

Energy Efficiency Technologies for AC Motors



POWEREFFICIENCY
CORPORATION

Agenda

- Overview of an AC Induction Motor
- Energy Savings Options for AC Induction Motors
- E-Save Technology™
- Conclusion / Open Discussion

AC Induction Motors

Overview

- An AC Induction Motor is a common device used to convert electrical power to mechanical power.
- Induction Motors are designed to run efficiently at high loads, but in many applications they can run at under 40% load for significant periods of time.
 - In the US 44% of motors operating in industrial facilities operate at less than 40% of full load (DOE/1998)
- Improving motor efficiency is a huge “untapped” Green resource
 - Motor driven systems account for 65% of electricity consumed by EU industry. Implementing high efficiency systems could save Europe over 200 billion kWh of electricity per year (European Copper Institute/2004)
 - Electric motors consume over 25% of the electricity in the U.S. (DOE/1998)



Energy Savings Options

For AC Induction Motors



- **NEMA Premium™ Efficiency Motors**
 - Provides efficiency levels for AC induction motors from 1-500 horsepower
 - Efficiency levels typically meet or exceeded only at loads over 70%

- **Motor Starter**
 - Provides full power to motor at all times and is not able to provide additional energy savings

- **Soft Starter**
 - Provides mechanism to reduce current inrush when starting a motor

- **Variable Frequency Drive**
 - Provide mechanism to reduce current inrush when starting a motor and can reduce the speed of the motor.
 - Reduction of speed can dramatically reduce the amount of energy used by a motor. Reduction of speed by $\frac{1}{2}$ will reduction energy consumption by a factor of 8.

Energy Savings Options

Pros and Cons



- **NEMA Premium™ Efficiency Motors**
 - PROS: Provides highest possible efficiency at large loads
 - CONS: Reduced efficiency at low loads; Premium priced motor
- **Motor Starter**
 - PROS: Least expensive motor starter
 - CONS: No energy savings capabilities
- **Soft Starter**
 - PROS: Reduces inrush current at startup
 - CONS: No energy savings capabilities after starting motor
- **Variable Frequency Drive**
 - PROS: Reduces inrush current at startup; Provides multiple energy savings capabilities while the motor is running
 - CONS: High price; Harmonics; Complexity of installation

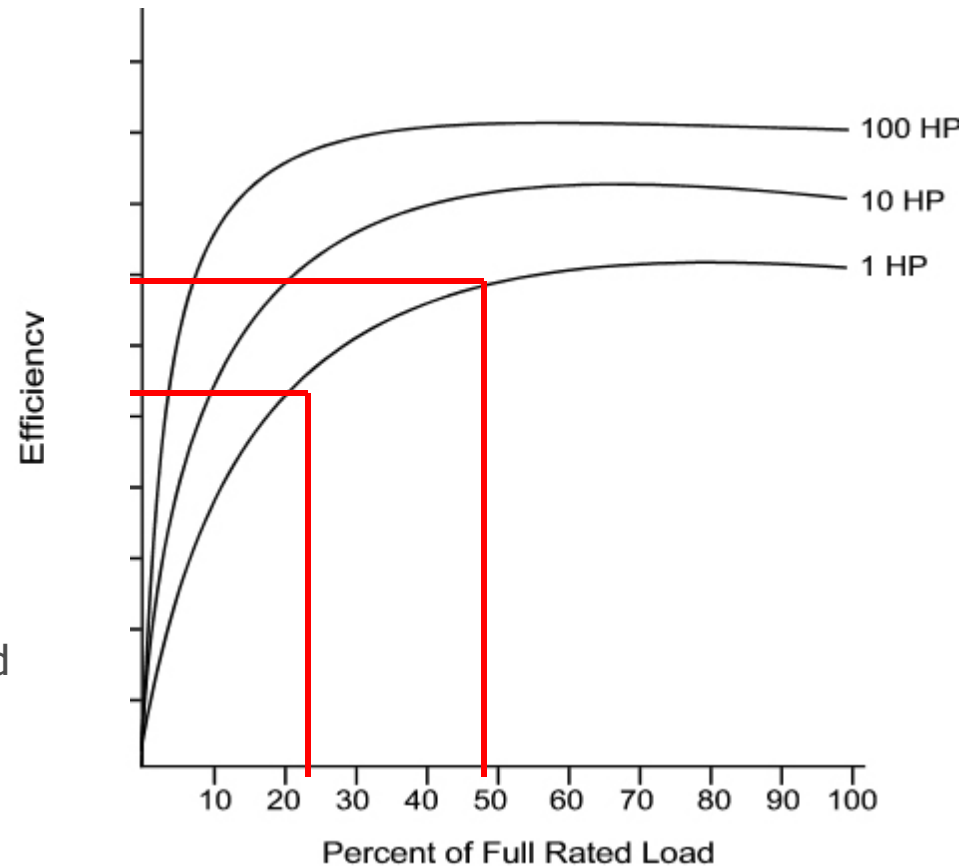


E-Save Technology™

The History of the Technology



- The technology has NASA roots, with the first patent being filed in 1976 by Frank Nola
 - US Patent 4052648 titled “Power factor control system for AC induction motors”
 - Several additional patents files over the next 10 years
 - Patent was based on AC induction motors operating most efficiently at around 75% of Full Rated Load, but between 0% and 50% of full load the efficiency drops significantly and the motor will consume considerably more energy than is needed

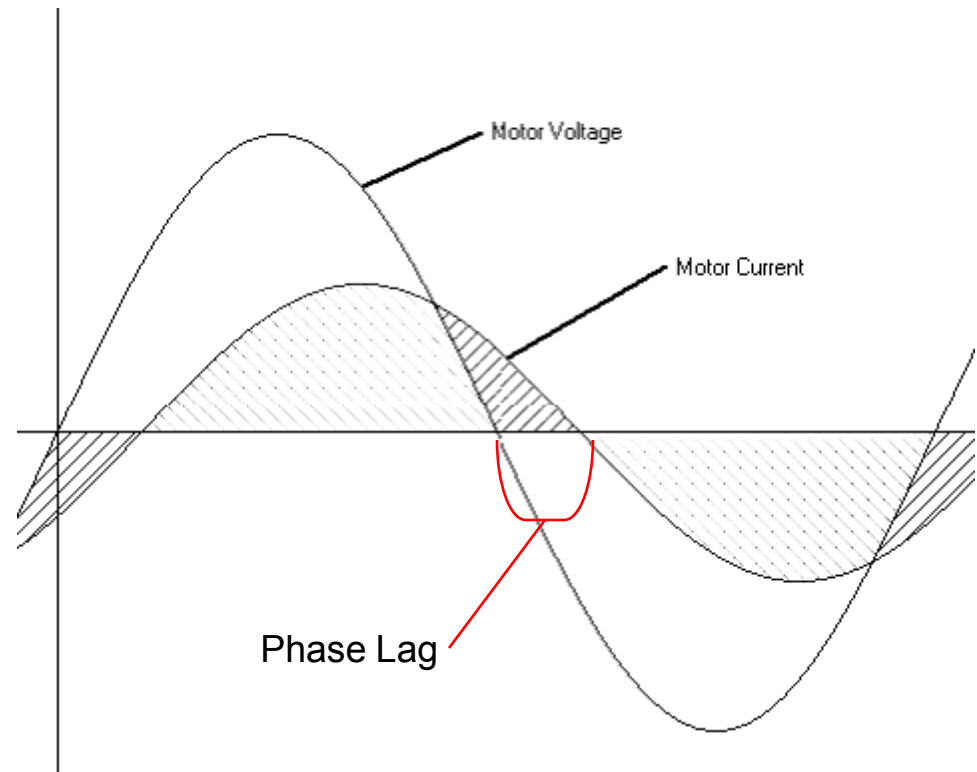


E-Save Technology™

The Science Behind The Technology



- In an AC Induction Motor, which are inductive AC circuits, components such as capacitors or inductors, provide energy storage
- This stored energy is not available to do the mechanical work at the motor shaft and therefore makes the motor less efficient and consume more power.
- When a motor is running the consumed energy generates a current waveform that lags the voltage waveform

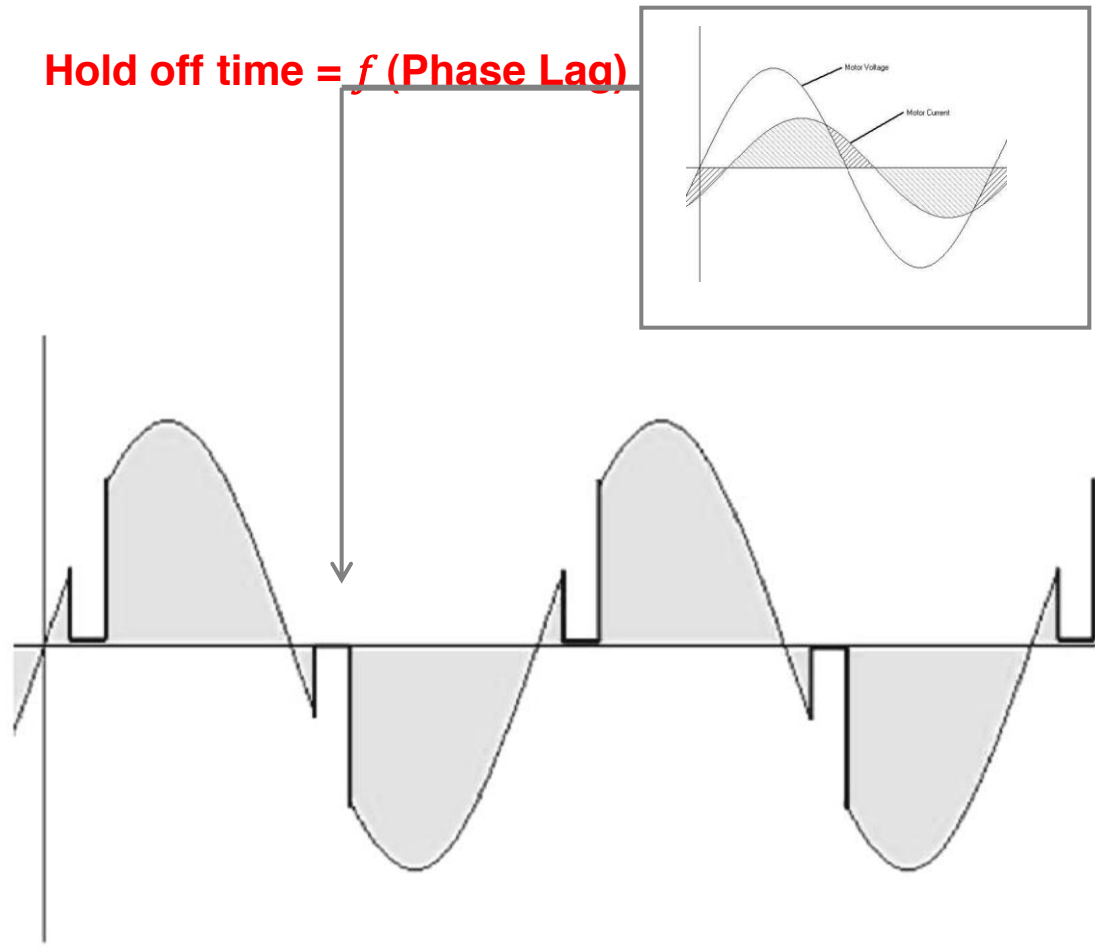


E-Save Technology™

How does it work?

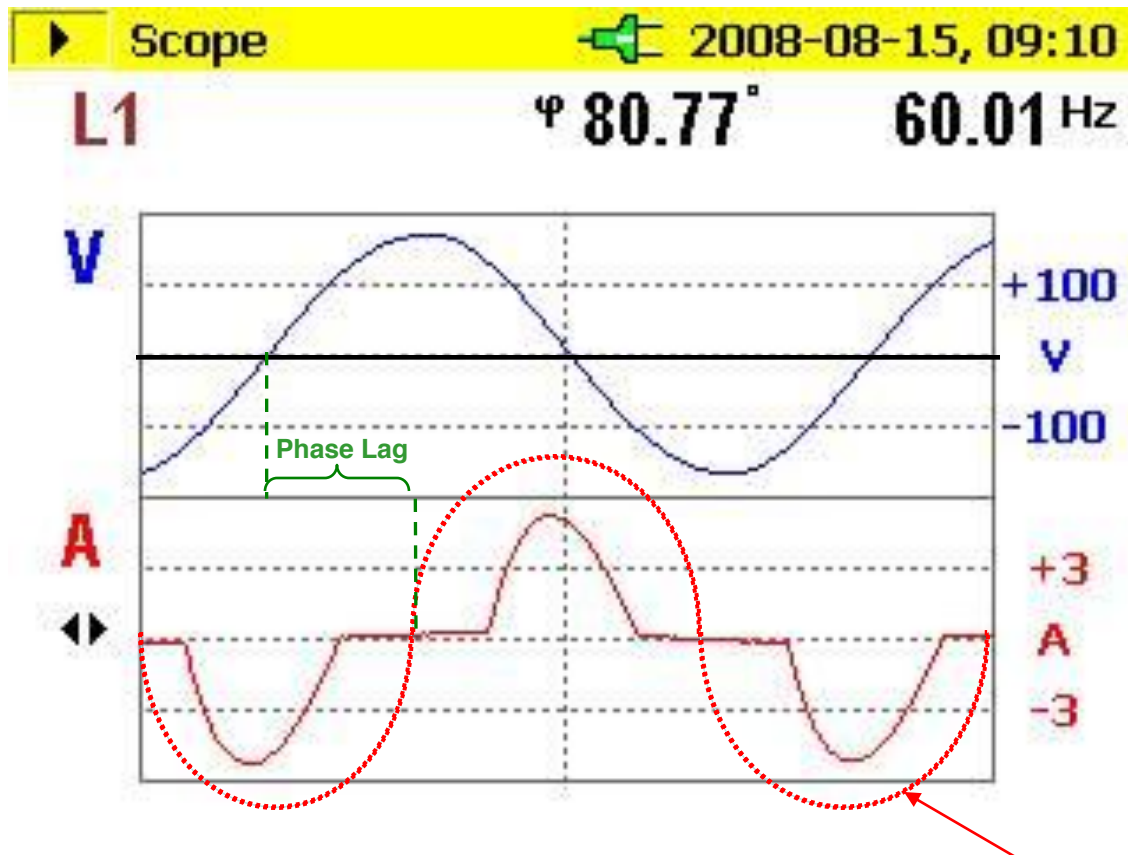


- E-Save Technology™ uses patented algorithms, Digital Signal Processing and patented circuits to monitor the motor and then provide the motor with the OPTIMAL amount of power required by the motor to perform the mechanical work.
- E-Save Technology™ will reduce energy savings without changing the speed of the motor



E-Save Technology™

How does it work?



Current Waveform Without E-SAVE Technology

Case Study

Escalator 40HP - Caesars Palace Hotel and Casino



TEST SUMMARY

An energy savings test was performed on two 40HP escalators (one up, one down) at Caesars Palace Hotel and Casino in Las Vegas, Nevada. The test was monitored by Nevada Power, the electric utility for Southern Nevada.

Power Efficiency's motor efficiency controller lowered the average kW used on the "Up" escalator from 6.08 kW to 4.01 kW for a 34% power savings. The average kW on the "Down" escalator went from 6.08 kW to 4.00 kW for a 36.5% power savings.

The graphs represent the kilowatt usage of the escalators over a period of 10 days. 5 days without the energy savings activated and 5 days with energy savings activated.



Caesars Palace Hotel & Casino
Las Vegas, Nevada

Application:	Escalator
Motor Size:	40HP
Average Savings:	35.75%
Annual Savings:	\$3,062.49
Power Rate:	\$0.08/kWh
Annual CO2 Reduction:	29 tons
Internal Rate of Return:	59%*

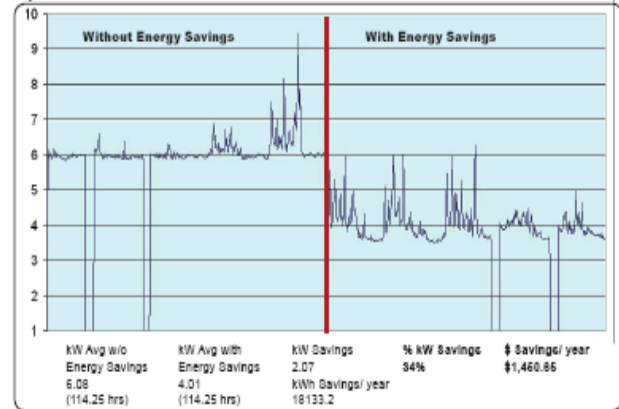
* IRR does not include unit installation costs

Expected Product Life Savings

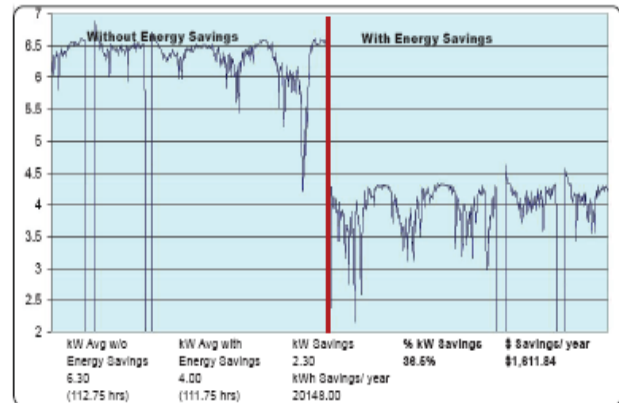
Product Life:	15 years
kWh Savings:	574,215 kWh
Cost Savings:	\$66,084*
CO2 Reduction:	445 tons

* Expected life cost savings is based on a 5% annual increase in cost of power

Up Escalator kW



Down Escalator kW



Estimated annual energy and demand-charge cost savings are based on Nevada Power calculations. Estimates are based on facility operations of 24 hours per day 7 days a week (8,760 hours/year).

Case Study

Jaw Crusher 300HP - Aggregate Plant



TEST SUMMARY

A 300 HP Power Efficiency motor efficiency controller was installed on a Jaw Crusher at an aggregate plant in Las Vegas, Nevada.

This application was chosen because an eight day collection of Power Factor and Kilowatt usage data was compiled in a savings estimate calculator developed by Power Efficiency Corporation.

The resulting savings estimate showed that this would be an attractive candidate for significant energy savings. Power Efficiency's motor efficiency controller showed savings of 25.41% kWh per ton.



Aggregate Plant
Boulder City, Nevada

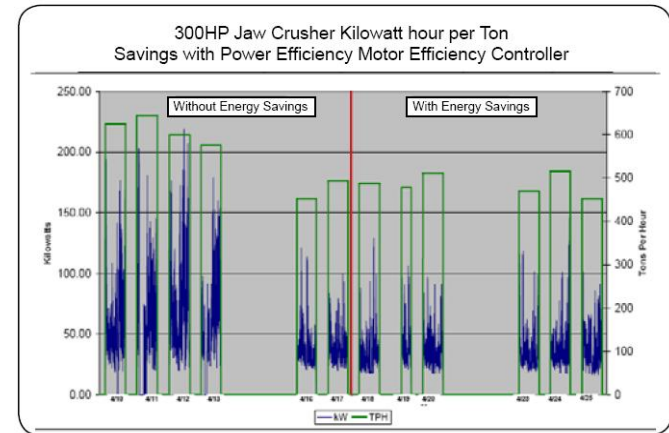
Application:	Jaw Crusher
Motor Size:	300HP
Average Savings:	25.41%
Annual Savings:	\$5,390.71
Power Rate:	\$0.10/kWh
Annual CO2 Reduction:	40 tons
Internal Rate of Return:	69%*

* IRR does not include unit installation costs

Expected Product Life Savings

Product Life:	15 years
kWh Savings:	766,800 kWh
Cost Savings:	\$110,310*
CO2 Reduction:	594 tons

* Expected life cost savings is based on a 5% annual increase in cost of power



Savings: kWh Per Ton

The average tons per hour from total test period is 541.44 and the average hours ran per day is about 12.5

Without Energy Savings:	\$0.01004 per ton / \$5.44 per hour
With Energy Savings:	\$0.00749 per ton / \$4.06 per hour
Energy Savings:	\$0.00255 per ton / \$1.38 per hour

If the plant runs 15 hours per day, 5 days per week, the **annual savings is \$5,390.71**

Case Study

Washer and Dryer - Application Testing



TEST SUMMARY

A Power Efficiency motor efficiency controller was installed on a GE Washer and a Whirlpool Dryer in Las Vegas, Nevada.

The resulting savings estimate showed that this would be an attractive candidate for significant energy savings. Power Efficiency's motor efficiency controller showed savings of 66 W per load of clothes.

Over a 15 year life of an application this would save over 360kW and nearly 0.3 tons of CO².

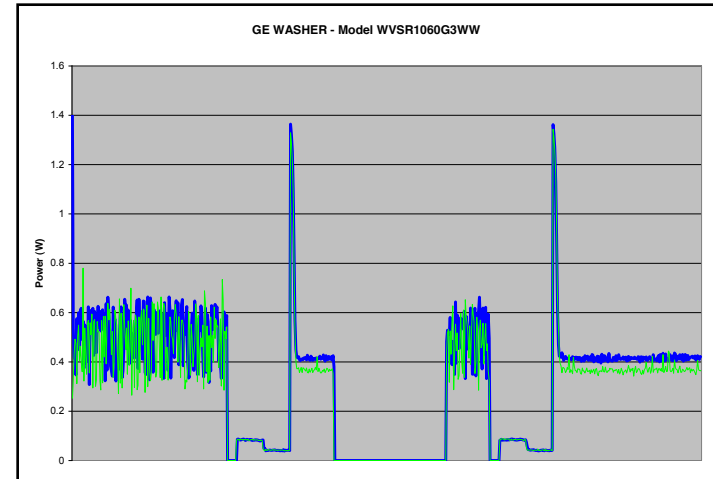


Application: Clothes Washer and Dryer

Average Savings: 66 W /load

Annual Savings: 24 kW

Annual CO2 Reduction: 0.02 tons



Conclusions / Open Discussion



- **E-Save Technology™** is a very cost effective way to save energy on AC Induction motors in constant speed and variable load applications
 - Implementing **E-Save Technology™** could save over 20 billion kWh in the U.S. manufacturing sector which is the equivalent of taking over 2.6 million cars off the road (DOE/1998)
 - Power Efficiency has installed and is currently selling products with this technology

- **E-Save Technology™** qualifies as an energy savings device with many utilities
 - Below is a partial list of utilities currently providing rebates and incentives
 - San Diego Gas & Electric
 - Los Angeles Dept. of Water & Power
 - Southern California Edison
 - Sacramento Municipal Utility District
 - Xcel Energy
 - Nevada Power and Sierra Pacific
 - Anaheim Utilities

- Additional information
 - www.powerefficiency.com