

**STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS
PUBLIC UTILITIES COMMISSION**

The Narragansett Electric Company
d/b/a National Grid

Docket No. 4780

RE: Proposed Power Sector
Transformation (PST) Vision and
Implementation Plan

PREFILED DIRECT TESTIMONY OF

**Gregory L. Booth, PE
President, PowerServices, Inc.
On Behalf of Rhode Island Division of Public Utilities and Carriers**

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1 land surveyor in North Carolina. I am also registered under the National Council of
2 Examiners for Engineering and Surveying.

3 **Q. ARE YOU A MEMBER OF ANY PROFESSIONAL SOCIETIES?**

4 A. I am an active member of the National Society of Professional Engineers (“NSPE”), the
5 Professional Engineers of North Carolina (“PENC”), the Institute of Electrical and
6 Electronics Engineers (“IEEE”), American Public Power Association (“APPA”), American
7 Standards and Testing Materials Association (“ASTM”), the National Fire Protection
8 Association (“NFPA”), and Professional Engineers in Private Practice (“PEPP”). I have
9 also served as a member of the IEEE Distribution Subcommittee on Reliability and as an
10 advisory member of the National Rural Electric Cooperative Association (“NRECA”)-
11 Cooperative Research Network, which is an organization similar to Electric Power
12 Research Institute (“EPRI”).

13 **Q. PLEASE BRIEFLY DESCRIBE YOUR EXPERIENCE WITH ELECTRIC**
14 **UTILITIES.**

15 A. I have worked in the area of electric utility and telecommunication engineering and
16 management services since 1963. I have been actively involved in all aspects of electric
17 utility planning, design and construction, including generation, transmission and
18 distribution systems. I have provided services to many regulatory agencies, and some 300
19 electric utilities. My experience includes work on grid modernization planning and design
20 and implementation ranging from Advanced Metering Infrastructure (“AMI”), Advanced
21 Metering Functionality (“AMF”), Geographic Information System (“GIS”) and self-
22 healing circuits to micro-grid installations with battery storage systems. My experience
23 spans all of the Regional Transmission Organization (“RTO”) regions on the east coast,

1 and many others throughout the United States. I have been providing services in Rhode
2 Island and other portions of New England for over 30 years.

3 **Q. HAVE YOU PREVIOUSLY TESTIFIED AS AN EXPERT BEFORE THE RHODE**
4 **ISLAND PUBLIC UTILITIES COMMISSION?**

5 A. Yes. I have testified before the Rhode Island Public Utilities Commission on numerous
6 matters, including Docket Nos. 2489, 2509, 2930, 3564, 3732, 4029, 4218, 4237, 4307,
7 4360, 4382, 4473, 4483, 4539, 4592, 4614, 4682, 4770, 4783, D-11-94, and D-17-45. My
8 testimony in Rhode Island has included filed and live testimony on previous Electric
9 Infrastructure, Safety and Reliability Plan Fiscal Year Proposal filings by National Grid in
10 Docket Nos. 4218, 4307, 4382, 4473, 4539, 4592, 4682, and 4783.

11 **Q. HAVE YOU PREVIOUSLY TESTIFIED AS AN EXPERT IN OTHER**
12 **JURISDICTIONS?**

13 A. I have testified before the Federal Energy Regulatory Commission ("FERC") and
14 numerous state commissions, including in Delaware, Florida, Maine, Maryland,
15 Massachusetts, Minnesota, New Jersey, North Carolina, Pennsylvania, and Virginia.

16 **Q. HAVE YOU RECENTLY TESTIFIED AS AN EXPERT IN NEW ENGLAND**
17 **CONCERNING GRID MODERNIZATION?**

18 A. Yes. I have testified in Massachusetts in Docket Nos. 15-120, 15-121, 15-122 and 15-123
19 on behalf of the Office of the Attorney General regarding Grid Modernization Plan dockets,
20 including providing testimony concerning the three Grid Modernization Plans submitted
21 by National Grid in Massachusetts.

22 **Q. DO YOU HAVE OTHER INVOLVEMENT AND EXPERIENCE WITH**
23 **COMPANIES THAT PROVIDE YOU WITH ADDITIONAL EXPERTISE**
24 **RELEVANT TO THIS DOCKET?**

1 A. Yes. My electric utility reliability assessment work for: the Rhode Island Division of
2 Public Utilities and Carriers ("Division"); the New Jersey Board of Public Utilities
3 ("NJBPU"); the Pennsylvania PUC; and the Virginia State Corporation Commission
4 ("SCC") over the last ten years has involved working with northeastern electric utilities on
5 an in-depth assessment of reliability enhancement, and the costs associated with such
6 enhancement, including annual construction work plan development for electric utility
7 systems. I have also evaluated and testified in Massachusetts on behalf of the Attorney
8 General's Office in numerous matters, including four Grid Modernization dockets.

9 **Q. HAVE YOU PREVIOUSLY TESTIFIED AS AN EXPERT BEFORE STATE**
10 **UTILITY COMMISSIONS AND OTHER REGULATORY AGENCIES?**

11 A. Yes. I have testified on numerous occasions before the FERC, including pre-filed
12 testimony in both wholesale rate matters as well as in electric utility reliability matters and
13 facility connection standards, including Duke Power Company and Dominion Power
14 dockets. I have also testified before the New Jersey Public Utilities Commission, the
15 Delaware Public Service Commission, the Maine Public Utilities Commission, the
16 Maryland Public Service Commission, Minnesota Department of Public Service
17 Environmental Quality Board, Virginia State Corporation Commission, the Pennsylvania
18 Public Utility Commission, North Carolina Utilities Commission, and Rhode Island Public
19 Utilities Commission, and the Massachusetts Department of Public Utilities (in Dockets
20 D.P.U. 11-56, D.P.U. 11-102/11-102A, D.P.U. 13-52, D.P.U. 14-01, D.P.U. 15-120,
21 D.P.U. 15-121, D.P.U. 15-122, and D.P.U. 15-123). My testimony before most of these
22 Commissions has been provided on numerous occasions.

23 **Q. HAVE YOU BEEN ACCEPTED AS AN EXPERT BEFORE STATE OR FEDERAL**
24 **COURTS?**

1 A. Yes. I have been accepted as an expert in the area of electrical engineering and electric
2 utility engineering, construction and reliability matters and the National Electrical Safety
3 Code ("NESC"), National Electrical Code ("NEC"), Occupational Health and Safety
4 Administration ("OSHA"), Electromagnetic Field ("EMF"), and forensic engineering,
5 including standard and customary utility operation practices in the electric utility industry
6 and the electric industry before 17 state and federal courts.

7 **Q. HAVE YOU BEEN INVOLVED DIRECTLY IN GRID MODERNIZATION**
8 **EVALUATIONS AND/OR IMPLEMENTATIONS FOR OTHER ELECTRIC**
9 **UTILITIES?**

10 A. Yes. I have provided project oversight for micro-grid Engineering, Procurement and
11 Construction ("EPC") projects for utilities, and numerous solar projects provided by our
12 firm and our individual team members. This has included projects such as the design and
13 project management for the construction of a 7,000 kW solar project in Delaware, and two
14 micro-grid and storage projects in North Carolina. I provided engineering analyses, and
15 completion of a large number of solar impact evaluation studies, solar interconnection
16 evaluation and preparation of formal interconnection agreements, as well as wind farm
17 generation impact studies and design of interconnection facilities for our utility clients,
18 statewide associations representing our utility clients, and directly to solar facility owners,
19 such as Duke Energy Renewables. I have delivered multiple electric utility Grid
20 Modernization Plans and Technology Studies to utility clients. I have been involved in the
21 planning, specifications, bidding, and award process and implementation of Automatic
22 Meter Reading ("AMR")/AMI systems and Supervisory Control and Data Acquisition
23 ("SCADA") systems. I have provided engineering services on advanced relay technology
24 implementation, together with the application of self-healing circuit technology. I have
25 completed many Volt/Var studies and provided engineering for implementation of

1 Volt/Var optimization using a variety of techniques. I have additionally provided our
2 utility clients with a wide variety of Time Varying Rate ("TVR") designs, including
3 implementation and monitoring of economic benefits.

II. PURPOSE OF TESTIMONY

1 **Q. HAVE YOU REVIEWED THE FILING OF NARRAGANSETT ELECTRIC**
2 **COMPANY D/B/A NATIONAL GRID (“NATIONAL GRID” OR “COMPANY”) IN**
3 **THIS MATTER?**

4 A. Yes, I have reviewed the documents the Company has filed to date in Docket Nos. 4770
5 and 4780, including its responses to data requests.

6 **Q. DID YOU FILE TESTIMONY IN DOCKET NO. 4770?**

7 A. Yes. This testimony is complementary to the testimony I filed in Docket No. 4770.

8 **Q. HOW HAVE YOU ORGANIZED YOUR TESTIMONY?**

9 A. Section I of my testimony provides an introduction and a summary of my background and
10 experience. Section II addresses the purpose of my testimony. Section III provides an
11 overview of my analyses and a summary of my position on certain components or programs
12 contained in the National Grid filing. Section IV is a detailed discussion of my analyses,
13 which includes my assessment and recommendation for components of the National Grid
14 filing. Section V is my conclusion and my recommendations.

15 **Q. WHAT HAVE YOU BEEN ASKED TO REVIEW BY THE DIVISION?**

16 A. Based on my knowledge of the Company’s distribution business gained from my
17 participation in the ISR and SRP Dockets, the Division requested that I review the
18 Company's proposed Power Sector Transformation ("PST") initiatives in Chapter 3 of PST-
19 1 that was originally filed in the Company's rate case Docket 4770, but was later
20 procedurally separated into Docket 4780 by the Commission. In addition to evaluating the
21 grid modernization proposals contained in Chapter 3, the Division also requested that I
22 identify whether there are any initiatives submitted by the Company as a part of its PST

1 filing that are more appropriately categorized as being a part of the distribution business.
2 My testimony is intended to address primarily the testimony of Mr. Sheridan, Schedule
3 PST - 1 and, specifically, the Grid Modernization Chapter 3.

4 **Q. WHAT IS THE PURPOSE OF YOUR TESTIMONY?**

5 A. My testimony addresses my analysis of the National Grid Power Sector Transformation
6 Plan, Chapter 3-Grid Modernization, to gauge whether or not the investments proposed by
7 the Company are foundational investments of grid modernization that pertain to the core
8 distribution business. My testimony includes observations, recommendations, discussion
9 of comparable programs implemented by other utilities, and my direct experience with
10 Grid Modernization Plan ("GMP") components, programs and implemented technologies.
11 The overall purpose of my testimony is to assist the Division in this filing with additional
12 independent experience and recommendations to the Public Utilities Commission ("PUC")
13 for its consideration and to summarize programs which can be fully or partially supported.
14 My evaluation considers the current foundational investment areas proposed by the
15 Company in the context of the need for a comprehensive, long term GMP that provides
16 transparency to future programs and enables a full consideration of proposed program
17 benefits. I have also utilized my experience and knowledge of the Company's proposed
18 grid modernization investments in Massachusetts to address potential cost sharing between
19 jurisdictions.

20 **Q. PLEASE EXPLAIN THE REVIEW AND ANALYSIS PROCESS YOU APPLIED IN**
21 **EVALUATING THE COMPANY'S INVESTMENT IN A MODERN GRID.**

22 A. My review and analysis process involved first an assessment of the materials filed by
23 National Grid in Docket Nos. 4770 and 4780, and how they correspond to the goals of
24 Docket No. 4600. I then evaluated the National Grid components proposed for the

1 distribution system, which are described as foundational and will clearly require expanded
2 work force asset management programs and training programs. In my testimony, I will
3 evaluate the Company's proposal as compared to industry practices, its Massachusetts
4 proposals, and most particularly the Docket No. 4600 goals since the Company has
5 articulated that its modern grid investments will advance the goals of Docket No. 4600,
6 which it listed as:

- 7 i. Provide reliable, safe, clean, and affordable energy to Rhode Island customers over
8 the long term (this applies to all energy use, not just regulated fuels);
- 9 ii. Strengthen the Rhode Island economy, support economic competitiveness, retain
10 and create jobs by optimizing the benefits of a modern grid and attaining
11 appropriate rate design structures;
- 12 iii. Address the challenge of climate change and other forms of pollution;
- 13 iv. Prioritize and facilitate increasing customer investment in their facilities
14 (efficiency, distributed generation, storage, responsive demand, and the
15 electrification of vehicles and heating) where that investment provides recognizable
16 net benefits;
- 17 v. Appropriately compensate distributed energy resources for the value they provide
18 to the electricity system, customers, and society;
- 19 vi. Appropriately charge customers for the cost they impose on the grid;
- 20 vii. Appropriately compensate the distribution utility for the services it provides;
- 21 viii. Align distribution utility, customer, and policy objectives and interests through the
22 regulatory framework, including rate design, cost recovery, and incentives.

23
24 Initially, my assessment will address four basic questions:

- 25 (1) Does the component achieve the PUC's stated objectives for grid modernization?;
- 26 (2) Is the proposed component or program an expenditure truly for grid modernization,
27 or is it simply part of the Company's "business as usual," which are those traditional
28 investments to support safe and reliable service as part of the Company's ongoing
29 operations?;

1 (3) Does the proposed component or program represent a benefit to the customer and
2 system?; and

3 (4) What have been the experiences of other utilities with similar components or
4 programs (lessons learned)?

5 Additionally, there must be continued oversight of each proposed component to assure
6 compliance with scope, schedule, and budget. Project changes, expansion and continuation
7 should be continually assessed, since proposed investments are influenced by changes in
8 technology. The continuation of discussions with National Grid regarding grid additions
9 that are approved seems almost essential, given that its modern grid investment in only
10 foundational programs does not demonstrate the long range programs, to be supported over
11 the years, necessary to implement grid modernization technologies and programs.

1 **III. OVERVIEW OF TESTIMONY**

2 **Q. WHAT CRITERIA DID YOU CONSIDER IN YOUR EVALUATION, INCLUDING**
3 **REACHING CONCLUSIONS TO THE FOUR (4) OVERARCHING FACTORS**
4 **YOU OUTLINED IN SECTION II. OF YOUR TESTIMONY?**

5 A. I considered current industry trends and technology available for grid modernization
6 components, together with the Company's approach. These include, but are not limited to:

- 7 a. National Grid's proposed foundational programs;
- 8 b. National Grid's reliance on Advanced Distribution Management System ("ADMS")
9 and AMF/AMI;
- 10 c. Risk associated with early obsolescence of proposed programs or components;
- 11 d. Emerging technologies;
- 12 e. Established technologies;
- 13 f. Cost effectiveness and evaluation of stated benefits;
- 14 g. Operational characteristics of the proposed investments and alignment to grid
15 modernization versus core business and customary practices; and
- 16 h. Grid modernization investments and outcomes from other utilities.

17

18 **Q. OVERALL, DO THE COMPANY'S PROPOSED INVESTMENTS ACHIEVE THE**
19 **DEPARTMENT'S STATED OBJECTIVES FOR GRID MODERNIZATION IN**
20 **DOCKET NO. 4600?**

21 A. The Company correctly characterizes the entire group of its proposed investments as
22 enabling technology, particularly for Distributed Energy Resources ("DER") integration,
23 which I consider foundational elements for the continued evolution of the modern grid.
24 These investments are only the first step, albeit an essential step. The Company has taken
25 a prudent approach by advancing these base, but critical, components in their efforts to
26 modernize the grid while meeting the goals of Docket 4600. Overall, I believe that the
27 Company's proposed investments are enablers of the objectives of the PUC and
28 stakeholders, as articulated in Docket 4600, related to grid modernization, and, in
29 particular, clean energy integration and management.

1 **Q. DO YOU OBSERVE DEFICIENCIES IN THE COMPANY’S PROPOSED GRID**
2 **MODERNIZATION COMPONENTS?**

3 A. My evaluation does not reveal deficiencies in the Company’s proposed components, but
4 rather notes the absence of a comprehensive Grid Modernization Plan (“GMP”) which
5 demonstrates both the short and long term initiative programs envisioned in the modern
6 grid by National Grid as it progresses through its own admitted “on-going journey”. I do
7 not dispute the Company has presented a meaningful initial step. What I do find lacking
8 is the presentation of a comprehensive and fully assessed GMP as the required next step in
9 order that the PUC, Division and stakeholders have a view of the future modern grid, its
10 components, and its cost/benefit, so there is not a random and uncoordinated series of
11 programs and technologies initiated on top of the essential foundational investments. Such
12 a GMP would outline the details, technologies, and timeline for implementation, and a plan
13 should be completed before the foundational enabling programs are fully implemented.
14 This second step should have a date certain for completion in the next year, which will
15 appropriately coordinate with the proposed AMI study. A GMP will not only provide the
16 long range vision, but will also mitigate the potential for early obsolescence and
17 unnecessary redundancy. This GMP should not delay the investments the Company has
18 proposed here, but should be in place to guide any second stage of investments as well as
19 any integration with a potential advanced metering infrastructure.

20 **Q. ONE OF YOUR FOUR OVERARCHING CONSIDERATIONS DISCUSSED**
21 **EARLIER WAS THE DISTINCTION BETWEEN GRID MODERNIZATION**
22 **COMPONENTS AND CUSTOMARY OPERATIONAL PRACTICES. CAN YOU**
23 **PLEASE ELABORATE?**

24 A. I believe this distinction is consistent with the view of most utilities. A major part of each
25 utility’s operations is the ongoing expenditures (capital and O&M) needed to satisfy a
26 utility’s public service obligation to expand infrastructure in order to provide safe and

1 reliable service. Programs, plans, and investments are routinely undertaken to meet
2 customer load requirements; reduce costs; replace damaged or worn equipment at the end
3 of its useful life; and maintain safe and reliable service. These ongoing “business as usual”
4 or “core business” plans are customarily funded by customers in the rates they presently
5 pay for service. In fact, as I mentioned earlier in my testimony, the Division specifically
6 requested that my review include identifying the initiatives that are truly core business
7 activities that should be undertaken in the ordinary course of business.

8 Typically, however, this type of routine investment brings with it new technologies. For
9 example, utilities once prepared engineering diagrams utilizing pen and mylar, but now use
10 computer aided design software, such as AutoCAD. The CAD software introduces newer
11 features and enhanced benefits unavailable with the former pen/mylar medium, but CAD
12 software represents merely the normal evolution of engineering recordkeeping. Thus, the
13 investment is triggered by routine business as usual factors, not “modernization.”
14 Similarly, utilities performing system modeling and studies using state-of-the-art software
15 or GIS system enhancement, while achieving improvements by using a more advanced
16 methodology, still represent the basic operation and maintenance requirements for an
17 electric utility and are not properly thought of as grid modernization programs. These types
18 of enhancements, in my professional opinion, are not components of grid modernization
19 plans any more than using a newer insulator or crossarm technology would be. It is
20 essential for the success and public acceptance of a GMP that it truly represent grid
21 modernization and technology for overall performance and economic benefit, and not
22 merely implement the same functions, but with the latest vintage of comparable
23 technology. Making this distinction between business as usual spending and true grid

1 modernization was my second step in my assessment of the Company's investment in a
2 modern grid.

3 **Q. EXPLAIN HOW THE COMPANY'S CURRENT APPROACH COMBINED WITH**
4 **YOUR POSITION THEY NEED A MORE COMPREHENSIVE GMP WILL**
5 **"AVOID EARLY OBSOLESCENCE AND UNNECESSARY REDUNDANCY"?**

6 A. National Grid has been implementing some modern grid programs and pilots in advance
7 of investing in foundational technology or preparing a comprehensive GMP. If the
8 Company continues investing in single, unrelated programs without a long term strategy,
9 it will most certainly create redundancy or early obsolescence. A modernized grid is driven
10 by integrated technology that allows utilities to monitor, control and manage a dynamic
11 system with increasing numbers of varying loads and generation. Incremental programs
12 deployed by the Company must integrate with existing communications and data systems
13 to avoid additional investment. The Company is correctly beginning its investments in the
14 enabling technologies to create the foundation for a modern grid. All of the Company's
15 proposed investments, with the exception of Feeder Monitoring Sensor additions, are
16 foundational to a modern grid and represent Step 1 of a GMP. The second step, however,
17 must be a GMP which outlines future programs that are compatible with foundational
18 technology. Additionally, grid modernization expansion should include the quantitative
19 and qualitative benefits of each proposed new technology and how the Grid Side programs
20 can be implemented in a manner most effectively, allowing for a future integration to the
21 ultimate AMF, ADMS, telecommunications and other enabling programs which serve as
22 the foundation.

23 **Q. WHAT IS THE SIGNIFICANCE OF THE COMPANY'S RELIANCE ON ADMS**
24 **AND AMF IN YOUR ASSESSMENT?**

1 A. The Company's proposed grid modernization activities rely heavily on the deployment of
2 ADMS and AMI. The Company discusses this reliance in its Distribution Operations
3 Platform. A utility that utilizes AMI will have a different strategic plan for technology
4 based grid improvements than a utility without AMI. This is due to the multi-functional
5 aspects of AMI, which may be complemented by certain grid technology such as ADMS,
6 and, in other cases, eliminate the need for some aspects of grid investment, such as feeder
7 monitors. Understanding a utility's strategic decision regarding the timing and penetration
8 of AMI will ultimately impact the scope and cost of associated capital investments.

9 Given the strategic importance of both AMI and ADMS in driving associated grid
10 modernization investments, including communications and cybersecurity, I have
11 performed my analysis of the current proposal based on the need for ADMS and AMF as
12 critical enabling activities or technologies. Although others are testifying in detail,
13 particularly on the AMF, it was essential to my testimony and position on all of the
14 investments proposed for my baseline to be established. Even absent the immediate
15 deployment of AMI, the other foundational technologies should be implemented in order
16 to advance a modern grid.

17 **Q. WOULD YOU SUMMARIZE YOUR OVERVIEW OF THE COMPANY'S PST**
18 **PROPOSALS IN CHAPTER 3 OF PST-1, AND YOUR POSITION ON THE NEED**
19 **FOR A LONG TERM GMP?**

20 A. While I am fully supportive of the Company's first step of investing in a series of
21 foundational programs, the PUC should require that the Company deliver a comprehensive
22 GMP which details the subsequent 5 years of investments, and outlines the long term (10
23 to 15 year) deployment of technologies. This needs to be developed with the Division and
24 stakeholder to assure that the PUC and all parties understand the long term programs which

1 everyone supports. It must also be developed recognizing the desirability to have a
2 significant degree of congruency with the programs underway and being implemented in
3 New York and Massachusetts, where coordinated development makes sense. The enabling
4 strategy and programs initially proposed by the Company in this proceeding are well
5 positioned. Absent a long term GMP, however, there is no vision for the next steps once
6 foundational investments are implemented. A strategy comprised of future technologies
7 and programs is an essential roadmap to efficient and meaningful deployment for the
8 highest potential benefit to the consumers and the Company.

IV. DETAILED DISCUSSION OF ANALYSIS

1 **Q. PLEASE DISCUSS HOW YOU HAVE ORGANIZED YOUR DETAILED**
2 **TESTIMONY ON EACH COMPONENT IN NATIONAL GRID’S POWER**
3 **SECTOR TRANSFORMATION PLAN CHAPTER 3.**

4 A. The Company’s Schedule PST-1 Chapter 3: Investment in a Modern Grid, classifies
5 investments into on-going grid modernization activities and new grid modernization
6 activities. These classifications demonstrate that National Grid has been incorporating
7 certain technologies, which are often considered part of a grid modernization program,
8 absent a comprehensive plan.

9 Under their new grid modernization activities category, National Grid proposes seven
10 investment areas. Many of the activities proposed as part of Docket 4780 can be described
11 as core business functions. These programs, plans and investments are routinely undertaken
12 to meet customer load requirements; reduce costs; replace damaged or worn equipment at
13 the end of its useful life; and maintain safe and reliable service. These ongoing “core
14 business” activities are already funded by customers in the rates they presently pay for
15 service. My testimony provides review and analysis of these seven components.

16 **Q. WOULD YOU SPECIFICALLY IDENTIFY THE COMPONENTS OF THE PST**
17 **THAT YOU ARE NOT ADDRESSING IN DETAIL?**

18 A. Yes. National Grid characterizes all of its proposed programs as foundational, without
19 describing the programs for which they serve as a foundation. Advanced metering
20 functionality and cybersecurity are foundational. Further, the current proposal is to
21 perform a study in coordination with New York. This is a reasonable approach that is
22 supported by the Division. Given the study needs to be performed, my testimony on these

1 two components is limited to an overview of how they fit into a comprehensive grid
2 modernization plan.

3 **1. System Data Portal**

4 **Q. PLEASE PROVIDE AN OVERVIEW OF THE PROPOSED NATIONAL GRID**
5 **SYSTEM DATA PORTAL.**

6 A. The proposed system data portal is an enabling technology intended to increase DER
7 penetration by providing guidance to DER providers. This portal supports the deployment
8 of Non-Wires Alternatives (NWA) by providing more timely information about potential
9 locations where DER may be a viable alternative to traditional investment.

10 The portal will give DER providers unified access to existing system data. Over time, the
11 Company proposes augmenting the data with more detailed assessments of hosting
12 capacity and capacity constraints including heat maps and other reports to highlight areas
13 where a DER solution may be cost effective. The Company has a similar portal deployed
14 in their New York jurisdiction.

15 **Q. FROM AN OVERALL PERSPECTIVE, DO YOU SUPPORT THE**
16 **IMPLEMENTATION OF A SYSTEM DATA PORTAL?**

17 A. Yes. The proposed system data portal is an enabling technology that is a necessary for grid
18 modernization, and specifically integration of clean energy sources. While the system data
19 portal does not in of itself provide a directly measurable benefit to the Customer, by
20 supporting DER providers and lowering the barriers to entry, the system data portal's
21 impacts should reduce greenhouse gases and lower power cost, which will benefit the
22 Customers and also lead to a more resilient system. A secondary benefit will be realized in
23 those situations where DER integration solves distribution capacity constraints, eliminating

1 the need for traditional line investments. These benefits would be identified as the
2 Company advances more robust non-wires alternative evaluations.

3 The Company's system data portal was deployed in the New York jurisdiction. The
4 Company proposes to use the lessons learned from that deployment to improve deployment
5 in Rhode Island. Due to the distribution planning time frame, it is not possible to determine
6 the magnitude of the NY benefit at this time. However, it is very likely that benefits will
7 accrue over time as DER resources are proposed as NWAs.

8 The system data portal is truly a grid modernization activity that supports the Rhode Island
9 policy to facilitate and increase DER penetration. It also provides benefits to customers
10 through supporting new wires alternatives. I support the Company's system data portal
11 proposal as a part of the core function of the utility. In addition, I see no reason why the
12 Company should delay implementation. It would be appropriate for the Company to
13 advance the project further than the initial funding proposal that has already been approved
14 by the Commission in the System Reliability Procurement ("SRP") Docket No. 4756.

15 **Q. DO YOU HAVE ANY OTHER COMMENTS RELATED TO THE COMPANY'S**
16 **PROPOSED SYSTEM DATA PORTAL?**

17 A. Yes. The Proposed system data portal should evolve over time to best meet the changing
18 needs of the system and the DER providers. It is expected that the first DER projects will
19 have the highest cost-benefit ratio. As DER penetration increases, additional data may
20 assist with finding viable DER projects that have attractive cost-benefit ratios, which
21 should allow the DER deployment to be sustained for a longer duration and at a higher
22 level of penetration. Also, while I support the implementation of the system data portal, I
23 believe the cost estimate provided by the Company for three engineers seems excessive. It

1 is my view that the Company's proposed annual rate allowance of \$700,000 should be
2 reduced by at least 30%.

3 **2. Automated Metering Functionality**

4 **Q. WHAT IS YOUR ASSESSMENT OF THE PROPOSED ADVANCED METERING**
5 **FUNCTIONALITY?**

6 A. My testimony does not include a detailed analysis of the Company's AMF proposal.
7 However; AMI is a necessary foundational component of grid modernization. Most grid
8 modernization activities rely on real time data from the electric distribution system. This
9 data is used for a wide range of business and operational activities including, but not limited
10 to, metering, more dynamic outage management, improved outage restoration duration,
11 reduction in lost crew time due to unnecessary travel, Volt-Var Optimization and
12 Conservation Voltage Reduction (VVO/CVR), improved self-healing circuit application,
13 and enhanced system planning. If AMI is not deployed, another method of recording and
14 receiving real-time system data for system operations is required. AMI is a widely used
15 and proven technology which is a foundational and is an enabling component of a modern
16 distribution grid.

17 **Q. DO YOU HAVE ANY OTHER COMMENTS RELATED TO THE COMPANY'S**
18 **PROPOSED AUTOMATED METERING FUNCTIONALITY?**

19 A. Yes. The decision to deploy AMI is a foundational decision that should be part of any
20 GMP. I support the adoption of AMI with the assumption that it is part of the GMP. In
21 supporting AMI, however, I also believe it is important for feeder monitoring sensors to
22 have a significantly reduced role. If the Company intends to implement AMI, then
23 alternative technologies, such as remote feeder sensors, are redundant and not necessary
24 once AMI is deployed.

1 **3. Feeder Monitoring Sensors**

2 **Q. PLEASE PROVIDE AN OVERVIEW OF THE PROPOSED NATIONAL GRID**
3 **FEEDER MONITORING SENSORS.**

4 A. The proposed feeder monitoring sensors provide real-time data from the electric
5 distribution system that may support several grid modernization activities. Although the
6 technology of these sensors continues to improve, they fundamentally provide a subset of
7 the data that an AMI deployment can provide due to the sheer number of AMI meters
8 versus the relatively small number of feeder sensors which could realistically be deployed.

9 **Q. FROM AN OVERALL PERSPECTIVE, DO YOU CONCUR WITH THE**
10 **PROPOSED FEEDER MONITORING SENSORS?**

11 A. Although the Company has already deployed many of these sensors, I do not support a
12 continued major deployment if AMF (AMI meters) is adopted. There is no indication that
13 these sensors add any benefit beyond the deployment of AMF. Feeder monitoring sensors
14 are simply redundant, and provide far less comprehensive information across all consumers
15 than AMF deployment will.

16 Although the feeder monitoring sensors could be supportive of grid modernization, an AMI
17 deployment is a superior solution, because AMI supports more grid modernization
18 capabilities and is truly foundational. Investment in feeder monitoring sensors would be
19 redundant once AMI is deployed. Even with a rapid deployment of the Sensors, the benefits
20 would have a limited duration before an AMI deployment. To the extent feeder monitoring
21 sensors are expanded beyond those existing, the Company should be required to show what
22 are justified in light of the pending proposal to deploy AMI.

1 **4. Control Center Enhancements**

2 **Q. PLEASE PROVIDE AN OVERVIEW OF THE PROPOSED NATIONAL GRID**
3 **CONTROL CENTER ENHANCEMENTS.**

4 A. The proposed Control Center Enhancements activity encompasses several distinct projects
5 including: DSCADA and ADMS; RTU Separation; and GIS Data Enhancement. The end
6 result of these activities is a dedicated DMS that is separate and distinct from transmission
7 operations. The Company currently uses a single SCADA system to support operations,
8 but does not operate a DMS.

9 Distribution Management and operation, like transmission operations, is a core business
10 function. Plans and investments to enhance the distribution operations through the creation
11 of a DMS are considered ongoing “core business” activities which are already funded by
12 customers in the rates they presently pay for service. The DMS is a core business function
13 that is an enabling technology that can be leveraged and enhanced by grid modernization
14 projects.

15 **Q. COULD YOU PROVIDE AN OVERVIEW OF THE PROPOSED**
16 **ENHANCEMENTS TO CREATE SEPARATE DISTRIBUTION AND**
17 **TRANSMISSION SCADA SYSTEMS AND DATA?**

18 A. Yes. This activity includes DSCADA and ADMS, and RTU Separation. A bright line
19 distinction between distribution and transmission data and modeling is proposed.
20 Distribution system data will be split from transmission system data by separating the field
21 RTUs that capture the data and send it to the SCADA system. In addition to enabling
22 dedicated DSCADA, a secondary benefit from creating a bright line separation between
23 transmission operations and distribution operations is that it eliminates FERC Critical

1 Infrastructure Protection ("CIP") oversight, and its associated risks and costs, from
2 distribution operations.

3 The DSCADA system, for distribution only, provides a platform for advanced modeling of
4 the distribution system that does not currently exist. New distribution network models,
5 based on the as operated distribution system conditions, form the basis of the proposed
6 ADMS. The ADMS would be interfaced to other systems, including the GIS.

7 Maintaining RTUs for the purpose of providing distribution information is a function that
8 resides within a utility's ongoing core business activity and, although is not a grid
9 modernization activity, it is certainly an enabling technology for enhanced grid capabilities.

10 The development and use of ADM applications is also a natural progression of core
11 business activities that should be funded by customers in the rates they presently pay for
12 service.

13 **Q. COULD YOU PROVIDE AN OVERVIEW OF THE PROPOSED GIS**
14 **ENHANCEMENT?**

15 The ADMS models and applications are intended to reflect actual and projected system
16 conditions, including the status of various distribution line devices. The proposed enhanced
17 GIS data is the source for this information, and would provide accurate and timely
18 information for modeling and display.

19 The Company's proposed GIS data enhancement is also a natural progression of core
20 business activities. GIS Data is the baseline data mapping software used by utilities to
21 locate system assets and identify attributes. Funding for GIS would be accomplished
22 through the basic rates customers pay for service.

1 **Q. DO YOU SUPPORT THE COMPANY'S PROPOSED CONTROL CENTER**
2 **ENHANCEMENTS?**

3 A. Yes. I support the proposed control center enhancements as part of the Company's core
4 business responsibilities. These enhancements will provide a platform from which future
5 grid modernization activities will be supported.

6 **Q. WOULD YOU CATEGORIZE THE GIS ENHANCEMENTS, RTU SEPARATION,**
7 **AND DSCADA AS CORE BUSINESS FUNCTIONS OR GRID**
8 **MODERNIZATION?**

9 A. They are core business functions. They are activities the Company should be implementing
10 as a part of their core distribution business. I do not believe it is appropriate for the
11 Company to define these as grid modernization activities. They should be implementing
12 these initiatives with the enhanced technology available, and seeking cost recovery in the
13 normal course of the distribution business, as they do with other distribution functions.

14 **5. Operational Data Management**

15 **Q. PLEASE DESCRIBE THE COMPANY'S PROPOSED OPERATIONAL DATA**
16 **MANAGEMENT.**

17 A. Like the Control Center Enhancements, the proposed Operational Data Management is
18 comprised of several activities. Many of the existing information systems currently work
19 somewhat independently of one another. The proposal calls for a more unified and well-
20 defined communication infrastructure to facilitate easier data exchange between the
21 various information systems.

22 An Enterprise System Bus ("ESB") is the first proposed component of Operational Data
23 Management. This is a layer of connectivity between systems that contains intelligence

1 about the systems and the data and provides automation, validation, and integration
2 capability.

3 Data Management and Analytics is the second proposed component of Operational Data
4 Management. This is a complex system of data collection, data storage, and information
5 analysis tools that are interfaced together. The Company's proposed solution uses PI
6 Historian, a data lake, and advanced analytics to provide the Data Management and
7 Analytics capability.

8 **Q. DO YOU SUPPORT THE COMPANY'S OPERATIONAL DATA MANAGEMENT**
9 **PROPOSAL?**

10 A. Yes. The Operational Data Management is a grid modernization project that builds upon
11 the Company's core business capabilities. The collection and analysis of system data is
12 critical to operating and maintaining a grid. For example, system data provides current
13 status for efficient operation, signals abnormalities so expedient action can be taken, and
14 is used to determine where system reliability improvements should be implemented. These
15 are core functions in distribution system operations. In addition, robust Operational Data
16 Management ("ODM") is critical to achieve the stated goals of the PST and facilitate grid
17 modernization due to the interoperability of advanced technologies that require more data
18 points, communication portals, and device control. ODM provides a more sophisticated
19 platform for core business operations while accommodating future needs of grid
20 modernization. It is one area of investment that must be prudently implemented to manage
21 step changes in technology while achieving long term ADMS functionality, benefits in
22 system reliability, economic operations, and customer engagement.

1 **6. Telecommunications**

2 **Q. PLEASE DESCRIBE THE COMPANY'S PROPOSAL FOR**
3 **TELECOMMUNICATIONS.**

4 A. The telecommunication proposal is less defined than other proposals, and suggests that
5 consideration will be given to various models without providing details of the
6 consideration. The Company recognizes that investments are required to support Grid
7 Modernization, but does not provide a basis for the enhancements proposed.

8 In the absence of a comprehensive telecommunication plan, any telecommunication
9 investment is subject to being obsolete, redundant, or not compatible with the
10 telecommunication requirements of other grid modernization systems.

11 **Q. DO YOU HAVE SPECIFIC RECOMMENDATIONS ABOUT THE COMPANY'S**
12 **PROPOSAL FOR TELECOMMUNICATIONS?**

13 A. Yes. As a part of the its Grid Modernization Plan, the Company should include a chapter
14 that addresses possible communication solutions in light of system conditions and current
15 and future needs to support the wide array of potential Grid Modernization programs and
16 activities.

17 **Q. DO YOU SUPPORT THE COMPANY'S PROPOSAL FOR**
18 **TELECOMMUNICATIONS?**

19 A. Yes, conditioned upon a conformance to a more comprehensive plan and initially
20 completing a comprehensive telecommunications study in advance of deployment. The
21 Company's telecommunications proposal supports the achievement of the Commission's
22 stated objectives for grid modernization. The proposal is truly for grid modernization,
23 while also enhancing the support for many core business activities, such as DSCADA. The
24 telecommunications proposal provides benefits to the system and to customers by enabling

1 customer engagement. Other utilities that have performed comprehensive
2 telecommunication studies have avoided stranded or otherwise unnecessary investment. I,
3 therefore, recommend a telecommunications study be completed first as part of the
4 telecommunications system deployment.

5 **7. Cybersecurity**

6 **Q. WHAT IS YOUR ASSESSMENT OF THE COMPANY'S CYBERSECURITY**
7 **PROPOSAL?**

8 A. My testimony does not include a detailed analysis of the Company's cybersecurity
9 proposal. However; almost every aspect of grid modernization depends on additional
10 communications capability, and many of these technologies touch elements of the
11 distribution system or customer equipment. Customers expect that their personal
12 information, including usage patterns, is protected and kept private. According to the NIST,
13 smart grid cybersecurity must address both inadvertent compromises of the electric
14 infrastructure, due to user errors, equipment failures, and natural disasters, as well as
15 deliberate attacks, such as from disgruntled employees, industrial espionage, and terrorists.

16 The Company's proposed risk-based framework shares elements of NERC's Risk Based
17 Assessment methodology used to help protect the bulk electric system. The proposal calls
18 for a phased roll out.

19 **Q. DO YOU SUPPORT THE COMPANY'S CYBERSECURITY PROPOSAL?**

20 A. I am not prepared to endorse the Company's proposal, but rather support a well-defined
21 cybersecurity and privacy protection plan which should be prepared before components are
22 installed and connected to the system. The cybersecurity plan should be based on an
23 understanding of the specific new technologies and communication systems introduced to

1 the distribution system, should identify any potential vulnerabilities, and should include
2 mitigation plans for these vulnerabilities. A cybersecurity and privacy protection plan helps
3 the Company prudently manage potential risks associated with grid modernization
4 systems. The Company's cybersecurity plan should be developed in a manner consistent
5 with its Massachusetts GMP proposal. In addition, I support the proposal described in
6 Division testimony of Mr. Balaban in Docket 4770 for an audit of Company investments
7 in information technology, including cybersecurity.

1 **V. CONCLUSION AND RECOMMENDATIONS**

2 **Q. WOULD YOU SUMMARIZE YOUR CONCLUSIONS OF THE ANALYSIS OF**
 3 **THE NATIONAL GRID INVESTMENT IN A MODERN GRID PROPOSAL AND**
 4 **YOUR RECOMMENDATIONS?**

5 A. Yes. The following Table 1 outlines each component of the Company’s proposal and my
 6 recommendation regarding acceptance of the program or component in whole, as modified,
 7 or as not accepted. It is my professional opinion that what I have provided in this table is
 8 an appropriate and prudent initial phase in establishing a modern grid. Table 2 outlines
 9 those currently active programs the Company has discussed which are being implemented
 10 as part of its core business and funded within the annual ISR Plan. Eventually, these
 11 programs need to be recognized, along with many others, to be considered as part of a
 12 comprehensive GMP. The programs within Table 2 have already been accepted in whole
 13 or in part as a component of a pilot project.

14
 15 **Table 1: Component Recommendations**

| National Grid Balanced Costs and Benefits | | Accepted | Accepted with Conditions | Not Accepted |
|---|----------------------------------|----------|--------------------------|--------------|
| 1. | System Data Portal | X | | |
| 2. | Advanced Metering Functionality* | | | |
| 3. | Feeder Monitoring Sensors | | | X |
| 4. | DSCADA | | X | |
| 5. | RTU Separation | X | | |
| 6. | GIS Data Enhancement | | X | |
| 7. | Enterprise Services (ESB) | X | | |
| 8. | PI Historian | X | | |
| 9. | Data Lake | X | | |
| 10. | Advanced Analytics | X | | |
| 11. | Telecommunications IT/OT | | X | |
| 12. | Cybersecurity** | | | |
| 13. | OMS | | X | |

16 * The pending proposal is to perform a coordinated AMI study with New York. Any final definitive opinions
 17 will need to wait for an evaluation of the study.

18 ** Cybersecurity is not addressed in detail in this testimony.

1

Table 2: Currently Active Programs

| National Grid Balanced Costs and Benefits | |
|---|-----------------------------|
| 1. | Automated Field Devices |
| 2. | Power Flow / Fault Analysis |
| 3. | DER & Load Forecasting |
| 4. | Power Quality Analysis |
| 5. | VVO/CVR Pilot |

2 **Q. WOULD YOU FURTHER EXPLAIN TABLE 2, AND HOW THESE PROGRAMS**
3 **SHOULD BE ADDRESSED, IF AT ALL?**

4 A. These currently active programs have been evaluated within the ISR Plan and have been
5 accepted. They do, however, have a correlation to both the core business and transition to
6 a modern grid. As I have previously testified, some are simply the natural progression of
7 applying the latest technology to a core business function, while others may become a true
8 portion of grid modernization. These ongoing programs will need to be addressed in some
9 way in the transition to a modern grid and their role defined in a grid modernization plan.

10 **Q. DO YOU HAVE A SPECIFIC RECOMMENDATION CONCERNING THE**
11 **CURRENTLY ACTIVE PROGRAMS, THOSE PROPOSED BY THE COMPANY,**
12 **AND THOSE PROGRAMS THAT HAVE NOT BEEN IDENTIFIED?**

13 A. Yes. I recommend the acceptance of all the Company's proposed investments, with the
14 exception of reducing the cost of the system data portal and eliminating further Feeder
15 Monitoring Sensor additions. These are all foundational to a modern grid and represent
16 Step 1 of a GMP. I then recommend the completion of a comprehensive GMP, with
17 collaboration between the Division and stakeholders. The currently active programs and
18 all proposed future programs should be incorporated in the proposed GMP with
19 comprehensive analysis, discussion and individual cost-benefit analysis. This GMP would
20 then be assessed along with the results of the AMI study through the regulatory process.
21 The resulting GMP would ultimately receive acceptance as National Grid's roadmap to

1 future grid modernization investments. This GMP should be completed in parallel with
2 the AMI study that was proposed, such that the GMP and AMI and being considered
3 together. This GMP, the AMI study, and ISR Planning should be considered in an integral
4 way, so as to make the capital component of multi-year planning transparent and consistent
5 within a long range plan vision. I also recommend that the Company move forward in the
6 ordinary course of business with the initiatives that I believe are core business; namely, the
7 GIS enhancements, RTU separation, and DSCADA. This structure also allows tracking of
8 individual programs or projects, ensuring that scopes and budgets are met, and providing
9 an opportunity for enhancements or re-direction as technologies evolve.

10 **Q. DID YOU ANALYZE THE COMPANY'S INVESTMENT LEVELS FOR THE**
11 **NEXT FIVE YEARS?**

12 A. I analyzed the Company's investment budgets and cost estimates based on its proposal.
13 These cost estimates appear developed using a sound methodology and conservative cost
14 estimating, with the exception of the system data portal. The costs are also consistent with
15 my experience and cost estimates proposed in other jurisdictions. However, the Company
16 will have a significant level of overlap, dependency, and crossover of costs not only
17 between the various foundational components, but between their operating jurisdictions
18 that are making similar investments. It is important to recognize that the Company has
19 outlined four distinct grid modernization plans in Massachusetts, for instance, which are
20 still pending approval. Therefore, true synergy between Company jurisdictions may or may
21 not exist in the short term. As a result of the interdependency of many components, both
22 the costs and benefits of any singular component will be difficult to clearly and singularly
23 define.

1 **Q. DO YOU HAVE A SPECIFIC RECOMMENDATION IN REGARD TO**
2 **BUDGETING?**

3 A. Yes. The feeder monitoring sensors should be eliminated from the budget to the extent
4 AMF will be deployed over the next 3 years. Also, as I testified earlier, the system data
5 portal costs appear to be overstated by 30 percent and should be reduced accordingly.

6 **Q. HOW DO YOUR RECOMMENDATIONS AND ADJUSTMENTS IMPACT THE**
7 **BUSINESS CASE?**

8 A. The Company should be required to resubmit a future business case, predicated on those
9 recommendations which are accepted by the PUC, within a new GMP to be completed over
10 the next two years. The Company would use a cost-benefit analysis for each new program
11 that is not foundational.

12 **Q. DO YOU HAVE ANY OTHER CONCLUSIONS OR SUMMARY**
13 **RECOMMENDATIONS?**

14 A. Yes. Throughout time, buzzwords have been applied to many programs, whether paradigm
15 shift, smart grid, or grid modernization or other terminology which may be applied to the
16 simple process of utilities growing and enhancing their ability to provide low cost, safe,
17 and reliable power supply. Throughout the United States, many utilities have been
18 embracing grid modernization for decades, and are actively and continually applying the
19 latest technologies for the enhancement of their utility systems without the necessity of
20 special rate relief or encouragement by utility commissions. The non-regulated consumer-
21 and municipally-owned utilities, for obvious reasons, have, in many cases, been the leaders
22 of technology implementation. Some of the regulated utilities have also been leaders in
23 this area without encouragement from the regulatory bodies or special rate relief.

1 Rhode Island is clearly one of New England's leaders in Power Sector Transformation,
2 including Grid Modernization. At the core of my recommendations is the need for the
3 process to be collaborative between the regulators, the consumers, stakeholders and the
4 utility. Grid modernization should be a winning value proposition for all participating
5 parties, and should not be looked on by any one of the stakeholders as one party wins and
6 another party loses. Rhode Island has long had a strong capital projects planning and
7 assessment process, and I suggest a similar grid modernization plan is a natural extension
8 and does not require special regulatory treatment. Lastly, I strongly recommend that
9 National Grid and the stakeholders take advantage of the lessons learned by their
10 counterparts, regardless of whether those counterparts are in New England, or are other
11 regulated and non-regulated utilities. The reality has been that the smaller systems have
12 been more nimble and have been able to successfully deploy technologies across their
13 entire system, and this provides excellent information to be relied upon by the larger
14 utilities for improving their selection of technologies, processes, and implementation.

15 **Q. DOES THIS CONCLUDE YOUR TESTIMONY?**

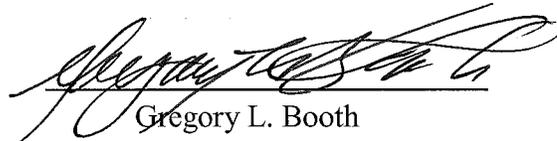
16 A. Yes it does.

AFFIDAVIT OF GREGORY L. BOOTH, PE

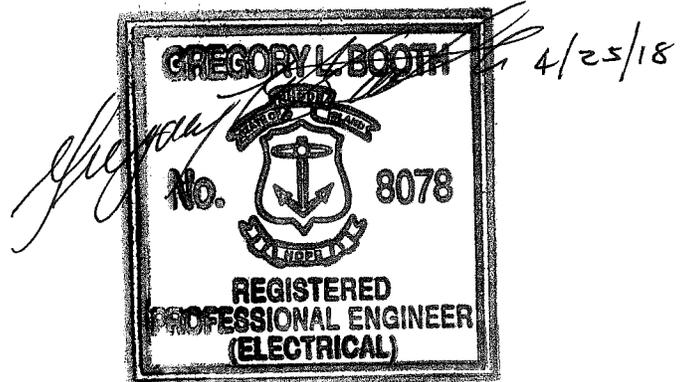
Gregory L. Booth, does hereby depose and say as follows:

I, Gregory L. Booth, on behalf of the Rhode Island Division of Public Utilities and Carriers, certify that testimony, including information responses, which bear my name was prepared by me or under my supervision and is true and accurate to the best of my knowledge and belief.

Signed under the penalties of perjury this the 25th day of April, 2018.


Gregory L. Booth

I hereby certify this document was prepared by me or under my direct supervision. I also certify I am a duly registered professional engineer under the laws of the State of Rhode Island, Registration No. 8078.



Gregory L. Booth, PE

APPENDIX-1

**RESUME OF
GREGORY L. BOOTH, PE, PLS
President
PowerServices, Inc.
Gregory L. Booth, PLLC**

Gregory L. Booth is a registered professional engineer with engineering, financial, and management services experience in the areas of utilities, industry private businesses and forensic investigation. He has been representing over 300 clients in some 40 states for more than 50 years. Mr. Booth was inducted into the North Carolina State University Electrical and Computer Engineering Alumni Hall of Fame in November of 2016 based on his accomplishments in the field of engineering.

Mr. Booth has been accepted as an expert before state and federal regulatory agencies, including the Federal Energy Regulatory Commission, the Delaware Public Service Commission, the Florida Public Service Commission, the Minnesota Department of Public Service Environmental Quality Board, the Maine Public Utilities Commission, the Massachusetts Department of Public Utilities, the New Jersey Board of Public Utilities, the North Carolina Utilities Commission, the Pennsylvania Public Utility Commission, the Rhode Island Public Utilities Commission, and the Virginia State Corporation Commission. He has been accepted as an expert in both state and federal courts, including Colorado, Delaware, District of Columbia, Florida, Georgia, Kansas, Maryland, Minnesota, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Puerto Rico, South Carolina, Texas, Virginia, West Virginia, Virgin Islands, and Wisconsin, and numerous Federal Court jurisdictions. Mr. Booth has provided expert witness services on over 500 tort case matters, and over 50 regulatory matters. Investigation and testimony experience includes areas of wholesale and retail rates, utility acquisition, territorial disputes, electric service reliability, right-of-way acquisition and impact of electromagnetic fields and evaluation of transmission line options for utility commissions.

Additionally, Mr. Booth has extensive experience serving as an expert witness before state and federal courts on matters including property damage, forensic evaluation, fire investigations, fatality, and areas of electric facility disputes and Occupational, Safety and Health Administration violations and investigations together with National Electrical Code and National Electrical Safety Code and Industry Standard compliance.

The following pages provided are the education and experience from 1963 through the present, along with courses taught and publications.

**RESUME OF
GREGORY L. BOOTH, PE, PLS**

Mr. Booth is a Registered Professional Engineer with engineering, financial, and management experience assisting local, state, and federal governmental units; rural electric and telephone cooperatives; investor owned utilities, industrial customers and privately owned businesses. He has extensive experience representing clients as an expert witness in regulatory proceedings, private negotiations, and litigation.

**PROFESSIONAL
EDUCATION:**

NORTH CAROLINA STATE UNIVERSITY; Raleigh NC,
Bachelor of Science, Electrical Engineering, 1969

**PROFESSIONAL
HONORS:**

Inducted into North Carolina State University Department of Electrical
and Computer Engineering Alumni Hall of Fame in November 2016.

REGISTRATIONS:

Registered as Professional Engineer in Alabama, Arizona, Colorado,
Connecticut, Delaware, District of Columbia, Florida, Georgia, Kansas,
Maryland, Minnesota, Mississippi, Missouri, New Hampshire, New
Jersey, North Carolina, Oklahoma, Pennsylvania, Rhode Island, South
Carolina, Texas, Commonwealth of Virginia, West Virginia, and
Wisconsin

Professional Land Surveyor in North Carolina

Council Record with National Council of Examiners for Engineering and
Surveying

EXPERIENCE:

1963-1967
Technician
Booth & Associates

Transmission surveying and design assistance, substation design
assistance; distribution staking; construction work plan, long-range
plan, and sectionalizing study preparation assistance for many utilities,
including Cape Hatteras EMC, Halifax EMC, Delaware Electric
Cooperative, Prince George Electric Cooperative, A&N Electric
Cooperative; assistance generation plant design, start-up, and
evaluations.

1967-1973
Project Engineer
Booth & Associates

Transmission line and substation design; distribution line design;
long-range and construction work plans; rate studies in testimony
before State and Federal commissions; power supply negotiations; all
other facets of electrical engineering for utility systems and over 30
utilities in 10 states.

1973-1975
Professional Engineer
Associates
1975-1994
Executive Vice President
Booth & Associates

Directed five departments of Booth & Associates, Inc.; provided
engineering services to electric cooperatives and other public Booth &
power utilities in 23 states; provided expert testimony before state
regulatory commissions on rates and reliability issues; in accident
investigations and tort proceedings; transmission line routing and
designs; generation plant designs; preparation and presentation of long-
range and construction work plans; relay and sectionalizing studies; relay
design and field start-up assistance; generation plant designs; rate and
cost-of-service studies; reliability studies and analyses; filed testimony,
preparation and teaching of seminars; preparation of nationally published
manuals; numerous special projects for statewide organizations,
including North Carolina EMC. Work was provided to over 130 utility
clients in 23 states, PWC of the City of Fayetteville, NC, Cities of

Wilson, Rocky Mount and Greenville are among the utilities in which I have provided engineering services in North Carolina during this time frame. Services to industrial customers include Texfi Industries, Bridgestone Firestone, Inc and many others.

1994-2004
President
Booth & Associates

Responsible for the direction of the engineering and operations of Booth & Associates, Inc. for all divisions and departments. The engineering work during this time frame has continued to be the same as during 1974 through 1993 with the addition of greater emphasis on power supply issues, including negotiating power supply contracts for clients; increased involvement in peaking generation projects; development of joint transmission projects, including wheeling agreements, power supply analyses, and power audit analyses. The work during this time frame includes providing services to over 200 utility clients across the United States, including NCEMC and NRECA.

2004-Present
President
Gregory L. Booth, PLLC

Providing engineering and management services to the electric industry, including planning and design. Providing forensic engineering, product evaluation, fire investigations and accident investigation, serving as an expert witness in state and federal regulatory matters and state and federal court.

2005-Present
President
PowerServices, Inc.

Providing engineering and management services to the electric industry, including planning and design and utility acquisition. Providing forensic engineering, product evaluation, fire investigations and accident investigation, serving as an expert witness in state and federal regulatory matters and state and federal court.

WORK AND EXPERTISE:

ELECTRIC UTILITIES: (more than 300 clients)

- All aspects of utility planning, design and construction, from generation, transmission, substation and distribution to the end user.
- Utility acquisition expert, including providing condition assessment, system electrical and financial valuation, electrical engineering assessment, initial Work Plan and integration plans, acquisition loan funds, testimony, assessment and consulting services for numerous electric utility acquisitions. Utility clients for acquisition projects include Winter Park, FL acquisition of Progress Energy, FL, system in the City limits, A & N Electric Cooperative acquisition of the Delmarva Power & Light Virginia jurisdiction, Shenandoah Valley Electric Cooperative acquisition of Allegheny Energy Virginia jurisdiction, Rappahannock Electric Cooperative acquisition of Allegheny Energy Virginia jurisdiction, and numerous other past and currently active electric utility acquisitions.
- System studies, including long-range and short-range planning, sectionalizing studies, transmission load flow studies, system stability studies (including effects of imbalance and neutral-to-earth voltage), environmental analyses and impact studies and statements, construction work plan, power requirements studies, and feasibility studies.

- Fossil, hydro, microgrid, wind, and solar generation plan analysis, design, and construction observation.
- Transmission line design and construction observation through 230 kV overhead and underground, including interface with DOT and other utilities.
- Switching station and substation design and construction observation through 230 kV.
- Distribution line design and staking, overhead and underground, including interface with DOT and other utilities.
- Design of submarine cable installations. (Transmission and distribution)
- Supervisory control and data acquisition system design, installation and operation assistance.
- Load management system design, installation and operation assistance.
- Computer program development.
- Load research and alternative energy source evaluation.
- Field inspection, wiring, and testing of facilities.
- Relay and energy control center design.
- Mapping and pole inventories.
- Specialized grounding for abnormal lightning conditions.
- Ground potential rise protection.
- Protective system/relay coordination.
- Grid Modernization Plan development, regulatory testimony, and implementation
- Pole Attachment Agreements, rate design, and testimony

UTILITY OPERATIONS:

- Storm assessment services., including interface with DOT and other utilities
- Regulatory testimony on storm response.
- Storm Response Plan development.
- Operations, including outage management and Call Centers.
- Outage management and operations enhancement services and testimony.

GENERATION DESIGN / FAILURE ANALYSES:

- Intermediate and peaking generation (gas and oil fired through 400 MW).
- Peaking generation (diesel and gas through 10,000 kW)
- Wind generation.
- Solar (PV) generation.
- Hydroelectric generation.
- Microgrid, including energy storage.

TELECOMMUNICATION: UTILITIES:

- Subscriber and trunk carrier facilities design.
- Stand-by generation and DC power supplies
- DC-AC inverters for interrupted processor supplies.
- Plant design and testing.
- Fiber optics and other transmission media.
- Microwave design.
- Pole attachment designs and make-ready design.
- Pole Attachment Agreements and rental rates calculations.
- Regulatory testimony.

FINANCIAL SERVICES:

- Long-term growth analyses and venture analyses.
- Lease and cost/benefit analyses.
- Capital planning and management.
- Utility rate design and service regulations.
- Cost-of-Service studies.
- Franchise agreements.
- Corporate accounting assistance.
- Utility Commission testimony (State and Federal)

FORENSIC ENGINEERING:

- Compliance with NESC, NEC, OSHA, IEEE, ANSI, ASTM and other codes and industry standards, including DOT standards.
- Equipment and product failure and analysis and electrical accident investigation (high and low voltage equipment).
- Stray voltage, electrical shocking, and electrocution investigations.
- Building code investigations.
- New product evaluation.
- MCC, MDP failure analysis and arc flash analysis
- Electrical fire analysis

INDUSTRIAL/ELECTRICAL ENGINEERING:

- Building design (commercial and industrial).
- Building code application and investigation. (NFPA and NEC)
- Electric thermal storage designs for heating, cooling, and hot water.
- Standby generation and peaking generation design.
- Electric service design (residential, commercial, and industrial).

INSTRUCTIONAL SEMINARS AND TEXT:

- Seminars taught on arc flash hazards and safety, including National Electrical Safety Code regulations for utilities.
- Courses taught on Distribution System Power Loss Evaluation and Management.
- Courses taught on Distribution System Protection.
- Text prepared on Distribution System Power Loss Management.
- Text prepared on Distribution System Protection.
- Seminars taught on substation design, NESC capacitor application, current limiting fuses, arresters, and many others electrical engineering subjects.
- Courses taught on accident investigations and safety.
- Courses taught on Asset Management.
- Courses taught on OSHA and Construction Safety.

TESTIMONY AS AN EXPERT:

- Concerning rate and other regulatory issues before Federal Energy Regulatory Commission and state commissions in Connecticut, Delaware, Florida, Maine, Maryland, Massachusetts, Minnesota, New Jersey, New Hampshire, North Carolina, Pennsylvania, Rhode Island, and Virginia.
- Concerning property damage or personal injury before courts in Colorado, Delaware, District of Columbia, Florida, Georgia, Kansas, Maryland, Minnesota, Missouri, New Jersey, New York, North Carolina, Ohio, Oklahoma, Pennsylvania, Puerto Rico, South Carolina, Texas, Virginia, West Virginia, Virgin Islands, and Wisconsin.

FIELD ENGINEERING:

- Transmission line survey and plan and profile.
- Distribution line staking.
- Property surveying.
- DOT highway relocation design.
- Relay and recloser testing.
- Substation start-up testing.
- Generation acceptance and start-up testing.
- Ground resistivity testing.
- Work order inspections.
- Operation and maintenance surveys.
- Building inspection and service facility inspection.
- Construction Management
 - Generation
 - Transmission
 - Substation
 - Distribution
 - Building Electrical Installations
 - GSA construction projects
 - NASA construction projects
 - University construction projects

PROFESSIONAL ORGANIZATIONS:

- a. National Society of Professional Engineers (NSPE)
- b. Professional Engineers in Private Practice (PEPP)
- c. National Council of Examiners for Engineering & Surveying (NCEES)
- d. Professional Engineers of North Carolina (PENC)
- e. National Fire Protection Association (NFPA)
- f. Associate Member of the NRECA
- g. NRECA Cooperative Network Advisory Committee (NRECA-CRN)
- h. The Institute of Electrical and Electronics Engineers (IEEE)
(Distribution sub-committee members on reliability)
- i. American Standards and Testing Materials Association (ASTM)
- j. Occupational Safety and Health Administration (OSHA) Certification
- k. American Public Power Association (APPA)
- l. American National Standards Institute (ANSI)