

Electric Power Technology for the Future

A Way to Proceed

- By Jack Casazza

Among its many disadvantages, old age has one advantage -- it provides perspective with which one can view the rising and falling tides of the past, what has worked well, and what did not, and why. This paper discusses an approach from the past that can be useful in discussing the first theme of this conference -- how to get an adequate amount of capacity of the right technologies for generation, transmission, and distribution over the next three decades.

The development of the needed technology involves two steps: first, determining the potential technical answers; and second, finding the best ways to achieve them. This paper focuses on the technology that may be needed. Because of the many uncertainties in the future, the answers must include sufficient flexibility and be revised from time to time to allow adjustments as the assumptions that were the basis of their determination change.

As one would expect, the procedures used in the past will require modification since both technology and needs will continue to change and evolve. However, certain features will retain their usefulness. The first of these is the need for cooperation between all segments of the electric power industry. Quoting from the preface to the 1962 National Power Survey:

“The National Power Survey on which this report is based was conducted in cooperation with all segments of the electric power industry. The National Power Survey is a major undertaking by the Federal Power Commission, in cooperation with advisory committees drawn from all segments of the electric power industry, to give greater impetus to the trend toward integration of the Nation’s power systems.

A major purpose of the Survey is to point out possible patterns of expansion that may result in reduced costs and to indicate the order of magnitude of these savings.

The Survey was conducted by the Commission as the most effective means of carrying out the provisions of Section 202(a) of the Federal Power Act. One of the most encouraging aspects of the national Power Survey is the manner in which representatives from all segments of the industry worked together to achieve positive results.

The National Power Survey does not attempt to resolve or even examine all the existing or anticipated institutional problems of the electric utility industry.

The heart of the Report is Chapter 15 which first discusses the criteria for power system planning, and next presents an illustrative pattern of power generation and transmission by 1980, with full regional and countrywide coordination and an indication of the savings that could be achieved as compared with the individual planning decisions of the Nation's power systems. The staff studies support estimates of potential net economies in the order of \$11 billion annually ...”

This project set the stage and led to much of the technological development over the next three decades, including the interconnections between regions, development of higher transmission voltages, facilitating large generators units, development of EMS system, new control technologies, etc. The study estimated annual savings of \$11 billion. By 1980 actual annual savings were \$20 billion and by 1988 \$26 billion. Quite an achievement over three decades through cooperation.

While a repetition of the 1962 study will not recognize the present situation, it provides a model useful in analyzing our future. A possible overall procedure for a 2007 National Power Survey could include the following key steps:

1. Organize a National Committee
 - a. Have 3 study groups
 - i. Generation
 - ii. Transmission
 - iii. Distribution
 - b. Overall sponsorship to be provided by DOE and FERC
 - c. Appoint an industry individual with wide experience and past high level responsibility to direct each study group.
 - d. Appoint a steering committee of technical experts with diverse technical backgrounds for each study group.
2. Develop an outline of procedures
 - a. Work to be done by each study group
 - b. Work to be done by other participants
3. Evaluate potential benefits and costs of various new technologies after making necessary studies, estimates, and reviews.
4. Prepare a draft report for review.
5. Publish national report for guidance of industry.

The 1962 National Power Survey was the responsibility of Joseph Swidler, Chairman of the FPC (predecessor of FERC) who worked closely with Philip Sporn of the American Electric Power Company, an internationally renowned engineer, who provided overall technical direction.

Where might the members of the steering committees come from?

- Utilities, generators, transmitters, distributors
- RTO's, ISO's
- National Academy of Engineers
- IEEE (Power Engineering Society)
- NERC
- EPRI
- Universities
- NARUC
- EEI
- APPA
- NRECA

DOE and FERC could supply the administrative staffing and bear organizing costs. In the past the individuals participating were provided by their employers at no cost. Selection should be based on qualifications, not establishing stakeholder representation. Experience and knowledge is required in the following categories:

- § Managing development of generation, transmission and distribution technology, including knowledge of costs and difficulties in constructing necessary facilities.
- § Planning, design, and operation of large power systems.

Background will be needed in other energy systems such as natural gas and hydrogen as well as potential future generation, transmission and distribution technology, future energy requirements of industry, commercial and residential consumers, including reliability and quality requirements, and future developments in communications and controls.

The basic approach needs to recognize that the overall national goal of reducing the need for foreign oil, reducing greenhouse gases and environmental problems, including:

- The role of electricity in transportation, such as the plug-in hybrid vehicle, can significantly affect electricity use and use patterns.
- Production of hydrogen by electrolysis can change electricity demand while production of hydrogen by chemical means can affect design requirements for electric power sources such as fuel cells. Will hydrogen play an important role? Will it be a competitor to electricity or compliment to electric power systems?
- Will energy supplied by natural gas have to be replaced with electric energy?

- Development of economic and efficient distributed energy storage can have major effects, allowing purchase of power when prices are low and storing for later use when prices are high and facilitating use of renewable sources such as solar and wind.

These are all alternatives that need evaluation for their potential future effects. These and others all need consideration in a National Power Survey.

In developing transmission systems, future needs will depend on generation patterns, customer use patterns, and development of new techniques for control of power flow in the lines and overall control of transmission networks. The optimum size of future synchronous grids should be examined, particularly the costs and benefits of smaller AC grids interconnected by DC, thus facilitating economic power exchanges while significantly simplifying planning, operation and control by reducing the number of participants, potential size of areas that might be blacked out and overall commercial operation costs.

The distribution system of the future will have many challenges. Reliability and the quality of electric supply may have to improve considerably as the devices on the customer's side of the meter change. Increased automation, the role of advanced metering, and new data collecting and analyses methods offer opportunities for the future.

Lastly, the study needs to consider the interrelationship between generation, transmission, and distribution and recognize the possibility of one of these systems affecting the others, either beneficially or harmfully. The objective should be the best total system.

The role of the National Power Survey would be to have the best expertise available review the potential developments and evaluate their potential role in the future, identifying those with the greatest promise and benefits to the nation.

Some of the steps required in a new National Survey include:

1. Review available studies on future needs and future technologies.
2. Estimate potential future generation additions and retirements for next 30 years. Develop possible scenarios covering range of developments:
 - a. Range of various fuel supplies;
 - b. High base load and nuclear;
 - c. High distributed generation;
 - d. Renewable technologies;
 - e. Most likely.
3. Estimate interregional transmission capacity requirements for all generation scenarios to achieve:

- a. Reduction in generator capacity requirements through pooling of reserves for emergencies;
 - b. Desired energy transfers;
 - c. Meet reliability requirements.
4. Review potential alternative means of meeting interregional needs at minimum cost while making maximum use of existing systems.
5. Develop proposals for long-range transmission requirements, including:
 - a. Use of DC to establish smaller non-synchronous regions;
 - b. Recognition of need to coordinate technical solutions and institutional requirements;
 - c. AC voltage to be used;
 - d. Key transmission lines required with all scenarios;
 - e. Probable circuit capacities required;
 - f. Likely short circuit duties;
 - g. New technologies to be utilized;
6. Predict technologies most likely to be needed.
7. Publish national report.

The National Power Survey that is published should not be a “blueprint” to be followed blindly. Rather, it is to provide long-range guidance that will indicate potential future technical needs. The electric power industry would be able to see possible future needs and compete in meeting them.

The Survey should be revised at least every five years.