power use a hidden cost
- Who can help me save energy?
 - People and information in the supply chain
- What actions should I consider?
 - New equipment – retrofit and repair



An Electro – Mechanical Device

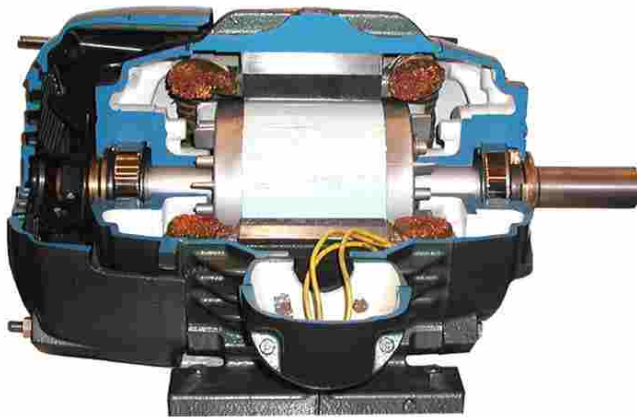
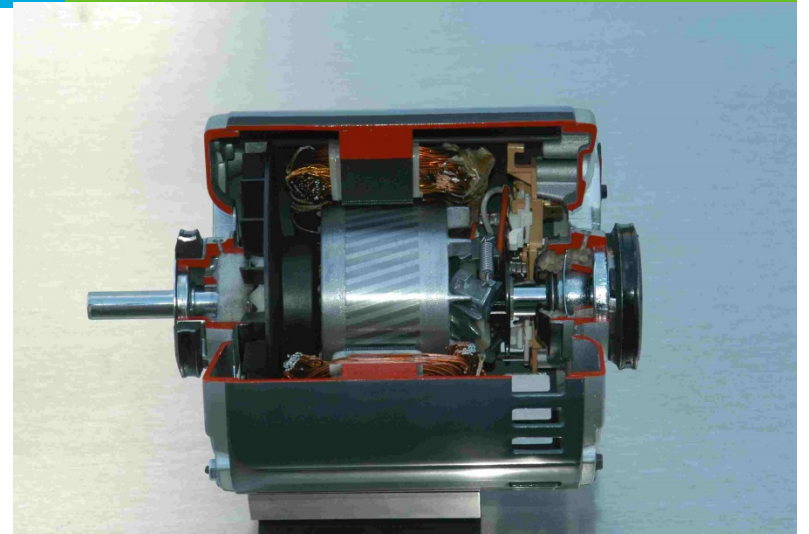
Nameplate Information

- Converts electrical energy into rotating mechanical torque
 - Built in many enclosures, sizes, power levels, speeds, voltages, duty, frequency, service factor, design or technology
 - Size or frame size
 - Small 42 frame to very large 8000
 - Power output
 - From sub fractional 1/20 to many thousands of horse power
 - Voltage
 - From 115 to 6600 volts AC



Enclosure- Nameplate Decision

- Open or [open drip proof]
 - WP1 - WP2
- Enclosed or TEFC
- Totally enclosed non-vent
- Air Over or AO
- Submersible



Voltage Needed Decision

- 115 -125 single phase
 - Residential and light commercial
- 200 -208 polyphase [three phase]
 - Commercial buildings, schools, offices
- 230-460 polyphase referred to as low voltage
 - Some commercial system most industrial applications
- 2300 -4400 referred to as medium voltage
- Above 4400 referred to as high voltage

NEMA or IEC Motor Design

- Typical NEMA motor designs for AC induction motors will be A,B,C or D
 - Design B is the most prevalent in building and user specifications
 - Design A is second – allows greater inrush current
 - Design C covers high torque motors from 1-200HP
 - Design D motors have very high slip for oil pumps
- IEC motors from Europe or Asia are designs N or H and may be found on some equipment

Motor Speed On Every Nameplate

- Each induction motor is built with pairs of poles – north and south
- The more poles the slower the motor speed
 - 2 pole = 3600 RPM
 - 4 pole = 1800 RPM
 - 6 pole = 1200 RPM
- Slip is the lag between the magnetic rotation in the stator and the actual rotation of the rotor in percent
 - Hence the nameplate speed for a four pole may be 1740-1780
- The more efficient the less the slip

Motor frame size and flanges

- Replacement motors need to match failed motor frame size
 - Check name plate frame and suffix to match
 - Frames define shaft height and diameter as well as feet and shaft length
 - Manufacturers will sometimes build HP and speed one frame size smaller or larger
- NEMA standards specify two common flanges
 - C and D



Enclosed polyphase pump motor

CATALOG # UJ3P2GM

MODEL #DT31

SHAFT
END BRG 6307-2Z-J/C3

OPP
END BRG 6205-2Z-J/C3

FR 182JM

TYPE UTE4

ENCL TE

PH 3 MAX
AMB 40 °C ID# W 10 645317-0024 M 0001

INSUL
CLASS F DUTY CONT WT 60 LB BAL

HP 3.00

RPM 1765

SF 1.25

HZ 60

VOLTS 575

MAX
KVAR 1.30

NEMA NOM
EFFICIENCY 89.5

AMPS 3.10

CODE K

DES B

SF AMPS 3.8

PF 81.0

GUARANTEED
EFFICIENCY 87.5

CC 030A,80C RISE/RES AT 1.00 SF



DT31M



MADE IN MEXICO OF IMPORTED AND DOMESTIC COMPONENTS

NIDEC MOTOR
CORPORATION

www.usmotors.com

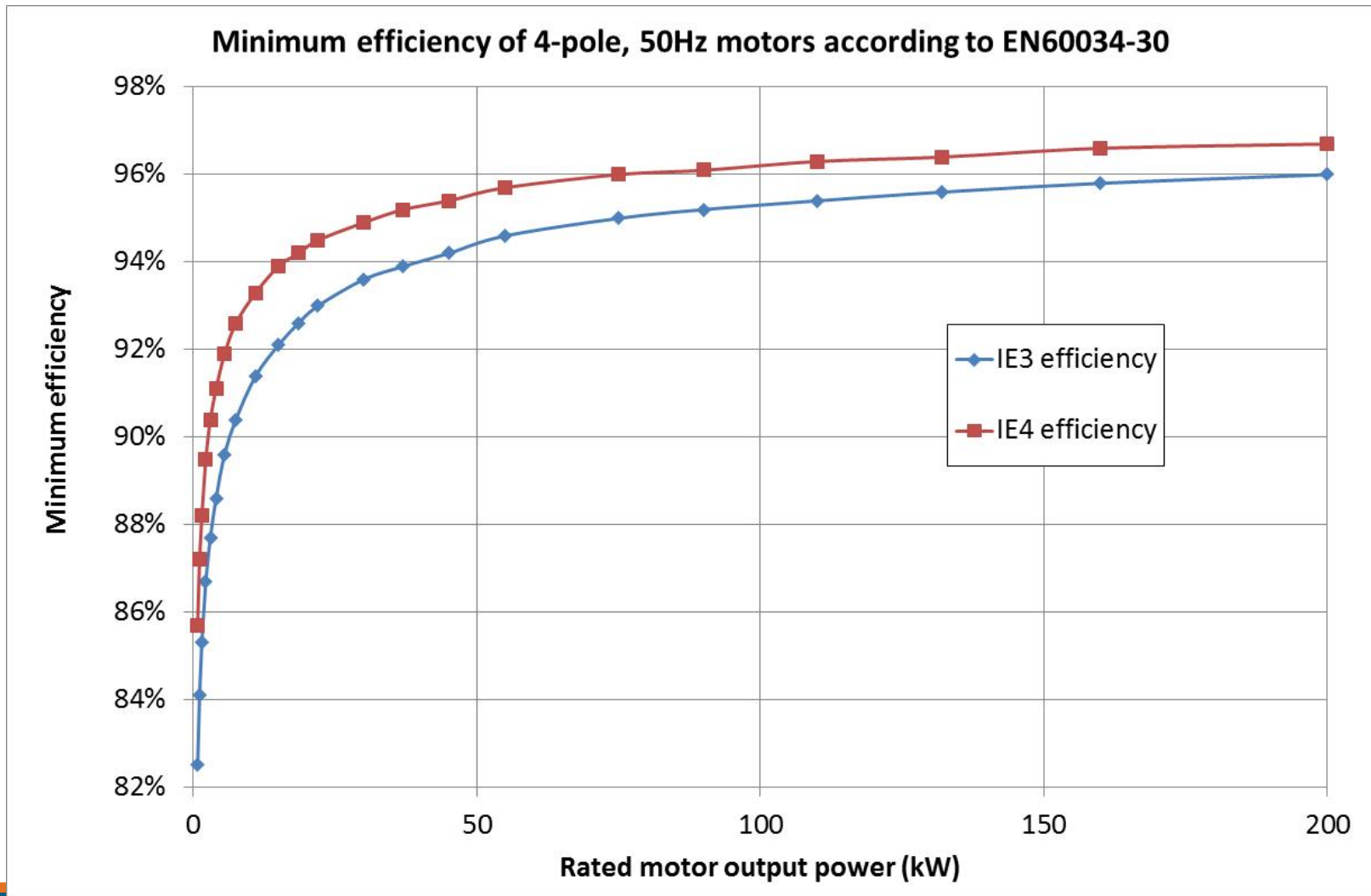


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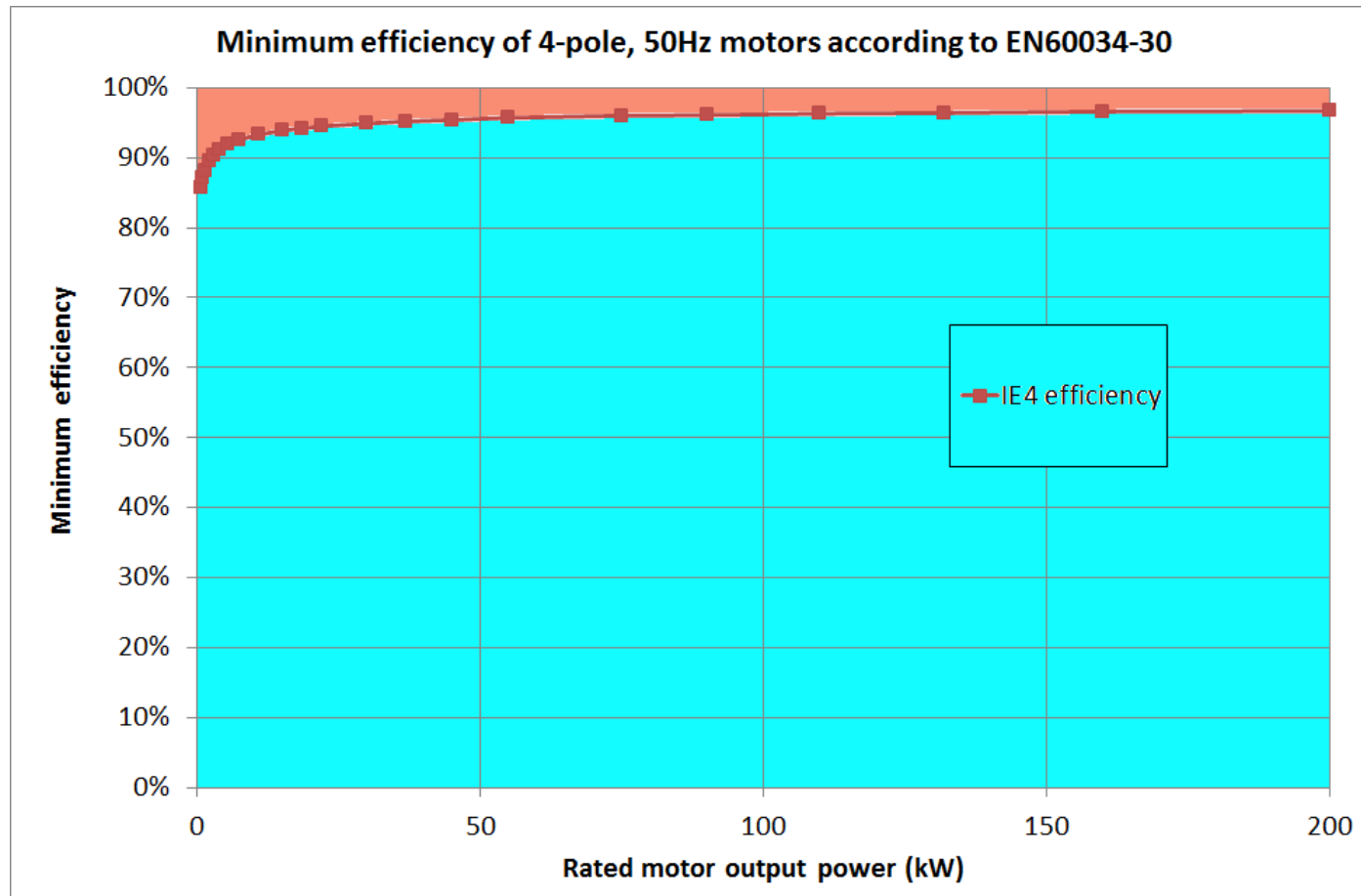
Motor Efficiency

- Expressed as the percentage of power converted to torque
- Regulated by the US Department of Energy since 1997
- Amendment affective June 1st 2016

IE3 [EPACT] and IE4 [NEMA Premium], comparison



Motor Efficiency vs Managing Power Usage

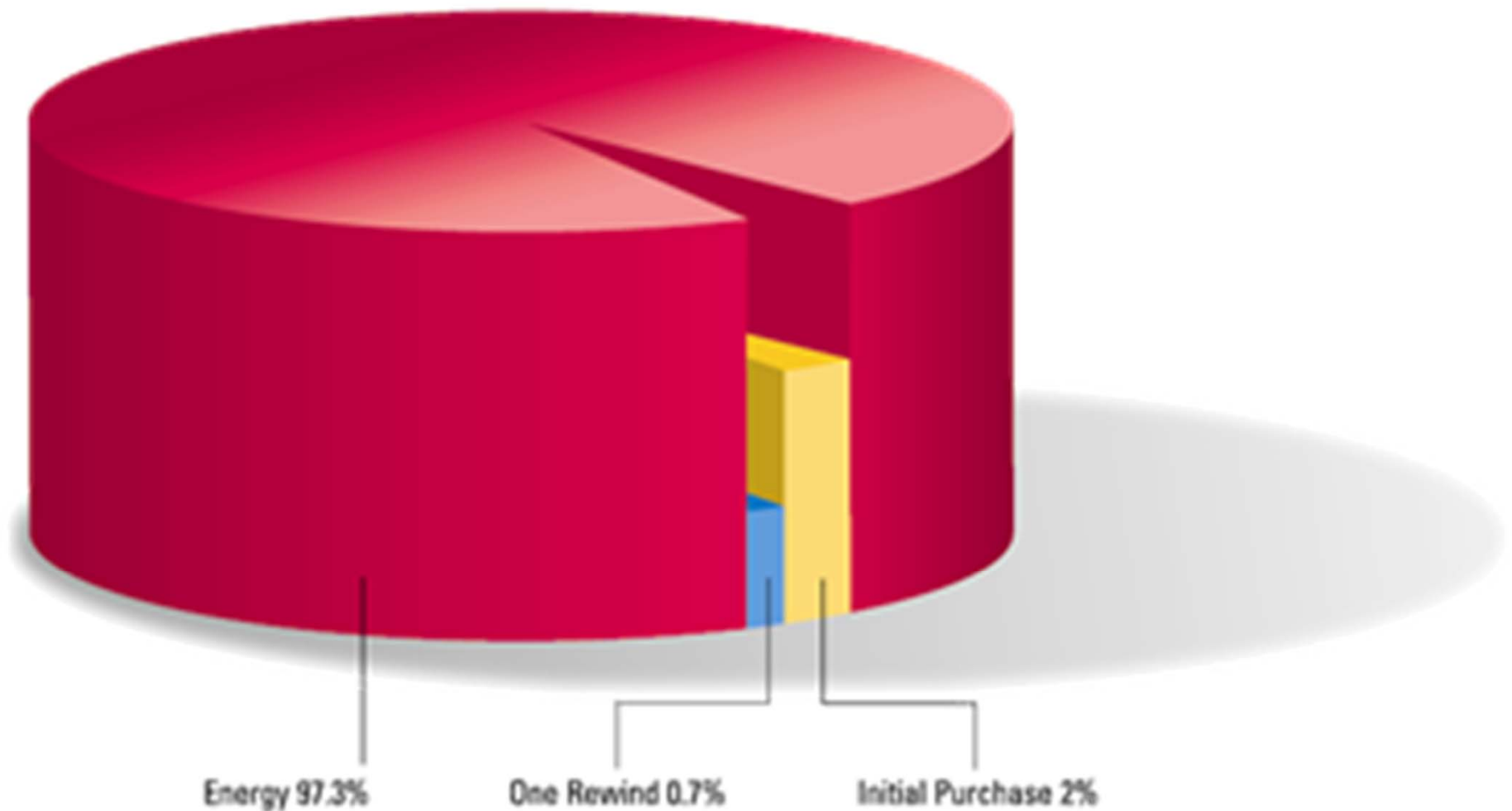


Power wasted in the motor



Power consumed by the load

Motor lifetime cost breakdown estimate



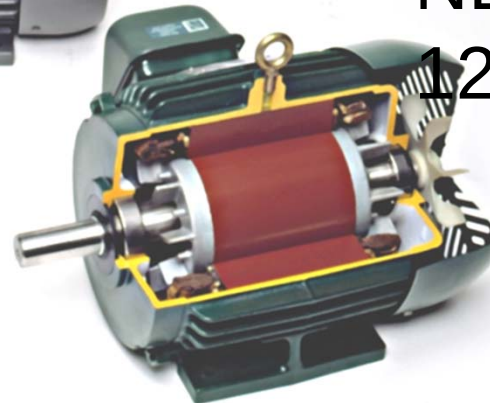
Progression of Active Material Increase Required to Add Efficiency

Lowest level
Exempt IE1



NEMA Premium
12-12 IE3

EPA Act 92
NEMA 12-11
IE2



Amended IHP rule results

- Expands the definition of covered product adding over 4 million units per year to be regulated
- Reduces non-covered motors to a small number
- Saves more energy than any rule ever issued by DOE
- Reduces confusion for enforcement agencies
- Allows distributors and resellers to “work through” existing inventories of current product
- Continues to use NEMA standards and table 12-12 as minimum performance levels protecting end user and OEM product utility
- Took affect June 1st 2016
- Continues to use NEMA standards, IEEE and CSA test methods

Motors added previously not covered by EISA

What additional designs are covered:

- NEMA Design A motors from 201-500 HP
- Electric motors with moisture-resistant windings, sealed or encapsulated windings
- Partial electric motors including gearmotors
- Totally-enclosed non-ventilated (TENV) electric motors
- Immersible electric motors
- Integral or non-integral brake electric motors
- U-frame motors
- Design C motors
- IEC 100 frame
- Electric motors with non-standard endplates or flanges
- Electric motors with non-standard base or mounting feet
- Footless motors (C-face or D-flange less base)
- Electric motors with special shafts
- Close-coupled pump motors
- 56J Jet pump motors (Enclosed)
- Vertical hollow shaft electric motors
- Vertical medium and high thrust solid shaft electric motors
- Electric motors with sleeve bearings
- Electric motors with thrust bearings
- Pre-NEMA frame motors
- Form wound motors <600 volts

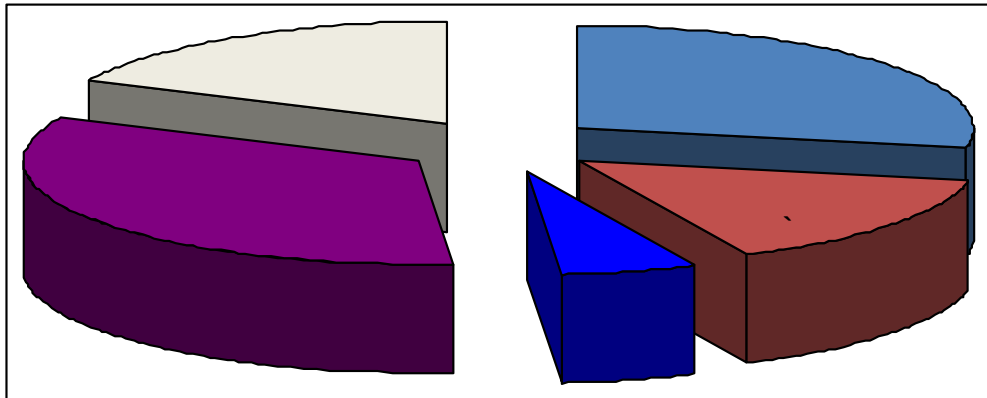
Motors not covered under IHP final rule

Exempt Motors:

- Single phase ODP motors (may be covered by Small Motor Rule)
- Single phase Enclosed motors
- DC motors
- Two digit frames (42 – 48) (may be covered by Small Motor Rule)
- 56 frame ODP (may be covered by Small Motor Rule)
- Multi-speed motors
- Medium voltage motors
- TEAO or Open Air-over motors
- Submersible motors
- Water-cooled motors
- Intermittent duty motors (S2-S8)
- Stator-rotor sets
- Design D motors
- Motors designed for Inverter Power (MG 1, Part 31) with no line start
- Synchronous AC motors
- Permanent magnet rotor AC motors
- Servo motors

**Affect of Expanded Product Scope
Millions of unit per year**

**Total 5.6 million units sold in
USA typical year**



**Motor rule amendment adds nearly 4
million units in four new categories**

■ Type 1 and 2

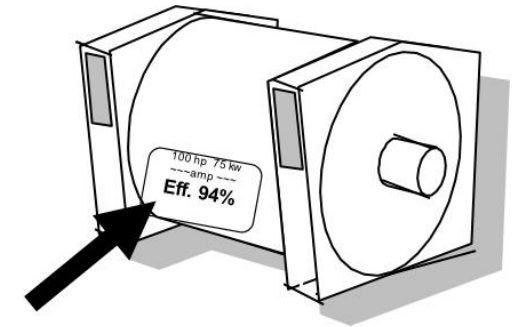
■ Partial &
Gearmotor

■ Definite &
Special

■ Imported
motors or
component

■ 56 Frame

Motor Nameplate data does not provide the whole picture



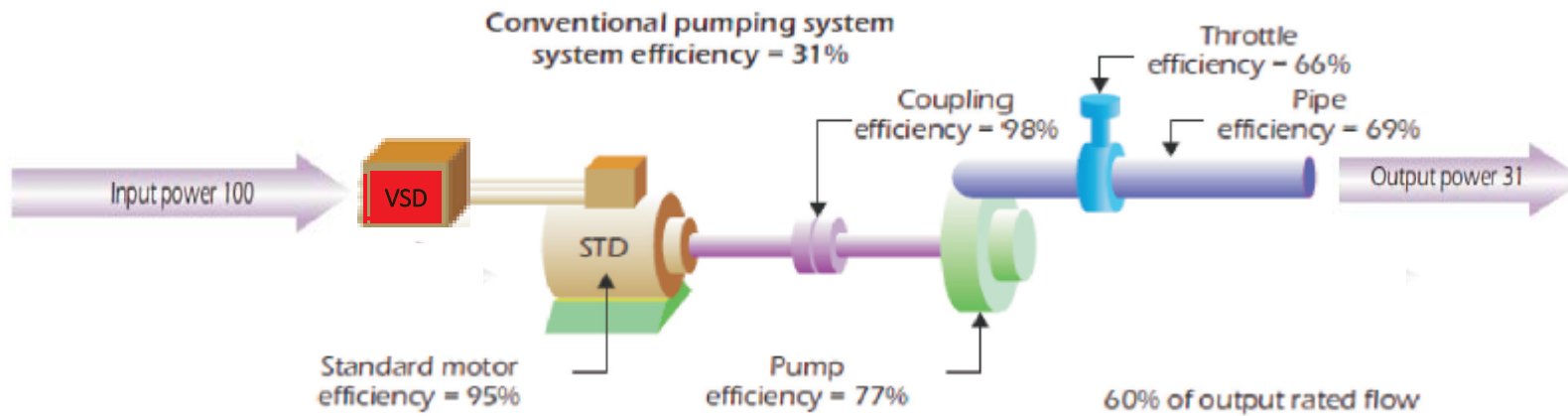
NAMEPLATE EFF.
94%

*THIS IS THE BEGINNING OF
THE STORY, NOT THE END!*

**“Variable speed requires, that the losses of the motor
plus converter shall be considered together!”**

*Jürgen Sander – Keynote address, EEMODS conference, Helsinki,
2015*

Moving from Motor to an Energy System



End Use Demands

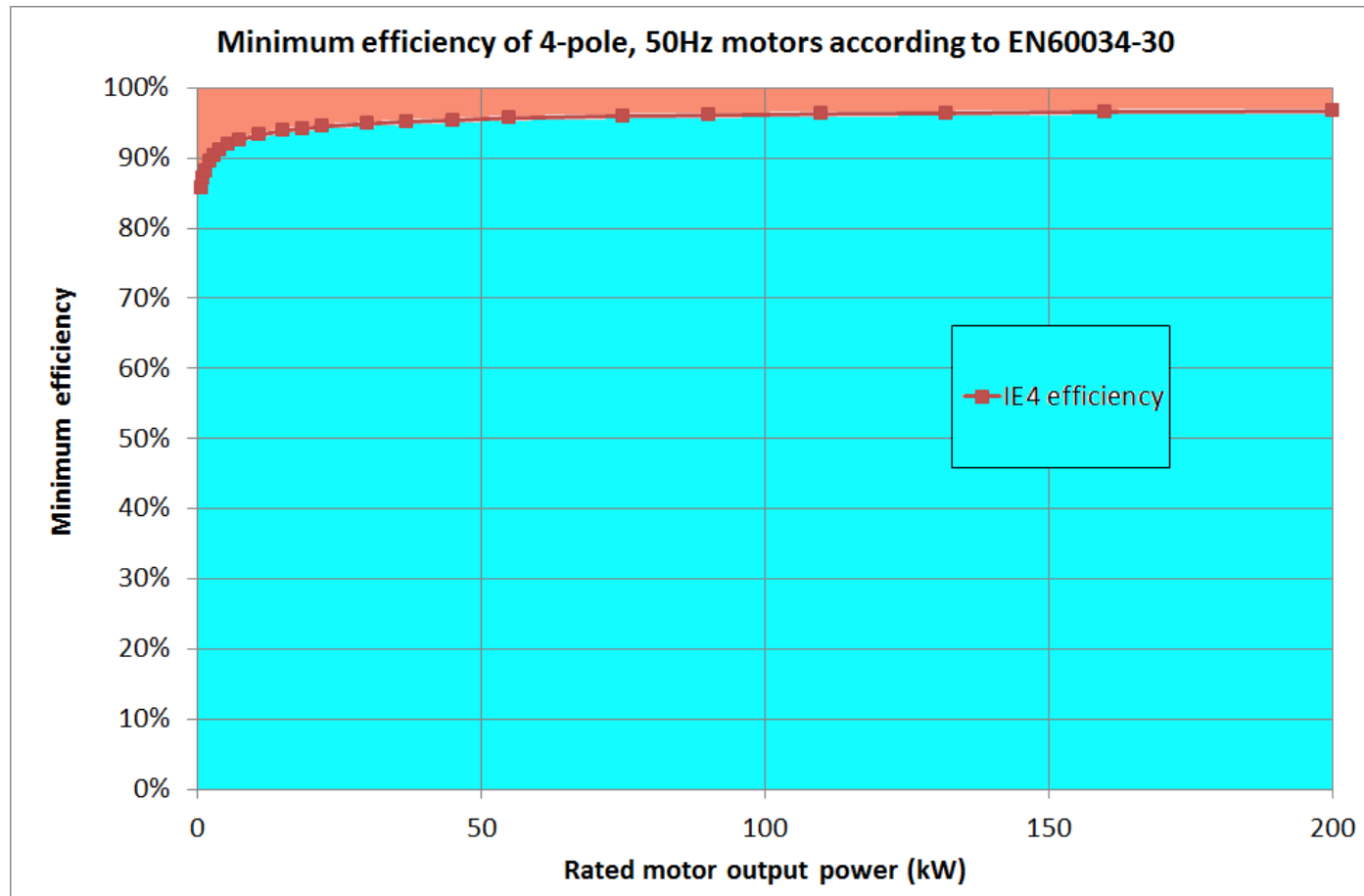
Minimum
Energy
Performance
Standards
(MEPS)

Extended Product- Motor-Driven Package
Label

Energy Efficiency of System Supply

Energy Efficient Engineering Practices & System Assessment Standards

Efficiency vs Managing Power With a Drive



Power wasted in the motor



Power consumed by the load

Adding an Electronic Drive Changes the Game

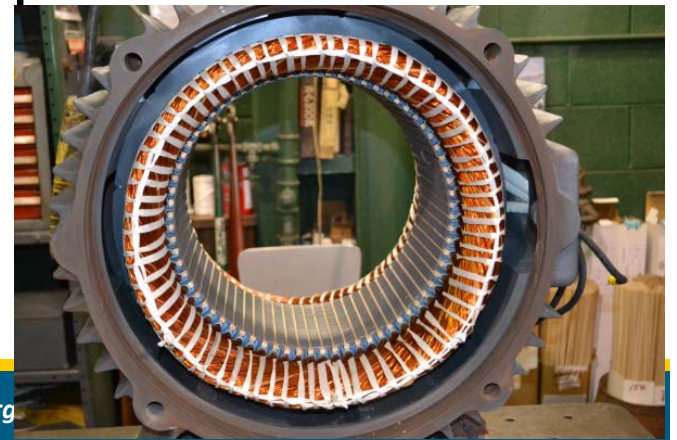
- Adjusts system speed to application need using power electronics
- Affinity law
 - Speed is proportional to the flow while the power is proportional to the cube of the speed.
 - If speed is halved, then the power input is reduced to one-eighth the original, which is a drastic reduction.
- Eliminates mechanical controls
 - VSD, VFD, Drive, SR Control
 - Many power drive systems [PDS] operate below 50% of nameplate power
- Controlling your car's speed only with a brake and no accelerator

What about motor repair ?

- Motors have two basic repair categories
 - 1. Simple mechanical issues
 - Replace bearings are well over 50% of motor repairs
 - Bent shafts, broken conduit box or flange
 - 2. Catastrophic failure [toasted]
 - Rewind copper wire in stator
 - Repair lamination damage in stator
 - Replace bearings
 - Broken shafts

Repair vs Replacement

- Considerations
 - Condition of failed unit
 - Bearing failure
 - Winding failure
 - Efficiency of failed unit ?
 - NEMA Premium or something less?
- Availability of replacement
 - Production line is down? Building HAC is shut down?
- General purpose or definite purpose motor?
 - Availability of replacement



Repair

- Motor repair industry trade association is EASA
 - Technical support to members for specific motor winding designs
 - Established repair standards
 - AR-100
 - Request motor efficiency is maintained during repair
- Motors have long lives- 20 -30 -40 or more years
 - Multiple repairs are common for higher HP motors
- Look at energy savings and replace with new NEMA Premium
 - Do the math initial cost vs operating cost

Comparison of options [10 HP @ 4000 hours per year at \$.10 /Kwh]

- Repair an old pre-Epact motor saves no energy
 - Returns low efficiency motor back into service
- Replace with a new NEMA Premium motor
Saves \$80 per year
 - Takes advantage of NEMA Premium efficiency
- Change from a fixed speed application to a motor and control reduces total power required by as much as \$1,000 per year

Life Cycle Cost Estimates Motor Only

- Where can you get life cycle cost information?
 - The internet of course- check NEMA.Org or any reputable motor manufacturer
 - **MG10** is your best resource and it's free from NEMA
- What should be considered ?
 - What is failed motor efficiency
 - Duty cycle [hours per day of operation]
 - What repair needs to be done?
 - How much energy [\$] can be saved with a new NEMA Premium replacement compared to cost estimates?

Energy System Potential Actions

- Specify DOE compliant motors built to NEMA standards
- Check nameplate data to be sure the replacement motor fits mechanically and meets electrical requirements of the system
- Consider adding electronic flow control replacing mechanical controls
- Request suppliers provide energy cost estimates for new equipment that include fixed speed and variable speed options
- Review repair options to optimize energy savings

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