GOOD PRACTICES IN SME

Replacing motors

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Are energy efficient motors cost-effective?

Motors are the most numerous group of electrical equipment and are used in practically every branch of industry.

The performance class of electrical motors is defined by the PN-EN 60034-30-1 standard:

- IE1 (Standard Efficiency),
- IE2 (High Efficiency),
- IE3 (Premium Efficiency),
- IE4 (Super Premium Efficiency).

The efficiency of the motor is dependent on its power rating – the higher the motors nominal power, the higher its energy efficiency. The requirements for minimal performance are codified by Commission Regulation (EU) 2019/1781 of 1 October 2019 laying down ecodesign requirements for electric motors and variable speed drives.

The dominant costs of a motor's lifecycle are the operational costs (costs of electrical energy), while the investment and maintenance costs amount to only about 5-10% of the lifecycle costs (LCC). Therefore, it is often the case that refurbishing old motors is not cost-effective. Given that energy efficient motors are about 20% more expensive than standard motors, while their energy consumption is lower, and assuming constant operation, the long-term optimal solution is purchasing a motor with the highest possible efficiency.

Source: KAPE based on "Podręcznika do samooceny zużycia energii dla MŚP", Jacek Szymczyk, 2020

Pic. 1 elmetsa: three-phase electric motor 200 kW

How to define the energy savings which can be achieved by replacing a motor with a higher energy efficient unit?

We can use the following formula to define the savings:

$$\Delta k = \left(\frac{P_N}{\eta_{ST}} - \frac{P_N}{\eta_{EE}}\right) \times t \times k$$

where:

$\Delta k - annual\ savings\ \left[\frac{PLN}{year}\right]$

$P_N - crankshaft\ power\ [kW]$

$\eta_{ST} - efficiency\ of\ a\ regular\ motor$

$\eta_{EE} - efficiency\ of\ a\ high\ energy\ efficiecny\ motor$

$t - amount\ of\ hours\ of\ work\ per\ year\ \left[\frac{h}{year}\right]$

$k - price\ of\ electrical\ energy\ \left[\frac{PLN}{kWh}\right]$

What are the savings when replacing a 30 kW motor with an efficiency of 90,7% with a high efficiency model?

The savings [PLN/year] (assuming the price of energy at 0,55PLN/kWh):

	Motor efficiency								
Motor hours [h/year]	94,0%	95,0%	96,0%	96,5%	97,0%	97,5%	98,0%	98,5%	99,0%
1500	958 PLN	1 235 PLN	1 507 PLN	1 640 PLN	1 772 PLN	1 903 PLN	2 033 PLN	2 161 PLN	2 288 PLN
2000	1 277 PLN	1 647 PLN	2 009 PLN	2 187 PLN	2 363 PLN	2 538 PLN	2 710 PLN	2 881 PLN	3 050 PLN
2500	1 597 PLN	2 059 PLN	2 511 PLN	2 733 PLN	2 954 PLN	3 172 PLN	3 388 PLN	3 601 PLN	3 813 PLN
3000	1 916 PLN	2 470 PLN	3 013 PLN	3 280 PLN	3 545 PLN	3 806 PLN	4 065 PLN	4 322 PLN	4 576 PLN
3500	2 235 PLN	2 882 PLN	3 515 PLN	3 827 PLN	4 135 PLN	4 441 PLN	4 743 PLN	5 042 PLN	5 338 PLN
4000	2 555 PLN	3 294 PLN	4 017 PLN	4 374 PLN	4 726 PLN	5 075 PLN	5 420 PLN	5 762 PLN	6 101 PLN
4500	2 874 PLN	3 705 PLN	4 520 PLN	4 920 PLN	5 317 PLN	5 709 PLN	6 098 PLN	6 483 PLN	6 863 PLN
5000	3 193 PLN	4 117 PLN	5 022 PLN	5 467 PLN	5 908 PLN	6 344 PLN	6 776 PLN	7 203 PLN	7 626 PLN
5500	3 513 PLN	4 529 PLN	5 524 PLN	6 014 PLN	6 498 PLN	6 978 PLN	7 453 PLN	7 923 PLN	8 388 PLN
6000	3 832 PLN	4 941 PLN	6 026 PLN	6 560 PLN	7 089 PLN	7 613 PLN	8 131 PLN	8 643 PLN	9 151 PLN
6500	4 151 PLN	5 352 PLN	6 528 PLN	7 107 PLN	7 680 PLN	8 247 PLN	8 808 PLN	9 364 PLN	9 914 PLN
7000	4 471 PLN	5 764 PLN	7 030 PLN	7 654 PLN	8 271 PLN	8 881 PLN	9 486 PLN	10 084 PLN	10 676 PLN

Source: KAPE