ENERGY CONSERVATION AND THE ELECTRIC MOTOR

A watt saved is a watt earned —the technology is here, but what will it cost?

BY MARY-SHERMAN WILLIS

The scramble is on for alternative sources of energy, from synfuels to fusion, but the relatively staid concept of energy conservation has been slow to take hold. Conservation is commonly associated with deprivation — with doing without fuel or electricity — and is an unattractive prospect in an age of high productivity. But that age is declining. As S. David Freeman, director of the Tennessee Valley Authority, the largest power producer in the United States, recently told a House energy subcommittee, "If we do not accept the fact that the joyride is over, we will never close the energy gap. Conservation is our cheapest and quickest source of energy."

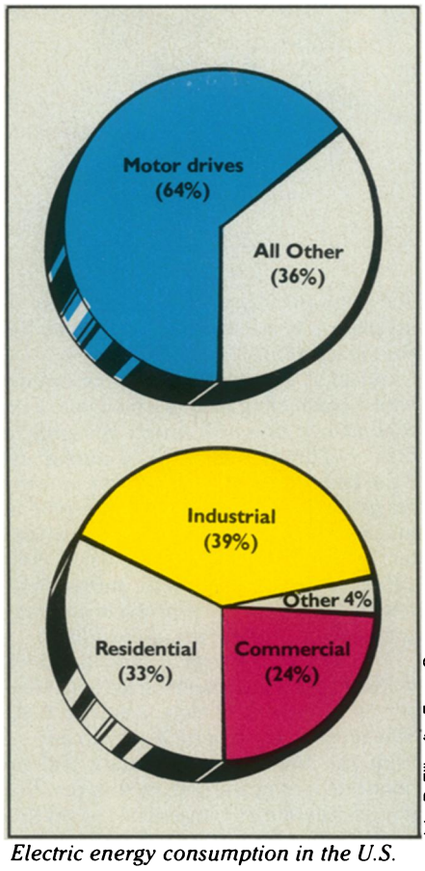
In technology, energy conservation translates as efficiency. High efficiency means a high output of work done by a system, compared with the input of energy to do it; less fuel is used and more fuel is available for other needs. It is an idea whose time has come and it is causing an engineering revolution in housing, manufacturing and transportation — systems that are governed by the marketplace. And so, inevitably, conservation and energy efficient technology are linked to cost effectiveness.

As an important example, consider the electric motor. While its basic design principles have remained unchanged for almost 40 years, it still offers a clean, economical, quiet and versatile source of mechanical power from electricity. It can range in horsepower from 0.01 hp to more than a thousand hp and can drive anything from a clock to a locomotive.

Some figures from a 1976 Arthur D. Little report and others indicate the magnitude of the role played by electric motors in the United States:

- They consume about two-thirds of all the electrical energy generated;
- they use one-third more energy than automobiles and consume the equivalent of 6 million barrels of oil (or 1.5 million tons of coal) daily;
- about 63 percent of the U.S. electric power drives industrial and commercial motors, with industry using the greater share;
- and most industrial motors are general purpose, AC polyphase motors, used as pumps, compressors, blowers and fans. The motors are about 50 percent to 70 percent efficient when fully loaded.

In terms of efficiency, motors from one hp to 125 hp could stand the most improvement. AC motors more powerful than 125 hp tend already to be highly efficient, says Philip Valence, one of the authors of the A. D. Little report. In 1976, motor efficiency was of least importance to the industrial user, whose power bill for electric motor drives was less than 2 percent of gross sales, the report said.



John R. Ellis after Exxon Corp.

Electric energy consumption in the U.S.

But what about today? Valence is working on a second report for the Department of Energy, commissioned by Argonne National Labs, which is due next year. He is already finding signs of industry's interest in "thinking conservation." The portion of the market devoted to high-efficiency motors has risen 5 percent in five years, he says. In 1977 only one manufacturer produced premium efficiency motors (80 percent or more efficient in the 1 hp to 25 hp range). Today, there are at least eight, and the number of orders for these motors is ten times higher than it was in 1977, according to figures of the National Electrical Manufacturers Association (NEMA).

But new high-efficiency motors cost more. Improved materials and machining, to reduce the heat losses (50 percent to 60 percent of the total losses) and lessen current requirements, can raise the premium costs as much as 25 percent. Yet, as energy costs go up, payback time is greatly reduced — sometimes down to two years, depending on how much the motor is used. And end-users may be adapting to longer-term payback periods, Valence says.

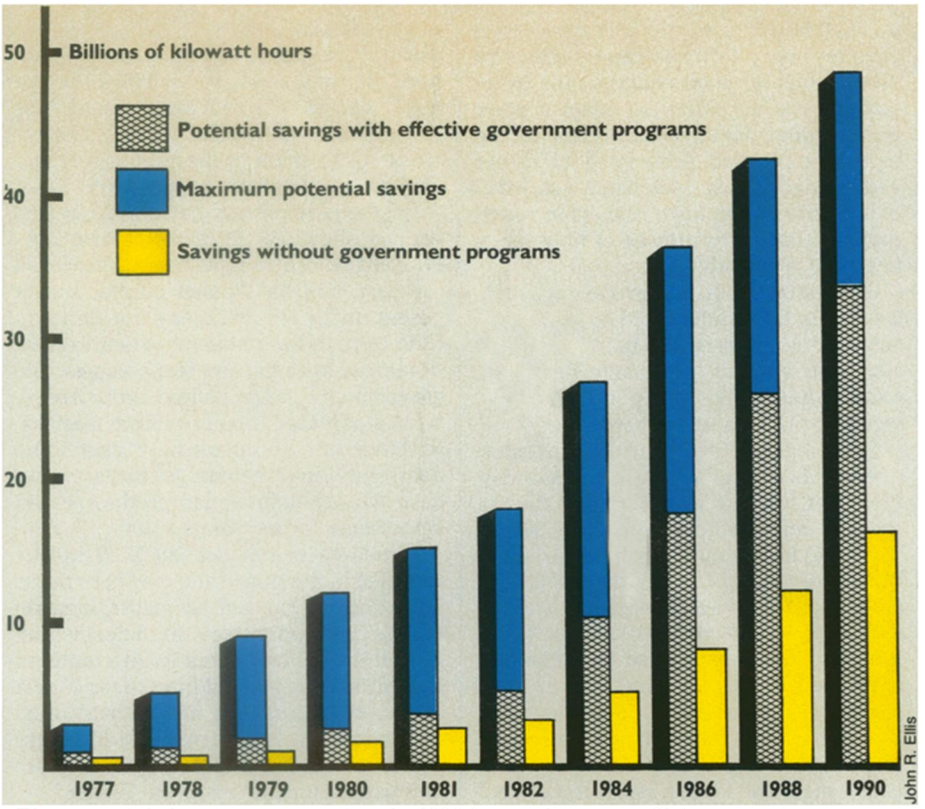
Meanwhile, a range of devices is becoming available to increase the efficiencies of existing motors, especially AC motors used with varying loads. The speed of an AC motor is essentially constant. As the load decreases, the excess power is simply wasted as heat. These devices use various means to change the electrical characteristics of the motor in such a way that the power can vary with the load. The motor runs more efficiently and cooler, extending its life (some say by 5 percent per degree cooler).

For example, the power factor controller (PFC), patented by Frank J. Nola of NASA's Marshall Space Flight Center, reportedly saves 40 percent to 60 percent power in unloaded, one-half hp to 5 hp motors. The PFC uses either Triac or silicon controlled rectifier semiconductor switches that function essentially the way a dimmer switch does for lights, by reducing the voltage applied to a motor when the load is reduced. Nola has been deluged with requests for plans and there are currently 22 companies licensed to manufacture it. But while some companies are already into production, "there are still a lot of teething problems"as one manufacturer put it, especially in developing a controller for three-phase motors and motors larger than 25 hp, both widely used in industry.

Joseph Pascente, president of Electronic Relays Inc., in Downers Grove, Ill., says his company sells a $30 PFC for single hp, single-phase motors, and a 7.5 hp controller for $74. Three-phase motor PFC's will be available by the end of summer, he says, and he predicts the devices will be selling for less than $5 per hp in two years (prices depend on the quantity ordered).

Another system, designed by Cravens L. Wandlass, modifies the capacitors in the motor windings. Wandlass has shown his motors to reduce power consumption from 12 percent to 50 percent, depending on the size of the motor and of the load. His company, Wandlass Motors Inc., in Tustin, Calif., is producing single- and three-phase

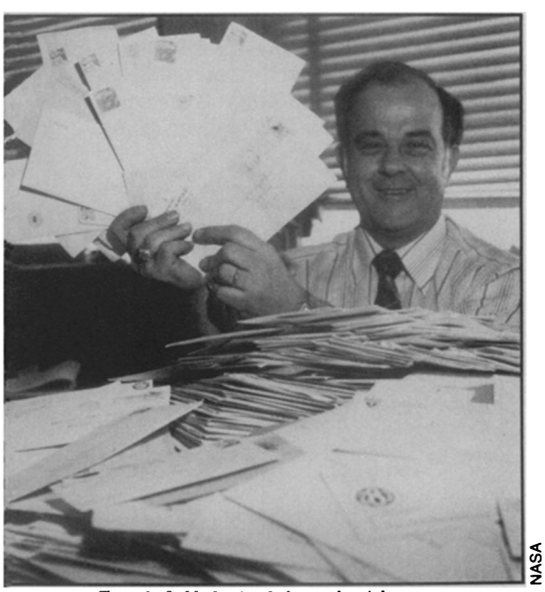
Science Service, Inc. is collaborating with JSTOR to digitize, preserve, and extend access to *Science News*. www.jstor.org



The potential electric energy savings by 1990 from using more efficient electric motors, as estimated by Arthur D. Little, Cambridge, Mass.

motors and will license technicians to modify existing motors, Wandlass says, adding that his new motors cost the same as standard motors because he uses the same methods of production and standard parts.

The Exxon Corp. recently claimed it has a new design for a variable speed motor control device. Their concept — to use a microprocessor to match motor speed to the load by varying both the voltage and the frequency of the electric wave form — is not new. At least four other companies. market similar devices. What is new is Exxon's claim that it can market the device for between $7.50 to $37.50 per hp by the mid-1980's — ten times cheaper than a similar device produced by another manufacturer today. But Richard Baker, the Exxon consultant who invented the device, says the figures anticipate a plummet in semiconductor costs in the next few years. If so, the payback period for the device can be as short as six months, he said.


NASA

Frank J. Nola is deluged with requests.

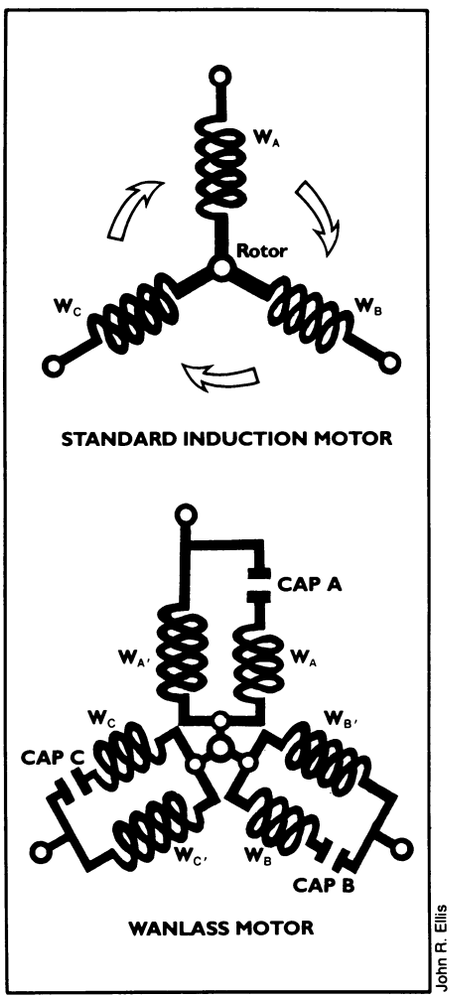
Exxon claims also that if, by 1990, half of the industrial motors in the United States used their device, it would save the equivalent of one million barrels of oil a day, which equals about the daily oil flow from Alaska. Current oil consumption in the United States is about 19 million barrels a day.

And NASA claims that even a 4 percent reduction in electric power consumption from their device would save the equivalent of 250,000 barrels of oil daily.

The potential for energy savings such as these has interested government energy planners for years. Last month the Federal Trade Commission approved a rule requiring household electric appliances to be labeled with the energy efficiency of the appliance — for example, the cost of running the appliance for a year. NEMA strongly endorsed this rule.

Meanwhile, Sen. Howard M. Metzenbaum (D-Ohio) has sponsored the "Industrial Equipment Efficiency Act of 1979," mandating government tested minimum standards for motor efficiency, similar to gasoline mileage standards on automobiles. Last year, the National Energy Conservation Policy Act authorized, among other things, an 18-month DOE study of the practicability and effects of these rules, now underway at A. D. Little.

But NEMA president Bernard H. Falk believes imposed standards are unnecessary and perhaps harmful. Market forces are already providing incentives for increased efficiency, and engineers are responding, he said. For example, the two-year payback period of some of the new motor controllers available today is considered an excellent investment incentive to many industrial motor users. And the five years that would be needed to establish government efficiency rules would create "chaos" in the industry. "The interplay of competitive forces created by economic pressures from users desiring to cut energy costs will achieve the same objective of energy efficiency for industrial products in less time, and at less expense to the user, than the mandatory approach being considered," Falk said.



The Wandlass motor adds a second set of windings and capacitors that store and regulate current.

While that view is to be expected from a proponent of free enterprise, "the question is whether or not industry is moving fast enough," Valence says. "That is what we're trying to answer in this next report." □