

SALVE REGINA UNIVERSITY

ENVIRONMENTAL ETHICS AND THE ELECTRIC POWER GRID:

A CASE FOR TECHNOLOGICAL MOMENTUM

**A DISSERTATION SUBMITTED TO
THE FACULTY OF THE HUMANITIES PROGRAM
IN CANDIDACY FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY**

BY

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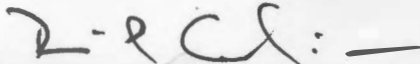
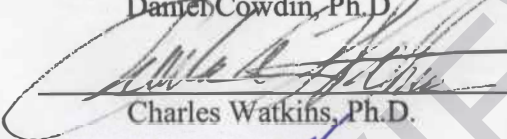
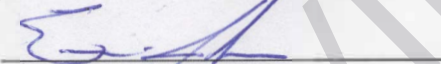

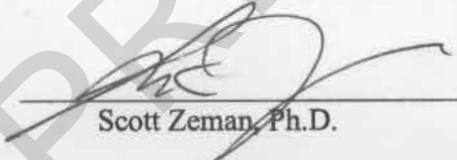
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GRADUATE STUDIES

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PREVIEW

In memoriam of
James P. Povlock, 1929-2015, electrical engineer and father,
and
Eric J. Shaw, 1957-2016, mentor and friend.

PREVIEW

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ABBREVIATIONS

AC	Alternating current
AEC	Atomic Energy Commission
AIEE	American Institute of Electrical Engineers
AAAS	American Association for the Advancement of Science
ASRI	Audubon Society of Rhode Island
CEQ	Council on Environmental Quality
CLF	Conservation Law Foundation
DC	Direct Current
EAB	Environmental Appeals Board
ECRI	Environment Council of Rhode Island
EDF	Environmental Defense Fund
EPA	Environmental Protection Agency
DOI	Department of the Interior
DDT	Dichloro-Diphenyl-Trichloro-ethane
FERC	Federal Energy Regulatory Commission
FTC	Federal Trade Commission
Hz	Hertz
IEEE	Institute of Electrical and Electronic Engineers
ISO	Independent System Operator
kV	Kilovolt
kW	Kilowatt
kWh	Kilowatt-hours

MW	Megawatt
MWH	Megawatt hours
NALF	Naval Auxiliary Air Field
NASA	National Aeronautics and Space Administration
NEES	New England Electric System
NEPA	National Environmental Policy Act
NEPA	New England Power Association
NEPEX	New England Power Exchange
NEPOOL	New England Power Pool
NWF	National Wildlife Federation
PG&E	Pacific Gas & Electric
PSI	Pounds per Square Inch
PUCHA	Public Utility Holding Company Act
PURPA	Public Utility Regulatory Policies Act
REMVEC	Rhode Island-Eastern Massachusetts-Vermont Energy Control
RIBBA	Rhode Island Beach Buggy Association
RICA&M	Rhode Island College of Agriculture and the Mechanic Arts
RICE	Rhode Island Committee on Energy
RIPUC	Rhode Island Public Utilities Commission
RIMS	Rhode Island Mobile Sportsfishermen
RIPS	Rhode Island Public Service
RIWF	Rhode Island Wildlife Federation
SEC	Security and Exchange Commission

UEP	United Electric Power
UER	United Electric Railways
V	Volts
WPI	Worcester Polytechnic Institute

PREVIEW

ABSTRACT

This qualitative analysis examines the effects of a growing environmental ethic on the electric power grid in southeastern New England from the late nineteenth century to the start of the new millennia. The increased awareness of the environment evolved into a new belief system of the population and altered the methods of construction, operation and maintenance of the advanced technology system of the electric power grid. The manner in which this occurred suggests that technological momentum is a better concept than technological determinism with which to examine the development of technological systems in the modern world.

This dissertation examines the trinity of actors affecting this process. The electric power companies, with the New England Electric System as the main protagonist, attempted to expand the electric power grid to meet expected consumer demand and economic opportunities. A devoted cadre of nascent environmentalists, dismissive of the commercial and technological requirements of the electric power grid, suggested to the population that the new idea of protecting the environment should instead take priority. The interaction of these two forces led to a governmental response that attempted to continue to meet the population's demands while preventing the degradation of the environment. The resultant transformation of the population's perception of the electric power grid, its regulation by the government, and its operation by the system members, suggest that advanced technology systems are influenced as much by philosophical concerns as any technical constraints.

INTRODUCTION

There's a powerful, obedient, swift, and effortless force that can be bent to any use and which reigns supreme aboard my vessel. It does everything. It lights me, it warms me, it's the soul of my mechanical equipment. This force is electricity.

- Captain Nemo to Professor Aronnax in Jules Verne's *Twenty Thousand Leagues Under the Sea*

The development of the electric power grid in the United States transformed the nation into an energy-intensive society. Americans had shown interest in electricity from the days of Ben Franklin's earliest experiments and had profited from his workman-like accounts of his lightning rod to make their homes safer.¹ Application of electric energy as a major power source was still over a century away however and electricity remained more of a curiosity than a source of power for society. In the 1800s electricity was used to power the telegraph stations that formed the communications network of the Victorian era and to energize other minor applications.² Power to drive the Industrial Revolution was chiefly provided by coal-fired steam plants or water mills running intricate systems of belt-driven machines, while on the farms animal and human power predominated.³ This methodology, though grueling for the majority of the population involved in agriculture or industry, was nonetheless sustainable.

1. E. Phillip Krider, "Benjamin Franklin and Lightning Rods," *Physics Today*, 59, no. 1 (January, 2006): 42.

2. Steve Parker, *Electricity* (London: Dorling Kindersly, 1992), 31, 37.

3. Vaclav Smil, *Creating the Twentieth Century* (New York: Oxford University Press, 2005), 14.

Thomas Edison's electric power generation prototype built in New York City in 1882, showed how electricity could be used to drive industrial activities and fill consumer desires.⁴ Over the course of only a few years, Edison developed and built a pilot electric generation station in New York City, the transmission lines from its coal-fired dynamos to the electric load locations and all the electrical connections, circuit breakers and fuses necessary to energize the lights in the selected buildings.⁵ Edison's construction was the first electric power grid in history, a combination of subsystems that generated electric power, transmitted it across metal cables to the designated establishments and then distributed the energy to the lightbulbs within those buildings.⁶

Under the guiding light of a host of ingenious inventors, engineers, and financiers, this system of electric power generation, transmission and distribution system rapidly expanded throughout the nation. By the middle of the twentieth century, the network of electric power plants and supporting systems provided a reliable and economic source of energy to all facets of society. This mature technology seemed poised to take the next great leap forward in the continuous quest for greater effectiveness and efficiency. Instead, the flood tide of technological development was altered by forces that had seemed insignificant when the electric power grid had been created.

Concurrent with the technological culmination of the electric power grid was the emergence of various schools of environmental ethics that took hold in popular

4. Ibid., 49-60.

5. Thomas P. Hughes, *Networks of Power* (1983; repr., Baltimore, MD: The Johns Hopkins University Press, 1983), 47.

6. Ibid., 40-43.

conception and gained political traction. The new social construction of environmental ethics acted to alter the course of development of the electric power grid in southern New England from one based purely on technical efficiency and effectiveness to a vector that had to account for principled concerns for the environment. How this occurred is the central research question to be examined in this dissertation. More generally, this action demonstrates that the concept of technological momentum is a more insightful hypothesis than technological determinism when investigating the progress of advanced technology systems.

Purpose

The theories of technological determinism as initially proposed by Lewis Mumford and then expanded on by Jacques Ellul suggest likely outcomes for any advanced technological society. Both authors discussed the effects of the tightening vise grip of advanced technology on modern society. For Mumford, the “monotechnics” of industrial age society acquired an internal inertia based on the generation of greater human control and power.⁷ Earlier technological endeavors based on life itself such as improved farming tools or home-spun woolen clothes were displaced by this quest for authoritarian control over nature and society. Ellul later posited a more general theory for the expansion of technology in human society. To Ellul, technology had led to the modern form of “*technique*” that had displaced all previous human endeavors.⁸ With its

7. Lewis Mumford, *The Pentagon of Power, Myth of the Machine Volume Two* (New York: Harcourt Brace Jovanovich, 1964, 1970), 155.

8. Jacques Ellul, *The Technological Society*. Trans. John Wilkinson (New York: Vintage Books, 1964), 4.

characteristics of rationality, artificiality, self-augmentation, universality and autonomy, *technique* diffused throughout and engulfed all elements of society. Future progress became solely based on *technique's* internal demands to achieve the one best way, the most efficient one.⁹ Slowly but surely all human activity was swept up and subordinated in this effort while earlier human desires and longings were brushed away as the technological drive increased without bound.

Thomas P. Hughes' discussion of technological momentum provides a different and perhaps more insightful hypothesis describing technological activity, one that allows advanced technology systems to be affected by social concerns as much as the technical demands of the maturing structure. The advanced technology systems do acquire a considerable developmental velocity, yet the mass of interrelated organizations, devices and schemes is not irresistible. Instead, much like any object in motion, forces affecting these organizations can lead to a change in direction in the development of the technological system. This is more difficult to achieve as a technology matures and organizational stakeholders resist any system disruption, but other humans still retain agency to alter the future development of the system.¹⁰

The discourse between these two hypotheses suggests an intriguing space in the investigation of a particular advanced technology system. The electric power grid, one of modern society's underpinnings, certainly meets the requirements of an advanced technology system in all of these authors' conceptions. When the development and

9. Ibid., 21.

10. Thomas P. Hughes, *American Genesis: A Century of Invention and Technological Enthusiasm 1870-1970* (New York: Penguin Books, 1989), 470-471.

operation of the electric power grid over the past few decades in southern New England is examined, one notes that this system developed somewhat differently than the theoretical construct of technological determinism would have predicted. The political mandates rising from the increased concerns of the population regarding environmental issues led to changes in the way the electric power grid was constructed and operated. The rise of this environmental consciousness and ethic acted as a dampening force on the electric power grid's technological trajectory and is more supportive of Hughes' hypothesis than Ellul's or Mumford's deterministic route. Examining how this occurred is the purpose of this investigation.

Interdisciplinary Analysis

Analyzing the evolution of the electric power grid in southern New England requires an interdisciplinary approach to better comprehend how the summation of forces affected the operation, maintenance, and construction of this advanced technology system. Certainly an appreciation of the technology of the electric power grid itself is the necessary entering argument for this examination. A general comprehension of the processes of generation, transmission, and distribution of the electric power grid is important in understanding how they function together to provide electricity to the consumer, affect the overall efficiency of the system, or inflict the greatest damage to the environment. In an examination of how technology informs technique to promote the most efficient system possible, one must be acquainted with the major advances in electric power technology.

Yet the knowledge and comprehension of the kilowatt ratings or carbon dioxide emission production of any individual plant is not sufficient to fully comprehend what is

transpiring. Theories of technology as proposed by Ellul, Mumford and Hughes are used to provide the hypotheses with which to examine the electric power grid's development as a system of advanced technology. Propositions regarding the ethical consideration of the environment mandate attention as these evolving concepts motivated individuals attempting to change the electric power grid's mode of operation. The ethical standards of the electric power grid's operators must also be considered in this analysis as another force that affected the system's development and growth. Such theoretical constructs were influenced by the technological advances that had been accomplished, but also provided feedback into the system on what should be done in the future.

Finally, the historical influences on the electric power grid and its operators and critics cannot be disregarded. The basis for human action regarding this advanced technology system evolved under the stresses of numerous contingent forces. Humans were affected by political and economic events even as they attempted to enjoy the benefits from the electric power grid and minimize its shortcomings. For example, the 1973 Yom Kippur War had economic ramifications that led to great changes in fuel prices and subsequently on many other aspects of the electric power grid well beyond the results on the battlefield.

The combination of these three perspectives provides an opportunity to attain a more balanced comprehension of the numerous forces affecting the electric power grid and how the resultant development should be considered. A reductionist methodology attempting to only examine the proximate causes of merely one of these forces is inadequate to fully comprehend what is occurring. Instead all of these unprivileged

viewpoints needs to be considered. Indeed, it is the careful synchronization of these perspectives that shines the greatest light on the development of the electric power grid.

Method and Structure

This qualitative analysis is divided into seven chapters. The inquiry will examine how the operation of the electric power grid in southeastern New England, with an emphasis on Rhode Island, was altered by the development of environmental ethical concerns of the population. While other factors will be considered, such as political, economic, and technological, the focus of this investigation will be on the environmental ones that disturbed the equilibrium of the electric power grid. The analysis will follow a general historical timeline but will branch off into a parallel construction in the examination of the particular issues.

Chapter One will be an introductory chapter which will contain a literature review. The chapter will consider Mumford's and Ellul's views on technological determinism as well as Hughes' concept of technological momentum. This review will consider other authors' critiques on the subject of technological determinism and momentum to provide a well-structured notion of these concepts. A discussion of the electric power grid and a systems analysis of its components, physical and organizational, will be conducted and a definition of the grid will be proposed. A review of the various strands of environmental thought will be presented to highlight the similarities and differences between the types.

The next part of the dissertation will provide the background of how the electric power grid developed in southern New England, looking at the technological, environmental, and political forces acting on the system. Chapter Two will provide the

historical background to the subsequent analysis. The initial construction of the electric power grid in southern New England will be described as well as the technological and social challenges to its operation. The objective is to describe how this advanced technology system reached maturity and eventual culmination during the mid 1960s due to a number of economic, technical, and political factors.

In Chapter Three the development of the nascent environmental movement, nationally and locally, will be considered, and how the concerns for the environment led to a developing environmental ethic that led to regulatory and political actions. The operating doctrine of the technological system of the electric power grid and the developing environmental concerns initially acted out of synchronization with one another, but the events of the early 1970s would force the two into alignment. The numerous environmental laws passed during the first Nixon Administration, the shock of the oil embargo in 1973, and the general economic malaise of the decade coincided with real technical limits limiting the operation of the electric power grid.¹¹ The interaction of these events was not necessarily a smooth one, but it set the initial conditions for a number of other conflicts which will be examined in the subsequent chapters.

Chapter Four discusses the Rhode Island state government and its method of regulating the companies operating the electric power grid. The state allowed the electric utility companies to exercise a natural monopoly over its consumers in designated areas in return for governmental supervision of their activities and pricing. The evolution of the

11. Richard F. Hirsh and Adam H. Serchuk. "Momentum Shifts in the American Utility System: Catastrophic Change-Or No Change at All?" *Technology and Culture* 37, no. 2 (April 1996): 286-293.

state's interaction with the owners and operators of these electric utility companies is unique as the leadership of the state government and the electric utilities were often the same people. The resultant momentum generated by this confluence of personnel was an important factor in the rapid maturation of the grid in southeastern New England. This was not always beneficial for the citizens of the state, however, and the intervention of the federal government and the new political forces in Rhode Island worked to disrupt this unity. The convergence of interests of the electric utilities and the government tended to bring these elements back together, even as the new environmental movement was coming of age and working to do just the opposite.

Having examined how the electric power grid matured in the southeastern New England area, the second part of the dissertation will analyze how the emerging national environmental ethic acted to stimulate humans to effect change in the grid's construction, operation, and maintenance. Chapters Five through Seven are examinations of specific events over the subsequent decades where ethical concerns for the environment affected the electric power grid in southeastern New England. These effects often rose from the principled concerns of citizens and resulted in political or legal actions that prevented the construction of a particular component of the electric power grid, advocated for a new manner of energy conversion and transmission, or promoted an entirely new makeup of the system. Some of these efforts were more successful than others; some are still ongoing. The reaction to the advanced technology system was not one that would have been foreseen even a few years before environmental ethics became an important concern. To some extent this is the story of the trials and tribulations of the New England Electric System (NEES, now National Grid) as it struggled to adapt in a very complex

situation.¹² In each of these chapters, the effects of national trends in the operation and regulation of the electric power grid are considered as is the continuing evolution of environmental beliefs. The interaction of the Rhode Island political arena to these technological, legal and ethical influences is also examined.

The first period, discussed in Chapter Five, involves the planned construction of two nuclear power plants in Charlestown, Rhode Island, during the 1970s. Proposed during the height of the energy crisis of that decade, this plant created more negative popular reaction than any regional electric power plant previously had. These plants were not built, in large part due to the citizen response against nuclear power and its environmental impact, though the economic concerns of the New England Electric System were also evident.¹³

Chapter Six will discuss the subsequent state and federal government, electric utility company and environmental group actions during the 1980s and 1990s, including the growing reaction against the coal-fired plants in Providence, Rhode Island and Fall River, Massachusetts. Several of these plants are still in existence, but the public reaction against them is due in no small part from the pollution they generate, demonstrating the tension rising from the interplay of the reliable and economic operation of the electric power grid and the public concerns of the environmental cost of its operation. The construction of gas turbine power plants in the area seemed to simultaneously meet the

12. John T. Landry and Jeffrey L. Cruikshank. *From the Rivers, The Origins and Growth of the New England Electric System* (East Greenwich, RI: Meridan Printing, 1996), 199-245.

13. *Ibid.*, 222-224.