

Contents

	<i>Page</i>
Chapter 1: Introduction and Summary	1
INTRODUCTION	1
SUMMARY	1
Causes and Costs of Extended Outages	1
Component Vulnerability and Impact on System	2
Current Efforts To Reduce Vulnerability	4
Policy Options To Further Reduce Vulnerability	5
Chapter 2: Causes of Extended Outages	9
NATURAL HAZARDS	9
Earthquakes	9
Hurricanes	12
Tornadoes and Thunderstorms	12
Geomagnetic Storms	13
SABOTAGE	14
Experience With Sabotage	14
The Threat	16
Chapter 3: Impacts of Blackouts	19
OVERVIEW OF COSTS OF BLACKOUTS	19
Types of Costs	19
Hypothetical Outage Cost Estimates	20
Actual Outage Cost Estimates	21
SECTORAL IMPACTS	23
Industrial	23
Commercial	24
Agriculture	25
Residential	25
Transportation	26
Telecommunications	26
Emergency Services	28
Public Utilities and Services	28
Chapter 4: System Impact of the Loss of Major Components	31
SHORT-TERM BULK POWER SYSTEM IMPACTS	31
The Importance of Any One Component: Preparing for Normal Failure	31
Impacts of Multiple Failures: Islands and Cascading Outages	33
LONG-TERM BULK SYSTEM IMPACTS	34
The Importance of Any Few Components: Large Reserves and Peak Capacity	34
System Impact When No Outages Occur: Higher Costs and Lower Reliability	35
BULK SYSTEM RECOVERY FROM OUTAGES	35
SPECIFIC EXAMPLES OF ATTACKS	36
Destruction of Any One Generator, Transmission Circuit, or Transformer.	36
Destruction of One Major Multi-Circuit Transmissions Substation or Multi-Unit Powerplant	36
Destruction of Two or Three Major Transmission Substations	37
Destruction of Four or More Major Transmission Substations	37
Chapter 5: Current Efforts To Reduce Energy System Vulnerability	39
CURRENT EFFORTS	39
Private Industry	39
Federal Government	40
States	43
STATUS OF THE U.S. ELECTRICAL EQUIPMENT MANUFACTURING INDUSTRY	44
Chapter 6: Options To Reduce Vulnerability	47
PREVENTING DAMAGE TO THE SYSTEM	47
Harden Key Facilities	48
Surveillance	49
Guards	49
Coordination With Law Enforcement Agencies	50
LIMITING THE CONSEQUENCES	51
Improve Emergency Planning and Procedures	51
Modify the Physical System	51
Increase sinning Reserves	52
SPEEDING RECOVERY	52
Contingency Planning	52
Clarify Legal/Institutional Framework for Sharing	52
Stockpile Critical Equipment	53
Assure Adequate Transportation Capability	55
Monitor Domestic Manufacturing Capability	55
GENERAL REDUCTION OF VULNERABILITY	55
Less Vulnerable Technologies	55
Decentralized Generation	56
Chapter 7: Congressional Policy Options	59
PRESENT TRENDS	59

	<i>Page</i>
Advantages	59
Disadvantages	60
LOW-COST GOVERNMENT	
INITIATIVES	60
Specific Initiatives	60
Advantages	61
Disadvantages	61
MODERATE AND MAJOR	
INVESTMENTS TO REDUCE RISKS..	62
Specific Initiatives	62
Advantages	63
Disadvantages	63

Boxes

<i>Box</i>	<i>Page</i>
A. The Armenian and San Francisco Earthquakes' Effects on Electric Power Systems	10
B. Hurricane Hugo's Effect on South Carolina Electric & Gas Co.	13

<i>Box</i>	<i>Page</i>
C. New York City Blackout	22
D. Transportation Impacts-Northeast and New York City Blackouts	27
E. The Organization of Electric Systems: Utilities, Control Areas, Power Pools, and Interconnections	32

Tables

<i>Table</i>	<i>Page</i>
1. Cost of the New York City Blackout—1977.	3
2. Options To Reduce Vulnerability	7
3. Direct and Indirect Costs	20
4. Comparison of Cost Estimates for Power Outages	21
5. Cost of the New York City Blackout—1977	23
6. Options To Reduce Vulnerability	48
7. Policy Package Components	60