Mid-Continent Area Power Planners:
A New Approach to Planning in the
Electric Power Industry

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One of the most significant developments on the American electric power scene is that of the rapid spread of area and regional interconnected systems. This development is so important because of the great economies it makes possible in the use of power resources, and because of the greater reliability of electrical service it provides in an era of large-scale generators and generation complexes. The Mid-Continent Area Power Planners have been in the forefront of this movement demonstrating the possibility and desirability of the coordination of diversely owned power systems.

In the following pages, the Mid-Continent Area Power Planners' origins, development, and achievements are discussed and evaluated. In Chapter I, this planning group is related to the broader integration movement with which the Federal Power Commission expects will lead to a national integration by 1960, if not much earlier. This movement, including MAPP, has important implications for the eight-fold increase of power consumption anticipated in the last thirty-three years of this century.

Chapters II and III are concerned with the problem of adequately integrating the important economics inherent in the power interconnection movement into the body of public utility economics. These chapters provide essential information for an
understanding and appreciation of the MAPP type of development. The third chapter also provides the standards against which MAPP is evaluated in the last chapter of the monograph.

Chapter IV traces the important background factors leading to the establishment of the Mid-Continent Area Power Planners and describes the significant factors leading to MAPP's success in the coordination of diverse ownership groups. The chapter also relates MAPP to the ongoing evolution of business organization in the electrical power industry.

Chapters V and VI are concerned with the objectives, history, issues, and achievements of the Mid-Continent Area Power Planners. In the latter chapter, it is necessary to consider the philosophical differences between MAPP members and the federal agencies operating in the Missouri Basin.

In Chapter VII, MAPP is judged against its prospects for growth and expansion; its economic performance is measured against the standards suggested in Chapter III, and against individual member appraisals of the MAPP organization. I owe great debts of gratitude to those people, above all others: to my wife, Joy, who persevered with me through three and four typing revisions of this monograph; to Professor Harry M. Trebing, Director of the Institute of Public Utilities at Michigan State University, and former Chairman of my graduate committee, who made the appointment making this project possible; and to A. W. Benkusky, MAPP Manager at the Coordination Center, who has worked tirelessly with me from the very beginning of the project, in giving me valuable contacts and orientation concerning MAPP, in correcting my "electrical engineering," and in keeping me posted on MAPP's latest developments.

I also want to express my thanks to MAPP Chairman Earl Ewald, who sanctioned my research and encouraged me in it. It was Lynn Monroe, First General Manager of the Omaha Public Power District, who first called my attention to the importance of interconnected systems in an earlier research project I undertook concerning the Omaha power frontier. Jack Wilkins, also of CPFD, provided me with valuable interconnected systems information. E. C. Spethmann, Secretary-Treasurer of MAPP, provided the minutes and correspondence of the Eastern Missouri Basin Power Conference and MAPP, without which this project could not have been undertaken. I also wish to express my appreciation to Mrs. Esther B. Waite of the Bureau of Business and Economic Research, Division of Research, Graduate School of Business Administration, Michigan State University, who did the editorial work on this project. Mrs. Mary Lou Harnett, my student secretary, helped in preparation of the manuscript.

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W. Stewart Nehon
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Introduction to MAPP
MAPP on the National Electrical Power Scene

The Mid-Continent Area Power Planners (MAPP) was established on February 8, 1963, by twenty-one power suppliers of the Eastern Missouri Basin. Fourteen of the charter-member firms were investor-owned utilities, six were generation and transmission rural electric cooperatives serving seventy or more distribution cooperatives, and one was a Nebraska public power district.1 Broadly, this organization was formed to provide a more effective means for power suppliers of diversified ownership to come voluntarily together to plan and coordinate generation installations and transmission tie lines which would enable each member to use his own facilities and resources to the mutual economic advantage of one and all.

According to the founders of MAPP, this is the first power planning organization sponsored by power suppliers of diversified ownership on an area-wide scale. Further, they state that their organization inspired the establishment of similar area planning groups which have been formed since—e.g., Western Energy Supply Transmission Association (WEST), which consulted with MAPP in its formative stage, and the Mid-America Interpool Network (MAIN), which is very similar to MAPP in organizational form, and includes several MAPP members.

These planning organizations, thus far, are just what the name
implies: planning groups, as distinguished from "pool" organizations, which are operating groups whose operations are carefully regulated by contracts between the participants. MAPP itself owns no transmission and generation property. Its members meet to plan on the basis of a broad memorandum of understanding which recognizes that, although each member retains and controls its own facilities, there are real economies and greater reliability to be achieved through the coordinated planning of generation installation and maintenance, the construction of transmission facilities to attain the economies of large-scale installations, and the assurance that newly erected plants go on the lines at, or near, full capacity.

The organizational structure of MAPP is relatively simple (see Exhibit 1). General policy guidance rests with the Management Committee.

EXHIBIT 1
MAPP ORGANIZATIONAL STRUCTURE

Committee which is composed of one representative from each member group (with the exception of municipal members which are represented by delegates elected on a state-wide basis). Business arising between Management Committee meetings is handled by an Executive Committee composed of seven members elected from the Management Committee.

Operating under the direction of these policy committees is the Coordination Center, which has a staff of five people: the Manager, two engineers, a Coordinator and a secretary. The present Manager is also an engineer. The present Coordinator is a former Commissioner of Economic Development of the State of Minnesota. In addition to his general assignments, the Coordinator also works closely with the Public Relations Committee in keeping members and the public informed of MAPP activities.

The Manager and the engineers at the Center work closely with the Planning Committee and are concerned chiefly with the collection of daily and hourly information from system members on anticipated peak loads for the next day, anticipated cold and spinning reserves, anticipated shutdown of equipment for maintenance purposes, and crisis outages in the system and adjacent systems, and other types of operating information. These data and information are received at the Center by teletypewriters and by telephone communications. On the basis of these data, the Center then advises its members: (1) where economy and dump energy is available, or where this energy can be marketed, (2) how to utilize, at any given time, the most efficient equipment consistent with demands, (3) how to ease the pressure on other members by rescheduling maintenance of equipment to non-peak periods of the system, (4) how to dispatch or obtain emergency power in case of crisis outages, and (5) the steps for starting up equipment after widespread, cascading outages, should they actually occur. The Center personnel have constructed an extensive wall map showing the main energy flow lines in the system and adjacent systems to help them carry out these functions.2

The principal standing committees working under the policy
committees and with the Coordinator and the Manager of the staff are as follows:

1) The Planning Committee is a core committee concerned with intermediate and long-range plans and feasibility studies for coordination of generation and transmission of hydro electrical generating units and high capacity bulk transmission lines. This committee also engages in reliability studies and coordination studies involving interconnections between systems internal and external to MAPP. There are six engineers on this committee plus an expert for the Upper Mississippi Power Pool, the Iowa Power Pool, Minnesota, Nebraska, Manitoba Hydro, and North and South Dakota. While this committee does the planning, the execution of plans rests with member firms or subdivision groups of members.

2) The Coordinating Committee is made up of one representative from each of the 25 power suppliers of MAPP who are members of the Coordination Center. MAPP does not require all of its members to be members of the Coordination Center. The municipal systems, because of their great number, are hard to coordinate with the present facilities in Phase I of the Coordination Center development (to be explained later). Operating coordination with the municipalities is presently effected through their MAPP power supplier representative of the system to which the municipal is connected. The members of this committee are operating personnel of the member utilities. This committee is concerned largely with operation procedures involving the Center and the dispatchers of the individual members. The primary objective of this committee is to guarantee, insurable as possible, that each member and MAPP as a whole derive the greatest benefits possible from the different activities of the Center.

3) The Public Relations Committee is made up of 19 members who have had experience in their own utilities with public relations activities. This committee has been deeply involved in creating a proper image of this new type of power organization before the public. It is large and includes congressmen and legislators in particular.

4) Finally, at various times, ad hoc committees are formed to deal with major problems not falling within the domain of the standing committees. Perhaps one of the most important of these ad hoc committees, to date, has been one to meet jointly with a committee of the Missouri Basin Systems Group (MBSG) in an effort to work out a coordinated planning of intermediate and long-range development for the entire Eastern Missouri Basin, including the intramarginal MAPP markets and the marginal markets of the western MBSG area.

It should be noted that the members of these committees serve voluntarily. Only the staff at the Coordination Center are paid employees of MAPP.

The different types of power suppliers—investor-owned companies, rural cooperatives, municipal utilities, and public power districts—are finding important savings through cooperative planning affecting a vast area of the East Missouri Basin. However, there were many power interests in this area who had hoped for a strong pool-type organization on an area-wide basis encompassing the whole Eastern Missouri Basin. Because of the diversity of these groups the formation of such a pool was looked on unfavorably in 1963. Even the smaller planning group was more than some of the western cooperative groups now comprising the Missouri Basin Systems Group pool were willing to endorse. However, there are those in MAPP who hope that as the Coordination Center becomes computerized, it will become the instrument which will convert MAPP into an area-wide pool operation. This issue must be considered further in the light of historical evolution and growing independency of utilities in the emerging age of gigantic generation centers and extra-high-voltage transmission.

What are the economic and reliability implications of this changing production and distribution scene in the electric utility field? How do area organizations fit into the national power network which has already, at least on an initial basis, been tied together since February, 1967, through an east-west intertie, and which is expected to be more firmly tied together within the next few years? What lies ahead for MAPP and similar regional groups? These are but a few of the questions to be considered here.

Obviously, as the mere phrasing of these questions so clearly indicates, even the present status and significance of the MAPP organization cannot be adequately understood without at least preliminary reference to the national and interarea power relationships and needs.

In the past, the American public has taken for granted the doubling of power needs and supplies each decade, little aware of the growth of the base from which these ten-year advances must emerge. Indeed, within the industry, the challenge has led to larger, more efficient generator units, more fully utilized at the
time they are first put on the line with better annual load factors. But now it appears that the American public has begun to realize that if this growth in the demand for electricity continues at this decade-doubling rate, in just thirty-five years from now we will be faced with the need for an electrical system almost seven times larger than that which we have at the present time. There seems little doubt that this rate of increase will continue throughout this period; perhaps it may even accelerate. Robert T. Person, President of the Edison Electrical Institute in 1966, has estimated that the electrical energy required of the industry in 1985 will approach $3 trillion kilowatt hours, and by the end of this century the demand should reach between six and ten trillion kilowatt hours. According to Person, this will mean an investment of something like $330 billion, approaching the GNP of Western Europe today. The very large generators and the concentration of generating centers which the industry has created to accommodate the growing American need for power have created real problems with regard to the development of adequate facilities for the transfer of energy from these sources. A. W. Benksius, MAPP Manager, has explained the situation in these words:

Very large concentrations of generating capability, remote from load which has developed as the large interconnected power systems have created problems which threaten utility reliability. Unless the facilities for transfer of energy from these sources to the loads are carefully designed, monitored, and controlled, relatively minor disturbances can set up a cascading of outages throughout.

The Management Committees of both MAIN and MAPP have given very serious and detailed study to the possibility of blackouts, similar to that which occurred in the northeast in 1965. Also, the Federal Power Commission, reflecting the growing public concern about the future adequacy and present reliability of the nation's electric utility system completed a thorough survey of the national power situation in 1964, and as it might be in 1980. It is interesting to note that at the first meeting of MAPP on February 8, 1963, a significant portion of the discussion was devoted to the Federal Power Commission's Regional Advisory Committee and its request for detailed information on MAPP's extra-high-voltage transmission program and the justification therefor. At this early stage in the development of the organization, this kind of information was available only for lines directed at Chicago and St. Louis. However, MAPP participants had given much attention to transmission line needs of the area at an earlier period when they had engaged in engineering studies on these matters for the Eastern Missouri Basin Power Conference (EMBPC), which held regular meetings between 1957 and 1962. It was therefore possible for MAPP to submit a proposal for a comprehensive system of transmission lines, reasonably justified as to feasibility, to the Regional Advisory Committee, which was apparently favorably impressed.

How close the thinking of the Federal Power Commission was to that of the leaders of MAPP is reflected in the National Power Survey, which called for area planning by all types of utilities, large and small, government and private, because the Commission was convinced that:

The greatest total savings to all power users can be achieved only through planning which looks far beyond the requirements of a particular system or locality. . . . Full co-ordination will require large investments for added transmission lines and related facilities, including those needed for conveying energy supplies from larger generation centers.

Further, the Federal Power Commission's North Central Sector, as set forth in the Survey, corresponds rather closely to that of MAPP. It does include Colorado, which MAPP does not, but it excludes Montana, a portion of which is included in MAPP. MAPP also includes the Manitoba hydro system in Canada (see Exhibit II).

The MAPP organization and concept, then, appear most timely and appropriate as the nation and the power industry brace themselves to prepare for the herculean tasks ahead of providing ample and reliable power for the remainder of this century. In the third chapter of this study, I will develop as fully as possible the economies inherent in different types of power integration to which the above quotation of the National Power Survey alludes in the phrase "the greatest total savings."
But the public utility problem is more than an economic one. It also has its profound human and political aspects too. Again, returning to another part of the *National Power Survey* cited above:

We are convinced that interconnection and coordination of all utilities large and small is achievable by 1980. We are also convinced that there is a growing trend throughout the nation toward more friendly cooperation among government units and private business in performing common functions.

Here, again, MAPP has pioneered. It was founded by members of diverse ownership interests, as was previously explained. Four and one-half years is a very short time in the life of an organization of this nature. But anyone who takes the time to review carefully the minutes of the Management Committee and

MAP on the National Scene
thirty-four or more consumers per mile of line in a concentrated area. Indeed, the farm electrical need was not to be met until the Rural Electrification Administration was established in 1935, with power to make loans to farm cooperative groups on most favorable terms. This was sufficient to start thriving electrical cooperatives for the distribution of power purchased wholesale from the private utilities, although in these marginal areas the private-company prices of energy to the cooperatives were high.

Because of these high wholesale prices these distribution cooperatives began joining together to form their own generation and transmission organizations with engineering and technical staffs forming a trained middle management for them. Thus a number of good, well-organized C & T cooperatives developed in the area. The present cooperative membership in MAPP, including Dairyland Power Cooperative, the largest of its kind in North America today, attests to the fact that this farm market was not submarginal as far asREA-type operations were concerned.

Strong private utilities and aspiring and growing rural cooperatives soon overcame early frictions and distrusts and found themselves working together in efforts to keep up with the expanding urban and rural electrical demands which put pressure on all concerned. By the early 1950's, these groups had found significant mutual advantage in interconnections and had begun to recognize further potential advantages in closer coordination of their activities. Both groups were active participants in the Eastern Missouri Basin Power Conference that sought to establish an organization which could realize the potential economies of coordination.

The second factor in the growing cooperation of private and public power interests is the human element. The men who attended these meetings included a significant number of college trained engineers, businessmen, farmers, and lawyers associated with both private companies and cooperatives. The contributions of these men to the development of MAPP are most difficult to measure objectively, but anyone who talks with these men and reads their actions and reactions in the minutes of the policy and engineering committees of EMPP and the management and planning committees of MAPP cannot fail to be impressed with their objectivity, dedication, and understanding—including their allowances for opposing points of view. They deserve most of the credit for the promising start MAPP has made in its four and one-half years of existence. Further, these men, working with men of comparable qualities in other power sectors, give promise of smoothly and efficiently extending the scope of power coordination to eventually envelop the entire nation and continent in a progressive, efficient power integration similar to that which the Federal Power Commission hopes ultimately to see realized. It is significant, and certainly not surprising, that the engineering personnel of MAPP-member systems are active participants in the Interconnected Systems Groups, as are the member utilities.

Both MAIN and MAPP have subcommittees studying anticipated area and interarea power needs for the remainder of this century. The MAPP subcommittee, in a preliminary study, has pointed out a critical problem which may need to be faced before the year 2,000: that of adequate sources of cooling water for the tremendous generation complexes which will undoubtedly be required at this time. These illustrations, again, demonstrate the quality and foresight of the men in these planning organizations. Whatever may develop in the future and beyond coordinated operations in MAPP, these activities surely will not eclipse the important work of its Planning Committee. Indeed, this planning is one of the chief justifications for MAPP.

Perhaps one of the most vital activities of area planners, requiring close cooperation with other area planners, has to do with finding ways and means of minimizing the potential danger of widespread blackouts where loss of key transmission lines or failure of large generators cause "cascading" outages across vast interconnected systems. As already noted, the 1965 blackout in New England and contiguous areas triggered research in both MAPP and MAIN. Cascading outages are a potential danger...
with the extensive interconnection of electrical systems. Yet the continuing benefits to be derived from these interconnections preclude the breaking up of systems as the remedy for the situation. Indeed, there are many in MAPP who believe that greater reliability can be achieved by the careful coordination of interconnected systems. This calls for, among other things, close relationships between the different area coordination centers.

MAPP and MAIN, on June 15, 1967, demonstrated the ability of two interconnected coordination centers to work together in arranging emergency assistance and coordinating system security actions. On this particular day, a weather front existed between the Twin Cities and MAPP-land on one side and Chicago and the MAIN region on the other. MAPP marketing areas had moderate temperatures; those of MAIN were hot — in the mid-nineties. A combination of problems in the MAIN area, including generators shut down for routine maintenance, aggravated by the demands for power, left parts of the MAIN system in a position of limited reserves to cover unscheduled outages. MAIN had previously alerted MAPP to the possibility of trouble, and MAPP found that because of the reduced power demands occasioned by cooler weather, Interstate and Northern States Power, with the help of other members, could quickly move substantial amounts of power into the MAIN area. When additional outages did occur, MAPP members were able to dispatch power into the MAIN area through at least three major tie lines. The Center at Minneapolis alerted systems to watch certain key transformers and lines for signs of overheating. The transfer of emergency power was made smoothly to meet the load demands in the MAIN area.

This cooperation was achieved between two adjacent coordination centers, both of which were newly operable and were restricted to teletype communications. Yet the concerted efforts of the coordination centers, and dispatchers experienced in scheduling generation over a wide area, provided sufficient power to meet the load demands.

The planning committees are now working on different types of computers which they hope ultimately will be able to do automatically what the men did in the above situation. These machines would be capable of monitoring energy flows in every part of the system, and of initiating compensatory action where disequilibria occur. Further, it will be possible to interconnect these computer "watchmen" in different systems. Area-wide and interarea-wide deployment and use of this equipment is relatively new.

The indications from the engineers are now that interarea coordination will be effective enough to insure that the electrical power industry will be able to maintain, and exceed, its high reliability rate of 99.98 percent, with the extensive interconnections and super-large generators connected to this interconnected network. But much work must yet be done to insure these results.

One thing is certain: area planning groups are at the center of this new reliability campaign — from the point of view of both planning this security and implementing it through interconnected, computerized, coordination centers. MAPP certainly will be a most active participant in this important program.

The efforts of engineers and coordination centers to make complex interconnected systems as foolproof as possible attest to the great faith of the engineers in the economic benefits to be derived from integrated systems. It is now time for the economist to concentrate on these considerations which are, or should be, his as well as those of the engineer. The next two chapters will be devoted to the economic aspects of power pools and related integrations.
The Economics of
Interconnected Systems
II
The Classification and Terminology of Interconnected Systems

The Memorandum of Understanding signed by the charter members of MAPP in 1963 points to the long recognized benefits of power pooling which some of its signators had experienced in subarea pools of the North Central states. They were aware of the rapid spread of various types of electric-system pools and forms of integration in recent years which has attracted the attention of engineers and, indeed, most other power people. There is the further implication that one of the principal ways by which knowledge of these benefits is gained is by actual experience in pool participation. These benefits are primarily economic deriving from the conservation and best possible use of resources to push the nation's electrical assets to the limit, looking ahead to the next one-third of a century of growing energy demands.

In a 1964 public utility text, considered one of the leading texts in the field, one cannot find a single reference to integrated electrical systems except for a short passage in connection with the discussion of the holding company. The word pool does not appear in the index, nor do words and phrases like interconnection, transmission line, or high voltage transmission.

A careful study of the periodical indexes likewise reveals few writings by economists, public utility or otherwise, on pools as subjects of economic interest. Yet people in the power industry
are excited about the economic possibilities in the integration of electrical systems. Those outside the power industry will find it hard to understand MAPP and similar organizations if they are not made aware of the economic benefits they bring.

For this reason Chapters II and III are necessary to any further study in depth of the MAPP organization; it is hoped that these chapters might also serve to prompt a more experienced and capable utility economist than myself to undertake the serious task of building up the economics of this dynamic area of the power industry. What is intended here is but a suggestion of what might evolve from such economics.

Classification

Interconnections are not new phenomena in the electrical world. They began with the early rationalization of municipal systems by holding companies and other interests. But it was not until the interconnections involved independent proprietary interests over substantial geographic areas that complicated contracts became necessary.

Various causes prompted these earlier associations of independent groups. In some cases, these ties permitted old obsolete equipment to be retired and more modern efficient equipment to be installed and put to fullest use. In other cases, two or more systems might serve communities with different industries and different peaking times. By interconnecting these systems, advantage could be taken of the diversity factors to reduce required reserves and improve load factors. Or, again, sudden load increases like those resulting from the major development of a war industry in an area might require the combined services of more than one power supplier. Gradually, the different types of economies of joint operations in systems became apparent. Gradually, too, it became apparent that interconnected systems relationships could be little more than those requiring synchroniza-

tion of the operations from the point of view of frequency, or they could involve directed coordination of operations requiring enforceable contract arrangements. Further, relationships might be extended beyond operations to joint planning of generation and transmission facilities for future use.

Perhaps one of the most valuable lessons learned in this evolutionary process was that the advantages deriving from interconnections could be enjoyed by diversified ownership groups in the same pool. The size of operation, or type of market served, made little difference. Large and small could benefit from interconnected facilities, although they might not enjoy them to the same degree.

As a result, a wide variety of pooling and planning arrangements came into being. Thus we are faced with the problem of attempting to establish a meaningful classification of these different pooling and planning groups.

Power Engineering has proposed a fourfold classification of interconnected relationships as follows:

1) Mutual agreements by which, for example, two firms might tie together to better cope with emergencies. Their circuits may or may not be closed as a general rule. These agreements may extend to other types of contingencies than emergencies.

2) Joint enterprises in which interconnected utilities jointly plan, build, and use generators and transmission lines. The objective might be to gain the advantages of large-scale generation, or it might be to meet a large demand imposed upon an area by a heavy energy-consuming project like that of a federal agency or business in a war situation for example. In these cases, the joint utilities form a new corporation or other business entity.

3) Completely integrated operating pools in which the different utilities sign contracts whereby they agree to be responsible for meeting their individual loads, and to coordinate generation and transmission resources. They also agree to abide by reserve ratios. These reserve ratios may be changed from time to time, as necessity demands. This reserve ratio is mainly to provide a cushion of emergency power, should it be needed. Members may purchase capacity within or without the pool when they find it economically advantageous to do so. Capacity additions are planned in a staggered format "to even out deficiencies and provide the greatest economy." There are also provisions by which one pool member with relatively high cost energy can curtail this production and receive lower-cost energy from other pool members. This is referred to as an economy energy transaction, which will be defined more carefully below.

Usually, planning and operating committees are provided to do the planning and to supervise operations. Dispatchers carry on the day-to-day activities with the help of automatic load control equipment.
4) Regional planning groups representing wider geographic areas than a particular pool. They coordinate planning and functioning of pools, and other suppliers in the area. They have two basic responsibilities: (a) to improve the economy of operations of their members, and (b) to improve greatly extended effective interconnection so that some kind of 'super-pool' organization is required so that these interconnections may be most efficiently planned and used. MAPP belongs in this category. The structure of organization outlined in the previous chapter is typical of this type of integration.²

Perhaps the third category above, "completely integrated operating pools," should be broken down into two subdivisions, as the research behind this project strongly suggests. There are what are called in the industry tight pools and loose pools.

The tight pool is an organization which is administered by a management staff with the power to determine what generators and transmission lines shall be built and who shall build them. It may also determine how the costs of these projects should be prorated among the pool members, although the formulae used are probably matters of contract. The staff also computes "equalization payments" for its members in observing the reserve requirements and other major contract relationships in connection with the pool.

The loose pool is an organization which has no administrative staff. General guidance is supplied by planning and operations committees made up of representatives from the member utilities. These committees' plans and operating procedures must be carefully drawn up and justified in the best economic interests of those who are asked to implement them. But the individual utility and its management reserve the right to make the final decision on any recommendation which the pool committee may make to it. Responsibility for supervising agreed upon energy flows and reserves may be rotated among the different dispatchers from time to time, the closest thing to a staff function involved here.

It was the latter type of pool which the Eastern Missouri Basin Power Conference (EMBPC) engineers recommended to the conference participants in 1959, after lengthy consideration of stronger pooling arrangements. It was also this type of pool which was finally adopted by the Upper Mississippi Valley Power Pool, which evolved out of the Eastern Missouri Basin Power Conference.⁴

It might be well to break regional planning groups into two subcategories also. There are those which are primarily planning groups. They coordinate operations very loosely, on the basis of carefully collected and analyzed information, they recommend action to members which the members are free to accept or reject. If computers are used, they are of a type which merely analyze, but do not control, energy generation and flows in the system.

Then there are those planning groups which give their coordination centers a greater degree of control over operations. They are equipped with computers which monitor and control energy flows in accordance with previously established programs. The center personnel must keep alert to conditions and select the proper programs for the computer, but once the program is put into operation its orders are carried out automatically.

There are those who believe that planning groups will eventually change from the first to the second type as representatives from wider and more diverse interests learn to cooperate, and as area and interarea systems take on greater significance on the national scene. The end result, then, will be an area pool with strong planning and operating activities.

At the present time, American Electric Power (AEP) uses a digital computer dispatch unit with analog backup which directly controls generation. The Pennsylvania-New Jersey-Maryland Pool (PJM) computer, on the other hand, does not directly control generation. Instead, it furnishes the operating center with guides for operation. The operator then advises the different dispatchers on what is the best procedure according to the computer. The MAPP Coordinating Committee is currently exploring both types of computers for possible use in the Coordination Center.⁵

Public utility economists might properly suggest the listing of a fifth category of groups which were formed rather early (certainly going back to the 1920's), but which are now beginning to come into their own. I refer to interconnected groups which
might well be called regional groups. Again, at least a two-fold classification is in order. First, there are the interarea or regional groups like the Interconnected Systems Group (ISG) which covers most of the United States east of the crest of the Rocky Mountains, with the exception of the northeastern portion— that portion which lies directly east of Lake Michigan and Lake Superior. This organization, in turn, has four subregional divisions which are concerned with establishing tie-line regulations respecting loads and operating procedures. Their primary concern is maintaining the reliability of the systems under their control.

Then there is the interregional type of organization; the largest and best known is the North American Power System Interconnection Committee (NAPSIC), which is concerned with establishing standards for tie-line bias settings, emergency shifting of power from region to region, and reliability in general. This organization ties together nine regional groups, including ISG.

Thus interconnected systems have expanded physically in the direction of national and international grids, the power industry has developed supervisory regulating groups concerned with their power coordination and service reliability— most timely developments.

The following is my own classification, which amends slightly the classification given by Power Engineering:

1) Mutual agreements
2) Joint operating agreements
3) Completely integrated operating pools
   a) tight pools
   b) loose pools
4) Area planning groups
   a) tight computerized coordination centers
   b) loose computerized coordination centers
5) Interconnected groups
   a) regional groups
   b) interregional groups including national and international organizations.

**Terminology**

In developing the economics of a particular area of the economy, not only is it necessary to classify the chief phenomena of the study, but it is also necessary to define key terms as precisely as possible. Fortunately, because of the technical nature of the industry under study here most of the terms are already carefully defined. Only in one of the areas listed below is it necessary to be somewhat arbitrary. This is the area of interconnected organizations with which my classification is concerned. These terms, most open to question, are considered first.

Those who write about the electric utility industry, especially at its public relations level, are sometimes inconsistent in the use of terms such as area, region, pool, and planning groups. In order to establish a more precise terminology in the development of this study, I propose to adopt the following definitions:

1) The Pool. It is an association of individual utilities bound together by contract, or agreement, to jointly plan and operate their facilities as if they were one utility. The primary aims of the pool are to gain the economic advantages of staggered generation installation and maintenance, reduced reserve requirements, larger and more economic generation and transmission facilities, and greater reliability of service.

2) The Planning Group is an area-wide organization of utilities and pools within a reasonably homogeneous geographic and economic environment. The organization plans area-wide generation and transmission facilities and market development, and provides what coordination of operations it can without owning generation and transmission facilities and without contract rights to operate its member facilities. Its plans are implemented if at all, only if they can be "sold" to individual utilities and subgroups of utilities in terms of their individual or group economic or reliability advantages. The digital computer with analog backup, if employed by the coordination centers, may force closer contracting of operation procedures, however.

3) The Regional Interconnected Groups are associations of pools and planning areas for purposes of establishing standards of operation and emergency control for wide geographic regions of the nation involving wide varieties of climate and economic interest. Too wide for close operating relationships between its utilities like those characterizing the pool, or as effective planning of generation and transmission, perhaps.

If planning group has been accurately defined, it becomes apparent why some superficial observers of such groups, when they were first formed, described them as "paper organizations." A careful observer of these organizations, however, cannot share this view for he will find that the economic benefits of power planning...
in area terms offer plenty of scope for plans which recommend themselves to the member groups on grounds that they cannot afford to disregard.

The last sentence in the definition of the planning group suggests the possibility of turning planning groups into area-wide pools. Computer developments and EHV lines may make this step possible, but whether the diverse interests and loyalties of individual members will make it possible is another question. It is significant that one of the first closely integrated operating groups, via computer, was a holding company, American Electric Power, already an integrated going concern from the point of view of business organization. In the dynamic technological field of electricity, definitions like this may have to be changed periodically.

In turning to definitions more firmly established in the world of electrical power, much less discussion and justification will be required. The next logical grouping of terms concerning interconnected systems deal with transmission lines.

4) INTERCONNECTION: a tie line or connection permitting the flow of electric energy between the facilities of two electric systems (Public Utility Reports Guide, P.U.R.).

5) EXTRA HIGH VOLTAGE TRANSMISSION LINES: those lines rated above 230,000 volts. (Allmana Svenska Elektriska Aktiebolaget [ASEA], developers of EHVDC lines.)

6) WHEELING: transportation of electric power from the point of generation to the point of delivery (Public Utility Reports Guide, P.U.R.).

7) WHEELING CHARGES: charges made by owners of lines engaged in wheeling. These vary according to the type of energy carried. Usually emergency energy is wheeled free of charge. The other charges are subject to pool agreement and may be changed from time to time (F. Linder, "Upper Mississippi Valley Power Pool," speech manuscript).

The following terms are concerned with the different types of wholesale energy moving over transmission lines.

8) ACTUAL TYPES OF INTERCHANGE ENERGY IN POOL OPERATIONS (as illustrated in the Upper Mississippi Valley Pool in 1962?"

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a) Participation Power: provides for continuous use of capacity for 13-month periods from a specific generating unit to the extent that such unit remains available for service. (Typically, both capacity and energy charges are made for this service. The capacity charge is based on dollars per kilowatt of capacity per month. The energy demand is expressed in terms of kilowatts per kilowatt hour.)

b) Seasonal Participation Power: the same as participation power except that it is sold for 6-month periods during either the winter seasonal period or summer seasonal period.

c) Emergency and Scheduled Outage Energy Services: provides for supply of power from one party to another during emergency outages or scheduled (maintenance) outages of generation or transmission facilities. The rates on emergency and scheduled outages are usually different. Frank Linder, for example, noted UMVP rates of 1962 were 1 cent per kilowatt hour on emergency energy, and 4.5 mills on scheduled outage energy.)

d) Economy Energy Exchange Services: provides for the interchange of energy when the incremental (out-of-pocket) costs of generating energy in one system is different from the incremental costs of another system and there can be an overall saving in adjusting generating schedules between systems. Transactions can be made whenever the difference in generation costs exceed six-tenths of a mill per kilowatt hour. Rates are established for economy energy so that both parties will share equally in the overall savings (a real inducement for using the most efficient plants relative to demand for energy by the consumer).

e) Wheeling Charges: there is no charge for wheeling unless the wheeling party has increased cost due to wheeling, in which case the wheeling party is reimbursed for the actual increase in operating expenses. If there is an increase in losses the wheeling party receives the recoupment at the time of the transaction, energy equal to the loss. (In practically all cases there has been no charge for wheeling and only occasionally is it necessary to reimburse losses.)

The Upper Mississippi Valley Power Pool has added several new services in its 1966 contract illustrating other possibilities in pool operations. For example, these:

f) Operation Control Energy: provides for the supply of power from one party to another in order to improve the electrical system operation, such as to unload a heavily loaded transmission line.

g) Peak Power: provides for supply of power from one party to another where power is required at a low load factor. It is sold on a six-
month seasonal basis and differs from participation power in that it is firm and not associated with a certain generating unit.

b) Short-Term Power: provides for the sale of power from one party to another for short-term periods of one week intervals. Short-term power is used for new loads such as an industrial load where the time power is required is indefinite. It is also used where initial operation of a new generation or transmission facility is delayed.

i) Firm Power: (within the Pool, the above clauses of power cover all conditions. However, for transactions with other parties outside of the Pool, an additional class of service is necessary to be compatible with other Pool contracts). Firm power provides for supply of power from one party to another where one of the parties is within the Pool and the other party is outside the Pool. It is a firm-power transaction.

Frank Linder, chairman of the MAIP Planning Committee, makes this interesting observation on reduced rates in the 1966 contract over those first cited reflecting a major goal of pool operations.

You will note that in the revisions to our Pool Agreement, rates have been decreased to its actual cost as possible which was done to make the most advantage of the Pool and not place any cost factors in the way of making power transactions. The additional clauses of power which have been added were developed as the needs arose and operating experience indicated.

Other important electrical terms in connection with interties included the following:

9) Spinning Reserve: generating units operating at no load or at various outputs, with excess capacity ready to take on more load (National Power Survey, glossary).

10) Spinning Reserve Interchange Service: provides for a party to purchase part or all of the spinning reserve obligation from another party. The rate for spinning reserve is 110 percent of the incremental costs of supplying spinning reserve plus one-half of the overall savings in the spinning reserve transactions (F. Linder, op. cit.).

11) Capacity: the maximum power output or load for which a machine, apparatus, station or system is rated (National Power Survey, glossary).

12) Demand Costs: costs incurred to meet customers' demand for service, independent of the quantity of service used or the number of customers served. Large costs related to investment in plant and facilities (F.U.R.).

13) Diversity Factor: a measure designed to show variation in time of use of service by different customers or classes of customers. Thus, if the sum of individual maximum demands (total connected load) is double the maximum demand (peak load) actually experienced, the diversity would be 2 (P.U.R.). (In connection with 31st factor, Garfield and Lovejoy point out: "The higher the diversity factor, the less the total plant capacity required to serve a particular market or service area. In addition, a high diversity factor is directly offset the consequences of the low load factor customers which form an important part of the market for electric service."

These authors go on to observe that are the great advantages of system integrations that they improve diversity factors.

14) Incremental Costs: bare extras expenses or "out-of-pocket" outlays incurred from the production of an additional quantity of service (P.U.R.).

15) Load Factor: the ratio of the average use, during a specified time interval, to the peak use during the same interval. May be calculated on daily, weekly, monthly, or annual basis (P.U.R.).

16) Readiness-To-Serve Costs: costs incurred to provide the plant and equipment to make it possible to serve (P.U.R.).

17) Reserve Capacity: production capacity of a given plant in excess of the maximum (peak) demand for it (P.U.R.).

This, then, is the terminology I will use most frequently in discussing some economic aspects of interconnected systems.

The next chapter will develop the economics of interconnected systems under the following headings: Transmission-Line Economics, Generation Aspects, and Institutional Aspects.
III  
The Economics of Interconnected Systems

Turning to the economics features of interconnected systems, we begin with two sections on transmission lines and generators as they are involved in interconnected relationships. It will be found that the economics of generation lead full-circle back to the economics of transmission with which we start. Following these two sections, selected institutional aspects of interconnected systems will be considered.

TRANSMISSION-LINE ECONOMICS

The basic equation of power transmission states that: "The amount of energy that can be transmitted by a line increases approximately with the square of the line voltage and decreases with the distance." Another fundamental fact is that the amount of energy carried by a power line is the product of voltage and current. Thus, by increasing the voltage, it becomes possible to lower the current and still deliver the same amount of energy as before. By reducing the current, significant reductions in conductor losses can be achieved—significant enough so that transmission lines of 345 kv. and up can carry energy, without excessive economic loss, 450 to 1,000 or more miles. Further, these extra-high-voltage lines will carry nine times as much power as would conventional lower-voltage lines, but they cost only about three times as much as a conventional line. Indeed, a 700 kilovolt line, several hundred miles long, according to Barthold and mieffer, will transport 2,500 megawatts, or enough to supply a city the size of Chicago.

The Allamana Svenska Elektriska Aktiebolaget (ASEA) of Sweden, developed the direct current EHV lines in 1954, the first one between Sweden and Gotland Island. According to Olav Berghund, an electrical engineer at ASEA, these direct-current lines have certain advantages over alternating-current EHV lines:

1. (1) Only two conductors are needed instead of three as in the case of alternating current, and it is possible to use ground as one of these conductors, either permanently, or in emergencies.

2. There is a saving in transmission towers in that two high voltage direct current (HVDC) lines will do the work of six alternating current lines (three on either side of the tower) where ground is used as a standby conductor. (3) Direct current is simpler and less expensive to insulate at high voltages than is alternating current.

Berghund estimates the operating savings of HVDC lines at 15 percent over HVAC lines, though this savings is partially offset by the cost of converting alternating current to direct current at the introduction point and direct current to alternating current at the exit point on the line. Long lines between major load centers without too many taps at interim points do not make these conversion costs unduly high, however.

Actually, MAPP engineers apparently make more of the "offsetting costs" than does Berghund. According to A. W. Benkusky, "a rough rule of thumb as to when DC should be considered over AC, is when the transmission distance is greater than 400 miles and the power transfer is 600 megawatts or higher." Of course, as Benkusky points out, decisions on this matter require exhaustive investigations. The minutes of the MAPP meeting reveal that the Manitoba hydro project has delayed, for some time, a decision on whether to use AC or DC. EHV lines on this important project, pending further engineering studies concerning the respective merits of HVDC and HVAC.
Finally, Berglund notes that direct-current flows are easier to control than are alternating current flows. Thus, he concludes: "HVDC can be programmed to act intelligently in emergencies, and it is an added tool to check transmission defects and helps prevent the occurrence of widespread failures."

The DC line, then, has an important part to play in intertie developments. It came at a most timely period when pooling activity accelerated after the second World War. It was a development that was especially appreciated in the mid-west and west of the United States, where major load centers are frequently separated by four or five hundred miles or more. It thus became possible to think in terms of planning and coordination in area terms, and even interarea terms.

At the federal government level considerable attention has been paid to EHV ties between regions. The Bureau of Reclamation has been interested in linking their administrative regions together either directly through EHV lines of their own, e.g., Bonneville and the Missouri Basin projects, or through a combination of government lines and lines of other interests, as will probably be the nature of a future line between the Missouri projects and the Southwestern Power Administration. And so the EHV movement is beginning to open up the field of regional as well as interregional planning.

Another important economic implication of the EHV development is that it makes possible mine-mouth thermal generation and hydro generation at sites which were previously submarginal because of their remoteness from major load centers. But now EHV can economically move such power to the load centers, where it can be economically distributed. Thus, MAPP has included the Manitoba hydro project so that it will have access to hydro power from the Nelson River when these projects and the EHV transmission links are completed.

The Manitoba hydro project immediately calls to mind another related advantage. Engineers of both MAPP and the preceding EMBPC were concerned about possible economies, on an area-wide basis, in coordinating thermal and hydro units, which apparently has been successfully achieved in the Pacific Northwest. This coordination will be discussed in the section on "Generation Aspects." But the role of high-voltage transmission in facilitating this economic coordination of thermal and hydro production should be noted here, because the two types of units are likely to be widely separated, geographically speaking.

Another economic advantage is that the EHV line enables right of ways to be used more fully, an old argument for upgrading a line from the voltage point of view. Further, Berglund has noted the possibility of putting HVDC lines underground in urban areas where right of ways are expensive and community beauty is an issue.

With the great variety of voltages now available for power transmission, there also arises another basic economic question. In a given situation, what size of line is most feasible economically? Among the more important variables involved here are those of distance, present load expected, future load anticipations, and the physical and financial implications of possible upgrading of the lines in the future to meet greater loads.

MAPP planners, for example, decided to use 345 kv lines in their major city links rather than 500 or 700 kv lines because present load expectations, and load expectations for some time ahead, could be handled by these lines. Further, a 900 kv line would cost 30 percent more than a 345 kv line. In the two Dakotas, feasibility studies revealed that 230 kv lines were sufficient for the lighter loads there. The chairman of the Planning Committee reported at the September 12, 1966 meeting of the Management Committee that a subcommittee of the planning group had been established to study power needs as they were likely to develop by the year 2000. One aspect of this study would be the 345 kv lines. When will loads exceed their capacity? Can these lines be upgraded economically? Thus the problems of matching lines and loads most economically for the present and the future are complex and require careful intermediate and long-range planning for their adequate solution.

Finally, through pool, area, and regional planning, it is possible
to avoid unnecessary duplication in the installation of long transmission lines. This does not necessarily mean, however, that all parallel lines serving a load center involve unnecessary duplication. It may be that the combined capacity of two or more lines is required to serve a heavy load center. Indeed, the accomplishment brochure of MAPP shows parallel EHV lines planned in both Canadian and U.S. sectors of the Manitoba hydro project. Still, the huge capacity of EHVDC lines, as noted earlier, reduces substantially the need for parallel lines if properly planned.

A. W. Benkusky cites a development in the Manitoba project in this connection:

Economic development of EHV DC lines has resulted in the decision by Manitoba Hydro to link the Niskon River Hydro Dams with Winnipeg via two 475 kv DC circuits. This results in the intriguing thought of possible interconnection between Canada and the U.S. using EHV DC and possible reduction in the number of otherwise thought of parallel lines.

We now turn to the economics of generation operation and planning as they have been influenced by transmission developments linking large generation centers together.

**Generation Aspects**

**RESERVES**

One of the first measurable economic benefits for the twenty-one charter members of MAPP after three years of association was the marked decline in reserve capacity which they had to maintain in 1966 compared with that of 1963. The decline was from 25.8 percent to 15.6 percent. Actually, as Benkusky pointed out, it was the reserve pools of MAPP which were most responsible for this decline in the reserves of the charter members in the first three years of MAPP history, before its major EHV transmission lines were in operation.

The members of the Upper Mississippi Valley Power Pool now operate with a 12 percent reserve requirement. It should be obvious that an isolated local system would require much larger reserve capacity than if it were closely interconnected with numerous other systems. There is, for example, a rule of thumb among municipal plant engineers that their reserves should be equal to the largest units required in serving the demands of their respective communities. If this largest unit were to go down, the regular service of the community could not be fully met unless reserve capacity were available to replace it. One big advantage, then, for municipal systems which interconnect with other systems is that they are no longer required to maintain reserve capacity equal to their largest units. The chances are now excellent, should the largest unit go down, that excess power would be available from other members in the interconnected system.

In my glossary of terms, I noted a service of the Upper Mississippi Valley Power Pool which provides for an interchange of energy in connection with emergency outages. This service greatly relieves the pressure upon the individual member to provide large amounts of usually idle reserve capacity. The savings in dollars and cents, both from investment and maintenance points of view, are significant in this one matter of generation—in substantially reduced requirements for reserve capacity.

Not only do interconnections reduce reserve capacity requirements, they also reduce spinning reserves as well, and for similar reasons, thus cutting down on operating expenses. Each company, in case of emergency, has the running capacities of the other members to fall back on for the duration of the emergency. As soon as the victim company can bring up its cold reserve, it can then reduce, to that extent, its purchases of spinning reserve from outside—an economic move if the local incremental production costs of the victim's operating reserve are not greater than the incremental costs of importing this power.

**INSTALLATIONS**

The total installed capacity required in interconnected operations to serve a given level of demand is less than the total installed capacity would be for the members were they operating as isolated units in meeting this given level of demand. This
economy is obtained because of diversity between loads of different systems on both an hourly and seasonal basis. For example, to some extent the winter peaking areas of MAPP land can, and do, help Nebraska meet her heavy summer demands for irrigation and air conditioning. Thus Nebraska needs to build less capacity, which capacity is hard to employ in the winter in Nebraska unless outlets are available in the winter peaking areas to the north.

Carrying this diversity implication a bit further, Nebraska delegates of the EMBC argued that other utilities would gain from an area-wide pool involving winter peaking systems because some of the Nebraska capacity required for summer peaking could then be used in the winter peaking areas during the winter months, thus reducing the amounts of capacity the northern systems would require to meet their winter peaks.11

Perhaps the most dramatic economies in pool and area developments are those which are associated with the deferrals of installations of plants made possible in the pool or area. These savings can be measured in dollars and cents in particular situations, and they are impressive. However, the long-run cost curve of generator production should first be considered.

This cost curve has sloped sharply downward within limits only now being realized; the per kilowatt costs of constructing large-scale plants are considerably less than those of constructing smaller plants. Experience has amply demonstrated that the power generating industry thus far is a decreasing cost industry. In the case of atomic power installations, only plants of the 400 megawatt level, or higher, are proving competitive with conventional fossil-fueled plants. Unfortunately, the incremental enlargement of demands of isolated power systems usually change too gradually for these systems to take full advantage of the economies of decreasing costs due to generation size. To increase capacity significantly would require the building of a plant considerably greater than the current demand or the probable demand in the immediate future. This would mean operating the new plant at less than full capacity for some time. In pool relationships, however, it is possible for these systems to defer the construction of their “next plant” until such time as the demand increases sufficiently so that the significantly larger and more economical new plant can be put on the line at, or near, full capacity—part of this capacity being used to help another member, or members, to defer plants. Meanwhile, power to meet the incremental annual increases of demand can be purchased from elsewhere in the pool.

The experiences of operating pools certainly bear out the reliability of these conclusions concerning the down-sloping long-run cost curve of generator construction. The Iowa-Illinois Gas and Electric Company expects its power load to increase from 270 megawatts to 550 megawatts during the decade of the 1960’s, according to R. M. Hetherington, vice-president in charge of operations. If the company were operating as an isolated system, its load curve would have called for a first unit of 50 megawatts at a cost of $835 per kilowatt. Next, two units of 75 megawatts would be required at a per kilowatt cost of $1200, and finally, a 100 megawatt unit would have to be constructed at a per kilowatt cost of $185. The company found, however, that through pool purchases of power it could postpone installations of generators until it could at last build and utilize a 200 megawatt plant. That plant could be built at a per kilowatt cost of $128. In terms of total investments the series of plants would have meant an outlay of $60,250,000 as against the total investment of one 300 megawatt unit of $38,400,000, a saving of $28,850,000, or a 36 percent reduction in cost.12

More recently, Benklysky states that: With the advanced development of the MAPP EHV 345 Grid, Iowa-Illinois Gas and Electric Company is participating jointly with Commonwealth Edison Company in the installation of an 80k mw atomic unit at Cordova on the Mississippi River. This is an excellent example of the economies in coordinated planning since Iowa-Illinois Gas and Electric Company will own and utilize 400 mw out of this 800 mw unit.13

According to material provided by the MAPP Coordination Center, in the period between 1967-1980, if MAPP had not existed, the member companies would have installed about 70 steam generating units with an average size of 206,000 kilowatts
at a per kilowatt cost of $138. With MAPP in existence, these same companies now plan 35 units averaging 400,000 kilowatts at a per kilowatt cost of $123, a saving of $15 per kilowatt. The same report indicates an overall investment saving of $98,-
000,000 for members of MAPP building generation in this period.

It would be possible to list a great number of other illustrations of a saving through deferred plants ultimately built at lower per kilowatt costs. The Louis Donnelly article, from which the Iowa-Illinois Gas and Electric Company example was taken, includes several other examples of similar savings in other pool relationships. But these two examples are reasonably typical to cite in support of my contention that there are impressive economies in pool-planned staggering of plant installation until such times as each plant, when it actually is built, can be built sufficiently large to enable it to take advantage of scale economies.

**Energy-Flow Exchanges**

Energy-flow exchanges, of course, made possible the staggered plant installation plans just discussed. The MAPP Accomplishments brochure contains a list of seven members of the organization who are currently net buyers of power, and eight members who are net sellers. There are also two non-member companies who are selling power to the members. Among the net purchasers are Northern States Power and Omaha Public Power District. Both are currently in the midst of deferral projects. Omaha purchased 35,000 kilowatts of power in the summer of 1967, contributing to the deferral of a 200,000 kilowatt addition which, as a result, is now scheduled to come on the line at near full-capacity production in 1968, and it will have the capacity to help supply the deferral of another member. Northern States was able to defer for two years its Allan S. King plant of 550,000 kw. Thus, in later years these companies will be net-sellers, and other companies in the net-selling list will become net-buyers as they move ahead in this staggered pattern with their deferred projects to ultimately increase their capabilities. The exchanges here are of firm power.

The Economics of Interconnected Systems

There are other exchanges of power in pool operation which contribute to generation economies in operations. We shall consider two of these: economy power exchanges, and scheduled outage exchanges.

Economy power exchanges, as we noted in our glossary of terms, promotes the employment of the most efficient units in an interconnected system consistent with the demands of day-to-day operations. Drawing again from MAPP for illustrations in explaining these economies, take a day in early autumn after the summer peaking period. Many of the plants throughout the area will have excess capacity on their hands. Here is an opportunity for members with high-cost production units, such as the small diesel units in many of the municipal plants, to shut these units down for the time and purchase equivalent power from the efficient units of other members with power potential to spare. The Coordination Center at Minneapolis will have knowledge of those members who do have this "economy energy" for sale. Thus, the municipal plants can probably arrange a transaction. The usual arrangement is that the buyers and sellers, after figuring the incremental cost of producing the equivalent power being negotiated for, to determine the savings which would result from replacing high-cost energy with lower-cost energy, agree on a price for the economy energy which divides equally the savings thus determined between contractors. Obviously, there is economic advantage in this transaction for both buyers and sellers, and such transactions go on every day in pools and areas.

What is important from the standpoint of broader economic interest is that in the process of striking these advantageous energy deals, the area, at any given time, is using its generators in the most efficient manner. It is revealing to consider some figures discovered by E. L. Michelson and D. W. Angland, representatives respectively of MAIN and MAPP, on the extensiveness of economy energy exchanges in MAIN. Two of the largest companies of MAIN in the year ending September 30, 1964 exchanged 650,000,000 kilowatts of economy energy. The authors point out that this is equivalent to a continuous flow for the
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self to meet the demands which his downed unit would ordinarily meet. In other words, this system of planning maintenance outages is another factor making it possible for utilities to reduce their reserve capacities.

**SCALE ISSUES**

We have just noted one problem of large-scale generator units in connection with maintenance. A much more basic problem of system economics is that of determining the optimum generator sizes for different system situations.

Earl Ewald and D. W. Angland have made a careful theoretical analysis of this question involving complicated probability mathematics. Some of the main conclusions of this analysis are reported here.

First, it is concluded that per kilowatt investment and operating costs of generators have been going down with the increasing size of generators installed. However, the authors find that in terms of the 1965 costs and technology, the downward cost curve of increasing generator size begins to flatten out at about 600 megawatts.

Further, it is noted that, as generator size increases, the need for reserves also increases because of the potential seriousness of a situation in which one or more of these large units might go down.

Ewald and Angland point out: "The economic selection of generator unit size involves effecting an economic balance between these two conflicting factors." That is, the conflict between declining per kilowatt cost due to increasing size of generators on the one hand, and the increasing need for reserve capacity as generator sizes are increased.

For illustrative purposes, if a system were faced with a new demand of 1,000 megawatts, its engineers would have to employ probability mathematics first to determine the different reserve units which would be associated with different sizes and numbers of identical units needed to meet the new 1,000 megawatt demand. The results of this mathematical exercise are then put in
analysis to demonstrate impressively the economic complexities of matching generator size and number of units to isolated and integrated loads. The range of decreasing per kilowatt costs as generator size increases is considerable, but apparently the large, modern units are at last reaching a flattening out of this per kilowatt costs decline. Further, as generator sizes increase, the need for greater reserves begins to challenge the decreasing per-unit costs of active-line generators. As system size grows, however, the percentage of reserve declines. In intersystem interconnections, it is possible to take advantage of lower per kilowatt cost generators while the reserve ratios continue to fall. Finally, all these economies on the generator side of the scale must be counterbalanced, to some extent at least, on the other side, in increasing per kilowatt transmission expenses as systems are increasingly interconnected.

Thus, we are given some insight into the complexities which the system-planning engineers face. Once again, the importance of the planning committees of pools and areas is underlined if we are to use our power resources efficiently in the coming critical years of power expansion.

**Thermal-Hydro Integration**

Perhaps one of the most successful integrations of thermal and hydro plants in the United States took place in the Pacific Northwest under power pressures of the second World War. The hydro power resources were being taxed to the limit, especially in low-water periods. It became imperative, therefore, to form a pool of thermal and hydro systems so that the urgent war demands for power in this area might be met. Thus the Northwest Pool came into being. In the intervening years, pool planners and operators have concentrated on the problem of thermal-hydro integration as few other groups have done. The EMIPC, as we, was convinced with the desirability of integrating thermal and hydro units since the Missouri hydro units were then being constructed. For this reason the power conference called upon the Northwest Pool for orientation. In one

In summary, Ewald and Angland have used this hypothetical

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**Mid-Continent Area Power Planners**

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of the early meetings of the conference, the Technical Committee on May 27, 28, 1957 heard Don S. Campbell, chief of the Power Division of the Bureau of Reclamation, speak on the subject of hydro-thermal integration in the Columbia River Basin.59

Campbell stressed the greater flexibility of hydro in starting and stopping generation. This quality of the hydros permitted them to pick up unexpected as well as anticipated peaking, leaving relatively understimulated the thermal generator sectors. This proved most beneficial for the power industry in the northwest where, in Campbell’s words, the “demand for power is most ‘fickle’ and where even relatively small fluctuations are meaningful where $5 million kilowatts are involved.” Small percentage changes in temperature, for example, might mean the putting down or bringing up of several steam plants in delayed and expensive reaction. So the hydros did smooth out thermal generation and thus helped to make it more efficient.

It took the Northwest Pool considerable time to work out the mechanics of energy flow and the procedures necessary to employ smoothly and profitably the peaking qualities of the hydros. Further, these organizational problems persisted in spite of the fact that the interests involved were in agreement that the pool was necessary and desirable.

The hydros in this area, however, were not solely concerned with peaking responsibilities; they also assumed an important part of the firm load in this area. Thus the problem of firming up the hydros in the dry season, which limited their outputs, was another one which had to be worked out by the pool planners.

Part of the solution for this problem came in the form of imported power from the state of Utah. The transfer of this power was made by the displacement method, since there were no EHV lines at this time. But the system worked well and the pool was even able to take advantage of time diversity between the eastern and western sections of this expanded system when it was completed.

The basic principle in thermal-hydro integration is to use hydro generators as much as feasible to reduce the use of more expensive thermal fuel. Campbell’s presentation stressed three major problems in achieving this principle in operation: (1) to organize the mechanical means and procedures for smoothly operating hydro and thermal units to take full advantage of the peaking potential of the hydro system, (2) to provide adequate thermal capacity to firm the hydros in the low-water seasons and adverse-water years, and (3) to provide adequate transmission systems for this integration. As noted earlier, the development of high voltage lines is a help in connection with this latter problem.

The intensity of these problems will vary considerably from situation to situation. The second problem, that of firming the hydros, would be much easier to solve, other things being equal, in a situation where the hydros constitute a small portion of the total energy supply in contrast to a situation where the hydros are a big portion of the power supply. The last problem would be difficult to solve if thermal and hydro sites were widely separated geographically. However, the EHV development has made it easier to integrate the Manitoba hydro system into MAPP in spite of the substantial distances involved.

The Missouri hydro development and the efforts of fourteen private power companies to obtain the privilege of firming the hydros suggest another possible advantage in integrated operations. If the hydros produce excess energy in the navigation season which is made available to nonpreference, wholesale customers (e.g., the fourteen companies), it is possible that an exchange arrangement might be worked out for the return of an equivalent amount of energy to the hydros in the winter months when they have difficulty in firming their preference loads. In other words, they can use their summer excess power to obtain an equivalent amount of firming power in the winter. The private companies, meantime, would be receiving power in the summer to help them meet summer peaks and defer significant addition to plant and capacity. There would, of course, have to be adjustment as the hydros would be providing excess energy and receiving back firming power. Even if the hydro navigation season surplus should ultimately disappear, this arrangement might provide significant deferential energy before the surplus vanishes.60
Careful planning of hydro-thermal integration is essential as the case of the Manitoba hydro integration illustrates. It gives every indication of moving ahead smoothly the work begun within the MAPP organization in which the Manitoba hydro has membership. The Manitoba hydro, fortunately, has had long experience in interconnected relationships with the Ontario hydro to the east and Saskatchewan Power to the west and knows the benefits of pool coordination. The first MAPP action taken was to employ the engineering firm, Sanderson and Porter, to study the immediate and long-range power requirements of the Manitoba hydro and a group of other MAPP members to be involved in the project, and to outline plans for the economical development of the subarea directly involved. This engineering firm was to work in close coordination with an ad hoc committee of MAPP set up to represent MAPP's interests.

The engineering firm submitted five different plans; one of these was adopted, and it is being developed at the present time. The plan illustrates all of the principles of thermal-hydro integration outlined above and comprehends hydro and lignite-field thermal plants and the accompanying transmission system. More important, this whole careful cooperative approach, involving private and public interests, is a positive demonstration of what can be accomplished for the mutual advantage of all, including utilities and their customers, both for the present and for the future.

This stress on the human organizational side logically leads to the next major section of the economy of interconnections — the institutional aspects.

Institutional Aspects

There are a number of institutional aspects of interconnected electrical systems which should be proposed for this new branch of public utilities economics. Most of these issues go beyond this particular study of MAPP. I shall discuss only two of these aspects, the administrative and the regulatory.

Administrative Problems

What sorts of business organization adapt themselves to the interconnected system? Certainly the present-day holding company, limited to contiguous groupings of operating firms is one possibility.

It was noted in the second chapter that the American Electric Power holding company was one of the first groups to employ a computer system capable of automatically coordinating the electric energy flows of its member operating companies, a step quickly taken through the centralization of administrative control of the holding company.

Perhaps one of the best case studies of integrated electrical systems is provided by Judge Dunn and Associates at the behest of Supreme Court Justice William O. Douglas. The general conclusion of this survey was that the complete integration of administration in the holding-company type of interconnected system enabled these systems to yield the greatest benefits of interlaced operations. Organizations are able to establish the integration on sound engineering design with the elimination of all unnecessary duplication of facilities and services; centralized purchasing of materials gives the advantage of bulk-purchase economies; and the decision-making process is centralized — no long sessions on policy differences of independent entities. Further, the integrated group is effective in size to attract specialized personnel, and the mechanical means of controlling energy flow, as noted immediately above.

On the other hand, the Dunn study recognized the danger that these groups might become too big geographically to be properly administered. Centralized technical staffs may become insensitive to grass-roots feelings and needs. Indeed, the study concluded, these integrations, from the point of view of effective management, could not extend more than “a few hundred miles.” In the case of the possibility of integrating with a hydro system, the integration might be extended further — the only justification cited for expansion.
During the intervening years, the two developments, EHV and computer control, have extended the physical possibilities of integration still further. But the question still remains whether these developments have extended the range of effective administration significantly. This type of organization is probably best adapted to highly concentrated, densely populated market areas.

Apparently, the Northern Plains utilities are too widely separated geographically and too diverse in ownership to be brought into effective holding company operations. They prize their independence greatly. Further, in the agricultural areas REA groups began to flourish with a different economic and political outlook. The Department of Interior hydro operations further complicate the power picture even more.

It is in this area that MAPP and its loosely structured sharing pools seek to achieve a degree of efficiency approaching that of the closely structured holding company integrations in the east. A major concern of this particular study in the discussion that follows is to explore these organizations, to determine, if possible, how well these pools and planning organizations stressing local-utility autonomy are succeeding in achieving the benefits of interconnected electrical systems.

In other areas of the west, tight pools have been developed to provide effective administration of interconnected systems. These pools are governed by administrative agencies above the member firms. The administrations enforce formal contract relations between their members in connection with energy flows, staggered maintenance schedules, generation deferrals and reserve sharing. In these matters the member firms give up their autonomy of action.

Questions have been raised concerning the legality of these contracts. The unanimous conclusions of a legal advisory committee, made up of representatives of private utilities, cooperatives, and government agency operations is that "there are no insurmountable legal barriers to the coordination of the electric utility system." Further, the committee found the general laws of contract adequate for covering these contracts. It has no suggestions for new legislation or regulation.

Returning to the looser pools and the planning areas of the Northern Plains, their interrelations are not formally contracted and hence they are less bothered by contract law. Beyond this, however, their diverse ownerships complicate the government regulation pattern.

Regulatory Aspects

The private utilities are subject to municipal and state regulations of public boards and commissions; they also come under the regulation of state and federal income tax authorities. If these groups operate interstate or are involved in holding companies (which most are not) the Federal Power Commission has jurisdiction. In the case of holding companies, the Securities Exchange Commission shares jurisdictional responsibilities. The cooperatives are under the regulation of the Rural Electrification Administration for the most part. Local public utilities are under the control of local and state commissions. The federal agency's power groups come under congressional control and also, in limited matters, the Federal Power Commission. 15

The interconnected systems of concern, if they transcend state boundaries, are under the control of the Federal Power Commission. Operating pools are required to register with the Federal Power Commission. Apparently, area planning groups having no contracts or binding agreements do not have to file with the Federal Power Commission. 16

This introduction to the economics of interconnection has involved both principles and institutional arrangements. It is hoped that what has been developed might provide a foundation for a more complete economic analysis of this subject. It is also hoped that the next chapters on MAPP origin, developments, and prospects will be more meaningful, read against this background of the economics of interconnection.
Historical Development
and Achievements of MAPP
IV

Backgrounds of the
Mid-Continent Area Power Planners

The history of how MAPP has won the cooperation and strong support of diverse power interests is a long one. MAPP, quite contrary to impressions given the public by some journalists at its inception, was the product of a long educational process which is still going on. This evolutionary process was absolutely necessary to the successful launching of this organization, and it must be carefully described.

Exit of the Holding Company

The Holding Company Act and the stockmarket crash of the 1930's forced a number of holding companies out of existence. The surviving holding companies were required to simplify their structures, and this caused a number of them to sell their stockholdings in unconnected utilities of the agricultural west.

With the exit of the holding companies, the integration movements of the Northern Plains were stopped, and the remaining operating companies were forced to consider new forms of interconnection which would achieve most, if not all, of the benefits the holding companies were receiving from integrated operations. But one essential condition for any new arrangement was that the different power entities involved would insist upon maintaining their own independence. This chapter is concerned with
the quest of these companies to find the advantages of integrated operations without sacrificing their meaningful individuality. In fashioning these new forms of interconnections, the utilities were further fashioning organizations which would accommodate other power interests that were now appearing in the eastern-sector markets in strong agricultural markets. The next section concerns this portion of the evolution.

The Rural Electrification Administration and the Missouri Hydro Development

The Rural Electrification Act, 1935, and the Flood Control Act, 1944, substantially changed the market situation and the basic policies of the investor-owned utilities by introducing new cooperative power suppliers and a federal hydro system which had a competitive impact on the market. Beyond this, these acts also caused the utilities to think in terms of diversified ownership pools.

After the passage of the Rural Electrification Act, the farmers of the Northern Plains region lost no time in getting into the power business. The Richland Co-operative Association was incorporated on January 8, 1936, and energized its lines on May 7, 1937, thus it was one of the earliest G. & T. cooperatives in Wisconsin and the area. On May 26, 1937, the Wisconsin Power Co-operative was formed. The Tri-State Power Co-operative was organized on December 12, 1938, over a year later. Both of these cooperatives became generators as well as distributors of power.

On March 12, 1938, the Wisconsin Power Co-operative put its Chippewa Falls Station into continuous operation with three diesel generators of 700 kilowatts each. On July 28, 1939, Tri-State awarded turbo-generator contracts and other equipment assignments for its Genoa Steam Power Station calling for two units of 3,000 kilowatts each. On April 24, 1940, these two cooperatives constructed a direct tie line between their plants. On December 16, 1941, the Wisconsin Power Co-operative and the Tri-State Power Co-operative met at the Genoa Station and formed a merger known as the Dairyland Power Co-operative. In 1953, for the first time, this cooperative served all the requirements of its distribution-member cooperatives.1 Today, of course, Dairyland is the largest power cooperative in North America.

Across the Wisconsin border in Minnesota, the Rural Co-operative Power Association was formed in 1940 and became one of the strongest cooperatives in the area. Later it combined forces with Northern Minnesota Power Association to form the United Power Association for building generating facilities on the Stanton, North Dakota, lignite fields. Further west, in a more marginal market situation, Minnkota Power Co-operative Incorporated came into being, also in 1940. This cooperative, through its capable manager, Andrew T. Freeman, became a chief proponent of the lignite fields through a development association including power, banking, railroad, and other interests.

There were other G. & T. co-operatives in the area, but Dairyland, Rural Co-operative Power Association, and Minnkota, through their capable leaders, came to play most significant roles in MAPP. Because the cooperatives served good agricultural areas with promising power demands, these organizations developed generating capacity early, and because of this they had to employ competent engineers and managers who capably expanded their cooperatives into significant power suppliers.

These same people later made their talents available to MAPP. Andrew Freeman and Kenneth Vig, the latter MAPP's first Coordinator, became active supporters of MAPP from Minnkota; E. E. Wolter and David Kopecky are enthusiastic participants from Rural Co-operative Power Association, and John Madgett and Frank Linder, representing Dairyland, are well-known names in MAPP.

The following conclusions are in order about this agricultural market and its exploiters in the eastern sector of MAPP-land.

1) The agricultural market here was intrarmanship in terms of REA development.

2) The cooperatives lost no time in developing generation capability, which meant: (a) forward looking and courageous board members, and (b) the early development of engineering staffs and sound middle-management.
3) The early adoption of the utility concept of reliable service to the customers characterized this development.

If the accounts of the cooperatives just cited have given the impression that their progress was smoothly and steadily upward, let us hasten to correct this impression by noting a few highlights of their history.

There was, apparently, a period of about ten years following the establishment of the Rural Electrification Cooperatives in this area in which the private utilities and the new power cooperatives had some serious, but not (for enlightened interests) insurmountable problems. One of these problems is especially important to this study, because it involved the survival of rural electrification. It concerned the wholesale supply price of energy.

The great fear of some cooperative enthusiasts was that the private companies would try to drive them out of business with high wholesale rates. Private groups, on the other hand, feared that the rural cooperatives would be federalized in the course of time. Further, from the private viewpoint, there were real problems in supplying energy where customers were fewer than three to a mile of line in many rural areas. Floyd E. Wheeler, Dairyland's lawyer, and one of its founders, described the outcome of this situation:

Many projects in these three states (Iowa, Minnesota, and Wisconsin) were held up because of the apparent impossibility of working out with the private utilities the field satisfactory wholesale rates. In west central Wisconsin, after a year or more of delay, the organized farmers finally met this problem with their government by building their own generation and transmission systems.

When the private utilities became convinced that the rural cooperatives were really going ahead with sizable generator installations, they began to lower their wholesale prices to levels attractive to the cooperatives. For example, Wheeler recalls that on July 29, 1939, as Tri-State Co-operative board members were preparing to pass on bids and contracts for several thousands of dollars worth of generating equipment, two private companies offered the cooperative a 1½ cent per kw hour, plus a demand charge on the highest demand of the year. This rate was simple with few contract qualifications. In Wheeler's view: "The rate offered in the proposal was not unattractive. Had it been offered a year or even a few months before, it is extremely doubtful if today there would be any Tri-State Power Co-operative power plant."

The offer, however, came too late, for the board had already met to pass on bids and award contracts for substantial amounts of generating equipment. Further, there was considerable sentiment among several board members that such an offer should have to await this development in the generation planning of the cooperative. So the die was cast, and additional cooperative generation came into being.

In the face of beginnings like these, what happened to bring the private companies and the cooperative into joint operation and planning seven or eight years later?

As the power cooperatives began to prosper, and as they enlarged their staffs, they attracted college trained electrical engineers who were carefully schooled in the economies of interconnected systems. Further, the total expanding demand for power in the Wisconsin-Minnesota area forced all power interests to utilize their facilities as efficiently as possible. Cooperatives and private utilities, alike, found a common cause in the promotion of interconnected systems.

On August 20, 1947, John F. Madgett, an electrical engineer and an excellent administrator with great respect for the economies of interconnected systems, took over as General Manager of Dairyland. On November 25, 1947, the first interconnection with a private company was made, this with Northern States Power Company, which needed extra power. At the same time, Northern States also entered a power exchange contract with Minnosta Power Co-operative. It was about 1955 that the Rural Co-operative Power Association interconnected with Northern States Power. In the meantime, Dairyland had also interconnected with the Interstate Power Company.

Thus, by 1955 the power cooperatives had achieved a con-
A considerable degree of utility maturity and a spirit of independence. Chief among the reasons for these attainments are:

1) The development of successful power cooperatives by forward-looking boards and capable staffs of engineers, lawyers, and administrators.

2) A growing sense of pride in these achievements, and with it, a growing sense of individuality and self-reliance.

3) A significant generating capability, even by private utility standards.

4) A growing realization, in this scale of power operations, of the need and benefits of interconnections, and beyond, of coordination between interests.

With respect to the growing sense of independence in Dairyland, R. W. Rahn described Dairyland's position in the dispute between the private power interests and the federal power interests as that of being "squarely in the middle." They did not want to see a great expansion of government in power at the expense of private power. They preferred a countering of forces in the power industry.7

Cooperative leaders at Elk River reflected the same neutrality of spirit in the private-public power dispute, as an interview with David Koppocky of the Rural Cooperative Power Association made clear. Power people were convinced that there were significant pooling advantages in private-public power interests which were more important than the ownership dispute. In the early 1950's, the Association had interconnected with most of the municipals in the area. As noted above, it interconnected with Northern States Power in the 1950's. Thus, this cooperative was given a foretaste of the economic benefits available from pool operations.8

In a telephone conversation with Kenneth Vig, the first Coordinator of MAPP, he stressed to the author the important impact of generating activity upon the managements of eastern-sector cooperatives in connection with their early development of the utility concept of reliability of service and with their involvement in interconnections. These background factors resembled those of the private companies in the area. Vig also assured the writer that his cooperative, Minnokota Power, installed generating capacity at an early stage in its history, and that the

fine engineering and technical staffs which this development occasioned were important factors in Minnokota's good record in a market averaging 1.5 to 2 customers per mile of transmission line. He also noted the importance of interconnections in this success.9

However, important developments and considerable education were required before coordinated pool relationships could be established between the various interested groups involved.

Perhaps it was the Flood Control Act of 1944, however, which triggered events that acted as the strongest catalyst in the whole process leading to MAPP. When it was announced that the Missouri River hydro power projects might have a total capacity of 2 million kilowatts, this seemed fantastic, even to power people. In the immediate postwar period. There would probably be surpluses of energy which would have to be moved out by extensive transmission systems to the load centers to the east. Some people envisaged the creation of a system resembling the Tennessee Valley Authority in the Missouri basin.

Things came to a head in 1950, when a Minnesota rural cooperative appeared before Senate and House committees in Washington, D.C., in support of a loan to build extensive transmission lines from the hydros into Minnesota. The private power companies also appeared before these committees in opposition, arguing that these lines would mean unnecessary duplication of transmission in the area. According to Carl T. Bremicker, a vice-president of Northern States Power, Senator Hubert Humphrey of Minnesota told both groups to go home and resolve their differences.10

Numerous meetings were held between the private company representatives and the rural cooperative people in efforts to resolve these differences. The outcome was the Minnesota Plan. Under this plan, the "co-operatives and private companies jointly agreed to support the building of certain high voltage lines by the federal government to bring hydro power to a number of load centers in Minnesota. It was further agreed that the several companies would wheel this power from these load centers to cooperative substations within the state. Still further, the private
companies jointly appeared with the cooperatives before Senate and House appropriations committees annually through 1957 in support of Bureau of Reclamation requests to build transmission lines to Minnesota. The wheeling agreements were signed in 1955 and have been in effect ever since.\textsuperscript{11}

Two other important developments took place in the first half of the decade. First, in 1951, the Northern States Power Company entered its first power exchange contract with an REA cooperative in the western sector of the area, Minnokota Power Co-operative. This contract was followed by numerous other agreements with generation and transmission cooperatives.\textsuperscript{12} Second, a joint engineering committee of twelve utilities retained the services of Ellerbe Company and Stone & Webster Service Corporation to study the power supply problems of the entire Eastern Missouri Basin. These service companies issued their report in June, 1956, recommending that an area-wide power pool be formed so that existing facilities could be fully utilized before new investments and installations were made.\textsuperscript{13} While these recommendations were not adopted at this time, they were factors prompting the establishment of the Eastern Missouri Basin Power Conference.

Finally, climaxing cooperative developments, in 1956 the Co-operative Power Association (CPA) was formed to negotiate collectively all power contracts of the member cooperatives. At this time the private utilities signed a wheeling agreement with CPA on terms similar to those agreed upon with the Bureau in the wake of the Minnesota Plan.\textsuperscript{14}

A. W. Benkusky provides the following background of the Co-operative Power Association:

The distribution cooperatives in southern and western Minnesota, with the exception of two, reached agreements with existing power suppliers in the area for supply of their power requirements. Over the years a close working relationship developed between the cooperatives and the utilities. In the early days there was no formal organization of these cooperatives although they did negotiate as a group. When Bureau power became available, Co-operative Power Association was formally organized. Agreements were signed with the utilities for wheeling the Bureau power and the utilities agreed to release loads they were supplying as the Bureau power became available.\textsuperscript{15}

Thus, the first half of the decade of the 1950's provided considerable opportunity for the private utilities and the cooperatives of the area to work together on major political problems as well as on problems of interconnected energy flows. All of this supplied an invaluable orientation on pool operations and area planning for all concerned. This whole educational process, however, was structured in a more formal way in the last half of the decade with the calling of the Eastern Missouri Basin Power Conference.

\textbf{Eastern Missouri Basin Power Conference}

The Eastern Missouri Basin Power Conference was called by Northern States officials, but the Conference, in a wider sense, was compelled by the events just reviewed and the joint engineering study of the twelve utilities. This study strongly recommended area-wide planning by the various power interests involved. There were still a number of smaller power interests in the area, especially at its margins, which had little or no experience with energy-flow and generation coordination. Indeed, among the cooperatives in the northwestern sector of the area, very few had power generating experience. These groups were dependent upon the hydro's and the Bureau of Reclamation for their energy.

Those responsible for convening the Conference wisely elected to invite all the power interests of the area to these meetings—private utilities, cooperatives, municipal systems, Bureau of Reclamation, Rural Electrification Administration, Army Corps of Engineers, and Federal Power Commission representatives. The primary purposes of this Conference were two: (1) to carry on an intensive program of self-education concerning the advantages and disadvantages of pool operations, and (2) to explore different types of pool systems with the hope that one of them might be adopted should the Conference find that the advantages of pools overbalanced the disadvantages.

The urgent need for the Conference was expressed by Allan King, president of Northern States Power Company, when he

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addressed the group at the first meeting held at Sioux Falls, South Dakota, January 8, 1957. He first called attention to the great increase of demands which each power interest represented at the meeting would face in its normal operations in the years ahead. Meanwhile, he observed, the Missouri Basin multi-purpose dams had injected a new element into the area picture. Currently authorized hydro projects would add 1.25 million kilowatts of firm capability to the area. But he cautioned "it is obvious from the studies that have been made, that capacity will all be committed by 1966, and there will be a deficiency locally in some areas by 1965."

King went on to point out that by 1975, according to the studies, the new capacity needed in the area would be equal to, or greater than, the present capacity of the dams. The Conference should be concerned with questions about who should build these capacities and under what circumstances. He told the group that those who had had experience with both thermal and hydro generator units in their systems already knew of the economies that were possible in the proper coordination of these units in making use of the peaking capacity of the hydro plants. This posed the problem of properly integrating the river hydros into the power scene of the future.

Finally, King addressed himself to the question of how the integration of an area could be established. He pointed out the need for a careful engineering review of the situation, and noted three studies available for this purpose: a study by the Army Corps of Engineers, engineering studies by the Federal Power Commission, and the private company joint-engineering study.

Concerning the latter joint study, King explained that the companies recognized the autonomy of the individual units operating in the area. Therefore, they instructed their joint engineering committee to find out if "it [is] impractical to conceive of a unified approach under contractual arrangements of mutual benefits to the various parties? That was the charge given this Committee."

Those engaged in the joint study had reported previously in 1956 that the integration of individual companies "was the only sensible engineering answer" for the area. They recognized that various interest groups would be involved, but they believed the common advantages in integration should prevail over differences of philosophy. The unified approach was not beyond the realm of possibility.

This report stirred up considerable dialogue among the sponsoring companies, who were now calling this conference of the whole area. They pointed out that Northern States Power was merely serving as a medium for bringing these groups together. The remainder of the first day was given to representatives of the different groups to explain their interest in the Conference. Included among these were Governor Aandahl, Assistant Secretary of the Interior; Mr. Hamil, Administrator of the Rural Electrification Administration; General C. E. Galloway, of the Army Corps of Engineers at Omaha; Kenneth G. Tower, Division Engineer for the Federal Power Commission; Dewey J. De Boer, Executive Director of the Nebraska Public Power System; and Hibbert Hill, Chief Engineer of Northern States Power Company. These participants indicated the broad coverage of interest groups, and these groups continued to work together throughout the course of the Conference.

While these speakers conveyed much information on their respective spheres of responsibility, time and space do not permit coverage of it here. Two points, however, should be noted from Hibbert Hill's report on the companies' joint engineering study referred to by Allan King. One conclusion of this committee was that the economies of integration were so overwhelming as to make integrated operations inevitable. The question was "shall it be purposefully planned, or shall it grow by doing what comes naturally and uneconomically?" The report concluded: "Our Committee would expect this integration to be worked out on a step-by-step basis, each step carried out by separate contracts defining the obligations of each participant."

Early in the first session of the EMPC two committees were formed—-a policy committee made up of policy heads of the participating groups and an engineering committee made up of technical representatives.
The membership of the committee was as follows: (1) the Generation and Transmission Co-operatives (two members each, one on each committee), (2) Nebraska Public Power Districts (two members from each district, one on each committee), (3) the private companies (two members from each company, one on each committee), (4) the Army Corps of Engineers, Bureau of Reclamation, and the Rural Electrification Administration (two members from each agency, one on each committee), (5) the municipal power groups (two members from each state, selected by the organizations of municipal utilities from North Dakota, South Dakota, Nebraska, Minnesota, and Iowa, one on each committee). Thus, the different interests were involved in the work of the Conference.

Finally, in the first session, instructions were given to the Engineering Committee. This committee was to collect basic data from all relevant sources, make a preliminary determination of the advantages of integration of existing and planned facilities for the area as a whole, and for individual interests, and explore the possibilities of pool operations.

Obviously, the bulk of the work of the Conference would fall on the Engineering Committee headed by Hilbert Hill. This committee was to bring its recommendations to the Policy Committee, however, for final debate and action.

The Engineering Committee, meeting on March 28-29, 1957, explored the following important issues:

1. Present and future power needs of the area.
2. Present capabilities and loads and future plans for expanded capabilities in the Basin.
3. The adequacy of the transmission systems and proposals for its expansion to adequately accommodate expanding energy generation.
4. Cost comparisons of planned and unplanned approaches to the future growth requirement of the area.
5. Pooling economies:
   a) Reduction in total installed capacity.
   b) Reduction in installed reserve capacity.
   c) Reduction in spinning reserves.

The Engineering Committee reported its findings to the Policy Committee from time to time. As a result, a significant dispersion of pool knowledge spread out over the entire area — to large and small producers, municipals, and remotely located distribution cooperatives in the west and northwest. By 1958 it appeared that the great majority of the interests in the Conference were accepting the pool, at least in principle, and the Engineering Committee was urged to continue its work on a model pool.

The Engineering Committee, encouraged by these reactions to its work, soon recommended that an area pool be established "at the earliest practical date." It recommended that a subcommittee be appointed to work out a detailed plan for pool operations, make estimates of the expenses of a pool office, and explore ways to raise the money to cover these expenses. Further, it recommended that a subcommittee should be formed by the Policy Committee to draw up a model pool agreement to guide prospective participants.

The Policy Committee, in May, 1958, approved the Engineering Committee programs as just outlined. Its subcommittee was to consist of representatives from the Bureau of Reclamation, the Army Corps of Engineers, the rural G. & T. cooperatives, the private utilities, and the three Nebraska public power districts.

This group worked continuously through the summer of 1958, and then intermittently until April of 1959. Three different pool-
ing agreements were carefully considered and presented for review by the whole Engineering Committee. From this review a final draft was drawn up for submission to the Policy Committee on May 8, 1933.

The ensuing Policy Committee meeting was, perhaps, the most important one of the entire Conference. In opening the Conference, Allan King noted that just a year earlier a subcommittee had been formed to draw up a tentative pooling agreement for the consideration of this meeting. He reported that this group had carefully drawn up an agreement to which he had reacted most favorably. However, in conferring with many firms in the area about the pool agreement, he had reluctantly concluded that it appeared many, including most significantly the Bureau of Reclamation, were not yet ready to sign the formal contracts that would have been required. However, this did not mean that the Engineering Committee and subcommittee members' work had been wasted. Rather, the goal of firm integration would have to be deferred for a time, and new intermediate steps would have to be devised.

It was decided that it would be best to start with a number of subarea pools—perhaps five or six—which should be loosely organized and coordinated. The big problem was how to coordinate the different pools. Should this coordination be achieved through the good offices of the Bureau of Reclamation at Watertown, South Dakota? Or should a coordination committee with rotating chairmen, perhaps, be given this responsibility, the chairman acting as coordinator?

E. E. Wolter, Manager of the Rural Co-operative Power Association, suggested that, if subarea pools were set up, the agreements of these groups should cover only: (1) interchange of emergency service; (2) spinning reserve requirement; and (3) installed reserve requirements—a further indication of the hesitancy of these groups to enter into close, detailed agreements. Then Dewey De Boer, Executive Director of the Nebraska Power System, proposed the motion which was adopted. He observed that the Nebraska Public Power Districts were deeply disappointed that the area pool could not be established at that time, however, they recognized that it was futile to attempt this integration if the Bureau of Reclamation could not participate. The motion approved by the Conference provided that:

1) The Policy Committee continue to function as it had in the past;
2) the Engineering Committee continue, also, as in the past;
3) the Engineering Committee be instructed to establish subareas operating committees;
4) the Engineering Committee be instructed to select a coordinator;
5) the Engineering Committee was to carry out the above instructions without reference to the Policy Committee;
6) the Policy Committee would hold its next meeting when requested by the Engineering Committee.

The following September, the Engineering Committee decided upon five subarea pool possibilities. They were as follows: (1) Iowa subarea pool, (2) Minnesota-Wisconsin subarea pool, (3) Nebraska subarea pool, (4) North Dakota subarea pool, and (5) South Dakota subarea pool.

The committee also recommended that a coordinator be selected. C. W. Minard, a Consulting Engineer of Omaha, Nebraska, and associated, before retirement, with the Omaha Public Power District, received the appointment as coordinator.

The progress of the subarea pool program in late 1931, slightly over a year away from the establishment of MAPP, is shown in Minard's summary report, where a section is devoted to each of these subarea pools as follows:

The Minnesota-Wisconsin Pool had actually been formed on February 10, 1931, and was in operation under the name of the Upper Mississippi Valley Power Pool. Characteristics of this pool have been discussed in Chapter III. Suffice it here to repeat that this pool was based on the memorandum of understanding and agreement prepared by the Engineering Committee, and was, by our classification, a "loose pool."

The North Dakota Pool was still in the planning stage. It would probably consist of Central Power Electric Co-operative, Dakotas Electric Co-operative, Minnokota Power Co-operative,
The last significant development preceding MAPP came when fourteen utilities decided, on their own, to offer to firm the hydro power of the Missouri Basin. This, too, was an involved action, and we shall note here only the offer and the consequences of its failure, the latter being an important point in the history of MAPP.

The Hydro-Firming Offer

As stated earlier, the hydro firming question had been considered by the Engineering Committee in the EMBC. On August 1, 1961, C. W. Minard submitted a study on the growing need of the hydros for firming power in meeting supplemental loads by 1967. A "letter of intent" followed respecting the intention of a group of private utilities to study jointly the hydro situation. From this study, the cooperating utilities would draw up a proposal to submit to the U.S. Department of Interior for a "federal hydro and nonfederal thermal system in the area." On January 29, 1962, these private utilities joined by a power cooperative and a Nebraska public power district presented a proposal to the Department of the Interior in Washington, D.C.

This proposal is paraphrased as follows:

1. The proposal is being submitted by fourteen power suppliers in North Dakota, South Dakota, Minnesota, Iowa, Nebraska, and Wisconsin.
2. The proposal would make it feasible for the government to increase the amount of firm power sold in the Missouri Basin to preference customers by 50 percent—with no additional cost to the government.
3. The local power suppliers making the offer presently own about 90 percent of the generation of major suppliers in the area.
4. The hydro plants which the suppliers are willing to firm are: Fort Peck, Garrison, Oahe, Big Bend, Fort Randall, Cavin Point, Canyon Ferry, and Yellow Tail.
5. From Corps of Engineers and Bureau of Reclamation figures, the suppliers estimate the capability of the hydro system at the eight plants assigned to preference customers to be 1,800,000 kilowatts.
6. In the winter months there will be insufficient water to produce all the energy required to serve the hydro firm load. In adverse water years there will also be an energy deficit in the summer. This problem is com-
pliated by the fact that the hydro production is low in the winter when load demands are high, and production is high in the summer when the load demand is lower.

7) In average water years, the hydro's combined peak load will be only 1,200,000 kilowatts. In advance water years the peak load would be 900,000 kilowatts. In better than normal water years more energy will be produced than is needed to meet the 1,850,000 kilowatt preference load in the summer, but this amount of energy will not be available in the winter months when demand is peak.

8) Thus, the thermal suppliers are willing to agree to firm up the 1,850,000 kilowatt load as required under average water conditions or adverse conditions.

9) The suppliers further indicate their willingness to work out an exchange arrangement in which hydro excesses of energy in the summer could be exchanged for firm energy in the winter months.

10) Likewise, the suppliers would be willing to work out a "banking" type of exchange by which the hydro could put surplus energy produced in better than average water years into a bank to help cover deficiency energy supplied by the thermals during years of low water.

11) The transmission system in the area is adequate for the transfer of energy required in this firming program.

12) The exchange of energy would have to be on the basis of 100 kilowatt hours of hydro dump energy for each 85 kilowatt hours of firm energy.

13) The local suppliers would permit the hydros to bank 4,000,000,000 kilowatt hours—ample to carry the government projects through an extended low water period. Judging from a study of water conditions on the river over a sixty-year period, only in the 1900's was there a low water period long enough to more than exhaust this proposed reserve of energy.

14) In the case of a repetition of such extreme conditions, the thermals would agree to sell the energy required to meet these conditions at cost.

15) The local suppliers are willing to provide a coordination office to handle energy scheduling and accounting of the energy transactions involved.

16) This proposal for firming would be for a twenty-year period with provisions for reopening and extending it.

This proposal is a classic example of the possibilities for hydrothermal integration, as noted in Chapter III. Further, it was a demonstration of the need for area-wide planning.

During the same period, the Basin Electric Cooperative Association proposed a counter plan for firming the hydros. Basin Electric was an association of distribution cooperatives located mainly in the Dakotas. It had applied to the REA for a loan to construct a 200,000 kilowatt thermal plant on the lignite fields. It would use this plant as a starter in its firming activities.

The two proposals were turned over to an interdepartment study committee of the Department of the Interior. This committee recommended that the Department accept the Basin Electric plan. This recommendation was accepted. The principal reason for the decision, according to Stewart Udall (in a letter to Allan King), was that the Department did not believe that the Bureau of Reclamation should be committed to exchange all of its surplus in the Eastern Missouri Basin with a particular utility group. There was an additional economic argument to the effect that the Basin Electric plan promised more revenue to the Bureau to help liquidate the Bureau of Reclamation's construction debt.

It is not my purpose to discuss the merit or lack of merit of the Department of Interior's decision, since this study does not extend to the Bureau or its preferred co-operatives of Basin Electric. On the other hand, this firming offer by the forerunners of MAPP must be reported in order to complete the history of that organization.

Fourteen important power suppliers of the area had been brought into close collaboration on an area project which was important to them. They lost, it is true, in this particular proposal. But their mutual interdependence was, if anything, more strongly impressed upon them by this loss. There were other plans to be looked into. High voltage transmission developments, large generator units and complexes, another potential hydrothermal integration possibility in the direction of the Nelson River in Canada, and indeed, still the question of working out some type of accommodation with the Missouri Basin hydros. The Secretary of the Department of the Interior, following the decision noted above, extended an invitation to find this accommodation. Neither the area people nor the Bureau interests were isolated systems.
So there was urgent area work to be done. These fourteen utilities were all represented at the organizational meeting of MAPP in January of 1960. A start had to be made somewhere. There were great economic possibilities in joint planning for these utilities alone, but, if the opportunity were left open for others to join, gradually the whole area might eventually be organized. For the time being, planning activities alone offered great savings. With the growth of EHV lines and interconnecting groups, the need for greater operation coordination would undoubtedly come in due time. In this event an area planning group could make a prompt and orderly adjustment to include operations as well as planning. In this way, the EMBPC concept of an area-wide pool might finally become a reality.

The next chapter is concerned with this new organization, MAPP. In reality MAPP is a logical extension of forces set in motion in the late forties and early fifties with the beginning of simple bilateral interconnections between cooperatives and investor-owned utilities.

V

Establishment of MAPP:
Basic Policies and Objectives

MAPP, in the first chapter, was described as a new and unique approach to forward power planning. To comprehend this description adequately, it is necessary to consider the policies and objectives of MAPP. While these policies and objectives were not concretely formulated in word and phrase before well into the first year (1963) of MAPP's existence, they were certainly in the minds of those directing the affairs of the charter member utilities. They involve the conditions which were noted at the beginning of the last chapter as essential for any successful new arrangement of power integration in this particular part of the United States. Specifically MAPP's policies and objectives are:

1) To support the principle of local control and operation of electric power facilities.
2) To promote integrated regional planning among MAPP members toward the establishment of a regional power pool. [In our terminology regions here would be called areas.]
3) To recognize the right and obligation of each MAPP member, regardless of size or type of corporate organization, to own or otherwise provide for facilities required to supply the present and long-range electric power requirements of its consumers.
4) To recognize the rights of existing municipal generating systems to share in the benefits of integrated regional planning.
5) To provide an organization for coordinating the activities of MAPP members in planning, constructing, and operating an integrated electric power system utilizing the latest technological developments in high-voltage transmission, generation facilities, and fuel sources.

6) To provide an organization for developing coordination with adjacent electric power suppliers, including the federal agencies, while reserving to each MAPP member its local initiative and individual freedom and control.1

These policies and objectives very obviously give expression to the strong sense of independence among the Northern Plains power utilities, but, at the same time, they reflect the strongly felt need of these same interests for an integrated relationship not infringing unduly on the independence reflected so sharply in the Eastern Missouri Basin Power Conference. The second objective still holds forth the hope of an area-wide pool, which so many in the EMBPC had wanted. The fourth objective reflects the same universality of utility interests sought in the EMBPC, and the sixth objective continues the hope that a suitable and constructive relationship can be established with the federal power interest.

The Beginnings

On January 10, 1963, an organizational meeting was called and a temporary management committee was established. Represented on this committee were twenty utilities of the area, including the fourteen which had petitioned to form the hydro. Most of the remaining six were power cooperatives. Earl Ewald, of Northern States Power, was elected chairman of this temporary committee. It was decided to invite representatives of twenty-four utilities in the area to meet on February 8 for the purpose of establishing a permanent planning organization. This meeting, however, had a pressing planning problem to consider. The Federal Power Commission was seeking information on the EHV plans which engineers in connection with the EMBPC had been exploring. Angland’s plan, in this regard, was discussed at this meeting, and it was agreed that Ewald should submit it to the Federal Power Commission with the understanding that, while the temporary committee viewed the plan favorably, it had not stamped the plan with its approval.2

This was not the last time the Federal Power Commission was to provide MAPP with grist for its planning mill in these first important years of organization.

Twenty-one of the twenty-four utilities’ representatives attended a meeting on February 8, 1963, and signed the Memorandum of Understanding.3 Three permanent committees were established at this meeting: the Management Committee, the Executive Committee, and the Planning Committee.4 Earl Ewald was elected chairman of the Management Committee and of the Executive Committee. John P. Madgett, General Manager of Dalrymple, was elected vice-chairman of the Management Committee, and E. C. Spethman of the Northern States Power Company was elected secretary-treasurer. The Executive Committee, as first formed, was to consist of three Management Committee officers plus two other members elected by the Management Committee. The number of members on the committee was later changed to seven.

The finances of the organization were based on the administration fund. This fund was to be raised by $100 assessments on each member organization, with reassessments of equal amount when the fund approached exhaustion. The expenditure categories which the fund would cover included provision for postage, printing, management meeting expenses, and miscellaneous expenditures. The other costs of management were to be borne by the member companies.

Similar expenses of the Planning Committee were also to be met from the administration fund. The cost of special projects was to be apportioned to the different members according to each party’s ‘rationation number’ as it related to the sum of the rationing numbers of all the parties. The rationing number was to be determined as follows: (a) one hundred percent of the first 100,000 kw of annual peak load of the party for the preceding calendar year, (b) seventy percent of the next 400,000 kw of annual peak load as just defined, and (c) fifty percent of the remaining peak load for the preceding year.

Substantive discussion at the first formal meeting was largely...
taken up with the request of the Federal Power Commission for EHV-line information and justifications, as discussed at the preceeding meeting. It was decided to submit the plans for the Twin Cities-St. Louis lines with justifications. As for the other projected lines, it was decided to give the Commission the England study discussed at the January meeting.\(^5\)

Reviewing the details of the financial arrangements set up at the first formal meeting is perhaps unnecessary, but these details seem to reflect the same simple structuring of MAPF as the committee arrangements reveal. As long as MAPF remains strictly a planning organization, this simple organizational structure will suffice. If the Coordination Center now in existence should move closer to operational controls over energy flows, with expensive computers, both the organizational and financial structures will become more complex.

Space does not permit a detailed report on the remaining minutes of the MAPF committee. However, the following short synopses of the first four years of MAPF history convey something of its dynamism and sense of direction. Chapter VI presents a wider treatment of these main issues.

**YEAR SYNOPSIS, 1963-1967**

1963. The first year of MAPF and the surface, appeared to be just what one would expect of a new organization. The minutes were filled with routine action structuring the organization and with appropriate public announcements of its unique attributes, in addition, substantial work was accomplished. Broad programs for generation and transmission had been largely completed, and had been conveyed to the Division Committee of the Federal Power Survey. These programs also provided substance for the selling job MAPF had to do in Washington and in the area. The Planning Committee was functioning too, but most of its activity was in connection with the troublesome Bureau-Missouri Basin System relationships. At least the dialogue with these interests continued. Beneath the surface, however, much productive work was going on which would become apparent early in 1964, as the focus shifted toward meaningful economic planning and away from the political controversies which plagued any new organization of this type at its beginnings.

1964. The year 1964 witnessed the successful progress of MAPF planning activities. At least three major transmission systems were well on the way through the planning process, with some construction underway. The preliminary Manitoba hydro studies were completed, and the decks were now cleared for more specific planning. The municipal participation program was successfully launched, load and capacity studies were up-dated, and significant study progress had been made on a coordinated system of communications for the MAPF organization. The Bureau's basin dialogue was apparently becoming more constructive as policy people were now turning their discussion over to the planning engineers. An effective program of public relations via the Coordinator, the chairman of the Legislative Committee, and the Public Relations Committee was being waged in area and national spheres. Negative criticism of MAPF seemed to be definitely on the decline, and MAPF achievements began receiving press attention—"a year of substantial progress within this young organization."

1965. The year 1965 was a year of solid progress. Planning activity was stretching the manpower of the Planning Committee to the limit when dealings with the Bureau concerning energy offers and an unequipped blackout in the northeast accelerated their activities greatly in connection with load, capacity, transmission capability, and reliability studies which now became imperative.

All committees were active, too, as reflected in the lengthy Management Committee agenda and numerous exhibit attachments to the meeting minutes. Even relationships with the Basin people, though faltering for a month or so in the early fall, moved significantly toward mature short- and long-range joint studies by the end of the year.

A dimension of area planning, not stressed significantly before this year, was that of promoting area reliability. The Planning Committee had started on this problem well ahead of the major northeast outage; this dramatic outage gave their plans new significance throughout the area and contributed substantially to expediting their activities. This became even more apparent in 1966.

EHV lines to Chicago and St. Louis were under construction, and planning and arrangements for the line to Omaha and Kansas City were nearing completion. The 330 kv network in North Dakota was formed to serve not only the United Power Association plant, but also the recently announced Minnkota plant, both of these plants to be on the lignite fields.

Planning at the Manitoba hydro indicated the Kettle Rapids site would be the first to be developed. MAPF members were studying the feasibility of constructing EHV lines between Winnipeg and Minneapolis to utilize this vast hydro potential.

1966. In this year the great emphasis was on reliability. The General Electric study of coordination possibilities for MAP yielded promising expectations regarding fuel savings and other savings. The Coordination Center was authorized, and a three-phase study for the Center was outlined.
Contacts were being signed between members and the Bureau for Bureau energy, and crash programs for an additional 230 kv line between the Bureau and the Northern States Power Company and for upgrading other inter-connecting lines with the Bureau were being carried out. A new interest in possible Bureau membership in the MAPP Coordination Center appeared.

The Omaha-Kansas City EHV line was approaching actual construction. New plans were being developed for the Des Moines-Southeast, Nebraska EHV line and were being worked out in liaison with the Omaha-Kansas City planning group—also to accommodate a new 800 mw nuclear power plant that Consumer Public Power District plans in southwestern Nebraska. This plant will serve the Nebraska market, and the Iowa Power and Light Company market in Iowa. Work on the 230 kv lines in the Dakotas continued.

Basin-MAPP joint engineering studies continued, and MAPP long-range studies were extended to the year 2000.

The above outline of activities is intended to show the nature of area planning and the direction in which this particular planning group is moving. These synopses form a rough outline for putting into proper perspective the issues to be discussed in the next chapter.

VI

Issues and Achievements

MAPP has faced many important challenges and issues and has done well in attempts at solving them. A close perusal of the MAPP Management Committee minutes, including written summaries of them, reveals at least eight major issues which should be identified and discussed: (1) establishment of MAPP identity and authenticity, (2) municipal-system integration, (3) Manitoba-hydro project, (4) transmission system development, (5) generation development, (6) Bureau-Basin relationships, (7) area coordination and reliability, and (8) interarea coordination and reliability.

The eight issues listed above comprehend most of the important problem areas with which MAPP has been concerned. They often interrelate, as will become apparent in the text below. Further, starting with the January meeting of the Management Committee in 1964, it was not uncommon to find at least six of these areas on the agenda of a particular meeting. Behind this particular agenda there were the agenda of other committee meetings feeding this plenary session. The urgency of the issues and their frequent discussion indicate the importance of area planning in the modern electrical power industry.

Establishing MAPP's Identity and Authenticity

When MAPP came into being, relationships between MAPP members (cooperative and private) and some of the present
members of the Missouri Basin Systems Group were still strained. At this time the United Power Association, an association of MAPP power cooperatives, had applied for an REA loan to build a 150 mw plant on the lignite fields. The Basin group saw this plant as a dangerous infringement upon their area. They had, therefore, countered with a proposal to build a plant of their own, offering to sell UPA a block of power from it; UPA did not approve of this arrangement (for reasons which will become apparent later). This, of course, tied up the UPA loan in Washington, D.C.1

Further, Senator Lee Metcalf of Montana, a strong supporter of the federal electrification program, saw the MAPP beginning as "a long insidious program . . . of private power companies to take over whatever opportunities and advantages there exist for long-distance transmission. . . ." at the expense of vital public transmission.2 Then Rufus Teraul, in the St. Louis Post Dispatch, had described the new organization as "a hastily pasted together grid . . . that . . . could eventually be used to force many of the 900 municipal systems, 77% of them in Missouri alone, into selling out to the companies.3"

Not only did MAPP face the problem of explaining a unique organization of diversified ownerships and stress upon local utility responsibility, but it was also forced to answer political criticisms and their power interests who had carried the debate into Washington by way of the UPA power plant controversy.

It was decided, therefore, to formally announce MAPP's new organization on August 21, 1963 at a dinner meeting in Washington, D.C. to be given for key government administrators and area congressmen and their assistants. Simultaneously, press releases would be issued to the MAPP area news media.4 It was decided that the Washington presentation should be a factual one, and slides were prepared to explain the organization, its programs, and its policies toward other power groups. It was the general feeling of cooperative members in MAPP that only when Washington Rural Electrification officials and the legislators were aware of the MAPP program and purpose as strong and sound ones, was there any hope of being able to cooperate satisfactorily with the Bureau and Basin interests on an even keel. Therefore, D. W. Angland's program for an area EHV grid, previously presented to the area advisory group to the National Power Survey, was given an important part in this presentation.5 Arrangements for the Washington meeting were made by J. W. Hoffman of Northern States Power Company, who had been named chairman of MAPP's Legislative Committee.

Judging from Hoffman's report on the August 21st announcement of the MAPP organization, responses to the publicity in Washington and from the area press were generally favorable. In Washington, 165 government administrators, congressmen and congressional assistants, plus a good press representation attended the dinner meeting, and the MAPP presentation was well received for the most part.

Hoffman made it a point to see Senator Metcalf the following day, as he had not attended the presentation. The Senator restated his concern that MAPP might undermine federal Missouri Basin power investments, but he did say that he agreed with the statement of MAPP policies and objectives.6 Two MAPP committees were formed as a result of these efforts to announce the MAPP organization: the Legislative Committee, mentioned above, and the Public Relations Committee. Dan Kelly of the Omaha Public Power District was made chairman of the latter committee. The Legislative Committee periodically informed area congressmen of MAPP achievements and general progress. In this connection, the committee worked in close cooperation with the Public Relations Committee. For example, in 1965 the committee used a brochure published by the Public Relations Committee, entitled MAPP Achievements, to keep congressmen informed of MAPP developments. The meetings with area congressmen in Washington were to be sponsored by local utilities. (The Legislative Committee has now become inactive, and a number of its functions have been taken over by the Public Relations Committee.)

The Public Relations Committee has relied chiefly on factual brochures to inform the public of MAPP activities. A major effort of this committee was the production of a motion picture en-
titled, "More Power for MAPP Land," which was first viewed by the Management Committee at the September 12, 1960 meeting. Meanwhile, a very ambitious advertising program was carried on in the Wall Street Journal and other national magazines. Kenneth Vig, the first Coordinator of MAPP, reported receiving a considerable number of inquiries concerning both power in the MAPP area and industrial opportunities in this area. These, he believed, came as a direct result of the national program of advertising.7

MAPP public relations have been factual, effectively executed, and in good taste. The prevailing psychology has been that of letting the facts of MAPP achievements speak for themselves. Gradually the public and its representatives in Congress have obtained an accurate view of the organization, and uninformed criticism has receded well into the background.

MUNICIPAL-SYSTEM INTEGRATION

As of September, 1967, MAPP claimed twenty-nine municipal systems scattered over the area. Virginia, Hibbing, Minnesota, and Lincoln, Nebraska were the latest to join. The machinery making it possible for the municipal organizations to join MAPP dates back to the early 1963 meetings of the organization, and also to a meeting with the Federal Power Commission. At the May 17, 1963 meeting of the Management Committee, a report was given on the activities of the Federal Power Commission Advisory Committee which was participating in the preparation of the National Power Survey. According to this report, Chairman Swidler of the Commission expressed concern for the small utilities and municipal systems in this day of spreading power pools. In the view of the Commission, pool economics are adaptable to these smaller units, and the existing pools should find ways of sharing these advantages with them. Earl Ewald of the Management Committee, after hearing this report, challenged the members of MAPP to find a satisfactory way of enabling the smaller utilities to participate in MAPP.8

This challenge was not the easiest one to accept. While there were real economies for municipal organizations in pool associations, these were not widely known or appreciated among many local municipal policy makers, not to mention the electorate. Municipal supporters were strongly independent and feared losing this independence in pool relationships. Pools and area planners were also aware of the fact that the coordination advantages of pool systems, in terms of developing computer and coordination centers, would be limited and could be extended in the direction of municipalities only at great expense and with serious technical complexities.9 Further, some MAPP members were concerned that while the municipalities would be on the receiving end of advantages made possible by the larger group, they would not be able to contribute too greatly to the economies of other members; especially was this true in an agricultural area where most municipal systems are very small.

In spite of these difficulties, the MAPP planners went to work on the problem at once. At the next Management Committee meeting, June 12, 1963, a Preliminary Statement Relating to MAPP-Area Municipal Systems was presented.

The statement frankly admitted that the participation of municipal systems and smaller suppliers in the MAPP area was definitely limited. However, "the members of MAPP ... encourage the municipal systems to participate to the maximum extent possible in the integrated area planning." MAPP encouraged the municipal systems to interconnect with members who would:

1) Make power available at wholesale to provide security and to make it possible for the municipalities to meet growth increments without having to build small incremental units. Rather, they can buy power to meet these demands until such time as it becomes feasible to install larger, more economic generators.

2) Provide a market for municipal excess energy.

3) Share reserves and hence substantially reduce installed reserve which, in isolation, would have to be equivalent to the municipal's largest unit.

4) Provide energy for scheduled outage of production facilities.

5) Reduce costs of providing spinning reserve. "Operating interconnected, the spinning reserve of the pooled system will be available."
6) Provide economy energy for the municipal systems from some of the most efficient generating capacity available.

Finally, the statement stressed the point that MAPP wanted to make available to municipal units:

the benefits of the latest technology in the electric power field to a degree it would be impossible for them to obtain operating in isolation. Yet, MAPP intends that the municipalities shall remain free to build and maintain their plants by local initiative to meet their responsibilities to their consumers.10

With this start, the planners then returned to the task of preparing a memorandum of understanding between MAPP and potential municipal system members. Finally, on September 11, 1964, a special meeting of the Management Committee was called at Breezy Point Resort, Minnesota. Municipal power representatives were invited as guests. The main topic on the agenda was action on the Memorandum of Understanding (for the municipal power suppliers). The Memorandum, after the usual statements concerning the location of the municipalities within the area, recognized the economics of pool relationships, concern for lowest costs possible to customers, and desires to participate in EHV and other studies, lists these agreements:

1) That the primary purpose of association with MAPP is to develop integrated area planning among the parties and adjacent federal agencies.

2) That membership is open to all local suppliers owning generation and distribution facilities and who are interconnected, or can be interconnected, with a member of MAPP.

3) The membership in MAPP can be terminated at any time by informing the other parties of this decision.

4) That coordination activities, it is understood, are to be directed by the MAPP Management Committee, in which each party shall have representation.

5) The Management Committee, among other things, (1) appoints a Planning Committee of qualified engineers representative of the group, and (2) develops more detailed agreement to guide the operations of the organization.11

Issues and Achievements

Guests and committee members were given copies of the Memorandum and an opportunity to raise questions and discuss it. No changes were suggested for the document, and the Memorandum was adopted. Thus, MAPP policy toward the municipalities was finally formulated, in major outline, at least.

John P. Face of the Cedar Falls, Iowa, Municipal System explained why Cedar Falls had joined MAPP. This municipality had interconnected with Iowa Public Service in 1957, giving Cedar Falls a capacity that would not be exceeded until 1967. Before 1967, the engineers and people of Cedar Falls would have ample time to decide whether to build a larger plant or continue to purchase energy from other MAPP members. He noted these advantages of municipal membership in MAPP:

1) The privilege of participating in area-wide planning which will add benefits directly or indirectly to the municipal operation.

2) The opportunity to defer additional generating capacity until a larger, more efficient plant can be installed.

3) The advantage of reduced generation reserve capacity, thus reducing the power capitalization of the town.

4) The reduction of spinning reserve with associated operation economies.

5) The ability to supply customers more reliably and economically.12

One point made clear at this meeting was that the area could only include those municipal systems which produced power themselves. It was also pointed out that the municipal system would be represented in the Management Committee by one representative selected for its state by the member municipalities; otherwise, the committee would become unwieldy and the municipalities would have representation far out of proportion to their power contribution as a group to the area. Chairman Ewald had observed earlier that studies indicated that by 1990 the Basin sector would have approximately 3 million kilowatts of capacity, the municipalities approximately 2 million kilowatts, and MAPP members approximately 23 million kilowatts of capacity.13

A few of the MAPP members were afraid the municipal invitation had been made so attractive that municipal systems on
the private utility lines might be encouraged to shift over to municipal power operations as members of MAPP in their own right. The great majority of the Management Committee, however, felt a liberal policy was needed in view of the Federal Power Commission position on municipals in power integrations. Further, it was argued that if MAPP did not make its offer attractive, competing areas and pools would make offers similar to this one to lure area municipals away.34

Generally, the policy has worked reasonably well, as the number of municipal members cited at the outset would indicate. The main complaint MAPP officials have is that they have found it hard to get the municipal systems to plan their use of generating units with the area to take full advantage of economy power. Further, favorable investment terms available to most municipal systems often encourage these systems to build small, inefficient plants to meet incremental demand increases, rather than to defer plant construction until larger and more efficient plants can be constructed at lower per kilowatt cost. Thus, they deprive themselves of the significant economy available to them in integrated relationships, and area power efficiency is not optimized.35

THE MANITOBA HYDRO PROJECT

Manitoba hydro power representatives showed an early interest in MAPP. They, too, had had experience with pool economics resulting from their own interconnections. There is great hydro potential in Manitoba with the opportunity for exploitation with large, efficient production units — provided adequate markets are available; hence Manitoba hydro was keenly interested in the new area forming across its border in the United States.

W. D. Fallis, General Manager of Manitoba Hydro, was present, at the October, 1933 meeting of the Management Committee to indicate that his group was interested in MAPP participation. In his first formal appearance before the committee in January of 1964, Fallis traced the history of changing Canadian policy regarding power exports and international pool arrangements as follows.

The first Canadian power policy was developed at the time the first Canadian corporation exploited the Niagara power potential. Much of this power had to find a market in the United States. Initial Canadian policy in connection with this exporting of power was to grant licenses of fifty years to these power interests, all providing for export of power to the United States. It was provided, however, that if Canada needed this power, not less than half of it had to be marketed in Canada. There was no provision for "repartition" to Canada of exported power. Prices were inflexibly fixed on this power. Thus Canadian companies virtually became public utilities of the United States insofar as service responsibilities were concerned.

As the Canadian power market began to expand, Canadian popular opinion came to oppose this liberal policy encouraging power exports. In reaction, then, new policy was formulated which imposed annual licenses for the privilege of exporting power, and enforcement policy was developed to discourage as much as possible the exporting of power. Meanwhile, the power companies themselves were also concerned about the inflexible prices imposed upon their energy.

Subsequently, the National Energy Board was established and a more adequate power policy has emerged. Export licenses may now be issued for periods not exceeding twenty-five years. The Board has the responsibility of insuring that power exports do not exceed Canadian power surpluses. Prices are to be set which are "just and reasonable in relation to the public interest." Moreover, in September of 1962, the Board issued licensing and regulations which the government recognized the need of longer term for export licenses to encourage power installations in Canada along the most efficient lines. Further, these exports should help bolster the Canadian exports generally.36 Thus the way is cleared for Canadian power interests to enter pooling arrangements with U.S. interests.

T. E. Story, Assistant Manager and Chief Engineer of the Manitoba hydro, presented the general outline of the hydro operations and interconnections. He went on to stress recent substantial increases in power demands which they were experiencing. These increases made it necessary to plan in terms of opening up the
great hydro potential of the Nelson River, with the further possibility of diverting the regulated flow of the Churchill River into the Nelson River. To open up this potential with anything but the most efficient large-scale equipment would be economically unwise. This hydro power could offer the MAPP power interests a "healthy" winter diversity factor, which should be of interest in view of growing summer peaks in much of MAPP-land.17

The case for the Manitoba hydro project with the MAPP system was a strong one, and at the April Management Committee meeting, steps were taken to employ the engineering firm of Sanderson and Porter to make a preliminary study of the immediate and long-range power requirements of the Manitoba hydro project and the MAPP utilities of the northern sector most interested in this project. The engineering firm was to outline an economic power development for the sector. An ad hoc committee of MAPP was set up to coordinate MAPP planning with the engineering firm. It consisted of representatives from the Manitoba hydro project, Minnesota Power and Light, Minkota, Northern States Power, and the Otter Tail Power Company. The study was to be completed before July 15, 1964.18

The Management Committee scheduled its July meeting at Winnipeg. The Sanderson and Porter firm reported the following recommendations:

1) The installation, by 1980, of 3,176,000 kilowatts of generation in Minnesota — coal and nuclear.
2) The installation, by 1980, of 2,980,000 kilowatts of hydro power in Manitoba.
3) The installation of 400,000 kilowatts of Ignite-fired generation in North Dakota.
4) The construction of three 345 kilovolt lines from Winnipeg to the Twin Cities.
5) The construction of a 230 kilovolt line from Winnipeg to Fargo.
6) The construction of a 230 kilovolt line from Fargo to Duluth.
7) The construction of a 230 kilovolt line from Stanton to Devil's Lake, North Dakota.
8) Further, it was recommended that a study be made of stability and voltage controls on the EHV lines between the Nelson River and Winnipeg.19

Using this report as a base, MAPP and the Manitoba hydro project engineers began planning the detailed generation and transmission needs for the project. Periodic reports show up from time to time in the Management Committee minutes. The most important developments reported to date are two in number. In November of 1965, E. M. Scott reported that their studies should be completed by 1966. Thus far, it appeared that 350 megawatts of capacity could be installed on the upper Nelson River. Five million kilowatts could be installed on the lower Nelson River, and an additional 600 megawatts could be established on the Churchill River diversion. The Kettle Rapids site would be the first area developed with 500 megawatts contemplated for the initial development. The Manitoba hydro project would need 100 megawatts of power from MAPP members in 1969, and this annual requirement would increase to 250 megawatts before the Nelson River project was completed.20

The second major development was communicated by telephone to the Planning Committee on August 2, 1966. In this conversation, Scott reported that continued studies had revealed that five, rather than four, 100 megawatt generators could be installed at the Kettle site by 1971 if the need for the extra generator could be made known by the summer of 1967. Five additional 100 megawatt generators could be installed on this site by 1973. Manitoba's requirements from the Kettle site in 1971 would be 175 megawatts, leaving 325 megawatts of surplus for possible use in MAPP-land. He estimated a surplus of 550 megawatts.21 Thus, MAPP planners were reminded of the need for the EHV transmission systems between Winnipeg and Minneapolis to make possible the power exchanges required in connection with the Manitoba project.22

There is little more information available in the Management Committee minutes on the Manitoba project. Certainly, the diversity possibilities as well as firming possibilities of this project must be receiving the attention of the MAPP planners. My own studies of seasonal diversity in MAPP, indicating a trend toward more and more summer peaking, would seem to suggest significant economies for MAPP as a whole and much more reliable
power for the Manitoba hydro in particular when this project is completed.

Altogether, when the Manitoba project is completed, there will be twelve hydro generation sites on the Nelson River with at least a potential capacity of 4,640,000 kilowatts.20 This does not include the 600,000 kilowatts from the Churchill River diversion project. Scott's estimates in late November, 1965, as noted above, would put the total capacity, exclusive of the Churchill River diversion, at 5,500,000 kilowatts. With the Churchill River diversion, this total capacity could reach more than 6 million kilowatts.

A. W. Benkusky informed me in a letter written September 11, 1967 that Manitoba hydro has recently announced plans to start development of the Nelson River project with installation of four 100 mW hydro units to be installed by 1971. Further installation of large blocks of hydro in the near future rests on the feasibility of constructing EHV transmission lines from the upper reaches of the Nelson River to the Twin Cities area.

This, then, brings us back from the area of power generation to that of transmission.

**Transmission System Development**

It was the EHV interconnection development in 1954 which made it possible to plan to link together the widely dispersed load centers of the Northern Plains. The quickness with which power interests in this area picked up the implications of the interconnection benefits is reflected in the timing of the Eastern Missouri Basin Power Conference in 1957. A perusal of the engineering minutes of this Conference reveals that considerable attention was given to a transmission system for the area. Elaborate maps and extensive justifications are found in the studies. These studies were updated from time to time.

MAPP plans for a transmission system were requested by the Advisory Committee of the National Power Survey. The same engineers who had worked so industriously on the EMBPC grid proposal were responsible for the MAPP grid submitted to the Advisory Committee. Reports of the Advisory Committee ses-
what might be called the North Dakota Loop running from the Twin Cities to Fargo to Grand Forks to Stanton, to Center to Mandan to Ellendale to Fergus Falls to Verndale, and back to Minneapolis. Then there is what might be called the Southern Loop running from the Twin Cities to St. Louis to Kansas City to Omaha to Sioux City, and back to Minneapolis. The third loop might be called the South Dakota Loop created by the Ellendale to Mitchell to Sioux Falls line. The northern terminal of this line is on the Ellendale-Fergus Falls-Verdale portion of the North Dakota Loop and the southern end of this link at Sioux Falls is but a few miles from the site of the 345 kv line to run from Sioux City back into Minneapolis. Finally, there is the Northern Minnesota Loop which runs from the Twin Cities north to Duluth, then northwestern to Virginia, then southwestern to Riverton and so back to Minneapolis.

In addition, Minneapolis, via the Chicago EHV line, is part of a MAIN-MAPP Loop involving Green Bay, Chicago, and St. Louis, the return to Minneapolis from St. Louis being via the St. Louis-Minneapolis 345 kv line. The Manitoba hydro project has necessitated a new loop from Minneapolis to Winnipeg and back by way of the North Dakota Loop. Crossing the North Dakota Loop is the important Fargo-Bismarck-Center line. Crossing the Southern Loop is the Hills-Des Moines-Brownville line, which until recently was planned to terminate at Omaha rather than Brownville.

The recent negotiations with the Bureau of Reclamation for energy sales resulted in a crash program to establish an additional Northern States Power Bureau 230 kv interconnection at Granite Falls. Involved here, too, is the upgrading of the 115 kv interconnecting lines with the Bureau both at Granite Falls and at Sioux Falls. There then is to be a new Audubon-Badoura 220/115 kv line. Also, the joint engineering committee of MBG and MAPP, in September of 1966, was reported to be studying a possible 345 kv line from Center to Watertown with a tie-back to Fargo, the tie-back to be a 230 kv line. These loops are the major sections of the MAPP grid today. The North Dakota and South Dakota Loops call for 230 kv lines for the most part. The Southern Loop and the MAIN-MAPP Loop are both 345 kv circuits. The most important part of the Northern Minnesota Loop, that between the Twin Cities and Duluth, is a 230 kv line. Much of the return line was in existence in 1963. The Minneapolis-Winnipeg sector of the Manitou Loop is to be made up of three parallel 345 kv lines.

The MAPP transmission-grid construction program is moving ahead rapidly and should be largely completed by 1970, ten years ahead of the original target date for this achievement. These lines are being constructed by participating groups of utilities to be served by the new lines. Each utility in the group constructs and owns the portion of line in its service area. MAPP neither constructs nor owns transmission lines, but it does help to plan and coordinate new lines. There is, with this coordinated, planning of transmission lines, also coordinated planning of new plants and refineries of plants, swap-power arrangements, and displacement power agreements.

The first line constructed in the grid was the Twin Cities-Duluth line in 1963. The feasibility studies on the Twin Cities-Chicago and Twin Cities-St. Louis lines were well along in 1963 when the Advisory Committee of the National Power Survey was seeking information on the grid plan of the new organization, as noted above.

The announcement of the actual signing of the agreement of the participating utilities of the St. Louis line was made by Charles H. Whitmore, president of Iowa-Illinois Gas and Electric, at the January, 1964, meeting of the Management Committee in Omaha, Nebraska. The participating utilities were Union Electric, Iowa Illinois Gas and Electric, Interstate Power, Iowa Public Service, Iowa Electric Light and Power, Iowa Southern Utilities, and Northern States Power. D. W. Angland pointed out that this line would coordinate three pools (upper Mississippi Valley, Iowa, and Illinois-Missouri) and permit them to defer four units from 1967 to 1970 and then construct larger, more efficient units. The postponed units totalled 700,000 kw. The line will also improve seasonal diversity factors for its members.

In the Northern Dakota sector, the Center-Stanton-Minot-
This line, like the Twin Cities-St. Louis line, would have a significant seasonal diversity factor. By February 25, 1966, the contracts for building the line had been signed by the participating utilities.

Not all of the MAPP grid has been touched either in general or detailed terms, but enough has been shown to indicate the ambitious plans and extensive construction work getting under way. The selected examples also indicate the variety of special purposes these lines serve in a coordinated system of interconnections like those of MAPP.

**Generation Developments**

The MAPP system faces the formidable job of having to build 18 million kilowatts of new base load generation capacity by 1980. This will require an investment of about $2 billion. With an assignment like this, the important pool and area economies already cited in his study take on new significance and possibility.

Present generation construction and future projects are all in the 100 megawatt class or larger. The transmission grid and coordinated planning have made it possible, as already noted, to utilize cheap lignite fuel at the mines. They also make it possible for the installation of nuclear plants large enough to out-perform fossil fuel plants of comparable size in the matter of economic efficiency. A listing of generation plants under construction or definitely planned will verify these conclusions and give a good overview of the generation building efforts going on in the MAPP system. The MAPP Achievements brochure provides such a listing.

1) There is the United Power Association, 183,000 kw, lignite fuel plant near Stanton which is in service and was dedicated on September 9, 1967.

2) The Union Electric Company at St. Louis completed in June, 1967, a 500,000 kw unit of a plant which will subsequently have a capacity in excess of 2 million kw.

3) The Interstate Power Company has in service a 233,000 kw installation at Clinton, Iowa, which was dedicated on September 6, 1967.
4) The Iowa Northern Utilities Company is installing a 200,000 kw unit at Burlington, Iowa, scheduled to be in service by May, 1968.

5) The Omaha Public Power District is completing a 200,000 kw unit at the North Omaha Plant for an in-service date of May, 1968.

6) The Northern States Power Company is on schedule with the installation of a 500,000 kw unit at the Allian S. King Plant to be completed by May, 1968.

7) The Dairiland Power Co-operative is constructing a 325,000 kw unit near its Genoa, Wisconsin station on the banks of the Mississippi to be in service by the winter of 1969. [The Manitoba hydro plants were discussed earlier.]

More recently, five new nuclear plants have been approved and another lignite plant has been announced. These plants are not listed in the Achievements brochure.

8) Northern States Power Company plans to construct the following nuclear plants on their system: 1970, Monticello-500,000 kw, 1972, Prairie Island, 500,000 kw, 1974, Prairie Island, second 500,000 kw.

9) The Omaha Public Power District plans to build a 400,000 kw nuclear plant at Florence, Nebraska to be in service about the summer of 1971.

10) The Consumers Public Power District, Iowa Power and Light intends to build a 500,000 kw nuclear plant near Brownsville, Nebraska by the summer of 1972.

11) The Minnkota Power Co-operative is just beginning construction of a 200,000 kw plant on the lignite fields at Center, North Dakota to be in service by the winter of 1970.

The importance of area planning as a basis for the decision to build these plants can be vividly demonstrated by considering some of the planning behind three of the above plants, each illustrating a different use of area planning opportunities. These are the United Power Association Plant at Stanton, the Minnkota Plant at Center, and the Consumers Public Power Plant near Brownsville.

The United Power Association is made up of the Rural Power Cooperative Association and the Northern Minnesota Power Association. Both cooperatives serve a high-cost power market in northern Minnesota. Both had associated with the Power Co-operative Association, a group of thirteen cooperatives including both generating and distributing cooperatives. This association sought to find and develop cheap fuel production sites. The group proved too large and too diversified of interest to continue the quest. The breakup of this group, the two northern Minnesota cooperatives (G. & T.) formed the United Power Association and worked out a replacement agreement with two investor-owned utilities—Northern States Power and Otter Tail, by which the private utilities would receive power from a UPA plant built on the lignite field. Both companies have markets in this western sector. In return, the companies agreed to supply the northern Minnesota market from their more efficient generation equipment. This is a perfect example of a displacement agreement working to the advantage of both groups. Northern States at the time was facing the problem of having to build new generating capacity in the western sector, which it could now defer. Thus, UPA's 132,000 kw lignite plant came into use near full capacity, and Northern Minnesota received cheaper power than the cooperatives could have produced locally.

Minnkota Power Co-operative had been active in a promotional group for the development of the lignite coal area. The cooperative needed new capacity to meet growing demands. The company elected to build a 200 mw lignite plant. While this plant is being constructed, Minnkota has arranged for the use of power from Northern States, Otter Tail, and Montana-Dakota Utility. Later, Minnkota will return an equal amount of power to these companies. The three companies had planned to stagger new generation construction among themselves. With the UPA plant and the new Minnkota plant being built, these companies deferred their generator plans and obtained this power for this western-sector market from the cooperative plants.

The Consumers Public Power District in Nebraska will face increasing power limitations beginning in 1968. Consumers, therefore, consulted with the Stearns and Rodger's engineering firm as to how it might use its nuclear experience at Sheldon Station. It was decided that a nuclear plant which would just be able to compete with a fossil-fuel plant would have to have a capacity...
of at least 400 mw. An 800 mw plant would be well within the competitive limits, but the consumer market would not require this large supply for a long time. However, arrangements were made by which Iowa Power and Light, which also needed more capacity, agreed to absorb the surplus power of the proposed Brownsville plant. An EHV line crossing the Southern Loop from Des Moines to Brownsville is being planned to make the huge power transfer involved here possible. This efficient nuclear plant should be going on the MAPP lines in 1972.41

BUREAU-BASIN RELATIONSHIPS

The relationships between MAPP and the Bureau and Basin people did not start on the most favorable terms, as has been noted previously. The hydro firming offer and the United Power Association's plant were both subjected to counter proposals by the Missouri Basin Systems Group. It is interesting that, almost without exception, the eastern G. & T. cooperative representatives interviewed attributed much of the misunderstanding with the Basin people to the fact that few if any of these people had any experience with power generation. As a result, they had attracted few college trained engineers and business administrators with educational and experience backgrounds akin to those of the middle managements of the eastern utilities—private and cooperative (G. & T.). Nor could the distribution cooperatives develop as fully the utility service concept. Thus it often became difficult to obtain a meeting of minds.

As for the Bureau, both private company and eastern cooperative staffs who have had the most contact with the Bureau do not rate its reliability facilities very highly due to their design. This creates problems in interconnection relationships. On the other hand, most of these same people have respect and praise for the Bureau's operating personnel.42

Actually, relations were to take a more positive direction when the Bureau developed surplus energy to sell. The Basin group is heavily dependent upon the Bureau for its power and for a good bit of its political outlook, and so, from my perusal of the

MAPP minutes, it appears that there has also been improvement here. Another important factor is that the northeast blackout of 1965 was a grim reminder to all concerned of the possible consequences of improper coordination of our vast networks. In 1966, the Bureau itself became involved in a major outage. The increased economic contact between the Bureau and MAPP with necessary coordination of interconnecting lines and a mutual concern for minimizing major outages have brought the two groups into closer planning relationships and operational cooperation. At present, agreement has been reached with the Bureau on its membership in the MAPP Coordination Center.

The justification for this optimistic interpretation of the MAPP-Bureau relationships is to be found in these specific developments shown in the MAPP committee minutes:

1) April 24, 1965, policy-level people of Ge Basin and MAPP met to lay the groundwork for intersector power planning. It was decided the best first approach should be by way of "pilot" engineering. Instructions were set up, therefore, to guide a joint engineering committee.44

2) May 21, 1965, a red-letter day in improving relationships, when Kenneth Halum, Assistant Secretary of the Interior Department, was in the area and asked to meet with private-company members of MAPP to offer hydro energy for sale, including peaking energy from the Big Bend plant. The excess energy should be available until 1970 or 1971. After that, Halum felt that the hydro peaking potential should be available and should be planned for.45

3) June 23, 1965, the Joint Engineering Committee met and reviewed their instructions:
   a) Prepare a report on scope of work which the committee feels should be undertaken.
   b) By straight engineering, identify transmission lines for joint planning.
   c) Investigate generation and transmission for the entire combined area.
   d) Issue a joint report of recommendations.

A study plan for 1970-1975 was drawn up and submitted in joint recommendation along with a total cost estimate of $10,000, or a cost of $5,000 to each group.46

4) September 15, a setback in getting the study going was announced. The Basin people had called another policy-level meeting of MAPP-MBSG. Meantime, Basin was not advancing the $5,000, its financial part of the study.47
5) October 18, 1965, the Joint Policy Committee met. Basin wanted a shorter-range study. MAPP argued that most major plans before 1970 had been converted into commitments by this time. Basin argued that there might be same changes that could be made in this period. MAPP expected a shorter-term study, like this might be directed at holding up BEA loans sought by MAPP members in this western sector. Finally, it was agreed to include a short-range study with the understanding that it would not be used to hold up BEA loans currently applied for.  

6) February 25, 1966, Frank Linder, chairman of MAPP Planning Committee, reported that the Joint Engineering Committee of MBSG-MAPP was moving forward, and that it was working on load-flow studies currently.

7) J. C. Glass presented a proposed agreement for Bureau surplus energy. The committee adopted the proposed agreement.

8) On August 2, 1966, it was reported that Northern States Power, Dairyland Power Co-operative, Minnesota Power and Light, Rural Cooperative Power Association, and Lake Superior District Power Company had all negotiated excess power contracts with the Bureau. The concentration of this demand geographically was forcing a crash program to establish another 230 kv interconnection with the Bureau at Granite Falls, along with other line upgrading to expedite delivery of Bureau energy.

Thus, the minutes on the changing relationships with the Bureau and the Basin, the indications are that Bureau excess energy contracts have been successfully negotiated and that the MBSG-MAPP engineering studies were moving ahead at the end of 1965. As these marketing and engineering contacts increase, old rivalries and fears will undoubtedly be pushed into the back-ground. The intersector interdependence should promote greater solidarity of interest throughout the entire Eastern Missouri Basin.

Area Coordination and Reliability

There were many at the Eastern Missouri Basin Power Conference who were very disappointed that the Conference did not culminate in an area-wide pool. The engineers in particular had been convinced in their studies that integrated operations on this scale were both feasible and highly desirable. Although MAPP is not an operating unit, it was given responsibility for coordinating its subarea pools, and the office of Coordinator was created to execute this responsibility. Now there was the need of an adequate communication system to provide this coordination.

Frank Linder reported to the December 1, 1964, meeting of the Management Committee that the Planning Committee had been confering with American Telephone and Telegraph Company about a communications program to make area operating coordination more meaningful and effective. The Bell System was to make a major report to the Planning Committee group on December 4th, and Linder was asking the Management Committee to consider seriously this communication program.

The feeling, at this time, among the engineers was that interconnections had become so numerous in the area that some kind of area supervision was becoming necessary if energy flows were to be adequately utilized. The Planning Committee continued to push their studies toward the establishment of a coordination center.

E. C. Glass made a study of coordinated dispatching and operations in May of 1965. He had consulted with Dr. Kirchmayer of General Electric, a leading authority on this subject.

Suddenly, before the end of 1965, the northeast blackout brought these coordination studies to the center of attention in the Management Committee meeting, November 18th, 1965. Dr. W. Angland had just returned from a MAIN meeting where there had been a discussion by men who were on a special Federal Power Commission investigation committee looking into the causes of this major power outage.

These investigators explained that five 230 kv lines had tripped out on overload in Canada. At the time, 1,200 megawatts of power were moving north. Another 400 megawatts of displacement power was in the system. When the lines went out, all this power sought new routes. The line outages had taken out 1,175 megawatts of generating capacity at Beck Station in Ontario, and another 700 megawatts of capacity went out as lines tripped off in chain reaction.

The irony of the whole affair was that Consolidated Edison, to the south of this area, had over a million kilowatts of spinning capacity available at this very time. Pondering this situation, the
MAIN group established four areas for examination in the hope of finding greater reliability for its own systems. The areas were:

1) Communications — obviously a breakdown in communications had kept Consolidated Edison from releasing the tight power situation which had developed in New England.

2) Review of procedures for automatic curtailing of noncritical loads.

3) Telemetering in order to obtain an accurate record of power flow so that action can be taken promptly.

4) Coordinating of the operations of several pools and systems through a centralized office.

As a result of these examinations, MAIN formed two task forces: one on load shedding with special attention on pool load shedding, another on an interpool coordination office.

Returning to the MAP meeting, Earl Ewald called on E. C. Glass to report on MAPP's investigations into the requirements of an adequately equipped coordination center. Glass talked in terms of a central computer at the center, tied to individual computers at member utilities and pools. He also reviewed his discussion with Dr. Kirkmayer and urged the group to approve a study proposed by General Electric to determine the economies in a possible MAPP coordination of energy flows. This approval was given, but members strongly suggested that reliability factors be weighted more heavily than economic factors in the study.

A letter dated December 2, 1965, from E. C. Glass to the Planning Committee, informed that committee of the Management Committee's authorization to go ahead with the General Electric study. Meanwhile, Linder and Glass had set up a Preliminary Outline of Functions (for a coordination center). Basic as this document is to the creation and understanding of the coordination center, it is too long to reproduce here. Its main points, however, must be summarized.

The outline is divided into two major parts: System Security and Operations Economy. The detailed breakdown of each division gives far heavier weight to the security aspects. The functions in connection with these latter aspects are summarized under headings of Preventive Action and Response to System Distress. Under Preventive Action these things are stressed: (1) generation reserve, (2) transmission reserves, (3) communication facilities, (4) telemetering facilities, and (5) load rejection.

Under Response to System Distress, the following main points are considered: (1) the crises, with a four-phase procedure involved, and (2) restoration of service and interconnections.

The second main division of the outline concerns the operations economy and is broken down into four main subdivisions as follows: (1) optimum dispatch, (2) automatic billing, (3) coordination of generator maintenance, and (4) marketing with contiguous areas.

Thus, the engineers outlined, in their view, the necessary functions of an area coordination center. Unquestionably, the emphasis in this new project has shifted from economic justification to reliability.

In mid-February, 1966, the Planning Committee, building on the proposed functions of a coordination center, formulated a recommendation for this proposed center and distributed copies to the Management Committee members for their consideration before their next meeting on February 25th. Meantime, the Planning Committee had day-long sessions with the Bell Telephone representatives and the International Business Machines representatives. It was in the latter session that the two computer systems, PJM and AEP, discussed earlier, were considered — the advisory system of PJM versus the direct-control system of AEP. The possibility of the new coordination center beginning computer operations by using a special terminal on Northern State's 300 computer was suggested by IBM. This connection could be installed by September of 1967. Three years would be required to install a 300 computer at the center.

The most significant Management meeting, from the point of view of the coordination center, was that of February 25, 1966. It was at this meeting that the center was authorized. Chairman Ewald made it clear that MAPP was not yet an operating pool, but he predicted there would be an ultimate need for operating coordination as EHV networks expanded.
EWALD went on to say that conferences with various members had indicated that a few members on the fringes of the area would not be interested in joining the center. The Manitoba hydro interconnections had not yet developed to make it possible for them to participate at that time, and Union Electric was already involved in coordination in the Illinois-Missouri Pool. W. D. Falls, however, was present and assured the committee that Manitoba hydro strongly favored the establishment of a center, though it could not now participate. Two types of membership were suggested in view of this situation—a sustaining membership and an operating membership. R. W. Steele, president of the Interstate Power Company, moved that the Planning Committee be instructed to draw up agreements to provide payments for both types of membership. E. E. Wolter, of the Rural Co-operation Power Association, amended the motion so that the Planning Committee would "be enlarged, in view of its rapidly expanding activities," and that $60 to $70 thousand be budgeted for starting the center. The motion, as amended, was passed.46

The Planning Committee received the results of the General Electric study during the summer of 1966. This study concluded that the annual savings in coordinated operations in the area would amount to a little over $2 million. This conclusion was based on 1964 data, and upon a number of limiting assumptions which led the Planning Committee to estimate the savings figure to be on the conservative side by at least 25 percent.47

In the final meeting minutes available to this study, those of September 12, 1966, E. C. Glass reported to the Management Committee on the results of the General Electric Co-ordination study of MAPP. He noted that the federal regulatory authorities and Congress were becoming increasingly concerned about power-system reliability. MAPP had a unique opportunity to lead the way in the direction of a solution to this problem. The center, Glass pointed out, could spot hazardous conditions in advance, e.g., (1) simultaneous scheduling of power that would create flows in an additive direction, thus overloading transformers; and (2) transmission and generation maintenance "pile-ups" at the same time through lack of adequate coordination. When the center has been computerized, in cases of sudden loss of facilities, it would be possible to explore various emergencies which might arise and recommend corrective steps within thirty seconds.

Interarea coordination would be another great advantage of the area coordination center movement, affording each area the opportunity to avail itself of greater diversity factors and reserves in tight power situations and emergencies. Also, in these interarea relationships, power could be marketed more efficiently.48

Thus, the coordination engineers are convinced that most widespread power failures are likely to result from "failure or mis-operation of transmission facilities which cause cascading (generator outages)."49 Linder, Glass, and other members of the MAPP Planning Committee believe their efforts in establishing the MAPP Coordination Center are significant in protecting the fine reliability record of the power industry, and that these efforts are bearing fruit at just the right time, as EHIV interconnections are spreading rapidly across the continent.

INTERAREA COORDINATION AND RELIABILITY

Once groups like MAPP become well established with "tele-typed," "telemetered," and computerized coordination centers, the next logical and orderly step is in the direction of interarea coordination. In the discussion of generator maintenance in Chapter III, it was pointed out that the close collaboration of MAPP and MAIN engineers resulted in a study suggesting that areas like MAIN, with heavy concentration of large generation centers, may receive real help in obtaining replacement energy while generators are down in peak periods from areas with less heavy generation complexes and other diversity factors. This is just one minor way in which interarea coordination can be profitably used. Glass, in his comments before the Management Committee just cited, touched on a much more meaningful relationship on the interarea level—the reliability relationship.
MAFP’s most productive interarea relationships have been with its neighbor on the east, MAIN. When MAIN was first organized, it invited MAPP to join its organization. Considerable discussion was given to this offer at the December meeting of the Management Committee in 1969. D. W. Angland’s views were representative of those expressed on the matter. He believed that each group should optimize its own area as a prerequisite to wider coordination. However, he also favored coordinating dispatching arrangements of the two areas. Spethmann summarized sentiment as being against joining MAIN at this time, but in favor of establishing a close liaison with the new group. It was decided that Northern States Power and Union Electric, both with interconnections in MAIN territory, should be urged to join MAIN to establish liaison with it.23

Since this time, other MAPP members have also joined MAIN. They are: Iowa Public Service, Iowa-Illinois Gas and Electric, Iowa Power and Light, Iowa Electric Light and Power, Interstate Power, and Iowa Southern Utilities. The companies joined MAIN in order to better coordinate the MAPP and MAIN EHV lines. Their operations, however, will continue to be coordinated by the MAPP center.24

To the west, stronger interconnections are being made with the Bureau, and continued exchange of energy will increasingly force closer coordination between the Bureau and MAPP, both for economic and reliability reasons. Agreement has been reached with the Bureau, and they will soon join the coordination center of MAPP. The joint engineering study is a further pressure toward closer cooperation between MAPP and the MBSG. It is interesting to note that joint long-range studies of these groups are exploring the possibility of MAPP participation in an EHV system linking the Missouri Basin with the federal hydro power projects of the Pacific Northwest.

It is probably true that much area work remains for area groups, but increasingly in the future, interarea, and even beyond, interregional planning and possibly operations, will become much more important in the power industry.
VII

Prospects and Evaluations

As an evaluation of an organization like MAPP is most difficult just because it has been so successful in its undertakings thus far. The prospects for the organization certainly are of concern in evaluating it. The most important evaluation, however, is the economic one. Referring to Chapter III, how well have the economies of integrated systems been realized by MAPP? Finally, the opinions of MAPP members should be noted.

MAPP Prospects

First, the prospects appear good that MAPP will soon encompass most of the Eastern Missouri Basin. Now that the Bureau has agreed to join the MAPP Coordination Center, the prospects increase that the Missouri Basin Systems Group will also join eventually. Joint studies of short- and long-range plans by these two groups are further forces working in this direction. Since 1964, there has been general recognition of the interdependency of these sectors as energy-flow and reliability requirements have become more and more appreciated in actual operating experience.

Second, most of the potential of the Manitoba hydro project is still to be realized. The economies of thermal-hydro integration are still to be achieved by MAPP. Political problems in connection with the Missouri hydro firming proposal brought prospects in this direction to an abrupt close for the time being, and the future prospects here are still hedged in with political uncertainties. The Manitoba hydro prospects, however, are different. They are still present and promising, and await only economic, engineering, and construction developments. As was pointed out in the last chapter, the total capacity which this project should ultimately add to MAPP load, including the Churchill diversion, should exceed 6 million kilowatts. Third, the Coordination Center is functioning, having established its offices in February of 1967. While its communication facilities are still restricted largely to teletype service, it has put these resources to good use during the summer of 1967 in demonstrating its potential for serving the economic and security interests of its members. In view of this performance, there appears little doubt that the organization will advance the funds necessary to expand its facilities to telemetering and computers. As yet, no decision has been made on whether to use the computer to advise utilities of desirable action, or to operate utility generation and transmission. Part of the decision will be based on the ideas of the members, and part on the advancement of computer development. There seems little doubt, however, that sooner or later, area operational coordination will become necessary. This closer coordination should strengthen most of the energy-flow economies, as well as system reliability, of the area operations. Furthermore, as the General Electric study indicated, the resulting economies in fuel consumption (based on 1964 operations) should equal $2 million annually. MAPP engineers, in 1968, thought that this figure was underestimated by at least 25 percent making the current annual fuel-saving potential about $2,500,000. This potential savings will have to be revised upward as the scale of electrical operations in the area increases.

Fourth, the new Coordinator, William B. Farrell, formerly Commissioner of the Minnesota State Department of Business Development, is well qualified by experience to give a big boost to this kind of industrial development in the area when and if the Management Committee sees fit to reinstate an earlier com-
Mid-Continent Area Power Planners

Prospects and Evaluations

Area Power Planners: Long-Range Planning Outlook. The following tentative conclusions were suggested for this future period in this report:

1) It is predicted that approximately 100,000 megawatts of new generation will have to be constructed in this last quarter of the century—a capacity approximately five times that which MAPP expects to have in 1975.

2) Nuclear-fueled plants will probably become the major component in future generation. Much of this nuclear development, however, depends upon the development of breeder reactors by 1985 if our future supplies of uranium are to be adequately assured. The committee expects nuclear power capacity to equal 90 percent of total operating capacity by 2000, but this capacity will supply approximately 80 percent of the total energy requirements by that time.

3) By the year 2000, about 6 percent of the generation source will be "e.xoteric". These so-called e.xoteric sources are identified as follows: (a) magnetohydrodynamics (MHD), (b) electrogravitics (EGD), (c) fuel cells, (d) thermonuclear electric generation, (3) thermionic generation, and (f) thermonuclear fusion reactors.

4) The more advanced types of breeder reactors should have low fuel costs of about 35 cents per million BTU.

5) Entering the nuclear age, much larger generator sizes promise economic performance over the fossil-fuel plants of today. Turbine manufacturers, while varying in opinion, see units of 2000 megawatts as feasible by 1980 and units of 4000 megawatts by the year 2000 as possibilities.

6) MAPP believes the availability of cooling water is a major limitation on plant sizes in the future unless air-cooled condensers can be significantly improved. MAPP land is fortunate in having the Great Lakes and the Mississippi River in its area in this connection.

7) A West German development operating under American patent rights gives promise of practical air-cooled condensers in the future. One of MAPP's members believes this condenser has possibilities in eastern Wyoming climatic conditions and is developing a 50-megawatt plant making use of this cooling system. The company and a neighbor may be company hopes to develop more "distant" generating capacities by this new method of cooling if the prototype works out. (It occurs to me that this air-cooling system might mean more substantial development of the lignite-field power generation potentiality since, it would appear, climatic conditions here are not too substantially different from these in eastern Wyoming.)

8) The committee has studied five geographic regions thus far which could become principal areas of power generation by the year 2000. This concentration of generation should put a premium on an adequate tran-
adecquate solutions of these great social problems. Dr. Klemme in a letter to the author, January 29, 1968, expressed his view on the matter of broader social concerns in the prediction of utility demand for the future:

I think that all utilities must take a critical look at the shape of the work, and particularly that of the United States, in making any long-term projection. The past history of such projections and/or predictions reveals that we have consistently underestimated because we have not allowed for the inevitability of change which, in the last century, has always tended to synergize the demand for energy as a replacement for human labor.

I expect to see these considerations coming into the long-range studies of MAPP and other electrical power interests in the future.

What are the prospects in all this long-range planning for lower per-unit power costs to the consumer? The National Power Survey (Chapter 17) identifies four major sources of potential reduction of power costs in the future, apart from a fifth one involving political considerations.

The first of these sources of lower per-unit power costs is the growth of loads and per-customer power consumption. The better than five-fold projection beyond the 1975 generator capacity expected by the MAPP planners is a strong indication that this first source of economy is amply present in the future of the Northern Plains area.

The second source is expected in the continued improvement in generation technology. The third source is the closely associated reduction in fuel costs. Fuel costs, it is pointed out in the Survey, make up about 15 percent of the total delivered cost to the consumer. Once again, the alertness of the MAPP planners to the economies in generation and fuel cost in nuclear power, and exotic power production, together with their interest and experimentation with air-cooled condensers indicates how far out on this economy frontier the MAPP engineers are.

The fourth source of future cost reductions cited by the National Power Survey is a sweeping movement of interconnected electrical systems with special emphasis upon the planning of
efficient energy flows, and generation and transmission facilities. I have endeavored to show how MAPP has exploited these economies in its first three years of existence. The same concern is reflected in the long-range report just reviewed.

Will the thorough exploitation of these four sources of cost reductions result in economies which will more than offset what appear to be present and future trends toward higher financial and equipment costs of the electrical power industry? Only time will tell, but it appears to this writer that the very substantial economies promised in the four categories cited above should far more than offset these rising financial and equipment costs in the long run, especially if plant and equipment continue to increase in productivity as present projections indicate. If I am wrong, then economies of interconnected systems take on even greater economic significance as partial offsets to strongly rising costs of the industry in this latter assumed situation.

Finally, everyone in MAPP is proud of what is one of the organization’s most important and timely contributions—that of proving that diversified power interests, carefully respecting the individual rights of each, can achieve a most effective degree of coordination and enthusiasm. Should this organization lose this respect and observance of local utility autonomy, it will lose its most important source of strength. This study could not turn up any evidence that this fundamental concept of MAPP has diminished thus far.

**Economic Appraisal**

Referring to Chapter III and the economies of integrated systems with generation and transmission coordination, it should have been made amply evident in the last chapter that most, if not all, of these economies are being realized in the MAPP organization.

Transmission lines are being used to improve diversity and load factors constantly. The great Southern Loop in the EHV system taps the warm summer-peaking climate of the middle and middle-southern parts of the United States. The interconnected Dakota Loops and the Northern Minnesota Loop tap the more extreme winter-peaking markets providing significant seasonal diversity within the system. Soon EHV lines will be coordinating hydro production in Canada with thermal production in the United States resulting in mutual economies for each type of power production. The EHV lines used in this coordination will be capable of carrying load three to nine times as great as low-voltage lines, and will easily justify themselves in economic terms in view of the heavy loads which the system will generate.

It was noted that the establishment of the Twin Cities-St. Louis line made possible four significant generator deferrals. The Twin Cities-Omaha-Kansas City line made possible at least two deferrals of power plants, with assurance of full capacity operations when those deferred generators are finally put on the line. The 230 kv network will make it possible to bring in two large lignite coal plants at full capacity with their scale economies and low fuel cost. Meanwhile, four private companies operating in this area will be able to defer several plants while using this efficiently produced energy from the lignite fields. Beyond this, significant exchange and displacement agreements were made, one of which helped to bring relatively low-cost energy into a high-cost energy market in Northern Minnesota. Thus the transmission system of MAPP is justifying itself economically. This transmission system includes 3,350 miles of high-voltage lines at a total cost of $212,700,000 (including substations). The generating savings resulting from the Twin Cities-St. Louis line alone are estimated at more than $100 million between 1967 and 1978.8

The economies in large-scale generators have been stressed at several points in this study. MAPP officials note a doubling of the average generating unit size over those originally planned prior to the formation of MAPP. The resultant saving between 1967 and 1980 is estimated at $268 million. There have been marked declines in reserves in the area, and more are anticipated. This means more efficient use of existing generation capacity. Maintenance outages are now being made with the advice of the Coordination Center, promoting greater security in the system and the economies of steady, uninterrupted service.
Since there is a connection between reliability of service and economy of service, it is not out of place here to note that the Coordination Center of MAPP is working in close cooperation with the MAIN center, and is thus in a position to help increase the security and steadiness of service of its members. Further, in this interarea contact, opportunity for marketing excess energy is broadened.

Thus, most of the potential economies of integrated systems noted in Chapter III are being realized in significant magnitudes in the MAPP area. Little wonder that the utility members of MAPP are enthusiastic about it. The final test of the success of this organization is the member reaction. It is examined here.

MEMBERSHIP SUPPORT

The growth of membership of MAPP is certainly some measure of MAPP's achievement. In four and one-half years, MAPP membership has more than doubled from twenty-one to fifty-one members: one Canadian Crown Corporation, fourteen investor-owned companies, twenty-eight municipal utilities, eight Rural Electrical C. & T. co-operatives, and two public power districts. MAPP must be filling important needs to experience this significant growth rate in its first half of a decade of being.

The minutes of the Planning and Management Committees reflect the wide and enthusiastic participation of members in MAPP affairs. Member attendance at the Management sessions reveals a consistently high percentage of eligible members at each meeting. When the size of the area is considered and travel time is taken into account, this indicates a high degree of loyalty to the group, and is a measure of the respect with which the organization and its activities are held.

The interviews conducted in connection with this study, whether at a public power district, a private company or a co-operative, invariably involved enthusiastic people, firm in their support of the organization, and steeped in its history. Each organization could cite two or three staff members who had figured importantly in the organization of MAPP and in the

Eastern Missouri Basin Power Conference activities which preceded MAPP.

Why do these utility representatives so strongly support MAPP? These were among the most frequently cited reasons:

1) The greater reliability of service provided by MAPP — usually the first thing mentioned.
2) Worthwhile economies gained in an organization that respects local autonomy.
3) Economic gains through coordinated planning of transmission and generation.
4) Reduced costs of operations through coordinated relationships in MAPP — reduced reserve requirements, advantageous energy exchanges, peaking energy, improved load factor.
5) Enlarged market for power sales.
6) MAPP meant the end of expensive isolated operations for some utilities.
7) Profitable interchange of views and information in committee participation.
8) Transfer of power on the basis of seasonal diversity.
9) MAPP’s continuing studies and research.

Apart from specific answers given to the questions about MAPP’s importance, the enthusiasm of these men, their willingness to give answers and provide information conveyed more of the spirit of this organization than anything else. Without this spirit, the tremendous amount of work described in the preceding chapter could not have been done.

MAPP, then, has performed well in terms of the three measures mentioned earlier. It is a flexible, alert organization delivering the economies inherent in integrated relationships that have won the strong support of its members. Further, MAPP is a leader in the quest for greater reliability through proper coordination of interconnected systems.

From the broader point of view of the economist, the organization is effectively demonstrating that diversified power interests can work together efficiently to enhance their own well-being while conserving effectively the energy resources that must be
handled with the finest stewardship if the tremendous demands facing the power industry in the next thirty years are to be met adequately.

Truly, this new approach to forward planning has had significant and beneficial impact upon the Northern Plains states. If its lessons can be learned and implemented effectively in other areas and regions of the United States, our national power resources for the future are strongly assured.

Notes

Chapter 1

1. MAFF Management Committee Meeting Minutes, February 8, 1963. There was an earlier organizing meeting on January 10, 1963, which set up temporary officers and invited twenty-four suppliers to meet on February 8 for the purpose of establishing a permanent organization. Twenty-one utilities responded, according to three minutes, and signed the Memorandum of Understanding.

2. A.W. Benkusky, MAFF Manager, two manuscripts of speeches, one presented on June 26, 1967 before the Midwest Power Accounting Association, and one on May 4, 1967 before the American Power Dispatchers Association. The author has also drawn on information acquired during a week and one-half visit at the Center.

3. Ibid.

4. According to A.W. Benkusky, “The East-West interties were opened on July 20th, due to operating problems that have not been solved. Study and discussion is underway to determine methods of making continuous closed operation practical.” Letter to the author dated August 8, 1967.


7. MAFF, Management Committee Minutes, February 9 and May 17, 1963.

8. MAFF, MAFF Accomplishments, a brochure in which this quotation from the National Power Survey is reproduced.

9. A.W. Benkusky: “The Interconnected Systems Groups is a voluntary organization made up of operating people of electric systems functioning in 32 states in the mid-and eastern United States. Their purpose is to set up general operating procedures that affect interconnected operation, i.e., time standard, reserve requirements, frequency bias, and the like.”

10. Comments by Frank Linker, Chief Electrical Engineer, Dairyland Power Cooperative, and Chairman of MAFF Planning Committee, on a subcom...
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48. MAPP, Management Committee Minutes, October 18, 1965.
50. MAPP, Planning Committee, August 2, 1966.
51. MAPP, Management Committee Minutes, December 1, 1964.
52. Ibid., May 7, 1965.
55. Ibid., January 10th and 11th, 1966.
56. MAPP, Management Committee Minutes, February 25, 1966.
57. MAPP, Planning Committee Minutes, August 1, 1966.
58. MAPP, Management Committee Minutes, September 12, 1966.
60. MAPP, Management Committee Minutes, December 1, 1966.

Chapter VII
1. The Bureau has now actually joined the Coordination Center, as of September 15, 1967.
2. See p. 80.
3. See p. 194.
4. I am indebted to Frank Linder, who made this report available to me.
5. See Chapter 8 of the National Power Survey, Part I, Federal Power Commission, for brief discussion of these "exist" sources.

Bibliography

Books

Documents, Microform materials, pamphlets


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Mcken, Howard L. "Cooperative Power Association: Its Origins, Objectives,