From Ratebase to Revenue: The Roles of Technology and Investment in Ten Short Points

By Leonard S. Hyman*

Technology made the old electric industry. Technology unmade the old electric industry. The regulators, the industry executives, the public policy shareholders tried to put it together again. Technology will unmake their efforts, too. Here is how and why.

First Point

The electricity supply industry began as a competitive enterprise. Edison intended to compete against the entrenched city gas industry. British generator entrepreneurs built without secured markets. Electricity users could—and did—self generate. The electric companies faced the need to make heavy, long-lived capital investments. The city councils, which controlled the ability to use the streets for right-of-way, could grant franchises, rescind them, or grant competing franchises, and they did. Many cities, moreover, established their own utilities, or took over privately owned utilities. How could investors protect the value of their investments, once sunk into the ground?

Second Point

The great pioneers of the industry, Edison, Insull and Westinghouse in the United States, Merz in the UK and Rathenau in Germany thought in terms of systems. They viewed technology in the manner best described by Thomas P. Hughes, who distinguished between the technical, which encompasses "tools, machines, structures, and other devices," and the technological, which encompasses "technical . . ., economic, political, scientific, sociological, psychological, and ideological . . ."[1]

Joseph Swan, the British inventor of the light bulb, thought in technical terms. Edison thought in technological terms. He invented a system that furnished a series of services desired by society. If he had focused on the light bulb, alone, he might not have succeeded. Electric lighting cost more than gas lighting, and the gas light industry persevered in perfecting its obsolete product, reaching a new pinnacle of success with the Welsbach Mantle (invented in 1886, four years after Edison opened the Pearl Street Station).

Edison's successors grasped the importance of economies of scale, load diversity, and the universal supply system, but how could they raise the money to put their ideas in place, if newcomers could move into those markets, and if corrupt city councils could upset the business so easily? They needed protection. For that matter, how could consumers benefit from economies of scale and load diversity, if the utility could never reach scale? In the early 1900s, the investor-owned electricity industry and the states began to make deals. The state would grant the utility a monopoly, forbidding competitors from selling electricity in the franchised area. In return for the monopoly, the utility would agree to limit its profitability to a given return on its investment plus recovery of costs. If costs declined as a result of increasing economies, consumers would benefit.

Third Point

The newly devised system worked. For close to 60 years, from the inception of regulation, into the 1960s, the real price of electricity declined steadily, reflecting the increasing economies of scale, diversity of load, and the new uses of electricity encouraged, in part, by the increasing cheapness of electricity. Economists can debate whether a competitive market, instead, would have brought greater benefits to consumers. Equity investors in this regulated industry, despite its low depreciation rates and heavy reliance on debt, earned returns below or at par with those of the market, indicating, at least superficially, that the regulators did not allow the industry to earn excessive profits. At the same time, returns did seem sufficient to allow the industry to attract capital at terms fair to existing investors.[2]

Intermission

To sum up, so far, the regulated utility, operating on a rate of return base, taking advantage of increasing economies of scale, provided reliable service, served a growing proportion of the population, reduced real prices steadily, and managed to earn a level of profits that attracted capital at reasonable terms. During this period of time, investment—that is, ratebase—determined pricing. The regulator set a return on a rate base, otherwise known as cost of capital, translated that return into a given level of operating income and added, to that figure the operating expenses, to determine the revenue requirement. The regulator then estimated volume of units sold and then determined price:

RR = revenue requirement ($)
CC = cost of capital (%)
OE = operating expenses ($)
RB = rate base ($)
OI = operating income ($)
V = volume of units sold (kwh)
P = price per unit ($)

so that:

$$\frac{CC \% RB}{100} = OI$$

$$OI + OE = RR$$

$$RR = P \% V$$

And, therefore:

$$P = \frac{RR}{V}$$

Technology played a key role in facilitating growth with declining costs. The technology required heavy investment. And the industry obviously earned its cost of capital, because it had little difficulty attracting the capital. Because of the predictability of costs and volume, and because of technical improvements that may have allowed the industry to beat

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[1] See footnotes at end of text.

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expectations, regulators could easily set a price derived from the revenue requirement.

Fourth Point

In the early 1960s, conventional steam turbines reached the efficiency limits inherent in the Rankine cycle. Building bigger produced no additional benefits. As noted by Richard F. Hirsh:

> . . . a long and successful history of managing a conventional technology set the stage for the industry's deterioration in the late 1960s and 1970s. After improving steadily for decades, the technology that brought unequalled productivity growth to the industry appeared to stall, making it impossible to mitigate the difficult economic and regulatory assaults of the 1970s.[3]

The industry sought to move on to a new real energy source, nuclear power, but nuclear power plants raised rather than lowered costs. Regulators and management had difficulty in understanding that the industry had run up against a major technological barrier, that they could not run the industry as before. They could not offset unexpected inflationary cost pressures with efficiency gains. They insisted on continuing the old process. In the 15 years, 1966-1980, credit ratings collapsed and electric utility stocks not only underperformed the rest of the stock market, but they even underperformed bonds. The return on book equity exceeded the bond yield by 645 basis points in 1966 while the bond yield exceeded the return on book equity by 380 basis points in 1980. The old utility technological and finance models broke down.

Fifth Point

At the same time that conventional steam generators reached their efficiency plateau, a new technology—the gas turbine—emerged. Utility engineers, by and large, did not foresee the amazing development of this device. They stuck to the tried and true, meaning the big. Yet, E.F. Schumacher asked, in 1973:

> Methods and machine cheap enough to be accessible to virtually everyone—why should we assume that our scientists and technologists are unable to develop them?[4]

Utility engineers, however, did not take *Small is Beautiful* as their text. Thanks to a combination of mindset commitment to the completion of existing projects, and government fuel-use legislation, they let others put gas turbines into service. They missed the new technological revolution, until they woke up to discover that the gas turbines could generate electricity more cleanly and at a lower cost than the big utility plants. The gas turbine erased the rationale for a natural monopoly in generation.

Sixth Point

The Public Utility Regulatory Policies Act of 1978 (PURPA) created a new electricity generating industry that would use the gas turbine and it also created an unusual investment vehicle. The law, to some extent, permitted the PURPA generator to avoid rate of return regulation, but to set a guaranteed state-mandated price, lock the utility into a long-term contract, force the utility to take the output whether needed or not, and piggy-back onto the utility's credit rating. Other than the construction and operating risk, the PURPA generator foisted all other risks onto the utility, but the utility collected no compensation for taking those risks. This arrangement encouraged the rapid development of the new technology and the flow of investment into the independent generating industry.

Seventh Point

Two decades of independent power production, the dramatic increase in efficiencies of gas turbines, computational power and communications that permit marketers and systems operators to keep track of a multitude of transactions, and the Internet, which establishes direct contact between customer and supplier, have eroded the old utility model down to a skeleton, the wires business.

Eighth Point

Even newer technology could threaten all aspects of what was the utility business and its offshoot, the independent power business. While utilities and their affiliates concentrate on transition plans, recovery of stranded costs, centralized control functions and purchase of power stations, entrepreneurs easily raise money to develop distributed generation and internet-based enterprises that threaten the viability of the old-utility-model which now operates in the guise of a competitive industry.

Ninth Point

Competitive industries do not operate without price signals to customers. Few ultimate electricity customers receive timely price signals. Nor do users of the transmission system in many markets. People who make investment decisions to supply a one-sided market may encounter unpleasant surprises when consumers finally obtain price signals. When price rises unexpectedly, expect one of two consequences: consumers reduce consumption, which wrecks the economies of some business models, or the government regulates, which produces the same consequence. Deregulation that leads to higher prices, for more than a brief period, will not survive. Remember, the new technologies will help consumers respond to price. Investing in the now dominant technology, at high prices that reflect a continuance of that dominance may involve greater risks than now appreciated.

Tenth Point

Despite the industry's success in reclaiming stranded costs and in slowing the onset of competition, the industry has not regained its old position with investors. Since the onset of competition, the stocks have grossly underperformed the market, and in the period 1995-1999, investors withdrew over $10 billion from mutual funds that specialized in utilities while they put $37 billion into funds specializing in technology. Electric utility and independent power shares now account

for an insignificant 3% or less of the market. Nobody has to own these stocks other than index funds.

Conclusion

In short, the electricity industry ran smoothly for decades, thanks to predictable technology improvements. Then the technology changed, the industry did not adapt quickly enough, but others did. Now, the industry faces competition from the technology that it shunned. It may face additional competition from new technologies. The old monopoly ended. The new monopoly may end even faster.

End Notes

[1] Thomas P. Hughes, "Technological History and Technical Problems," In Chauncey Starr and Philip C. Ritterbush, eds., *Science Technology and the Human Prospect* (New York: Pergamon Press, 1980), p. 182.

[2] For details on industry pricing and profitability and returns on investment, see Leonard S. Hyman, *America's Electric Utilities: Past, Present and Future* (Vienna, VA: Public Utilities Reports, 1997).

[3] Richard F. Hirsh, *Technology and Transformation in the American Electric Utility Industry* (Cambridge, UK: Cambridge University Press, 1969), p. ix.

[4] E.F. Schumacher, *Small is Beautiful* (New York: Harper & Row Perennial Library, 1975), p. 34.

The Jane Carter Prize

The British Institute of Energy Economics, the International Association for Energy Economics and the Association for the Conservation of Energy invite the submission of essays for the 2001 award of the Jane Carter Essay Prize. The prize will be a cash award of US $800 together with a plaque.

Essays can be on any aspect of energy efficiency and conservation or on aspects of general energy and environmental policy which are relevant to energy efficiency. The aim is to encourage new thinking on these subjects. The emphasis of the essay should, therefore, be on the policy, rather than the scientific or technical, aspects of the subject.

The competition is open to anyone under the age of thirty-five. Essays should not be more than 8,000 words long. They can be based on work done for another purpose, e.g., an academic thesis or policy report, but the results of that work should be presented in an original form. The wining essay will be considered for publication in a range of energy and environmental journals.

Essays should be submitted in English, in triplicate and typed form by 30 June 2001 to:

Mary Scanlan, Administration Secretary
British Institute of Energy Economics
37 Woodville Gardens
London W5 2LL
United Kingdom

Each essay should include a 150 word summary. The name, address and age of the author should be on a separate sheet which can be detached from the essay which will be judged anonymously. Manuscripts will not be returned.

Book Review

Thatcherism and the Fall of Coal

By M. J. Parker, Oxford University Press for Oxford Institute for Energy Studies, ISBN 0-19-730025-1, pp. 246, 72 tables, index: £39.50 / $65 each (inc. p&p).

At the start of the 1980s UK coal mines employed over 200 thousand people, and produced over 100 million tonnes per year. By the end of the 1990s, more than 95 per cent of those jobs and 80 per cent of the output had been lost. Within a short space of time, a major British industry had all but passed into history, and as a result the entire political and industrial landscape of Britain had been irreversibly changed... What caused the fall of coal? Was it just the result of political malice from Conservative governments determined to crush the power of the National Union of Mineworkers forever? Was it due to unstoppable market forces in the energy market that made UK deep mines unviable? Or did management and unions through their mistakes create the conditions for their own destruction?

In this book Michael Parker provides an insiders account of the decline of the UK coal industry. He rejects any one simple explanation, and details how the Thatcherite political agenda, economic forces, and the industrys own performance interacted to bring about this decline; often in ways which were unforeseen by the players themselves.

The author shows how the Thatcherite political agenda to break the power of the NUM, and to turn the nationalised coal industry into a commercial enterprise, had great internal coherence. Although the outcome was not the result of any pre-ordained master plan, this agenda was implemented with considerable caution and skill (except in 1992). But the Conservative governments were also attended by good fortune, being assisted by the folly of the NUM leadership (which was a decisive factor in enabling the Government to defeat the Great Strike of 1984/5), the professionalism of British Coal in managing decline, the unforeseen way in which electricity privatisation led to the 'dash for gas', and the unpredicted severity of international trends, which reduced the real value of UK output by two-thirds.

As the author concludes, the economic fundamentals and Conservative governments' objectives pointed in the same direction. In spite of large increases in productivity and the closure of many high-cost pits, the economic pressures to reduce deep-mined output were unremitting; and with the fall in capital investment, on-going decline became inevitable. Neither massive 'down-sizing', nor the 'magic wand' of coal privatisation was able to create, even on a much-reduced scale, a sustainable and viable deep-mine industry. The consequences of this legacy were passed, in a final irony, to New Labour.

Michael J. Parker was until 1991 Director of Economics at the British Coal Corporation, and a former Chairman of the British Institute of Energy Economics. He is a graduate of Oxford University, and an Honorary Fellow of the Science Policy Research Unit at the University of Sussex. Since 1993 he has been a member of the governments Energy Advisory Panel.

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