Economic Analysis of Premium Efficiency and Rewind Motors:
Energy Savings and Increased Efficiency for Arkansas Row Crops Producers

Ranjit Mane, Brad Watkins, and Christopher Henry
University of Arkansas, Division of Agriculture Rice Research and Extension Center
Stuttgart, Arkansas

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Overview

– Energy Efficient Motor, Standard Efficiency Motor, Premium Efficiency Motor
  • Efficiency and Costs
– Rewind of Electric Motor
  • Cost of Rewind
– Comparison of Premium Efficiency Motor and Rewind Motors
  • Net Present Value (NPV)
  • Payback Period (PP)
– Results and Conclusion
  • Energy Saving
  • Policy Implications
Introduction

– Arkansas is 3 largest irrigated state (USDA, 2014)
  • 5 million acres
  • 13 pump per farm

– Efficiency of Pump (Gustafon et al. 2004)
  • Electric pump (50 – 99 %)
  • Diesel Pump (40 %)

– Diesel Pump to Electric Motor
  • Energy savings
  • Increased efficiency

– Energy Efficient to Premium Efficiency Motor
Premium Efficiency Motor
Need for Premium Efficiency Motor
Rewind Motor

– Motor Repairs (Nadal et al. 2002)
  • Every 5 – 7 years
  • 4 – 6 times before replaced

– Common motor repair problems
  • Replacement of rewind
  • Bearings

– Efficiency of Rewind Motor
  – As per Dept. of Energy, Office of Energy Efficiency and Renewable Energy (EERE).
    • Decrease in efficiency by 1 percent for less than 40 HP motors
    • Decrease in efficiency by 0.5 percent for more than 40 HP motors

– Motors used in Agriculture are classified as “specialty motor”
Motor Rewinding Process

Mechanical Tests
- Test Mechanical fits using calibrated outside & inside micrometers - Peening, Metalizing, Sleeving

Initial Winding Tests
- Megger Test – Leakage to the ground
- Phase to phase tests
- Disassembly, Cleaning, Drying
- AC/DC High Potential Test
- Comparison tested to test shorts within windings

Coil Removal
- Direct flame, Chemical Stripping, Burnout,
- Mechanical Stripping – Thumm Method, Water Blasting, Hot Vapor Chemical Strip
- Clean Stator

Stator Winding
- Winding with proper insulation in the stator slots

Post Winding Tests
- Megger Test, Hi-pot test, Impedance & Spin Tests

Varnish Insulation
- Dip and Brake, Trickle Varnishing, Vacuum Pressure, Impregnation

Final Tests
- Megger Test, Current and Voltage Measurements, Temperature Measurements

Source: Sahni and Boustani, (2010)
Comparison of Premium\(^1\), Energy Efficient\(^1\), Standard Efficiency and Rewind\(^2\) Motor

Source: \(^1\)NEMA , \(^2\)Authors Estimates
Objective

– Compare investment decision on a premium efficiency motor and a rewind motor using Net Present Value and Pay back Period.
Data and Methodology

– Data
  • US Motor (NIDEC Motor Corporation)
  • Cost of Rewind
    – Entergy Arkansas, Inc.
    – Layne, Stuttgart
    – T and W Electric, Pine Bluff

– Methodology
  • Net Present Value (NPV)
  • Payback Period (PP)
Assumptions

- Electric Motor
  - OPH (Operating Hours Per Year): 1300 hrs
  - Price of Energy: 0.12 \$/kWh
  - Life expectancy of motor: 23 Years

- Cost of Rewind
  - 65% of a new standard efficiency motor (Entergy Inc.)
  - Survey results for Arkansas
    - 40 HP: 24% - 67%
    - 75 HP: 21% - 58%
    - 200 HP: 18% - 46%
# Cost of Electric Motor

<table>
<thead>
<tr>
<th>Type of Motor</th>
<th>10 HP</th>
<th>20 HP</th>
<th>30 HP</th>
<th>40 HP</th>
<th>50 HP</th>
<th>60 HP</th>
<th>75 HP</th>
<th>100 HP</th>
<th>200 HP</th>
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</thead>
<tbody>
<tr>
<td>Premium Efficiency</td>
<td>NA</td>
<td>4,542</td>
<td>5,709</td>
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<td>Rewind (As good as new)</td>
<td>2,438</td>
<td>2,426</td>
<td>3,045</td>
<td>3,576</td>
<td>4,242</td>
<td>4,901</td>
<td>5,966</td>
<td>7,537</td>
<td>15,744</td>
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<td>Rewind (Good)</td>
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<td>Rewind (Fair)</td>
<td>2,438</td>
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<td>3,045</td>
<td>3,576</td>
<td>4,242</td>
<td>4,901</td>
<td>5,966</td>
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<td>15,744</td>
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<tr>
<td>Rewind (bad)</td>
<td>2,438</td>
<td>2,426</td>
<td>3,045</td>
<td>3,576</td>
<td>4,242</td>
<td>4,901</td>
<td>5,966</td>
<td>7,537</td>
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## Operating Cost Per Year

<table>
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<tr>
<th>Type of Motor</th>
<th>10 HP</th>
<th>20 HP</th>
<th>30 HP</th>
<th>40 HP</th>
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<th>60 HP</th>
<th>75 HP</th>
<th>100 HP</th>
<th>200 HP</th>
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<tbody>
<tr>
<td>Premium Efficiency</td>
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<td>2,141</td>
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<td>2,210</td>
<td>3,290</td>
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<td>6,580</td>
<td>8,090</td>
<td>10,637</td>
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<tr>
<td>Rewind (As good as new)</td>
<td>1,131</td>
<td>2,210</td>
<td>3,290</td>
<td>4,421</td>
<td>5,483</td>
<td>6,580</td>
<td>8,090</td>
<td>10,637</td>
<td>21,024</td>
</tr>
<tr>
<td>Rewind (Good)</td>
<td>1,157</td>
<td>2,261</td>
<td>3,365</td>
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<td>5,608</td>
<td>6,729</td>
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<td>Rewind (Fair)</td>
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<td>8,455</td>
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## Payback Period

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<tr>
<td>Premium Efficiency</td>
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<td></td>
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<tr>
<td>Energy Efficient</td>
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<td>9.9</td>
<td>5.8</td>
<td>7.5</td>
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<td>∞</td>
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<tr>
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<td>10.6</td>
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<td>&gt;60</td>
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<td>&gt;60</td>
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<td>14.2</td>
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<tr>
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<td>5.6</td>
<td>7.3</td>
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<td>5.6</td>
<td>5.0</td>
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<td>5.0</td>
<td>6.4</td>
<td>6.3</td>
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<tr>
<td>Rewind (bad)</td>
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<td>2.4</td>
<td>2.4</td>
<td>2.4</td>
<td>2.8</td>
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# Net Present Value of Energy Savings

<table>
<thead>
<tr>
<th>Type of Motor</th>
<th>10 HP</th>
<th>20 HP</th>
<th>30 HP</th>
<th>40 HP</th>
<th>50 HP</th>
<th>60 HP</th>
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<tbody>
<tr>
<td><strong>Premium Efficiency</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Energy Efficient</td>
<td>NA</td>
<td>-583</td>
<td>-79</td>
<td>318</td>
<td>857</td>
<td>592</td>
<td>-1,188</td>
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<tr>
<td>Standard Efficiency</td>
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<td>84</td>
<td>1,264</td>
<td>1,739</td>
<td>2,378</td>
<td>1,649</td>
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<tr>
<td>Rewind (As good as new)</td>
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<td>-1,556</td>
<td>-662</td>
<td>-545</td>
<td>-261</td>
<td>-1,563</td>
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<td>-11,013</td>
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<tr>
<td>Rewind (Good)</td>
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<td>-500</td>
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<td>Rewind (Fair)</td>
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<td>26,261</td>
<td>30,365</td>
<td>35,755</td>
<td>69,270</td>
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</table>
# Decision Matrix

<table>
<thead>
<tr>
<th>Type of Motor</th>
<th>10 HP</th>
<th>20 HP</th>
<th>30 HP</th>
<th>40 HP</th>
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<td><strong>Premium Efficiency</strong></td>
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<td></td>
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<tr>
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<td>NO</td>
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<td>YES</td>
<td>YES</td>
<td>YES</td>
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<tr>
<td>Standard Efficiency</td>
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<td>YES</td>
<td>YES</td>
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<td>NO</td>
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<tr>
<td>Rewind (As good as new)</td>
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<td>NO</td>
<td>NO</td>
<td>NO</td>
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<tr>
<td>Rewind (Good)</td>
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<td>YES</td>
<td>YES</td>
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<td>Rewind (Fair)</td>
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<td>YES</td>
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<td>YES</td>
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<tr>
<td>Rewind (bad)</td>
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<td>NO</td>
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<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
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</tbody>
</table>
Results and Conclusions

– Premium Efficiency Motor
  • 10 HP – 200 HP
    – No investment if rewind is as good as new
  • 20 – 30 HP and 100 – 200 HP
    – No investment if rewind is good

– Rewind of Electric Motor
  • Cost of Rewind
  • Quality of Rewind : EASA Certification

  • Manufacturing based on NEMA Premium Efficiency Motor
Thank You !