The gutting of America: Investment in electricity generation dries up

by Anthony K. Wikrent

Beginning in 1988, areas in the United States began to experienced occasional reductions in electricity, and even some complete interruptions—not because of an extraordinary accident, but because the United States no longer has sufficient electrical generating capacity to meet peak demands. Spokesmen for the electric utility industry and other experts are warning that this situation will worsen, unless the United States begins to add new capacity for generating and distributing electricity. But the U.S. electrical equipment industry has been so decimated by a decade of declining orders, that it no longer even has the physical capacity to rebuild its electricity generating and distribution capacity.

The first area to feel this latest effect of the collapse of the physical economy was the Northeast, which in the summer of 1988 experienced a number of temporary voltage reductions (brownouts), and even a few complete interruptions of service (blackouts). In February 1989, severe cold weather and snow storms in the Pacific Northwest drove electricity demand so high, that the Bonneville Power Administration was forced to cut back power to the large aluminum production plants of Intalco near Ferndale, Washington, and of Kaiser Aluminum's plants at Mead, near Spokane and Tacoma, Washington.

Another severe cold wave in December 1989, which dropped two inches of snow on the northern Florida Panhandle, caused a statewide demand of 33,883 megawatts (MW)—a peak demand that was not expected to be seen until 1995. In a desperate attempt to provide minimal service without endangering the electric system's equipment, Florida electric utility companies instituted "rolling blackouts"—cutting off all electricity to one locale for a period of time, then restoring service, while cutting off a different area—on Dec. 24 and 25.

In June 1989, the U.S. Council for Energy Awareness, the trade association for the U.S. nuclear power industry, issued an analysis which warned that during 1990-91, the U.S. electricity capacity margin—electricity generating and distribution capacity that is maintained as an operating margin for unusual peaks in demand, or extraordinary reductions in capacity because of accidents or repairs—would fall below the minimally acceptable level of 17%. The council noted that the Eastern Seaboard of the U.S. had fallen below that margin in 1988, leading to 37 occasions when available reserves fell below the 6-7% of the capacity safety level mandated by the New England Power Pool.

By December 1989, the New York-New England area had suffered 11 brownouts. The Greater Boston Chamber of Commerce estimated that these electricity service disruptions caused the loss of $86.8 million in economic revenues in the state of Massachusetts alone. The U.S. credit-rating agency, Standard and Poors, Inc. issued an analysis that the declining reliability of electricity service in the region threatens the creditworthiness of the entire area.

Actually, even a 17% capacity margin is not adequate, since about 30% of peak demand is determined by the weather. A 20% capacity margin has historically been considered the minimally safe margin for electricity generation in the United States. But by 1988, out of the nine regional electricity reliability systems, only two were at or above that margin.

Depression mentality rules planning

These crippling shortages of electricity are occurring because the shift by the U.S. to a post-industrial economy, increasingly enforced by environmentalist fanatics, has curtailed the addition of new electricity capacity (see **Figure 1**). Not only have U.S. electric utilities ceased beginning new projects, but many projects already begun were terminated before completion.

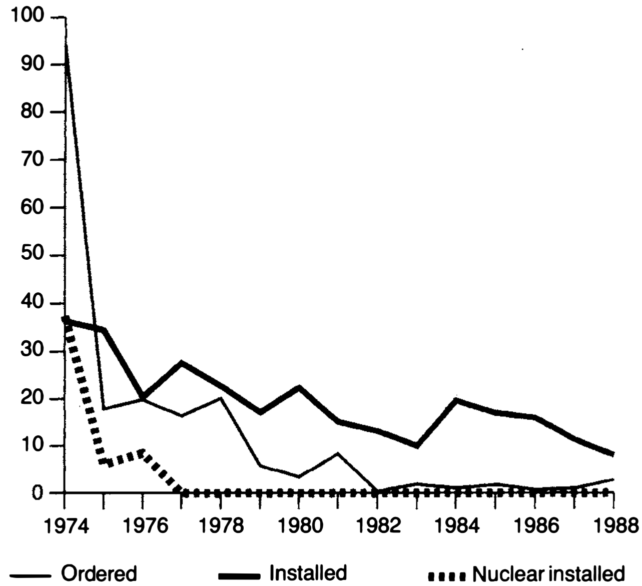
Faced with a Luddite assault on nuclear power by the environmentalists on the one hand, and on the other by U.S. financial markets hostile to investments in basic economic infrastructure with the attendant low rate of return, U.S. electric utilities committed themselves to plans for increasing capacity by only about 72,180 MW between 1988-98 (plus about 30,000 MW being added by independent power producers). Their plan was based on the asssumption that demand for electricity would grow only 2% annually—less than even the 2.8% growth in the immediate aftermath of the 1973 oil crisis (see **Figure 2**).

Sales of electricity in the United States grew 4.5% in

FIGURE 1

Orders and installations of turbines for electric utilities are grinding to a halt

(thousand megawatt capacity, in continguous United States)

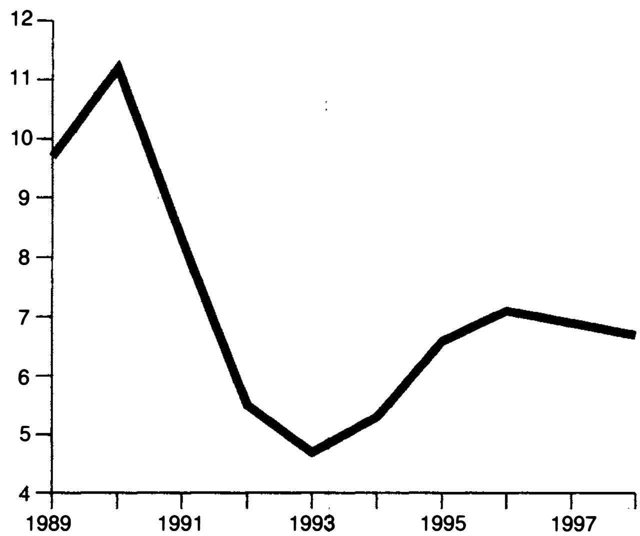


Source: Edison Electric Institute.

FIGURE 2

Projected additions to electric generating capacity indicate vicious economic cycle

(thousand megawatts)



Source: North American Electric Reliability Council.

1987 and 5.1% in 1988. Industry analysts predict that such growth rates will continue, meaning that in fact, 250,000 new megawatts of capacity is needed. It is also highly unlikely that even the planned addition of 72,000 MW will actually be built, since only 44% of that is currently under construction. And a major unknown is what will happen to the 107 coal-burning power plants, mostly located in the Midwest, which will be unable to comply with the new Clean Air Act amendments.

Spreading the poverty

Rather than adding new electricity generation capacity, utilities began to "wheel" power among them: If one region had a surplus of power, it delivered it to a region that was short. Though this capability is critical in an emergency, when equipment is down, it has now been done on a continuous basis for nearly two years, as a way of allowing utilities to avoid building new plants.

Wheeling has also been extensively used for short-term cost-cutting by replacing electricity generated with higher-priced fuels, such as oil, with power that is cheaper, such as hydroelectric. This has been done on an hour-to-hour basis. Wheeling of power has placed enormous stress on the transmission system, and has left many power lines operating at above 90% of capacity for significant periods of time. This decreases the ability of the utilities to respond to genuine emergencies, and threatens the reliability of the entire system.

Unlike the transport of other commodities, where an interruption in one spot can be quickly isolated (water mains turned off, for example), a disturbance occurring at any one point in an electricity distribution system will be felt at all other points in the grid, and cannot be easily isolated. There is no way to separate the electricity flowing through the power lines that is replacing power in an emergency, from power being wheeled between utilities to save money.

Similarly, according to the North American Electric Reliability Council, "Electricity transfer from one portion of an interconnected area will, to some extent, flow over all transmission lines, not only those in the direct path of the transfer." If there is a problem, voltage collapse and instabilities can occur in fractions of a second, and may destroy a critical piece of equipment somewhere else in the distribution system.

If there were to be an economic upsurge in manufacturing industries, and a return to the 6-8% per year growth of electricity demand of the 1960s, the United States would face an immediate crisis, not just because the new capacity being built is wholly inadequate to meet even present, truncated demand. More importantly, because the United States has lost the ability to manufacture critical equipment for the electrical industry, such as interrupters and high-voltage circuit breakers, and is rapidly losing the capability to produce other equipment, such as transformers, large steam turbines, and control panels.

Case study: the transformer industry

A clear example of how the United States has destroyed itself economically is provided by a study of the transformer industry. The steep decline in construction of new electricity capacity has caused the electrical industrial equipment and electrical generation equipment industries to dramatically "downsize" over the past decade. The downsizing of transformer production is a catastrophe because of the nature of the product, and because transformers are key components in the electricity distribution system.

Large power transformers, of 10,000 kilovolt amperes (kVA) and above, are used to step up the voltage of electricity generated by a power plant, usually between 2.4 and 30 kilovolts (kV) to the higher voltage (sometimes as high as 765 kV) required to move the current efficiently through hundreds of miles of transmission lines. These power transformers are known as generator transformers. Along the transmission lines are other power transformers, known as shunt reactors, which operate to keep the voltage up to the required level over long distances. Where two different transmission systems interconnect, autotransformers adjust the voltage level of one system to the other.

Once the current reaches the location where it must be divided into different distribution systems for delivery to end users, "substation" or "step-down" transformers are used to step down the voltage of electricity from the high-power transmission lines to the lower voltage required for local power line distribution, usually 345 kVA, but ranging from one to several hundred kVA.

All these different types of transformers are known generically as power transformers. Each is custom-designed and tailor-made to meet its specific application, as well as other specifications of the utility purchasing the power transformer. Such factors as the length and particular features of the transmission line, and the characteristics of the load being served, can vary significantly between applications. The typical price of a power transformer runs well over $1 million.

Other transformers will further step down the voltage to 230 kVA or 115 kVA for final delivery to distribution transformers, which reduce the voltage to 110 volts to serve two to five residential homes. The most common distribution transformer used in the United States is rated at 25 kVA, but may range as low as 4 kVA and as high as 138 kVA. Industrial plants are served with 440 volts, and may be served by distribution transformers of up to 500 mVA, but 5 mVA is most common. The market for distribution transformers is primarily determined by new residential construction.

Generally, the higher the voltage in the line, the less the loss of current. However, the equipment needed to handle the higher voltage can cost considerably more than that needed for lower voltages.

The unique design of power transformers imposes extraordinary burdens on manufacturers. Because there is no set standard design, they cannot be mass produced, nor is it possible to build up inventories. Rather, manufacturers must retain the sophisticated engineering and scientific personnel needed to design them, supervise their production and installation, and test them, along with the highly skilled work force needed to fabricate and install them according to design. Moreover, the immense size and weight of power transformers requires very large manufacturing facilities and equipment, including overhead cranes able to lift up to 500 tons, and testing equipment able to simulate the most adverse operating conditions, such as lightning strikes. Massive vacuum and pressure chambers are needed to remove all moisture from the completed unit, and to force the impregnation of dielectric (non-conducting) oil in the internal windings.

These considerations dictate a much larger burden of fixed costs for transformer manufacturers than is normal for other manufacturers in other industries. A steady volume of orders is required to keep unit costs price competitive. Underutilization of manufacturing capacity drives up unit costs disastrously, making the manufacturer increasingly uncompetitive, and increasingly unable to support the research and development expenditures required to sustain a technological position. The demand for power transformers is thus very inelastic, being almost entirely derived from the addition of new electric power generation and distribution capacity.

It was exactly this process, where declining orders forced declines in production capacity, that has engulfed the U.S. power transformer industry and has shrunk it to less than half its size since the 1970s. No better example can be found of how the physical economy is destroyed if it is subordinated to financial and monetary considerations—such as a blind ideological belief in "free" markets, or "free" trade. After the market for power transformers peaked in 1974 at 293,012 megavolt-amperes, it collapsed to 66,004 mVA by 1984, as utility companies ceased adding new generating or transmission capacity. New orders for power transformers in 1988 were only 83,872 mVA (see **Figure 3**).

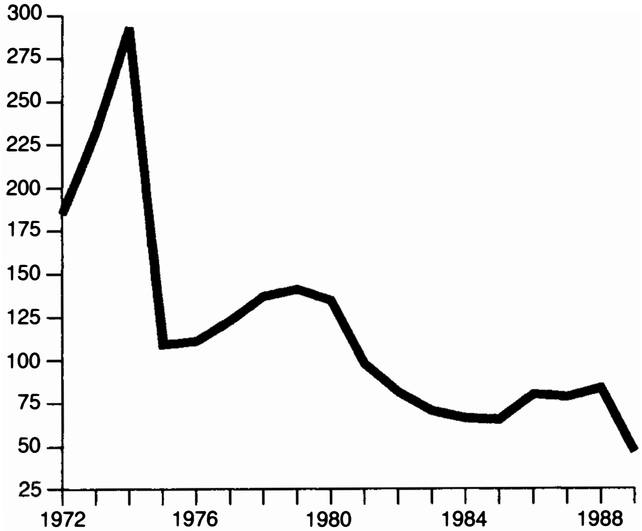
The collapse of the market forced down capacity utilization rates to under 50% by 1986. According to a special survey done by the National Electrical Manufacturers Association at that time, transformer manufacturers had not shown a profit on their operations since 1980. A wave of business failures and major restructurings by remaining companies in the industry caused U.S. production capability to shrink rapidly. In 1986, there were 244 companies with 293 manufacturing facilities engaged in producing all types of transformers, distribution as well as power. Four companies that dominated the industry, accounting for aproximately 55% of industry shipments, as measured by dollar value. By 1985, shipments of transformers, at 46,933 mVA, were less than one-fourth of the 186,709 mVA shipped in 1975, and the industry was operating at less than 50% capacity.

In the 1960s and early 1970s, the transformer industry operated at close to 90% capacity. In 1988, orders of 83,872

FIGURE 3

New orders plunge for power transformers of 501 kilovolt-amperes and larger

(gigavolt-amperes of capacity)



Note: Figure for 1989 is estimated, based on doubling figure for first half of year.
Source: Edison Electric Institute.

mVA were booked, and the order backlog at the end of the year was 67,511 mVA. In 1974, orders of 293,012 mVA were booked, and the backlog stood at 186,709 mVA. Total employment in the transformer industry dropped 32.3% from 50,700 in 1973, to 34,300 in 1990. Imports as a percentage of apparent supply more than tripled in the same period, from 3.3% to 11.5%. The latter figure is misleading to the degree that it does not reflect the loss of domestic ownership in the industry.

In 1987, Westinghouse became the nation's predominant transformer manufacturer when General Electric adandoned the industry and sold its transformer manufacturing facilities to Westinghouse. This was ironic, because Westinghouse had already begun "downsizing" its transformer manufacturing capacity in 1984, when it closed facilities in Greenville and Sharon, Pennsylvania. The Westinghouse facility in Muncie, Indiana was reduced from 1,600 workers to only 460.

In 1987, the firm ASEA A.B. of Sweden merged with Brown Boveri of Switzerland to become one of the world's largest manufacturers of heavy electrical equipment. In 1989, Westinghouse, which had previously established a joint venture with ASEA Brown Boveri Ltd. to produce and market power transformers in the United States, sold its 55% interest in this venture to ASEA Brown Boveri, leaving McGraw Edison, bought by Cooper Industries in 1985, as the last U.S.-owned company with significant capacity to produce power transformers. In June 1988, Cooper also bought RTE Corp., which manufactures liquid-immersed power and distribution transformers.

In February 1989, the National Electrical Manufacturers Association testified before the Senate Government Affairs Committee that nearly 40% of U.S. transformer production capacity had been shut down in the previous 30 months.

No incentive for new technology

A major technological advance in the transformer industry has been the development of "amorphous metals." By rapidly cooling a molten compound of iron, silicon, and boron, a metallic material is produced with a random atomic structure similar to glass, which can be cast as thin as 1 mil, as compared to 11 or 12 mils for the silicon steel used up to now, while achieving considerable reductions in current loss in transformer cores.

According to Edward van Damm of the Electric Power Research Institute (EPRI), it is not economical for U.S. utilities to replace existing transformers with new ones constructed out of amorphous metals. New transformers will be installed only as new capacity is built, and only if the utility has higher cost types of power. A utility with large amounts of cheap hydropower capacity will not find it economical to purchase and install the new, more expensive transformers.

But technological levels between the major international manufacturers of transformers are at best a minimal consideration for buyers. Far more important are the terms of financing. Here, U.S. companies operate at a severe disadvantage compared to their foreign competitors, because the U.S. Export-Import Bank amply reflects the usury that dominates the U.S. economy, and is also more often used to enforce adaptation to "appropriate technologies," such as windmills, rather than the most modern industrial equipment available. In the early 1980s, interest rates on loans offered by the Exim Bank were approximately 190 basis points higher than comparable institutions.

Besides power transformers, the United States has almost completely lost the ability to produce other equipment, such as high-voltage circuit breakers. Like power transformers, these devices are large and complex, with detailed specifications and requiring elaborate testing. However, their design is far more standardized than the design of power transformers. McGraw Edison is the only U.S. company left able to produce high-voltage circuit breakers, and its production capacity is almost negligible when compared to annual demand, even at the depressed levels of today.

A joint venture between Hitachi and General Electric also assembles high-voltage circuit breakers in the United States, using sulfur hexafluoride produced in Japan. Sulfur hexafluoride is a gas that quickly extinguishes the arc in a circuit breaker, and offers a major reduction in size of equipment. This is a particularly strong advantage in Europe, with its shorter distances.