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Data Article

Data on electrical energy conservation using high efficiency motors for the confidence bounds using statistical techniques



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ABSTRACT

In this article, we describe details of the data used in the research paper “Confidence bounds for energy conservation in electric motors: An economical solution using statistical techniques” [1]. The data presented in this paper is intended to show benefits of high efficiency electric motors over the standard efficiency motors of similar rating in the industrial sector of Pakistan. We explain how the data was collected and then processed by means of formulas to show cost effectiveness of energy efficient motors in terms of three important parameters: annual energy saving, cost saving and payback periods. This data can be further used to construct confidence bounds for the parameters using statistical techniques as described in [1].

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Specifications Table

Subject area	Energy economics, statistical analysis
More specific subject area	Electrical energy conservation using energy efficient motors
Type of data	Tables, figures and graphs
How data was acquired	Using motor data and energy consumption forms while personal visits at surveyed industries
Data format	Raw, filtered, analyzed
Experimental factors	Factors needed to calculate energy saving, cost saving and payback period by a similar rating energy efficient motor in place of an existing standard efficiency motor
Experimental features	Statistical analysis of the data using student's <i>t</i> -distribution in terms of confidence bounds of the energy conservation parameters.
Data source location	1. Hyderabad, Pakistan (latitude 25.367°N, longitude 68.367°E) 2. Jamshoro, Pakistan (latitude 25.26°N, longitude 68.20°E)
Data accessibility	Data is available with this article

Value of the data

- The data highlights the benefits of using high efficiency motors in place of existing standard efficiency motors in industrial sector of Pakistan in terms of annual energy savings, cost savings and payback periods.
- The annual energy consumption and annual operational cost are compared for a sample data of 20 standard and energy efficient motors (EEMs).
- The data described in this article supports the step by step statistical analysis in terms of confidence bounds for the three parameters: annual energy savings, cost savings and payback periods for EEMs.
- The confidence bounds based on the discussed data which are presented in associated research paper [1] can be used to attract financers for large scale purchase and replacement of standard motors (SMs) by EEMs to conserve sufficient amount of electrical energy.
- The procedure described in this article and the underlying research paper [1] can be used by researchers for processing the data related to high efficient motors in other countries (the data in Refs. [2–10]) in order to generate encouraging confidence bounds to promote electrical energy conservation using EEMs [1].

1. Data

The data in this work describe general information about existing low-efficiency motors at surveyed sites, like: motor application type, utility rate being used, annual operating hours and related information from motor nameplates. We also present the comprehensive values of some important parameters for each standard motor in the sample like: input volts, input amperes, input kW, operating speed (in rpm) and power factor.

2. Experimental design, materials and methods

The data presented in this article is basis for the statistical analysis in terms of confidence bounds – as discussed in [1] – for the annual energy savings, cost savings and payback periods of EEMs when replaced for SMs. To acquire the necessary data, some industries based at Pakistan were surveyed and data on existing standard efficiency motors were noted while personal visits. We describe in next section, the acquired data, its processing using different formulas and its descriptive statistical



Fig. 1. 2.1 HP motor used for dearator transfer pump.



Fig. 2. 2.2 kW motor used for AC chiller plant.

analysis which is required for the construction of confidence bounds. To gather the best possible sample of existing standard efficiency motors, we surveyed the industries where majority of the motors were installed. Surveyed industries included: Pakistan Steel Mill (PSM), Karachi; Thermal Power Station, Jamshoro; Regional Control Centre, Jamshoro; and, Water Works/Pumps, Hyderabad. The data was obtained in the year 2011 while personal visits to the surveyed industries. Some photos of motors at survey sites are given in Figs. 1–3 according to their applications. The important electrical parameters related to the installed standard efficiency motors were noted on the *motor data and energy consumption form*, a sample in Fig. 4. For reference, a completely filled form for 2HP motor can be found as Fig. 1 of [1]. The comprehensive data measured and noted in these forms for all 20 sample SMs is gathered in Table 1. The values in Table 1 can be used to calculate power (in kW), annual energy consumption (in kWh/year) and annual operational cost (in Rs./year) for the 20 sample SMs.

Similar rating EEMs with price and efficiency detail comparison with those of SMs (as per Table 1 in [1]), when processed with the cost effectiveness formulas and conditions given in [1], resulted



Fig. 3. 1.6 HP motor used for water treatment.

encouraging values of annual energy savings, cost savings and payback periods. An example of such calculation is given here to support the statistics in the main paper, i.e. Ref. [1].

3. Example calculation of cost effectiveness parameters for a 2HP motor

The following analysis for 2HP motor operating at 75% of full rated load illustrates how to determine the cost effectiveness of obtaining an energy-efficient versus a standard efficiency motor for the initial purchase case. The formulas are used from Ref. [11].

- **Kilowatts saved:**

$$\begin{aligned} \text{KW Saved} &= \text{HP} \times L \times 0.746 \left[\frac{100}{\xi_{SM}} - \frac{100}{\xi_{EM}} \right] = 2 \times 0.75 \\ &\times 0.746 \left[\frac{100}{79.8} - \frac{100}{83.8} \right] = 0.066933 \end{aligned} \quad (1)$$

This is the amount of energy conserved by the energy efficient motor during each hour of use.

Annual energy savings are obtained by multiplying by the number of operating hours at the indicated load.

- **Energy saved:**

$$\text{kWh Savings} = \text{Operating hours} \times P_{\text{input Saved}} = 8640 \times 0.066933 = 578.305 \quad (2)$$

- **Annual cost savings:**

$$\begin{aligned} \text{Total Cost Savings} &= (\text{kW Saved} \times 12 \times \text{Monthly Demand Charge}) + (\text{kWh Savings} \\ &\times \text{Energy Charge}) = (0.066933 \times 12 \times 380) + (578.305 \times 9) = \text{Rs. } 5509.96 \end{aligned} \quad (3)$$

In this example, installing an energy-efficient motor reduces utility billing by Rs. 5509.96 per year. The simple payback for the incremental cost associated with an energy efficient motor purchase is the ratio of discounted list price premium (see Table 1 in [1]) or incremental cost to the total annual cost savings. A list price discount of 75% is used in this analysis.

Motor data and energy consumption form

Employee Name: _____ Date: _____
 Company: _____ Location: _____

1. General Data

Motor application: _____
 Energy rate: _____

3. Measured Data

Input volts: _____
 (By volt meter)

Input amperes: _____
 (By ampere meter)

Input kW: _____
 (By power meter)

Operating speed: _____
 (By tachometer)

Power factor: _____

2. Motor Nameplates Data

Manufactured by: _____
 Phase, Hz: _____
 Voltage rating: _____
 kW/HP rating: _____
 Full load Ampere rating: _____

4. Calculated values

kW: _____
 (Input volts × input amperes × pf × 0.001732)
 Annual energy consumption: _____ kWh
 (kW × annual operating hours)
 Annual operating cost: Rs. _____/ year
 (Annual energy consumption × average energy rate)
 + (fixed energy rate × kW × 12)

Fig. 4. Motor data and energy consumption form.

Table 1
Summary of measured electrical parameters for 20 sample SMs.

Serial number	Motor rating (HP)	Motor rating (kW)	Measured voltage (V)	Measured current (A)	Measured power (kW)	Power factor	Annual operating (h)
1	1.5	1.119	355	2	1.11	0.90	8640
2	1.6	1.1936	355	2.4	1.301	0.88	8640
3	2	1.492	370	3.7	2.133	0.90	8640
4	2.0107	1.5	354	2.9	1.77	0.96	4320
5	2.1	1.5666	354	2.9	1.77	0.96	8640
6	2.9490	2.2	369	5.2	3.19	0.96	4320
7	3	2.238	369	5.2	2.99	0.90	8640
8	4	2.984	210	19	6.21	0.90	8640
9	4.6	3.4316	210	19	6.21	0.90	8640
10	5	3.73	373	8.4	4.88	0.90	8640
11	7.3726	5.5	380	11	6.8	0.94	8640
12	7.5	5.595	380	11	6.8	0.94	8640
13	10	7.46	419	65	37.73	0.80	8640
14	10.0536	7.5	420	84	48.56	0.80	8640
15	20.10724	15	420	19	12.02	0.87	8640
16	40.21448	30	410	43	27.42	0.88	4320
17	49.59786	37	418	54	41.701	0.80	720
18	73.72654	55	419	64	39.94	0.80	8640
19	80.42895	60	403	108	60.255	0.80	720
20	100.5362	75	416	105	61.501	0.80	720

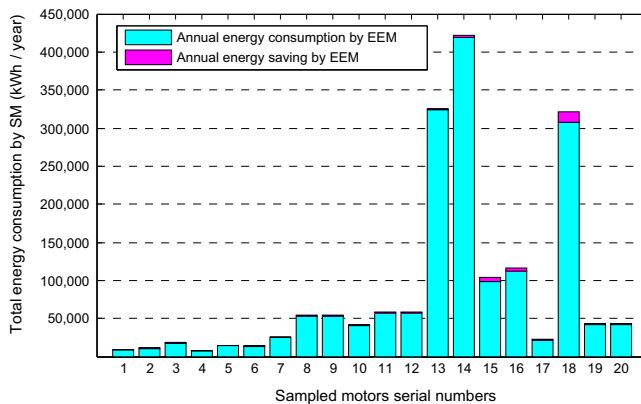


Fig. 5. Comparison of total annual energy consumption by 20 SMs and EEMs.

• Payback period

$$\text{Simple Payback} = \frac{\text{List Price Premium} \times \text{Discount Factor}}{\text{Total Annual Cost Savings}} = \frac{1650 \times 0.75}{5509.96} = 0.22459 \quad (4)$$

Thus, the additional investment required to buy this energy efficient motor would be recovered within 0.22459 years.

Similar analysis for other motors in the sample lead to the 20 values for each parameter: annual energy saving, cost saving and payback periods for replaced EEMs for SMs. Fig. 5 shows the break-up of total energy consumption by sampled SMs in terms of energy consumption by similar rating EEMs and corresponding energy savings. Fig. 6 describes that the sum of annual operational cost on an EEM and its corresponding cost savings equals the annual operational cost on similar rating SM. Finally, the

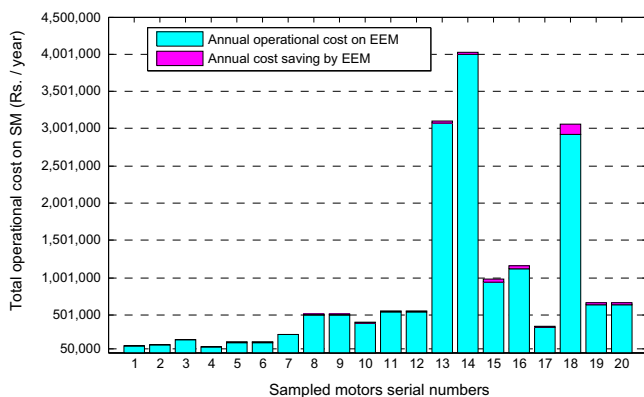


Fig. 6. Comparison of annual operational cost on 20 SMs and EEMs.

data described in this article is further analyzed statistically in Ref. [1] to construct the confidence bounds for energy conservation parameters.

Transparency document. Supplementary material

Transparency document associated with this article can be found in the online version at: <http://dx.doi.org/10.1016/j.dib.2016.06.004>.

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