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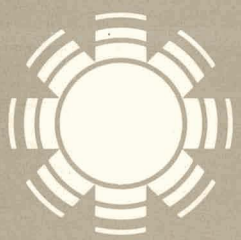
An Overview Assessment of Potential Small Electric Utility Applications of Wind Energy Systems



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AN OVERVIEW ASSESSMENT OF POTENTIAL SMALL ELECTRIC UTILITY APPLICATIONS OF WIND ENERGY SYSTEMS

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NOVEMBER 1978

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PREFACE

This report documents work performed in compliance with Contract No. EG-77-C-01-4042, Task No. 3507. The report was prepared by T. S. Jayadev, F. W. Perkins, and C. D. Percival of the Systems Analysis Branch of the Solar Energy Research Institute. The authors wish to thank Neil Woodley, Branch Chief, and Dean Nordman for their valuable inputs to this study.

Neil H. Woodley, Chief
Systems Analysis Branch

Approved for:

SOLAR ENERGY RESEARCH INSTITUTE

J. Charles Grosskreutz
Assistant Director, Research

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ABSTRACT

A survey of small municipal and rural electric cooperative (REC) utilities was accomplished. The relationship between these small utilities and the mean wind power at their locations was found by locating them on appropriate maps of mean wind power density. Some of the safety, systems, and economic implications of WECS deployment by these utilities were discussed.

The authors conclude that certain financing advantages and geographical considerations make the Great Plains region a strong candidate for the early commercialization of WECS.

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SECTION 1.0

INTRODUCTION

This report considers certain electric utility systems with regard to their size, location, and type of organization. Specifically, a field survey of rural electric cooperatives (REC) having a summer or winter peak demand less than or equal to 10 MW was done by the authors [1]. This information is compiled in Appendix A. A survey of small municipal electric systems (presented courtesy of Burns and McDonnell Engineering Co., Kansas City, Mo.) is presented in Appendix B.

With respect to wind energy the size of candidate utilities is important. Because of their small size it is felt that the installation of a modest number of presently available wind energy conversion systems (WECS) would have a significant impact on the amount of power purchased by the utilities. Almost all of the REC are distribution cooperatives with no generating capacity. Some of the municipal systems have generating capacity; almost all of them use diesel generators. A very few have hydroelectric power. Many of the diesel generators burn relatively expensive No. 2 fuel oil. The combination of a WECS with a diesel generator provides firm capacity and fuel savings dependent on the capacity factor and size of the WECS.

An important property of the REC and municipal utilities is their financing. The bulk of the cost of a WECS is expected to be its capital cost, with operations and maintenance expected to be about one third of the annual costs [2]. The annual costs are strongly dependent on the cost of money. For example, assuming a fixed charge rate of 12% for the municipals or REC and 18% for a private utility, with a loan of $1,000 amortized over 20 years, the annual charge to the private utility is $173.88; for the municipals or REC it is $133.88. This is a difference of 23% of the higher cost. The total capital cost of WECS in production is estimated to be between $1,038 and $432 per kW [2]. Assuming a value of $735 per kW, the annual fixed charge to a municipal or REC would be $98.40 per kW, while the fixed charge rate to a private utility would be $127.80. (The calculations assume the same loan amount and payback period as the previous calculation.)

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SECTION 2.0

SURVEY OF SMALL REC AND MUNICIPAL UTILITIES

A survey of small (summer or winter 1974 peak demand less than or equal to 10 MW) rural electric coooperatives and small (0.5 to 2 MW peak demand) municipal utilities was undertaken. The object of the study was the correlation between the locations of candidate small utilities and regions of high wind energy density. The data used are listed in Appendices A and B. Maps were also generated using these data and the best current data detailing the national wind energy availability [3].

Figure 2-1 shows contours of average power in the wind per square meter during the summer and locates the small RECs having summer peak electrical loads in the base year. Figure 2-2 shows the winter wind power contours and the small RECs having winter peaks. Figure 2-3 shows the winter wind power contours and the locations of the small municipal utilities. On all maps the shaded areas are mountainous regions and the numbers given are estimates of lower limits for exposed mountain tops and ridges. If a utility's location could not be determined, it was either not mapped (REC) or, for a municipal utility, a point was placed in a random location within the boundaries of the appropriate state. Only a small number (<3%) of the utilities had to be so treated.

Almost all of the RECs are distribution cooperatives with no generating capacity. Many of the municipal systems have generating capacity, most commonly a diesel engine-driven electric generator.

Inspection of the maps shows a large number of small utility systems in the north and central midwest. (In the state of Minnesota alone, the municipal utilities in the 0.5 to 2 MW range represent a combined peak demand of 31.19 MW, with an average demand of 1.3 MW. With only 25% of peak demand in wind, the municipal electric systems in Minnesota represent a potential market for thirty-nine 200-kW WECS.) This area, extending south to the Texas panhandle, is noted for strong and persistent winds, well suited to WECS utilization. (The strongest winds on the plains occur in the spring. Winter data are mapped because of their correspondence to the peak loads in many cases of interest). Of note are the many small systems in a band running from Minnesota to Texas, corresponding to some of the country's highest wind energy density areas.

Other small systems may be found in locally windy regions. However, present development of commercial wind turbines should be concentrated in the plains area for a number of reasons. First, a high quality wind resource is available there, which implies that individual installations will have good productivity. On a systems basis a high quality wind resource implies that a dispersed WECS installation may be assigned capacity credit. Second, the land in this area is relatively flat and open, implying that there will be many candidate sites for a WECS and that cost will be fairly low because of multiple land use considerations. Access to the installations generally should entail no difficulty. The lack of trees in the area also tends to reduce turbulence in the windstream. Third, widely dispersed population

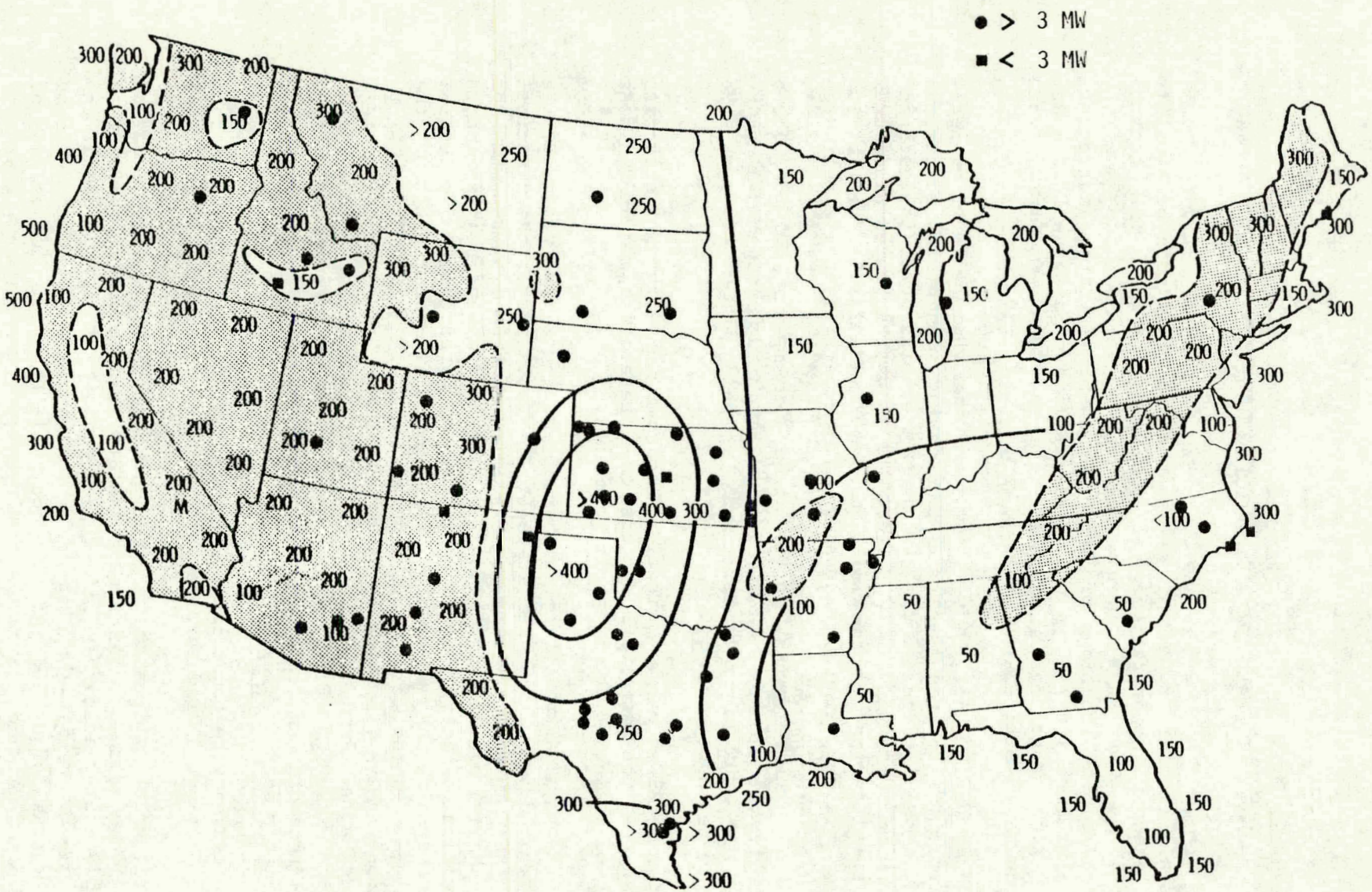

Figure 2-1. Seasonally Averaged Summer Mean Wind Power Contours [3] and Location of Small Summer-Peaking Rural Electric Cooperatives

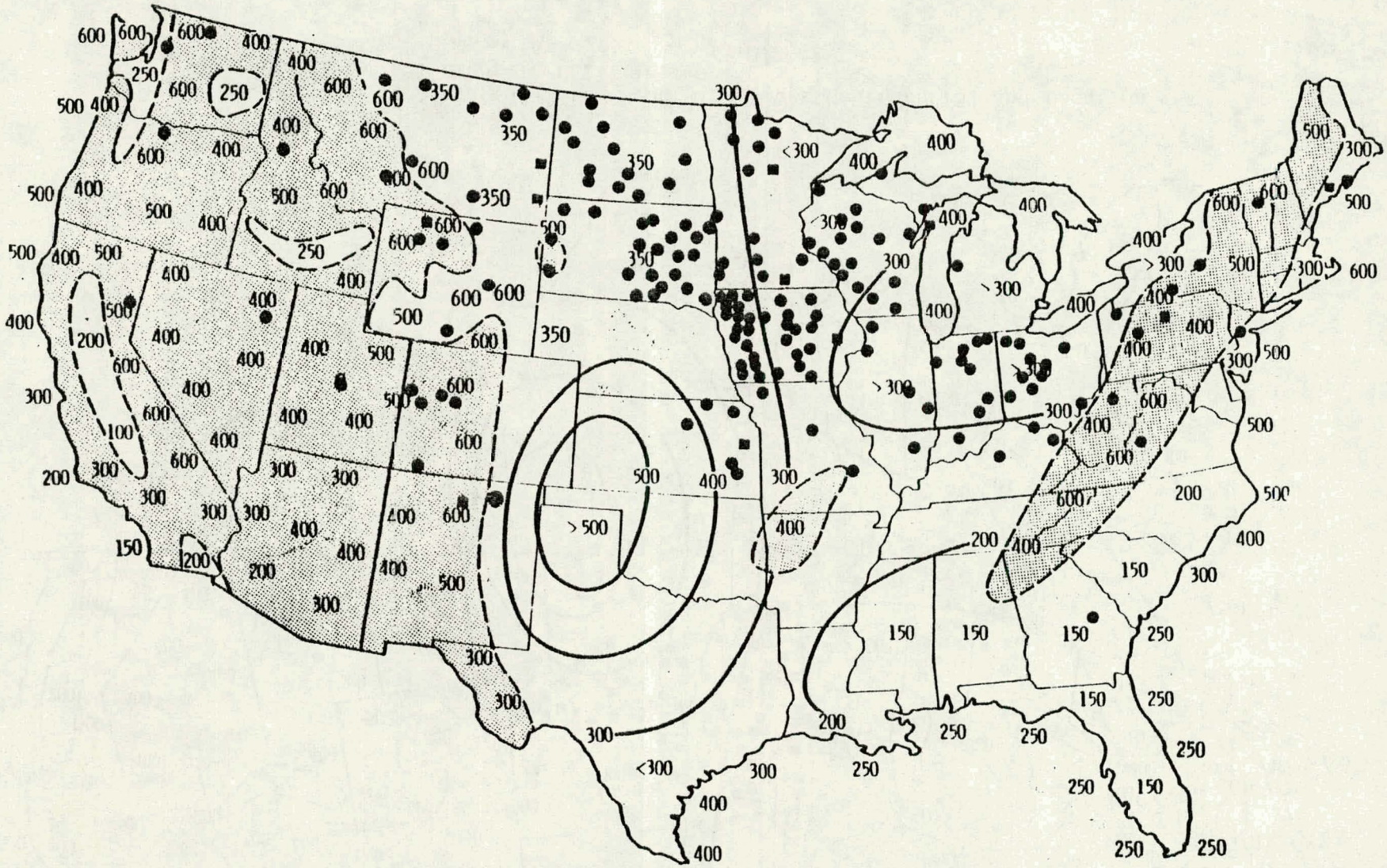

Figure 2-2. Seasonally Averaged Winter Mean Wind Power Contours [3] and Location of Small Winter-Peaking Rural Electric Cooperatives

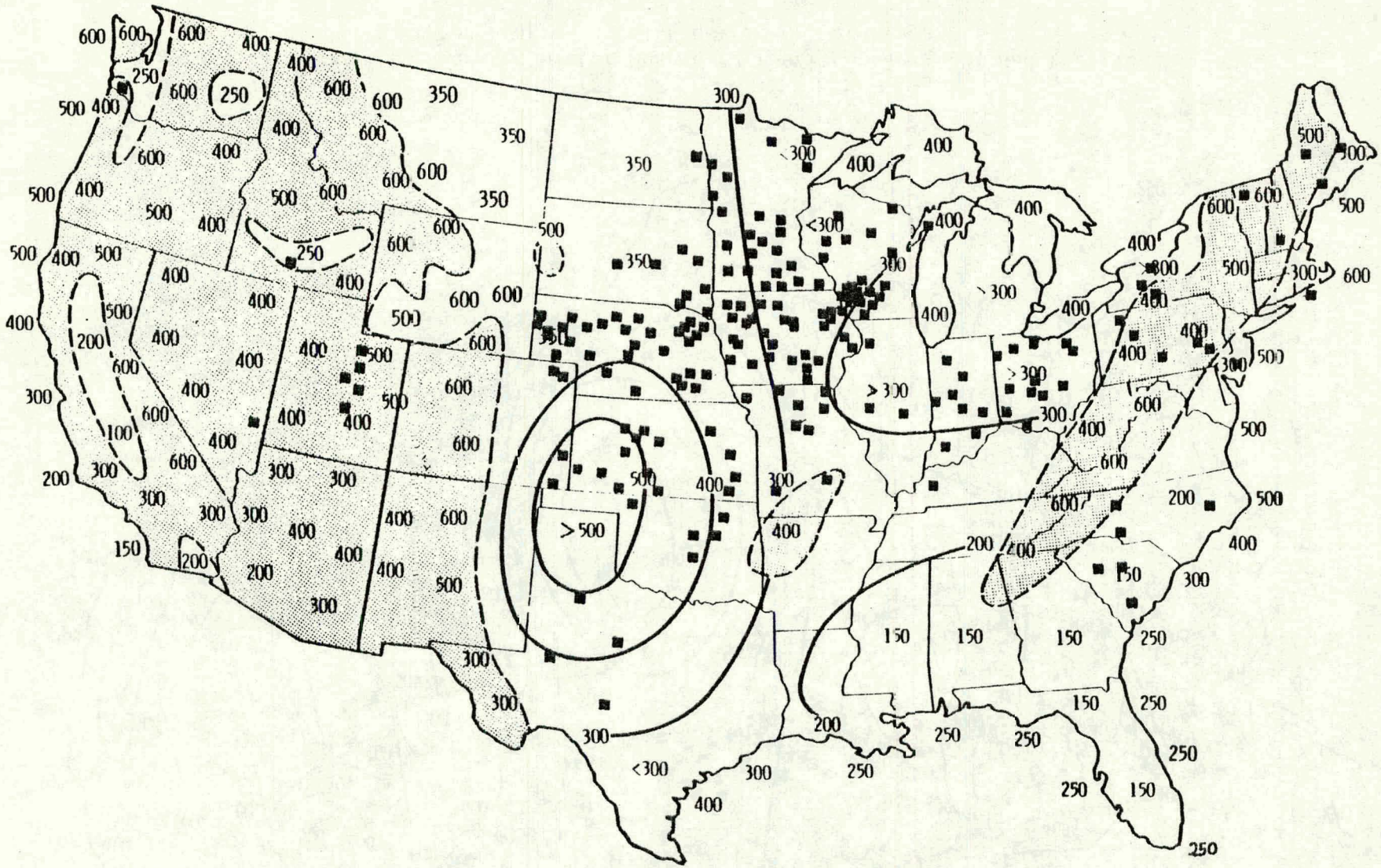

Figure 2-3. Seasonally Averaged Winter Mean Wind Power Contours [3] and Location of Municipal Electric Utilities

centers minimize the chance of electromagnetic interference with TV and radio communication.

That the plains are in the geographical center of the country also has commercial implications. If a WECS manufacturing facility were built in Iowa, it would have ready access to the entire midwest for early production. As the WECS market expanded, the central location would retain its place for new manufacture. Probably as important as the maturing technology would be a centrally located rebuilding and service facility. (Freight rates for the large and bulky components of WECS can be expected to be high.)

The Great Plains region has historically been host to many wind turbines. Estimates of electricity-generating WECS still surviving range into the thousands, and there are many more thousands of surviving small water pumping windmills. It would be surprising if the people living on the plains severely opposed the building of large WECS; this might not be the case in other areas of the country.

In summary, there are many small REC and municipal utilities for which present day WECS could provide a substantial portion of the peak electrical demand with substantial fuel savings accruing for energy produced. Most of these utilities are in the Great Plains. Commercial development of WECS should concentrate on this region in order to foster a strong commercial base in a discrete geographical region.

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SECTION 3.0

WECS ECONOMIC ISSUES

3.1 BENEFITS AND PENALTIES TO THE UTILITY

Both systems and penalties may befall the small utility that installs wind systems. Naturally the amount of energy (kWh) that must be purchased or generated by conventional means would be reduced, with the greatest benefit to the utility occurring during its period of peak demand. To the degree that wind energy and peak demand are coincident, there would be a direct monetary benefit from the displacement of high marginal cost power. More than likely, the energy produced by the WECS would reduce the amount of oil required for producing electricity.

If the primary source of electricity to the small utility is purchased, some supply contractual problems might arise. Some supply contracts require a minimum energy purchase over a given time period. Wind systems, perhaps in combination with conservation efforts, could cause a violation of this clause and financial penalty. However, this penalty would be more than offset by the reduction in demand charges. A reduction in the energy purchased or generated might require a rate increase because the capital cost of existing equipment must be recovered through fewer kWh.

Because of the unpredictability of wind, it probably would not be possible to consider the entire WECS installed capacity as available to meet system demands. Also, WECS probably cannot be considered as part of the required spinning reserve. For these reasons the total conventional capacity required to be spinning approaches that required without the wind plants. Also, all available wind energy would be utilized because of its near zero incremental cost, so that the average load on the conventional units probably would decrease, causing the average efficiency to decrease also.

3.2 TRANSMISSION AND DISTRIBUTION SYSTEM CREDITS AND COSTS

Transmission and distribution cost effects of wind plants is a topic of current research. The WECS location with respect to the utilities' service area and existing facilities affects the costs or credits (if any) attributable to the wind facilities when compared to conventional power plants. The existence of a source of power such as WECS on the distribution system might require modifications to the present relaying fusing and voltage control systems to ensure prompt fault clearing, acceptable voltage, personnel safety, and prevention of damage to utilization equipment. The solution to these and other concerns could involve costs that would reduce the advantages of individual applications of WECS.

3.3 EFFECTS ON UTILITY ECONOMICS OF INDEPENDENT WECS (PASSIVE SYSTEMS)

The addition of wind systems at the user's location means a reduction in conventionally produced energy, but if backup must be provided conventional facilities must be capable of supplying peak requirements. This might necessitate rate changes and the institution of a demand charge if one is not presently in force.

3.4 IMPACTS ON GENERATION CONSTRUCTION SCHEDULES AND COSTS

The addition of WECS might delay the addition of conventional power sources, a delay which could mean paying more for the conventional power plants but could also allow for technological advances. The amount of delay would depend on the allowed WECS capacity credit. Likewise, the total installed capacity would be larger than for conventional generators unless the WECS capacity credit were equal to 100%.

3.5 NON-UTILITY OWNERSHIP

Smaller utilities face a unique difficulty in the use of WECS because they must of necessity take less risk with respect to new technologies. A suitable strategy might therefore be for a third party to reduce this risk to the utility.

The existence at the load of wind systems also capable of supplying energy to the utility grid might require extra hardware and special operational procedures. To prevent the backfeed of current from WECS into a fault, additional equipment would be needed and new distribution system design concepts might need to be developed. To allow repair of the distribution system, a means to positively disconnect all WECS must be provided and access be made available to the utility. To determine the quantity of energy provided to the utility, extra metering would be needed because the utility probably would not pay the same amount for electricity received as for electricity produced.

3.6 LEVEL OF WECS INSTALLED CAPACITY (PENETRATION)

The level of WECS installed capacity determines its effect on a utility. Very small penetration by WECS causes little to no system-wide operational difficulties, although there might be some localized problems and special hardware requirements. For the utility that generates its own electricity, the reduction in the average efficiency of the generation system would probably not be noticed.

Larger penetration into a utility by wind systems can cause several problems. For the utility that purchases its electricity, significant reduction in peak kW demand and kWh purchases would have a positive economic effect. For the utility that generates electricity, large WECS penetrations would require generating system operation and expansion modifications. The intermittent nature of the wind would probably not allow the system dispatchers to consider the full WECS capacity as available to meet system demands. Thus the capacity of the conventional power plants committed to service would approach that required if the wind plants did not exist, with the nearness of the approach dependent on the capacity credited to the wind plants. Since the wind plants would have an incremental cost of power production near zero, maximum available wind energy would be utilized, requiring that conventional power plants compensate for wind fluctuations. Since the conventional capacity spinning approaches that required without the wind plants, the average load on each conventional unit would be lowered, resulting in a reduced efficiency of these units. Unless the wind availability were as reliable as a conventional boiler, extra capacity would also need be installed.

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SECTION 4.0

DISTRIBUTED VS CENTRALIZED SYSTEMS--TECHNICAL ISSUES

WECS in sizes smaller than 10 MW for REC or municipal utilities can be classified as distributed systems. Centralized systems, on the other hand, are similar to conventional power stations, having large total installed capacities of 50 to 100 MW. The distinction between distributed and centralized systems is made here on technical rather than economic considerations. Distributed wind systems may be connected at different points of a T&D network at local centers on the distribution system or on subtransmission. Such dispersed interconnections pose distinctly different technical problems than do larger central system installations connected to high voltage main grid transmission. Distributed systems also pose different economic and institutional problems.

4.1 MACHINE SIZE

Wind systems can be classified into

- small systems < 50 kW
- medium size systems 50 to 300 kW
- large systems > 300 kW

Although the classification is not rigid, the three categories represent different technologies. Small systems have to be built with high reliability and safety in unattended operation, perhaps to utilize lower average wind speeds, and to be suitable for domestic use. There has been considerable experience with this size of machine. (Table 4-1).

TABLE 4-1. COST IN $/FT^2 OF SOME TYPICAL WIND MACHINES ON THE MARKET

Manufacturer	Machine Size (kW)	Rated Speed (mph)	Blade Diameter (ft)	Total Cost of System ($)	$/ft^2 of Swept Area	Remarks
Aeropower	1.0	25	4.5	2,500	44.0	
American Wind Turbine	1.8	20	16	2,675	13.3	water pumping
Dynergy	5.0	24	15	5,800	32.9	vertical axis
Kedco	3.0	25	16	3,500	17.5	
Grumman	15.0	26	25	20,000	40.0	

Medium-size machines may have the greatest applicability in the near future because technology can be scaled up from small machines with some modification. There are many distributed applications that can use this size of machine; e.g., irrigation systems, desalination plants, electricity production for rural communities, etc. There has been considerable experience in Europe, accumulated in the 1950s and 60s, which has made the

construction of these machines familiar territory. Considerable operating experience has accrued from the European Gedser Mill and Hutter's machines, and in this country from the early Smith Putnam machine and more recently the DOE/NASA Mod 0 machines.

Large machines in the MW size range are currently being designed. They are still in the experimental stage and a few years are needed for the technology to mature.

Each size machine has its own markets. It is conceivable that distributed wind systems could include all of the machine sizes. The REC and municipal electric utilities may in the future have machines of all sizes connected to their systems. The small machines will almost certainly be located at load centers under utility ownership, servicing, or backup.

Medium-size machines could be located at load centers, as in irrigation, or could serve as electric power plants individually or in clusters at good wind sites. Such a power plant would most likely be owned by RECs and municipal utilities. The technology for these machines has been developed and mass production could make them economically viable in the 1980s for RECs and municipal utilities.

Large machines perhaps will make the largest contribution to the national energy scene in the 1990s. The technology is yet to be proven, with considerable research and development needed.

4.2 ONE-WAY AND TWO-WAY POWER FLOW

In one-way power flow connection there is no power transfer from the WECS to the grid. In a two-way connection power can flow both ways. (See Figure 4-1). Flow of power back to the utility system poses both technical and business complications. It is conceivable that a consumer having a wind system could be supplying power instead of consuming it. Then the cost of distribution, backup, and other factors must be incurred by the utility, making development of rate structures quite complex. On the other hand, for a passive connection wind energy is used to decrease the energy consumption and peak demand. In this case the present rate structures may continue with minor modifications.

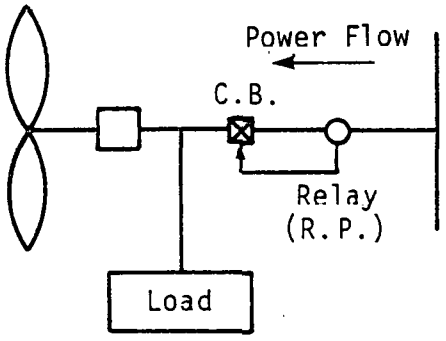

Figure 4-1-a. Wind Energy System Connected to the Utility Grid for One-Way Power Flow.

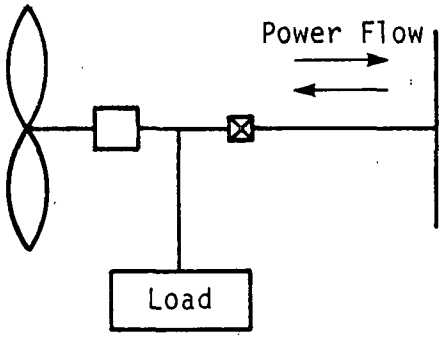

Figure 4-1-b. Wind Energy System Connected to the Utility Grid for Two-Way Power Flow.

With a reverse power relay to sense excess WECS-generated energy being fed into the utility and passive interconnection, a wind system can be isolated from the utility system when the power reverses. In this case the necessary 60-Hz reference signal is provided by the utility system for the synchronous inverter if one is used with the wind system. Alternatively, the utility could provide the excitation and starting power necessary for induction generators. The wind system does not feed into the fault on the utility system because it becomes isolated by the reverse power relay. This connection is preferred if the wind system is at the load site and owned by the consumer.

In an active interconnection, power flow can occur both ways. The wind system is connected to the utility distribution or transmission network wherever it is convenient; for example, at a substation. The wind system can interact dynamically with the rest of the system, making voltage transients and stability important. These problems are far more serious in a distributed system than in central power stations, because the wind systems may be weakly coupled to the power system as a result of long transmission or distribution network segments separating the wind machine from other generators. Also, in case of a fault with a synchronous generator, a wind machine can feed power into the fault. This puts additional burdens on protection systems.

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SECTION 5.0

IMPACTS ON TRANSMISSION AND DISTRIBUTION SYSTEM

Several benefits may accrue from distributed wind systems as compared to central station wind power plants from the point of view of electric transmission and distribution system design and operation. Some of the important factors are discussed here.

5.1 LOAD-SUPPLYING CAPABILITY OF TRANSMISSION SYSTEM

Unlike the central station, distributed wind systems located close to the load may sometimes result in credits from increased load-supplying capability in the system. In an electric utility system the maximum load that the system can supply is usually limited by a number of design and operating factors, including generation, transmission, and distribution on the system and neighboring interconnecting systems.

5.2 TRANSMISSION LOSSES

As shown schematically in Figure 5-1, the current flowing through the transmission line is reduced because the wind system supplies part of the load [4].

5.3 TRANSFORMER SIZE

When the wind system is supported by dedicated storage in a distributed system, peak load-sharing can be accomplished. In that case, the transformer size required is smaller than that for a power system without distributed wind power plants. [4]

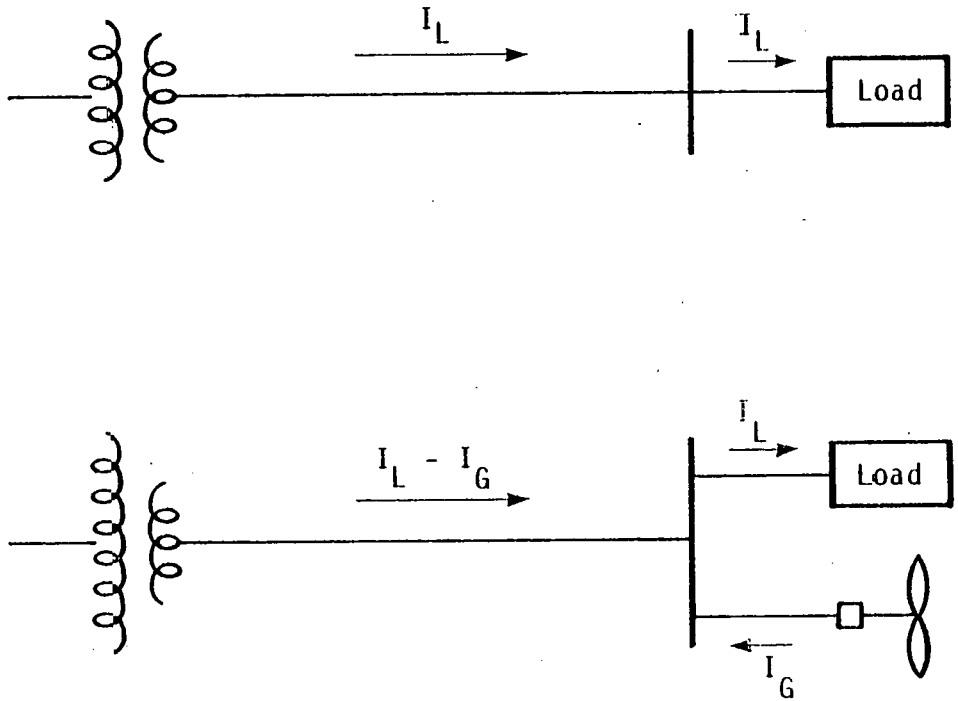

Figure 5-1. Decrease in Transmission Current Due to Wind Gusts

SECTION 6.0

SYSTEM PROTECTION FOR DISTRIBUTED SYSTEMS

6.1 POWER SYSTEM STABILITY

A wind system at the end of a transmission line or a distribution feeder is weakly connected to the synchronous machines in the system. If the WECS incorporates a synchronous generator, as in NASA-developed wind systems, the weak coupling can lead to instabilities. The problem is compounded by the fact that wind gusts can cause large power changes (power being proportional to the cube of wind velocity) in fractions of a second. The control systems that respond to such power changes in such short times have to be very fast. Such power oscillations could also affect nearby electrical equipment connected to the same feeder.

In distributed wind systems this problem is compounded because the host system to which the WECS is connected may be small, of a size comparable to the wind system itself. In this case wind gusts could set up oscillations with synchronizing power exchanges occurring between the WECS and the conventional generator in parallel. Such a situation would be typical of many RECs and municipal utilities where the installed capacity is of comparable size to the WECS. The transient stability problems associated with machines of a comparable size are far more complicated than the problem of a wind system connected to an infinite bus, which has been studied recently by NASA.

6.2 VOLTAGE TRANSIENTS

When the wind system is subjected to gusts, the input power fluctuates over a wide range in a few seconds. This causes the load angle in a synchronous machine to change, causing changes in power and voltage at the terminals as shown in Figure 6-1. This could affect the operation of appliances connected to the system, particularly brief changes in the vertical height of a television picture. If the wind system is connected through an asynchronous link, voltage transients can be controlled effectively.

6.3 HARMONICS

Waveform of voltage as supplied by conventional generators is a pure sinewave. However it can deviate from sinewave due to other generators or loads resulting from injection of harmonics. When a synchronous or induction generator is used, there are no problems with harmonics. If a synchronous inverter is used to interface WECS with the power system, attention should be paid to harmonics. The output current of a synchronous inverter is shown in Figure 6-2. A straightforward Fourier analysis can be done to calculate the magnitute of harmonics. Such a methodology, though on an entirely different power scale, has been applied to HVDC systems.

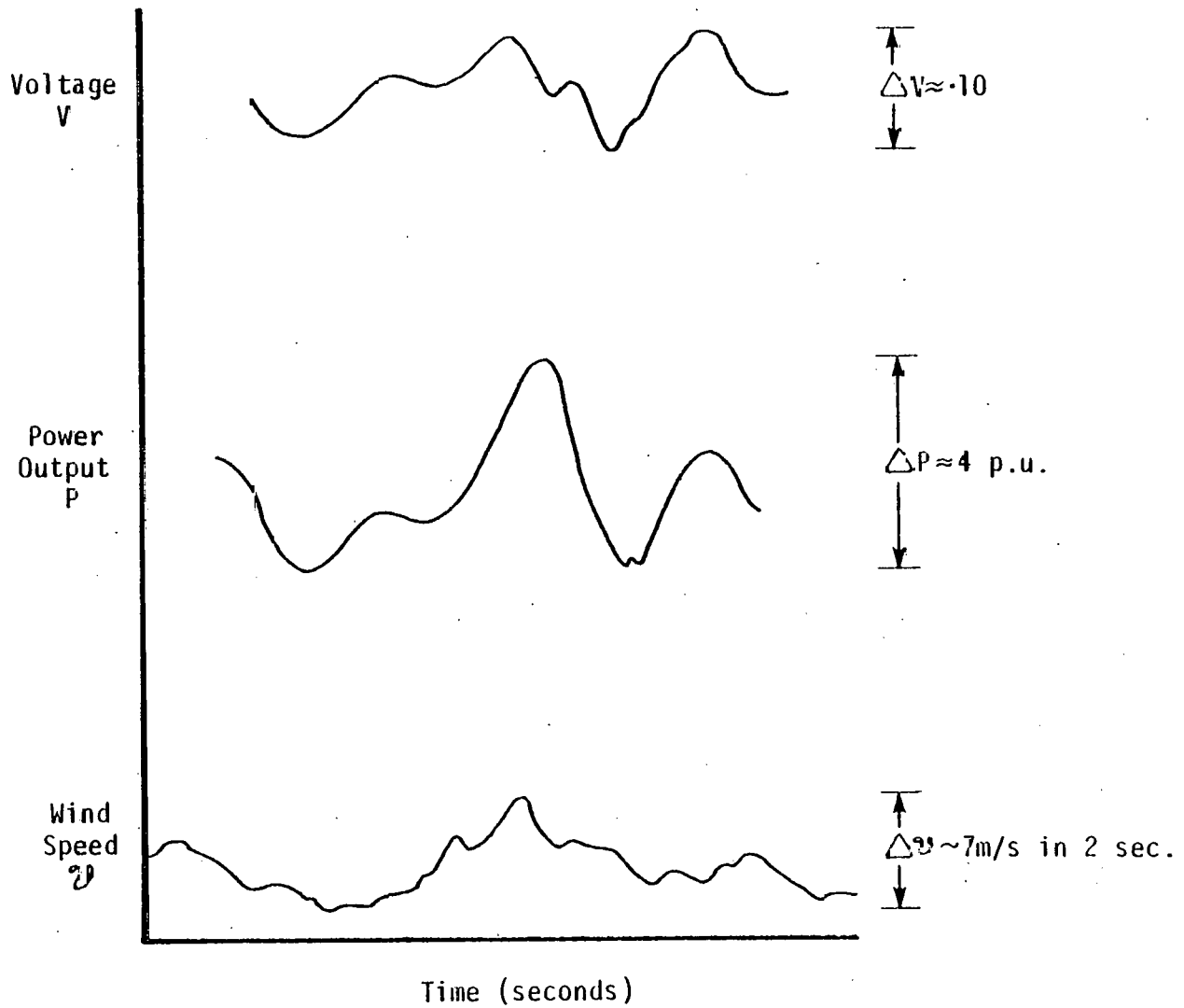

Figure 6-1. Line Voltage and Power Output Transients Due to Wind Gusts

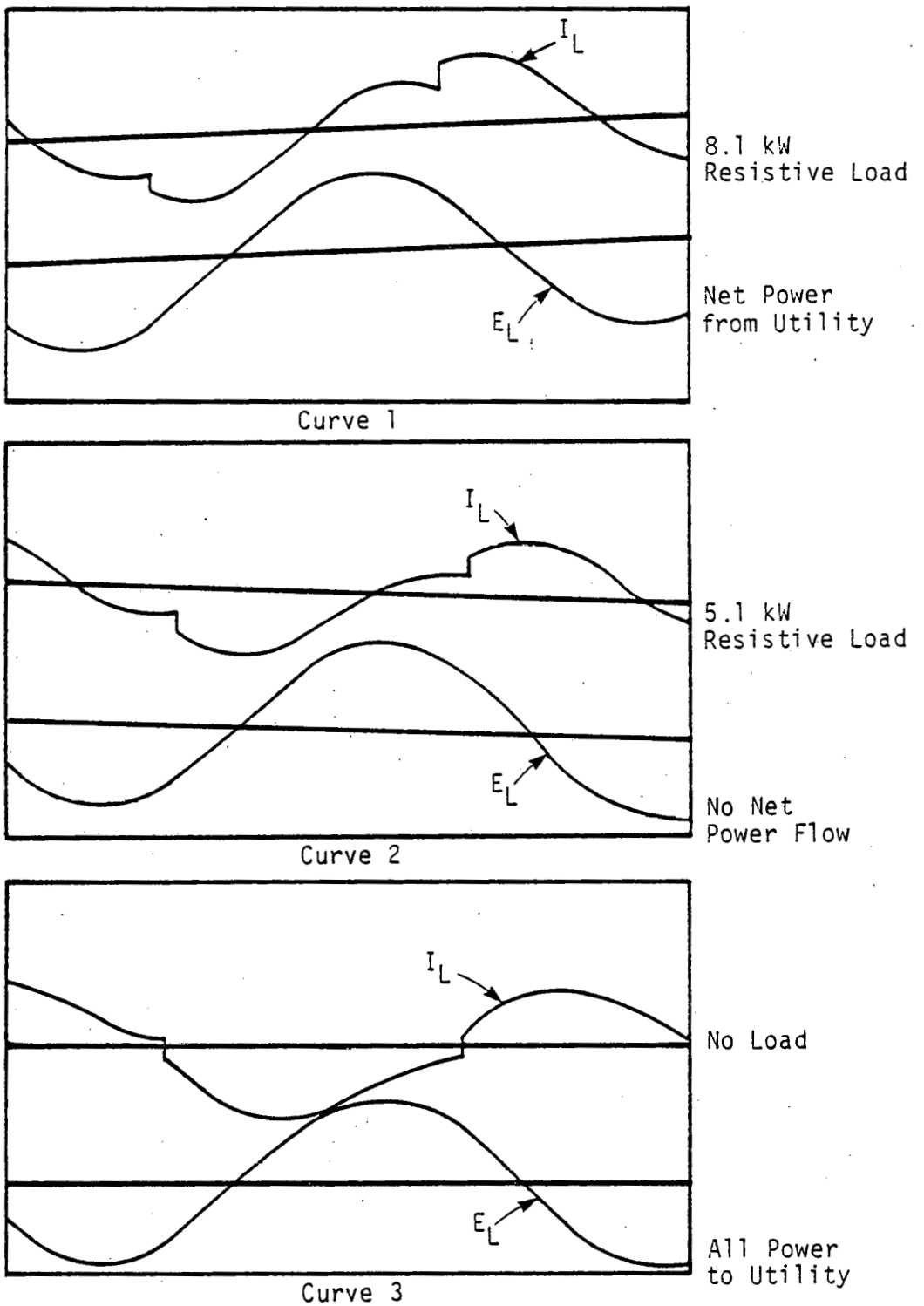

Figure 6-2. Current and Voltage Waveforms at the Interface of Synchronous Inverter and the Utility Grid

6.4 PERSONNEL SAFETY

When a number of wind generators are on a distribution system, personnel safety questions can arise. The circuit breakers may be open, isolating the feeder from the rest of the line. (Figure 6-3). However, if the wind system connected to the feeder continues generating, it presents danger to the workers on the feeder. If the WECS is using a synchronous inverter for the interface, triggering of SCRs could be derived from the line. In that case the SCRs will be open circuits when the feeder is dead, thus isolating the wind system from the feeder. If the wind machine is an induction generator, isolation is again automatic because excitation is derived from the feeder. However, if the induction generator has power factor connecting capacitators, there may be a danger that the induction generator is still producing power. In such a case protection schemes have to be devised to ensure safety of personnel.

6.5 FAULT INTERRUPTION CAPABILITY

Addition of another generator to the power system always has the potential to increase power feeding into a fault, particularly if the WECS is using synchronous generators where excitation systems are independent. To remedy the problem, the interruption capability of protection devices has to be increased and the protection devices must be coordinated for proper functioning. If an asynchronous link is provided (an induction generator) that receives excitation from the grid, there is no fault power fed into the fault by WECS. This is another incentive for using induction generators in WECS.

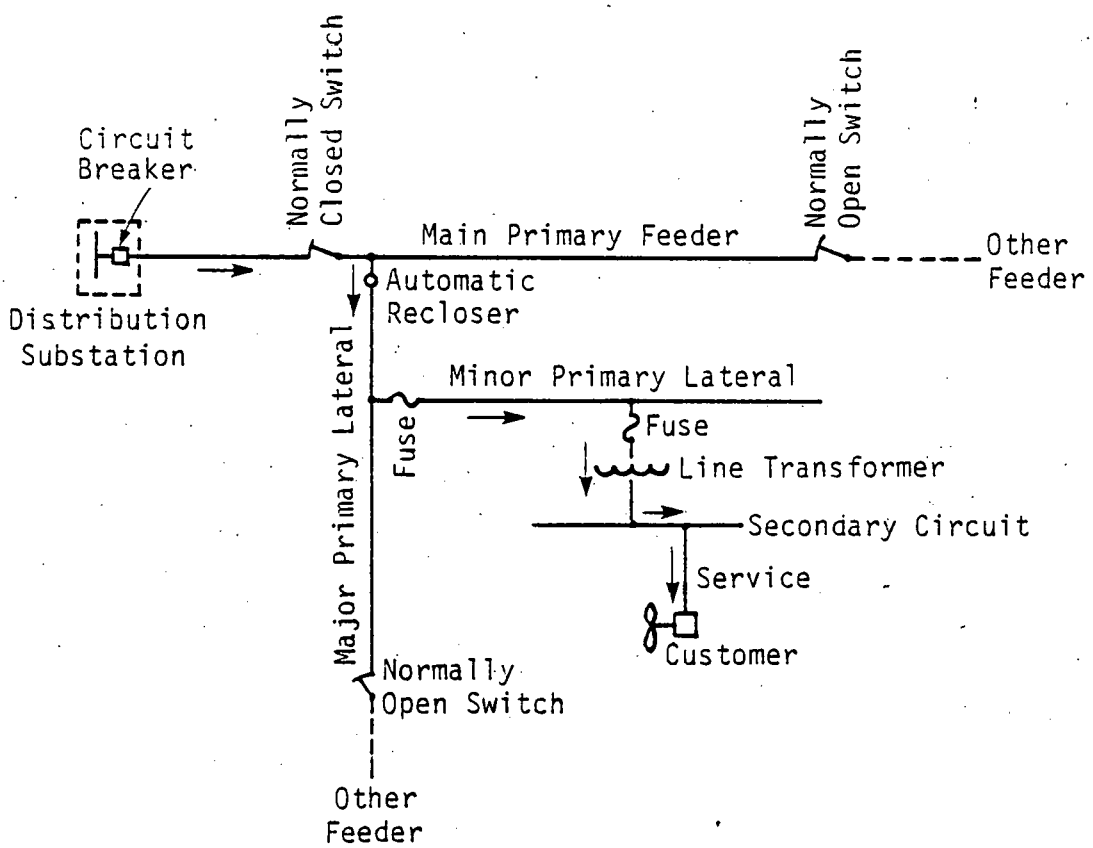

Figure 6-3. Wind Energy System in a Typical Utility Distribution Environment

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SECTION 7.0

SOCIAL ISSUES

Many social issues are involved in the expansion of a new technology. Some of the issues of major importance to the commercialization of WECS are:

- environmental effects of thermal, noise, or chemical pollution,
- effects on communication,
- physical protection of people and livestock,
- legal liabilities and insurance, and
- land use issues.

This list should not be taken as exhaustive. For elaboration on these points, the reader is referred to the bibliography.

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Appendix A
1974 OPERATING DATA FOR SMALL RURAL ELECTRIC COOPERATIVES[1]

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Alaska						
Glacier Highway Elec. Assn.	Auke Bay	900	1,500	0	-	5.82
Kodiak Elec. Assn., Inc.	Kodiak	6,890	7,430	12,778	Diesel	5.83
Kotzebue Elec. Assn., Inc.	Kotzebue	806	1,240	3,400	Diesel	12.04
Naknek Elec. Assn., Inc.	Naknek	850	1,050	1,550	Diesel	10.0
Nushagar Elec. Coop., Inc.	Dillingham	530	850	1,900	Diesel	11.6
Arizona						
Duncan Valley Elec. Coop.	Duncan	3,257	2,557	0	-	3.04
Elec. Dist. No. 4 Pinal Co.	Eloy	26,000	9,500	0	-	N/A
Graham Co. Elec. Coop.	Pima	16,868	9,871	0	-	3.2
Arkansas						
Ashley-Chicot Elec. Coop., Inc.	Hamburg	9,415	5,842	0	-	2.69
Clay Co. Elec. Coop. Corp.	Corning	9,253	7,352	0	-	3.0
Farmers Elec. Coop. Corp.	Newport	14,469	9,618	0	-	2.1
Mississippi Co. Elec. Coop., Inc.	Blythe-ville	8,045	6,159	0	-	2.3
Rich Mountain Elec. Coop., Inc.	Mena	9,001	8,334	0	-	3.1

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
California						
Anza Elec. Coop., Inc.	Anza	2,066	2,232	0	-	4.4
Lumas-Sierra Rural Elec. Coop., Inc.	Portola	7,000	9,450	0	-	1.08
Colorado						
Delta-Montrose Rural Power Lines Assn.	Delta	5,110	6,254	0	-	2.4
Grand Valley Rural Power Lines, Inc.	Grand Junction	8,821	10,850	0	-	2.6
Gunnison Co. Elec. Assn., Inc .	Crested Butte	3,800	8,915	0	-	2.7
K.C. Elec. Assn.	Hugo	6,300	5,220	0	-	N/A
La Plata Elec. Assn., Inc.	Durango	7,619	9,092	0	-	2.8
San Luis Valley Rural Elec. Coop., Inc.	Monte Vista	34,062	9,801	0	-	2.9
Sangre De Cristo Elec. Assn.	Buena Vista	5,149	7,783	0	-	2.9
San Miguel Power Assn., Inc.	Nucla	8,000	N/A	0	-	2.5
White River Elec. Assn., Inc.	Meeker	9,040	8,980	0	-	1.6
Georgia						
Slash Pine Elec. Member-ship Corp.	Homer-ville	9,175	8,898	0	-	2.8

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
The Little Ocmulgee Elec. Membership Corp.	Alamo	8,348	9,008	0	-	N/A
Upson Co. Elec. Membership Corp.	Thomaston	9,350	8,973	0	-	N/A
Idaho						
Idaho Co. Light & Power Coop. Assn., Inc.	Grangeville	4,300	8,834	0	-	1.5
Lost River Elec. Coop., Inc.	Mackay	9,431	3,706	0	-	1.4
Prairie Power Coop., Inc.	Fairfield	1,013	643	0	-	3.2
Raft River Elec. Coop., Inc.	Malta	39,000	9,000	0	-	1.5
Salmon River Elec. Coop., Inc.	Challis	5,373	4,130	0	-	1.8
Illinois						
Clay Elec. Coop., Inc.	Flora	5,785	7,897	0	-	2.1
Edgar Elec. Coop. Assn.	Paris	8,758	10,448	0	-	2.54
Farmers Mutual Elec. Co.	Genesco	3,328	3,818	0	-	2.7
Illini Elec. Coop.	Champaign	8,530	10,950	0	-	3.0
Jo-Carrol Elec. Coop.	Elizabeth	6,250	9,620	0	-	2.8
Monroe Co. Elec. Coop.	Waterloo	10,168	8,529	0	-	2.75
Spoon River Elec. Coop.	Canton	9,133	8,632	0	-	3.0

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Indiana						
Fayette Union Co. Rural Elec. Membership Coop.	Liberty	4,685	6,250	0	-	2.12
Fulton Co. Rural Elec. Membership Coop.	Rochester	8,376	12,666	0	-	1.9
La Grange Rural Elec. Membership Coop.	La Grange	9,226	10,152	0	-	2.2
Marshall Co. Rural Elec. Membership Coop.	Plymouth	9,144	12,246	0	-	2.3
Miama Cass Co. Rural Elec. Membership Coop.	Peru	7,128	12,432	0	-	2.3
Newton Co. Rural Elec. Membership Coop.	Kentland	3,162	4,545	0	-	2.3
Orange Co. Rural Elec. Membership Coop.	Orleans	8,279	9,670	0	-	2.3
Rush Co. Rural Elec. Membership Coop.	Rushville	6,280	9,647	0	-	N/A
Steuben Co. Rural Elec. Membership Coop.	Angola	2,902	3,356	0	-	2.6
Iowa						
Adams Co Coop. Elec. Co.	Corning	3,709	5,789	0	-	2.8
Benton Co. Elec. Coop. Assn.	Vinton	7,837	11,036	0	-	2.4
Boone Valley Elec. Coop.	Renwick	830	1,280	0	-	2.3

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Buchanan Co. Rural Elec. Coop.	Indepen-dence	9,234	14,316	0	-	2.5
Butler Co. Rural Elec. Coop.	Allison	9,700	17,780	0	-	2.4
Cedar Valley Elec. Coop.	Ansgar	6,756	10,524	0	-	2.4
Chariton Valley Elec. Coop.	Albia	4,150	5,760	0	-	2.7
Cherokee Co. Rural Elec. Coop.	Cherokee	4,560	6,159	0	-	2.1
Clarke Elec. Coop., Inc.	Osceola	8,267	11,462	0	-	3.23
D.E.K. Rural Elec. Coop.	Ester-ville	7,993	11,210	0	-	2.5
Farmer's Elec. Coop., Inc.	Green-field	9,677	18,698	0	-	2.6
Franklin Rural Elec. Coop.	Hampton	N/A	7,871	0	-	2.7
Glidden Rural Elec. Coop.	Glidden	4,150	6,100	0	-	2.8
Grundy Co. Rural Elec. Coop.	Grundy Center	5,200	8,372	0	-	2.9
Guthrie Co. Rural Elec. Coop. Assn.	Guthrie Center	9,372	11,569	0	-	2.7
Hancock Co. Rural Elec. Coop.	Garner	4,635	7,169	0	-	3.1
Hardin Co. Rural Elec. Coop., Inc.	Iowa Falls	8,838	12,137	0	-	2.9

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Harrison Co. Rural Elec. Coop.	Woodbine	N/A	8,112	0	-	2.4
Humboldt Co. Rural Elec. Coop.	North Humboldt	5,000	7,214	0	-	3.2
Ida Co. Rural Elec. Coop.	Ida Grove	3,024	5,283	0	-	2.3
Lyon Rural Elec. Coop.	Rock Rapids	6,012	8,934	0	-	1.8
Marshall Co. Rural Elec. Coop.	Marshall-town	9,991	10,932	0	-	N/A
Monona Co. Rural Elec. Coop.	Onawa	7,382	6,781	0	-	2.4
Wyman Elec. Coop.	Stanfer	3,945	4,970	0	-	2.8
O'Brien Co. Rural Elec. Coop.	Primghar	4,080	6,191	0	-	2.3
Osceola Rural Elec. Coop.	Silbey	3,048	4,248	0	-	2.19
Pella Coop. Elec. Assn.	Pella	3,768	4,449	0	-	2.9
Plymouth Elec. Corp.	Le Mars	8,619	11,416	0	-	2.8
Pocahontas Rural Elec. Coop.	Pocahontas	7,024	10,208	0	-	2.8
Rideta Elec. Coop., Inc.	Mount Ayr	4,843	6,381	0	-	N/A
Sac Co. Rural Elec. Coop.	Sac City	3,610	4,270	0	-	N/A
Sioux Elec. Coop. Assn.	Orange City	9,240	13,456	0	-	N/A

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
South Crawford Rural Elec. Coop.	Denison	3,997	3,886	0	-	N/A
Southern Iowa Elec. Coop. Inc.	Bloomfield	8,940	10,135	0	-	2.7
Woodbury Co. Rural Elec. Coop.	Moville	4,152	6,312	0	-	2.4
Wright Co. Rural Elec. Coop.	East Clarion	7,299	10,295	0	-	3.2
Kansas						
Brown-Atchison Elec. Coop. Assn.	Horton	5,976	7,101	0	-	N/A
Caney Valley Elec. Coop. Assn.	Cedar Vale	8,297	6,345	0	-	3.3
The C.M.S. Elec. Coop.	Meade	10,057	5,674	0	-	3.1
Coffey Co. Elec. Coop. Assn.	Burlington	3,691	4,554	0	-	N/A
Doniphan Elec. Coop. Assn.	Troy	2,762	2,716	0	-	2.4
Great Plains Elec. Coop. Assn.	Colby	12,916	8,208	0	-	2.9
Iola Coop. Elec. Light & Power	Iola	6,000	6,400	0	-	3.12
Lane-Scott Elec. Coop.	Pighton	10,466	6,562	0	-	2.9
Leavenworth Jefferson Elec. Coop.	McLouth	8,847	9,507	0	-	2.4
Lyon Co Elec. Coop, Inc.	Emporia	4,737	4,232	0	-	2.21

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Nick Elec. Coop., Inc.	Belle-ville	12,081	7,557	0	-	3.06
Nemaha Marshall Elec Coop. Assn., Inc.	Axtell	7,657	8,390	0	-	2.1
Winnescah Rural Elec. Coop.	Pratt	6,050	4,350	0	-	2.15
Northwest Kansas Elec. Coop. Assn., Inc.	Bird City	7,070	4,207	0	-	3.4
Norton-Decatur Coop. Elec. Co.	Norton	15,410	9,335	0	-	3.6
P.R. and W.C. Elec. Coop. Assn.	Wamego	6,027	4,563	0	-	2.9
Radiant Elec. Coop., Inc.	Fredonia	8,075	6,832	0	-	2.64
Sekan Elec. Coop. Assn., Inc.	Girard	7,913	5,919	0	-	2.7
Smoky Hill Elec. Coop., Inc.	Ellsworth	5,261	5,054	0	-	3.3
Smoky Valley Elec. Coop. Assn.	Lindsberg	994	804	0	-	2.9
Sugar Valley Elec. Coop. Assn.	Mount City	2,750	3,000	0	-	N/A
Sumner Cowley Elec. Coop., Inc.	Wellington	9,811	7,975	0	-	1.9
Twin Valley Elec. Coop., Inc.	Altamont	4,163	3,469	0	-	2.7
Victory Elec. Coop. Assn., Inc.	Dodge City	16,733	8,681	0	-	3.0
Kentucky						
Fox Creek Rural Elec. Coop. Co.	Lawrence-burg	8,664	12,012	0	-	2.9

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Grayson Rural Elec. Coop. Co.	Grayson	9,930	14,886	0	-	3.1
Louisiana						
Pointe Coupee Elec. Member-ship Corp.	New Roads	15,908	6,552	0	-	2.5
Maine						
Kingman Elec. Coop.	Kingman	1,000	1,050	0	-	N/A
Swans Island Elec. Coop., Inc.	Minturn	310	245	350	Diesel	N/A
Union River Elec. Coop., Inc.	Aurora	600	622	0	-	N/A
Michigan						
Alger Delta Coop. Elec. Assn.	Gladstone	6,105	7,367	0	-	2.9
Oceana Elec. Coop.	Hart	10,104	9,600	0	-	3.0
The Ontonagon Co. Rural Elec. Assn.	Ontonagon	2,589	3,350	0	-	4.0
Western Michigan Elec. Coop.	Scottville	7,824	7,912	0	-	3.2
Minnesota						
Arrowhead Elec. Coop.	Lutsen	2,498	2,831	0	-	3.4
Brown Co. Rural Elec. Assn.	Sleepy Eye	9,282	13,633	0	-	2.22
Carlton Co. Coop. Power Assn.	Kettle River	8,503	10,322	0	-	3.6
Clearwater-Polk Elec. Coop., Inc.	Bagley	6,372	8,982	0	-	2.3

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Faribault Co. Coop. Elec. Assn.	Frost	3,580	5,079	0	-	2.7
Goodhue Co. Coop. Elec. Assn.	Zumbrota	8,285	13,277	0	-	2.6
Itasca Mantrap Coop. Elec. Assn.	Park Rapids	7,733	8,570	0	-	2.6
Lyon-Lincoln Elec. Coop., Inc.	Tyler	8,097	12,294	0	-	N/A
North Pine Elec. Coop., Inc.	Finlayson	6,758	9,220	0	-	3.32
North Star Elec. Coop.	Baudette	6,305	8,028	0	-	2.4
Red Lake Elec. Coop.	Red Lane Falls	6,500	12,470	0	-	2.23
Red River Valley Coop. Power Assn.	Halstad	9,343	13,293	0	-	2.0
Renville Sibley Coop. Power Assn.	Danube	7,600	11,029	0	-	N/A
Roseau Elec. Coop., Inc.	Roseau	8,684	11,426	0	-	2.3
South Central Elec. Assn.	St. James	9,293	15,389	0	-	2.3
Southwestern Minn. Coop. Elec.	Pipestone	8,298	12,192	0	-	2.0
Traverse Elec. Coop.	Wheaton	6,361	9,276	0	-	2.0
Wells Elec. Assn.	Wells	1,877	2,560	0	-	2.9
Missouri						
Barton Co. Elec. Coop., Inc.	Lamar	10,160	9,150	0	-	2.3

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Crawford Elec. Coop., Inc.	Bourbon	7,456	8,087	0	-	3.0
Gascosage Elec. Coop.	Dixon	12,461	9,737	0	-	2.1
Howard Elec. Coop. Assn.	Fayette	3,650	4,040	0	-	2.9
Nodaway Worth Elec. Coop., Inc.	Maryville	8,650	10,648	0	-	2.7
Ralls Co. Elec. Coop. Assn.	New London	6,150	6,500	0	-	2.9
Se-Ma-No Elec. Coop.	Mansfield	6,075	5,722	0	-	3.2
Montana						
Beartooth Elec. Coop., Inc.	Red Lodge	4,720	6,668	0	-	2.2
Big Flat Elec. Coop., Inc.	Malta	1,966	3,674	0	-	2.6
Flathead Elec. Coop., Inc.	Kalispell	8,715	8,675	0	-	1.4
Goldenwest Elec. Coop.	Wibaux	N/A	2,422	0	-	3.0
Hill Co. Elec. Coop., Inc.	Havre	6,594	9,861	0	-	2.3
Marias River Elec. Coop., Inc.	Shelby	8,000	10,039	0	-	1.6
McCone Elec. Coop., Inc.	Circle	7,635	11,737	0	-	2.3
Mid Yellow-stone Elec. Coop., Inc.	Hysham	3,522	4,096	0	-	1.7
Northern Elec. Coop., Inc.	Opheim	-	6,750	0	-	2.2

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Park Elec. Coop., Inc.	Livingston	3,772	5,174	0	-	2.2
Sheridan Elec. Coop., Inc.	Medicine Lake	7,139	11,670	0	-	1.9
Southeast Elec. Coop., Inc.	Ekalaka	1,815	2,819	0	-	3.1
Tongue River Elec. Coop., Inc.	Ashland	5,609	7,448	0	-	2.6
Valley Co. Elec. Coop., Inc.	Glasgow	2,183	3,558	0	-	3.8
Vigilante Elec. Coop., Inc.	Dillon	17,153	8,992	0	-	2.0
Nebraska						
Panhandle Rural Elec. Member-ship Assn.	Alliance	23,413	7,499	0	-	3.0
Nevada						
Wells Rural Elec. Co.	Wells	5,568	5,780	120	Hydro	N/A
New Jersey						
Sussex Rural Elec. Coop., Inc.	Sussex	8,260	11,840	0	-	-
New Mexico						
Central New Mexico Elec. Coop., Inc.	Mountain-air	5,820	5,500	0	-	4.0
Columbus Elec. Coop., Inc.	Deming	14,352	5,388	0	-	4.2
Mora San Miguel Elec. Coop.	Mora	1,059	1,149	0	-	2.4
Northern Rio Arriba Elec. Coop., Inc.	Chama	2,700	2,416	0	-	3.6

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Sierra Elec. Coop., Inc.	Elephant Butte	3,231	2,341	0	-	4.1
Southwestern Elec. Coop., Inc.	Clayton	1,490	1,140	0	-	5.5
New York						
Delaware Co. Elec. Coop., Inc.	Delhi	5,986	3,680	0	-	2.6
Otsego Elec. Coop., Inc.	Hartwick	-	4,900	0	-	-
Steuben Rural Elec Coop., Inc.	Bath	5,100	8,500	0	-	2.2
North Carolina						
Cape Hatteras Elec. Membership Corp.	Button	4,020	1,890	2,600	Diesel	-
Halifax Elec. Membership Corp.	Enfield	10,637	9,377	o	-	3.3
Harker's Island Elec. Coop., Inc.	Harker's Isand	-	-	29 pole miles	-	-
Ocracoke Elec. Membership Coop.	-	220	160	345	Diesel	-
North Dakota						
Burke Divide Elec. Coop., Inc.	Columbus	-	8,461	0	-	2.3
Capital Elec. Coop., Inc.	North Bismarck	9,020	11,811	0	-	2.3
Cavalier Rural Elec. Coop., Inc.	Langdon	7,214	10,164	0	-	2.3
James Valley Elec. Coop., Inc.	Edgeley	7,848	12,807	0	-	2.4
Kem Elec. Coop., Inc.	Linton	6,812	10,361	0	-	2.6

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
McKenzie Elec. Coop., Inc.	Watford	5,332	8,404	0	-	2.8
McLean Elec. Coop., Inc.	Garrison	5,457	9,032	0	-	2.3
Mor-Gran-Sou Elec. Coop., Inc.	Flasher	8,227	14,243	0	-	2.5
Mountrail Elec. Coop., Inc.	Stanley	4,668	7,859	0	-	2.3
Oliver-Mercer Elec. Coop., Inc.	Hazen	6,883	-	0	-	2.2
R.S.R. Elec. Coop., Inc.	West Milnor	6,738	13,546	0	-	2.5
Sheyenne Valley Elec. Coop., Inc.	Finley	8,442	11,457	0	-	2.3
Slope Elec. Coop., Inc.	New England	5,468	9,240	0	-	2.4
West Plains Elec. Coop., Inc.	Dickinson	7,467	12,833	0	-	2.1
Williams Elec. Coop., Inc.	Williston	4,494	6,539	0	-	2.1
Ohio						
Adams Rural Elec. Coop., Inc.	West Union	5,589	6,805	0	-	3.1
Darke Rural Elec. Coop., Inc.	Green-ville	7,392	12,969	0	-	2.5
Delaware Rural Elec. Coop., Inc.	Delaware	-	7,618	0	-	-
Firelands Elec. Coop., Inc.	New London	9,892	14,195	0	-	2.5
Logan Co. Coop. Power & Light Assn., Inc.	Belle-fontaine	6,434	10,824	0	-	2.6

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Marion Rural Elec. Coop., Inc.	Marion	5,100	9,200	0	-	2.1
North Western Elec. Coop., Inc.	Bryan	6,994	11,026	0	-	2.7
Tri Co. Rural Elec. Coop.	Napoleon	6,591	7,567	0	-	2.7
Union Rural Elec. Coop., Inc.	Marysville	5,109	10,920	0	-	2.9
United Rural Elec. Coop., Inc.	Kenten	5,809	8,984	0	-	2.0
Washington Elec. Coop., Inc.	Marietta	7,942	11,767	0	-	2.9
Oklahoma						
Kiwash Elec. Coop., Inc.	Cordell	10,954	6,818	0	-	3.1
North Fork Elec. Coop., Inc.	Sayre	9,016	8,778	0	-	2.6
Oregon						
Columbia Power Coop.	Monument	8,147	8,100	0	-	2.0
Hood River Elec. Coop.	Odell	8,000	15,550	0	-	1.15
Pennsylvania						
New Enterprise Rural Elec. Coop.	New Enterprise	1,732	2,492	0	-	2.5
Sullivan Co. Rural Elec. Coop., Inc.	Forksville	4,593	8,678	0	-	2.6
Warren Elec. Coop., Inc.	Youngsville	-	6,837	0	-	2.5
South Carolina						
Coastal Elec. Coop., Inc.	Walterboro	10,551	9,122	0	-	2.5

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
South Dakota						
Beadle Elec. Coop., Inc.	Huron	6,030	6,747	0	-	2.7
Black Hills Elec. Coop., Inc.	Custer	5,416	7,079	0	-	2.8
Bon Homme-Yankton Elec. Assn., Inc.	Tabor	6,969	7,794	0	-	2.5
Butte Elec. Coop., Inc.	Newell	5,085	5,834	0	-	2.7
Cam Wal Elec. Coop., Inc.	Selby	6,434	8,540	0	-	2.3
Charles Mix Elec. Assn., Inc.	Lake Andes	4,761	5,052	0	-	-
Cherry Todd Elec. Coop., Inc.	Mission	9,520	9,310	0	-	2.3
Clay Union Elec. Coop.	Vermillion	6,237	6,768	0	-	2.12
Codington Clark Elec. Coop., Inc.	Watertown	6,096	10,347	0	-	2.43
Douglas Elec. Coop., Inc.	Armour	2,691	3,609	0	-	2.3
Fem Elec. Coop., Inc.	Ipswich	4,575	9,002	0	-	-
Grand Elec. Coop., Inc.	Bison	6,569	9,991	0	-	2.6
Intercounty Elec. Assn., Inc.	Mitchell	8,622	12,288	0	-	2.5
Kingsbury Elec. Coop., Inc.	De Smet	-	4,314	0	-	2.5
La Creek Elec. Assn., Inc.	Martin	6,930	6,300	0	-	2.5
Lake Region Elec. Assn., Inc.	Webster	5,775	8,883	0	-	2.5

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Lincoln Union Elec. Co.	Alcester	7,494	9,816	0	-	2.1
Moreau Grand Elec. Coop., Inc.	Timber Lake	4,760	9,116	0	-	-
Northern Elec. Coop., Inc.	Bath	9,200	10,500	0	-	2.0
Oahe Elec. Coop., Inc.	Blunt	4,311	5,130	0	-	2.4
REE Elec. Coop., Inc.	Miller	3,990	5,200	0	-	2.4
Rosebud Elec. Coop., Inc.	Gregory	9,868	12,149	870	Diesel	2.1
Spink Elec. Coop., Inc.	Redheld	2,022	2,451	0	-	2.7
Tri Co. Elec. Assn., Inc.	Plankinton	7,583	11,054	0	-	2.4
Union Co. Elec. Coop., Inc.	Elk Point	3,264	2,706	0	-	2.5
Whetstone Valley Elec. Coop.	Milbank	6,411	9,219	0	-	2.1
Texas						
Bartlett Elec. Coop., Inc.	Bartlett	7,585	6,072	0	-	2.4
Belfalls Elec. Coop., Inc.	Rosebud	6,502	4,736	0	-	3.04
Ok Elec. Coop., Inc.	Seymour	10,750	7,000	0	-	2.9
Coleman Co. Elec. Coop.	Coleman	8,410	7,906	0	-	3.0
Concho Valley Elec. Coop., Inc.	San Angelo	7,560	5,926	0	-	2.9
Dewitt Co. Elec. Coop., Inc.	Cuero	7,685	7,202	0	-	3.4

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Dickens Co. Elec. Coop., Inc. Inc.	Spur	9,988	7,702	0	-	3.8
Fannin Co. Elec. Coop., Inc.	Bonham	4,749	4,460	0	-	3.5
Fort Belknap Elec. Coop., Inc.	Olney	7,521	-	0	-	3.0
Hall Co. Elec. Coop., Inc.	Memphis	2,350	2,962	0	-	4.0
Hunt Collin Elec. Coop., Inc.	Greenville	3,188	2,406	0	-	-
J.A.C. Elec. Coop. Assn.	Bluegrove	10,314	8,546	0	-	2.8
Jackson Elec. Coop., Inc.	Edna	4,234	3,546	0	-	-
Kimble Elec. Coop., Inc.	Junction	5,255	4,634	0	-	-
McCulloch Elec. Coop., Inc.	Brady	5,673	4,091	0	-	3.5
Navarro Co. Elec. Coop., Inc.	Corsicana	10,602	8,949	0	-	2.9
Nueces Elec. Coop., Inc.	Robstown	15,630	9,963	0	-	3.5
Rita Blanca Elec. Coop., Inc.	Dalhart	10,803	9,021	0	-	3.9
Robertson Elec. Coop., Inc.	Franklin	8,081	-	0	-	3.6
San Patricio Elec. Coop., Inc.	Sinton	14,076	8,679	0	-	3.5
Southwest Texas Elec. Coop., Inc.	Eldorado	10,241	9,500	0	-	3.5
Wharton Co. Elec. Coop., Inc.	El Campo	15,125	9,264	0	-	3.0

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Utah						
Dixie Rural Elec. Assn.	Beryl	2,469	2,969	0	-	-
Flowell Elec. Assn., Inc.	Fillmore	5,500	512	0	-	1.9
Vermont						
Washington Elec. Coop., Inc.	East Montpelier	6,173	11,358	0	-	3.3
Virginia						
Craig-Botetourt Elec. Coop.	New Castle	4,914	7,745	0	-	3.1
Washington						
Lincoln Elec. Coop., Inc.	Davenport	19,380	9,460	0	-	1.1
Nespelein Valley Elec. Coop., Inc.	Nespelein	4,934	6,961	0	-	-
Okawogan Valley Elec. Coop., Inc.	Winthrop	2,660	5,320	0	-	1.2
Tanner Elec. Coop.	North Bend	1,534	3,031	0	-	1.7
West Virginia						
Harrison Rural Elec. Assn., Inc.	Clarksburg	3,829	4,400	0	-	2.5
Wisconsin						
Buffalo Elec. Corp.	Alma	7,500	11,200	0	-	2.7
Central Wisconsin Elec. Corp.	Iola	7,238	9,140	0	-	3.1
Chippewa Valley Elec. Coop.	Cornell	9,384	10,356	0	-	2.2

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Columbus Rural Elec. Coop.	Columbus	5,700	8,280	0	-	2.7
Crawford Elec. Corp.	Gays Mills	4,812	7,380	0	-	2.5
Head of the Lakes Elec. Corp.	Superior	3,128	4,138	0	-	-
Jackson Elec. Coop.	Black River Falls	7,260	8,772	0	-	3.1
Jump River Elec. Coop., Inc.	Ladysmith	7,452	8,334	0	-	3.3
Lafayette Elec. Coop.	Darlington	6,603	8,874	0	-	2.6
Oconto Elec. Coop.	Oconto Falls	8,632	10,227	1,000	Hydro	2.7
Pierce-Pepin Elec. Coop.	Ellsworth	9,684	12,828	0	-	2.8
Price Elec. Coop., Inc.	Phillips	4,874	5,657	0	-	3.1
Richland Elec. Coop.	Richland Center	5,500	6,454	0	-	2.3
Rock Co. Elec. Coop., Assn.	Jamesville	5,200	7,828	0	-	2.3
St. Croix Elec. Coop.	Baldwin	9,216	13,620	0	-	2.42
Taylor Co. Elec. Coop.	Medford	5,500	7,000	0	-	2.2
Washington Island Elec. Coop., Inc.	Washington Island	850	725	2,120	Diesel	4.7
Waushara Elec. Coop.	Wautoma	13,505	7,150	0	-	2.9

Cooperative	Location	Summer Peak kW	Winter Peak kW	Generating Capacity kW	Type	Cost ¢/kW
Wyoming						
Big Horn Rural Elec. Co.	Basin	8,667	9,104	0	-	2.8
Bridger Valley Elec. Assn., Inc.	Mountain-view	5,216	6,750	0	-	2.9
Carbon Power & Light, Inc.	Saratoga	7,134	8,182	0	-	2.5
Garland Light & Power	Powell	1,574	1,947	0	-	2.4
Nobrara Elec. Assn., Inc.	Lusk	11,428	6,953	0	-	3.8
Riverton Valley Elec. Assn., Inc.	Riverton	6,382	8,005	0	-	2.6
Sheridan-Johnson Rural Elec. Assn.	Sheridan	5,488	6,188	0	-	3.5
Shoshone River Power Co.	Cody	8,222	8,530	0	-	2.0

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Appendix B
SMALL MUNICIPAL ELECTRIC SYSTEMS WITH 1974 PEAK DEMAND BETWEEN 0.5 AND 2 MW
(COURTESY BURNS AND MC DONNELL, KANSAS CITY, MO.)

System	Address	Peak Demand-MW
Center Municipal Electric Light and Power System	Box 400 Center, Colo. 81125	1.25
Haxtun Municipal Power and Light Department	Box 205 Haxtun, Colo. 80731	0.98
Holly Light, Power and Water Department	Box 458 Holly, Colo. 81047	1.08
Holyoke Municipal Light and Power Department	207 West Denver Holyoke, Colo. 80734	1.98
Springfield Municipal Utilities	Box 4 Springfield, Colo. 81073	1.16
Albany Light and Power Department	Box 356 Albany, Ill. 61230	0.95
Altamont Municipal Electric Light Plant	601 West Madison Ave. Altamont, Ill. 62411	1.50
Bethany Municipal Light Department	Bethany, Ill. 61914	1.44
Argos Municipal Light And Water Department	119 West Walnut St. Argos, Ill. 46501	1.00
Bainbridge Municipal Electric Department	Box 216 Bainbridge, Ill. 46105	0.77
Darlington Light and Power Company	Darlington, Ill. 47940	1.28
Coatesville Municipal Light and Power Company	Coatesville, Ind. 46121	0.57
Thorntown Utilities	102 North Pearl St. Thorntown, Ind. 46071	0.58
Veedersburg Municipal Electric Department	Railroad Ave. Veedersburg, Ind. 47987	1.78
Warren Water and Light Department	132 North Wayne St. Warren, Ind. 46792	1.84
Anita Municipal Utilities	828 Main Anita, Iowa 50020	1.51

System	Address	Peak Demand-MW
Alta Municipal Power Plant	209 E. Second St. Alta, Iowa 51002	1.91
Bancroft Municipal Electric Plant	Bancroft, Iowa 50517	1.65
Brooklyn Municipal Electric Plant	207 Front St. Brooklyn, Iowa 52211	1.60
Cascade Municipal Electric Department	102 Pierce St. Cascade, Iowa 52033	1.40
Coggon Municipal Electric Plant	131 West Main Coggon, Iowa	0.56
Dayton Light and Power Department	101 S. Main St. Dayton, Iowa 50530	1.04
Dike Electric Department	Box 160 Dike, Iowa 50624	0.69
Eldon Municipal Electric Light and Water Works	Eldon, Iowa 52554	1.25
Gowrie Municipal Light Plant	Gowrie, Iowa 50543	1.81
Graettinger Electic Utility	Graettinger, Iowa 51342	0.91
Guttenberg Electric Utility	Box D Guttenberg, Iowa 52502	1.33
Hopkinton Municipal Utilities	Box 248 Hopkinton, Iowa 52237	0.82
Hudson Electric Department	Hudson, Iowa 50643	1.98
Keosauqua Municipal Light and Power	Box 216 Keosauqua, Iowa 52565	1.06
Lake Park Municipal Utilities	Lake Park, Iowa 51347	1.36
Manilla Municipal Service Department	Box 335 Manilla, Iowa 51454	1.13
Mapleton Municipal Electric Plant	Front St. Mapleton, Iowa 51034	1.64
McGregor Municipal Utilities	126 First Street McGregor, Iowa 52157	1.17

System	Address	Peak Demand-MW
Paullina Minicipal Light and Power	103 E. Commerce St. Paullina, Iowa 51046	1.45
Preston Municipal Light and Power	Gillette St., Box 24 Preston, Iowa 52069	1.60
Primghar Municipal Light	741 16th St. Primghar, Iowa 51245	1.28
Renwick Municipal Light and Power Plant	Renwick, Iowa 50577	0.60
Rockford Municipal Light Plant	Rockford, Iowa 50468	0.90
Sanborn Municipal Electric Plant	Box J Sanborn, Iowa 51248	1.77
Shelby Electric Department	Shelby, Iowa 51570	0.77
Strawberry Point Municipal Electric Department	Strawberry Point, Iowa 52076	1.30
Whittemore Electric Light and Power Plant	Whittemore, Iowa 50598	1.10
Haven Electric Department	118 S. Kansas Avenue Havens, Kans. 67543	0.73
Alma Electric Department	Alma, Kans. 66401	1.04
Altamont Municipal Electric Department	Box 305 Altamont, Kans. 67330	1.34
Attica Municipal Water and Light Plant	Attica, Kans. 67009	0.85
Cawker City Municipal Light and Water Department	Cawker City, Kans.	1.00
Centralia Municipal Electric Department	Centralia, Kans. 66415	0.72
Chetopa Municipal Power Plant	Chetopa, Kans. 67336	1.13
Cimarron Municipal Electric Light Plant	Main St. Cimarron, Kans. 67835	1.84
Johnson Municipal Light Plant	Box 387 Johnson City, Kans. 67855	1.63

System	Address	Peak Demand-MW
Moran Water and Electric Department	Moran, Kans. 66755	0.66
Protection Electric Department	Protection, Kans. 67121	1.50
Sharon Springs Municipal Light and Power	Sharon Springs, Kans. 67758	1.52
Wilson Municipal Water and Light Department	Wilson, Kans. 67490	1.55
Smoky Valley Electric Coop. Association, Inc.	117 East Lincoln, Box 469 Lindsborg, Kans. 67456	0.99
Bardwell City Utilities	Box 217 Bardwell, Ky. 42023	1.90
Lubec Water and Electric District	24 Water Street Lubec, Maine 04652	1.24
Ada Water and Light Department	10 Fifth Ave. Ada, Minn. 56510	1.94
Arlington Municipal Utilities	312 Alden St. Arlington, Minn. 55307	1.92
Barnesville Municipal Light Department	Box 295 Barnesville, Minn. 56514	1.01
Baudette Municipal Light Plant	Baudette, Minn. 56623	1.46
Biwabik Water, Light, Power and Building Commission	Box A Biwabik, Minn. 55708	1.35
Blooming Prairie Public Utilities	Blooming Prairie, Minn. 55971	1.85
Brownton Municipal Light Department	City Hall Brownton, Minn. 55312	0.67
Buhl Water, Light, Heat and Building Commission	105 Jones Avenue Buhl, Minn. 55713	0.75
Fairfax Municipal Power Plant	206 South First Street Fairfax, Minn. 55332	1.34
Grand Marais Public Utilities Commission	Box 83 Grand Marais, Minn. 55604	1.75
Halstad Municipal Utilities	Halstad, Minn. 56548	0.92

System	Address	Peak Demand-MW
Hawley Public Utilities Commission	Box 277 Hawley, Minn. 56549	1.15
Janesville Municipal Utility	219 North Main Janesville, Minn. 56048	1.32
Kenyon Municipal Utilities	713 Second Street Kenyon, Minn. 55946	1.75
Lanesboro Public Utilities	202 Parkway S., Box 333 Lanesboro, Minn. 55949	0.94
Moose Lake Water and Light Commission	Moose Lake, Minn. 55767	1.88
Mountain Iron Municipal Light Department	Box 505 Mountion Iron, Minn. 55768	0.73
North Branch Light and Power Commission	Box 62 North Branch, Minn. 56568	1.55
Pierz Utilities	Pierz, Minn. 55364	0.87
Preston Public Utilities	Box 157A Preston, Minn. 55965	1.76
Spring Grove Municipal Lighting System	Spring Grove, Minn. 55974	1.26
Truman Municipal Light Plant	Truman, Minn. 56088	1.48
Tyler Municipal Light and Power Department	Box 398 Tyler, Minn. 56178	1.01
Westbrook Municipal Light and Power Plant	Westbrook, Minn. 56183	1.04
Winthrop Utilities	Winthrop, Minn. 55396	1.43
Fayette Water and Light Department	117 S. Main St. Fayette, Mo. 65248	1.65
Kahoka Municipal Electric Light and Water Department	255 North Washington Kahoka, Mo. 63445	1.85
La Plata Municipal Power and Light Plant	La Plata, Mo. 63549	0.70
Lockwood Water and Light Company	Box O Lockwood, Mo. 65682	1.27

System	Address	Peak Demand-MW
Princeton Electric Department	604 Main St. Princeton, Mo. 64673	1.75
Salem Municipal Light and Power Plant	W. 3rd and Grand Salem, Mo. 65560	1.75
Shelbina Municipal Water and Light Department	W. Chestnut Shelbina, Mo. 63468	1.50
Slater Municipal Utilities	Box 247 Slater, Mo. 65349	1.90
Stanberry Light, Power and Water Department	City Hall Stanberry, Mo. 64489	1.98
Arapahoe Light and Water Department	Box 235 Arapahoe, Nebr. 68922	1.73
Arnold Light and Water Department	Box 462 Arnold, Nebr. 69120	0.70
Bartley Electric Department	Box 177 Barkley, Nebr. 69020	0.97
Battle Creek Municipal Light and Power Department	Box 128 Battle Creek, Nebr. 68715	1.39
Bayard City Light and Water Department	Bayard, Nebr. 69334	1.64
Bridgeport Utilities	Bridgeport, Nebr. 69336	0.78
Callaway Municipal Light Plant	Box 157 Callaway, Nebr. 68825	0.76
Chappell Municipal Utilities	757 Second Street Chappell, Nebr.	1.70
Curtis Light and Water	310 Center Avenue, Box 31 Curtis, Nebr. 69025	1.61
Deshler Municipal Utilities	Deshler, Nebr. 68340	1.81
Dorchester Electric Department	Dorchester, Nebr. 68343	0.85
Emerson Municipal Utilities	Emerson, Nebr. 68733	1.08
Friend Municipal Light and Water Department	146 Maple St. Friend, Nebr. 68359	0.59

System	Address	Peak Demand-MW
Howells Municipal Electric Light System	Howells, Nebr. 68641	0.98
Laurel Municipal Electric Plant	101 Elm St. Laurel, Nebr. 69352	1.85
Lyman Electric Department	Box 301 Lyman, Nebr. 693562	0.69
Lyons Municipal Utility	Lyons, Nebr. 68035	1.55
Mitchell Light Department	Mitchell, Nebr. 69357	1.34
Paxton Municipal Power Department	Paxton, Nebr. 69155	0.57
Pender Municipal Light Plant	Pender, Nebr. 68047	1.22
Pierce Utilities	113 South Brown Pierce, Nebr. 68767	1.32
Randolph Municipal Electric Light Plant	Box 220 Randolph, Nebr. 68771	1.28
Sargent Municipal Power Plant	Box 40 Sargent, Nebr. 68874	1.46
Spalding Electric Department	Spalding, Nebr. 68665	1.02
Spencer Electric Department	Spencer, Nebr. 6877	0.87
Stromsburg Electric Department	Stromsburg, Nebr. 68666	1.79
Stuart Municipal Water and Power Department	Stuart, Neb. 68780	0.90
Sutherland Municipal Water Department	Sutherland, Neb. 69165	1.12
Sutton Light and Water Department	Box 437 Sutton, Neb. 68979	1.70
Talmage Electric Department	City Hall Talmage, Neb. 68448	0.58
Wisner Municipal Electric Light and Water Department	Box 367, 1115 Avenue East Wisner, Neb. 68791	0.92
Caliente Public Utilities	Caliente, Nev. 89008	1.30

System	Address	Peak Demand-MW
Carlin Municipal Power Plant	Box 37 Carlin, Nev. 89822	1.09
Woodsville Water and Light Department	3 North Court St. Woodsville, N.H. 03785	1.83
Pemberton Electric Department	114 Hanover St. Pemberton, N.J. 08068	1.34
Andover Water and Light Department	4 Main Andover, N.Y. 14806	0.78
Angelica Electric Department	White St. Angelica, N.Y. 14709	0.58
Bergen Municipal Electric Department	13 S. Lake St. Bergen, N.Y. 14416	1.06
Cornelius Municipal Electric Light Syotem	Box 66 Cornelius, N.C. 28031	0.78
Pineville Electric Company	20 Dover St. Pineville, N.C. 28134	1.60
Sharpsburg Electric Department	Box 305 Sharpsburg, N.C. 27878	1.31
Northwood Municipal Light and Power Department	Northwood, N.D., 58267	1.84
Beach City Board, Public Affairs	Box 388 Beach City, Ohio 44608	0.92
Bloomdale Municipal Light and Power Department	Box 286 Bloomdale, Ohio 44817	1.20
Bradner Municipal Electric Light and Water Department	Box 516 Bradner, Ohio 43406	0.82
Elmore Municipal Light and Water Department	108 Clinton St. Elmore, Ohio 43416	1.20
Grafton Municipal Utility Service	1009 Chestnut St. Graften, Ohio 44044	1.94
New Knoxville Board of Public Affairs	Corner Main and W. Breman St., New Knoxville, Ohio 45871	1.20
Pioneer Municipal Plant	Box 332 Pioneer, Ohio 43554	1.12

System	Address	Peak Demand-MW
Plymouth Board of Public Affairs	25 Sandusky St. Plymouth, Ohio 44865	1.20
Prospect Municipal Light Plant	198 N. Main, Box 186 Prospect, Ohio 43342	1.19
Seville Municipal Light and Power System	40 West Main St. Seville, Ohio 44273	0.95
South Vienna Light Department	Box 45 South Vienna, Ohio	0.53
Waynesfield Board of Public Affairs	Waynesfield, Ohio 45896	0.86
Wharton Board of Public Affairs	Wharton, Ohio 43359	1.07
Chelsea Municipal Light and Water Department	600 Walnut Street Chelsea, Okla. 74016	0.83
Copan Light and Water System	Box 218 Copan, Okla. 74022	0.72
Granite Electric Department	Box 116 Granite, Okla. 73547	1.33
Waynoka Light and Water Department	201 East Cecil St. Waynoka, Okla. 73860	1.89
Wynnwood Water and Light Department	Box 82 Wynnwood, Okla. 73098	0.88
Yale Municipal Light Department	Yala, Okla. 74085	1.13
Pond Creek Municipal Power Department	Pond Creek, Okla. 73766	1.43
Hatfield Municipal Electric Plant	Chestnut St. Hatfield, Pa. 19440	1.60
Smethport Electric Departmetn	Water Street Smethport, Pa. 16749	1.80
St. Clair Municipal Electric Light Department	39 North Second Street St. Clair, Pa. 17970	1.63
Watsontown Electric Department	Box 273 Watsontown, Pa. 17777	1.86

System	Address	Peak Demand-MW
Due West Commissioners of Public Works	Box 128 Due West, S.C. 29639	1.15
Prosperity Commissioner of Public Works	Prosperity, S.C. 29127	1.06
Westminster Commissioner of Public Works	Box 216 Westminster, S.C. 29693	1.80
Arlington Light Department	Arlingston, S.D. 57212	1.07
Elk Point Municipal Light and Power Plant	Box 280 Elk Point, S.D. 57025	1.66
Estelline Municipal Light and Power Department	Estelline, S.D. 57234	0.87
Groton Electric Light and Power Department	Box 121 Groton, S.D. 57445	1.70
Howard Muncipal Power Department	Howard, S.D. 57349	1.69
Tyndall Light and Water Department	Tyndall, S.D. 57066	1.67
Volga Municipal Light and Power Department	108 Kason Ave. Volga, S.D. 57071	1.24
Wessington Springs Municipal Electric Department	Wessington Springs, S.D. 57382	1.09
Castorville Utility System	Box 479 Castorville, Texas 78009	1.86
Crosbyton Power and Light System	119-23 South Ayrshire Crosbyton, Tex. 79322	1.62
Lexington Municipal Electric Department	Lexington, Tex. 78947	1.06
Winters Light and Power Plant	Winters, Tex. 79567	1.20
Fairview Municipal Electric Department	City Hall Fairview City, Utah 84629	0.70
Helper Light and Power Department	Helper, Utah 84526	1.56

System	Address	Peak Demand-MW
Levan Municipal Electric Light System	Levan, Utah 84639	0.60
Monticello Electric Department	35 West 1st N. Monticello, Utah 84535	1.03
Mt. Pleasant Municipal Light and Power Department	115 W. Main St. Mt. Pleasant, Utah 84647	1.60
Johnson Water and Light Department	Johnson, Vt. 05656	1.25
Ruston Electric Utility	5117 N. Winnifred Ruston, Wash. 98407	0.74
Argyle Municipal Electric and Water Utility Plant	Argyle, Wis. 53504	0.94
Black Earth Electric Utility	1210 Mill St. Black Earth, Wis. 53515	1.43
Cashton Water and Light Department	709 Main St. Cashton, Wis. 54619	1.17
Centuria Municipal Electric Utility	Centuria, Wis. 54824	0.67
Cornell Water and Light Utility	Cornell, Wis. 54732	1.66
Deerfield Municipal Light and Water Department	113 N. Main Deerfield, Wis. 53531	1.21
Elroy Municipal Light and Water Department	507 Franklin St. Elroy, Wis. 53929	1.44
Florence Water and Light Commission	Florence, Wis. 54121	1.08
Gresham Municipal Light And Power Department	Box 157 Gresham, Wis. 54128	0.78
Hazel Green Light and Water Utility	Box 112 Hazel Green, Wis. 53811	0.60
Hustisford Electric Utility	Hustisford, Wis. 53034	1.65
La Farge Municipal Electric Company	La Farge, Wis. 54639	0.95

System	Address	Peak Demand-MW
Merrillan Electric Light and Water Department	Merrillan, Wis. 54754	0.50
Muscoda Electric and Water Department	109 N. Second St. Muscoda, Wis. 53573	0.76
New Glarus Municipal Light and Water Works	313 2nd St. New Glarus, Wis. 53574	1.82
New Lisbon Municipal Electric	218 E. Bridge St. New Lisbon, Wis. 53950	1.71
Pardeeville Electric Commission	124 Lake St. Pardeeville, Wis. 53954	1.66
Prairie Du Sac Municipal Electric Utility	560 Park Ave. Prairie Du Sac, Wis. 53578	1.69
Princeton Electric Light Department	438 Main St. Princeton, Wis. 54968	1.70
Stratford Municipal Electric and Water Department	Box 144 Stratford, Wis. 54468	1.64
Trempealeau Municipal Electric Utility	50 E. 3rd St. Trempealeau, Wis. 54661	0.94
Viola Municipal Electric Utility	Viola, Wis. 54664	0.70
Basin Municipal Light and Power Department	Box 618 Basin, Wyo. 82410	0.75
Lusk Light and Power Department	North Main, Box 385 Lusk, Wyo. 82225	1.70
Pine Bluffs Light, Water and Power Department	Pine Bluffs, Wyo. 82082	1.25
Upton Municipal Light and Power Department	Upton, Wyo. 82730	0.78

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