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Report on the Need for

Cranston-Rowan 138 kV Transmission Line

Proposed by East Kentucky Power Cooperative, Inc.

Case Number 2005-00089

Prepared by

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June 9, 2005

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Executive Summary

On April 21, 2005, East Kentucky Power Cooperative, Inc., (EKPC) filed an application for a certificate of public convenience and necessity for the construction of a 138 kV transmission line in Rowan County, Kentucky. The proposed line would be 6.9 miles long, connecting the existing Cranston Substation (Cranston) near Triplett, Kentucky with the existing Rowan County Substation (Rowan) near Morehead, Kentucky. The Kentucky Public Service Commission engaged the services of MSB Energy Associates, Inc. (MSB) to prepare an independent review of the need for the proposed Cranston-Rowan transmission line.

MSB first characterized the load growth, generation system and transmission system related to those parts of northeastern Kentucky served by EKPC. MSB then characterized the problems on the transmission system in northeastern Kentucky without the proposed transmission system improvement. Finally, MSB assessed alternatives that could potentially address those problems. This report documents MSB's findings and conclusions regarding the need for the proposed Cranston-Rowan transmission line.

Conclusions

MSB concluded that EKPC's proposed Cranston-Rowan transmission line is an electrically and economically viable alternative.

MSB concluded that three potential alternatives should be considered. Each potential alternative requires some additional information before a determination can be made whether it is electrically and economically viable.

- One potential alternative is the Cranston Tap-KU Line alternative identified by EKPC. MSB cannot ascertain that this potential alternative is electrically and economically viable until EKPC provides additional information to adequately address the construction, operational and cost issues identified by MSB.

  Construction: EKPC should explain how it would be able to take the existing KU Goddard-Rodburn 138 kV line out of service during construction without jeopardizing service reliability or incurring redispatch costs. (The KU Goddard-Rodburn outage is a first contingency outage that triggers extensive low voltage and overload problems.)

Operational: EKPC should explain how it would compensate for the reduced flexibility and accelerated need for additional transmission system improvements associated with protecting against loss of the reconductored Cranston Tap-Rodburn line (a single contingency outage that is equivalent to the outage of the existing KU Goddard-Rodburn 138 kV line).

Cost: EKPC should revise its cost estimates for this alternative to include costs of redispatch and accelerated further transmission improvements associated with construction and operational issues identified by MSB.

- One potential alternative identified by MSB is the Cranston-Parallel Line alternative, which is a modification of EKPC's Cranston Tap-KU Line alternative that eliminates its construction, operational and cost issues. It is highly probable that this potential alternative is electrically viable. It is also probable that this alternative is less costly than EKPC's Cranston Tap-KU Line alternative. MSB cannot ascertain that the potential Cranston-Parallel Line alternative is economically viable until EKPC provides additional information:

    Feasibility of corridor sharing: EKPC should assess whether it is feasible to construct a new 138 kV line that shares or parallels the existing KU Goddard-Rodburn line from the vicinity of Cranston Tap to Rodburn.

    Cost: EKPC should assess the cost of building the new 138 kV line in a shared or parallel corridor in light of improved construction access and potentially reduced incremental right of way.

    Confirm electrical performance: Assuming the feasibility and cost assessments are favorable, EKPC should confirm that the electrical performance of a 138 kV termination at Rodburn is satisfactory. Adequate performance is highly probable based on studies EKPC has already performed on its identified alternatives.

- Another potential alternative identified by MSB is the Goddard-Hilda-Rowan upgrade to 138 kV alternative. MSB cannot ascertain that this potential alternative is economically or electrically viable. This potential alternative does not provide the Cranston area with a second source, but it may eliminate area overloads and low voltage problems at substantially lower costs than the proposal and other potential alternatives. EKPC should provide an assessment of:

  Cost: EKPC should assess the cost of upgrading the existing 69 kV line to 138 kV, which would require an assessment of existing line condition, the necessity to replace structures rather than reinsulating them, and the incremental right of way required.

  Electrical performance: Assuming the cost assessment is favorable, EKPC should analyze electrical performance, including other alternatives to providing a second source to the Cranston area.

Characteristics of Existing System

Regarding the forecasts of demand for electric power:

- EKPC forecasts growth in system peak demand and energy to continue at levels similar to recent historic growth rates.
- EKPC forecasts that it will remain winter peaking while neighboring utilities are summer peaking.
- The five member cooperatives in the area served by the proposed Cranston-Rowan line forecast moderate growth in electrical demands. The forecasted growth rates over the next decade are substantially less than historic growth rates over the past decade.
- The load shapes of the five member cooperatives suggest that loads are at peak or near peak (80% of peak) for hundreds of hours per year.

Regarding EKPC's power supply strategy:

- EKPC relies on owning baseload coal units and peaking combustion turbine units sufficient to meet summer peak loads.

- EKPC relies on purchasing additional capacity to meet winter peak loads, which is possible because its utility neighbors are summer peaking with excess capacity in the winter.
- EKPC relies on purchasing economy energy when market prices are lower than the cost of operating its combustion turbines.

Regarding the transmission network

- EKPC's strategy to buy capacity and energy requires a transmission network capable of transporting electric power reliably when it is available and economic to purchase.
- Power flows generally from the north to the south into and across Kentucky.
- In the proposed project area, power flows generally to the south and east.

Transmission Problems

The problems with transmission in the Goddard-Cranston-Rowan area are fundamentally local, reliability-driven problems. The problems are characterized by:

- Severe thermal overloads on the Kentucky Utilities (KU) Goddard-Rodburn 138 kV line and the Goddard-Hilda 69 kV line.
- Low voltages along the Hilda-Elliottville 69 kV line.
- Risk of loss of supply to Cranston due to radial 138 kV feed.

The overload/low voltage problems are caused or exacerbated by:

- Growth in demand for electricity in the local area.
- Growth in regional demands for electricity increasing power flows on critical lines.
- Increased EKPC generation capacity at Spurlock site in 2005.
- EKPC's economic strategy to purchase power, which increases power flows on critical transmission lines.
- Planned further expansion of baseload generating capacity at Spurlock site in 2008.

- Regional power transfers from the north to the south across Kentucky.

Alternative Solutions

The local nature of the transmission overload and low voltage problems limit the number of transmission alternatives that could be developed. The immediacy of the transmission problems and the magnitude of the load reductions or supply additions limit the number of non-transmission alternatives to the proposed project that could be viable. EKPC considered three alternatives in developing its proposal. MSB considered several others.

- EKPC determined that the Cranston-Rowan 138 kV line alternative is electrically viable. MSB concurs that the proposed Cranston-Rowan alternative is electrically viable.
- EKPC determined that the Cranston Tap-KU Line 138 kV alternative is as electrically viable as the proposed Cranston-Rowan 138 kV line, but rejected the alternative because of cost. MSB does not agree that the Cranston Tap-KU Line 138 kV alternative is as electrically viable as the proposed Cranston-Rowan 138 kV line, but agrees that it is more costly.
- MSB identified the Cranston-Parallel Line 138 kV alternative, a modification of EKPC's Cranston Tap-KU Line alternative that has the potential of being electrically more viable and less expensive than the Cranston Tap-KU Line alternative. EKPC should further analyze the Cranston-Parallel Line 138 kV alternative, particularly the feasibility of paralleling the existing corridor, the cost, and the electrical benefits or problems with terminating at Rodburn.
- EKPC briefly considered reconductoring the existing KU Goddard-Rodburn 138 kV line as an alternative, but rejected it for a number of reasons including construction problems and system operability during construction. MSB concurs that those problems make upgrading the KU Goddard-Rodburn 138 kV line alternative impractical.
- MSB identified the alternative of upgrading the voltage on the Goddard-Hilda-Rowan 69 kV line to 138 kV. EKPC should develop further information on this potential alternative, particularly regarding the cost and electrical viability.

- MSB concluded that wheeling power on neighboring systems was not a viable alternative.
- MSB concluded that redispatching EKPC's generation could provide relief to the transmission problems, but that it would be very costly and not a viable alternative to making improvements to the transmission system.
- MSB concluded that building large power plants, including strategically building baseload capacity at the JK Smith site, is not a viable alternative.
- Because of the immediacy of need and size of reduction, MSB concluded that implementing load management is not a practical alternative to replace the proposed transmission improvements.
- Because of the immediacy of need and size of reduction, MSB concluded that implementing energy efficiency is not a practical alternative to replace the proposed transmission improvements.
- Because there is no evidence that distributed generation sites and projects are being implemented, and because of the immediacy of need and size of contribution required, MSB concluded that distributed generation is not a practical alternative to replace the proposed transmission improvements.

Section I Eastern Kentucky Electric System Characteristics

To better understand the purpose of East Kentucky Power Cooperative's (EKPC) proposed Cranston-Rowan transmission line and its alternatives, it is important to put it into the context of the transmission system in eastern Kentucky. This helps identify the problem EKPC is proposing to solve with the Cranston-Rowan proposal, assess whether the problem is local or regional in nature, identify alternate solutions, and assess the persistence of the problem and solutions.

Overview

Power plants generate electricity, often at points distant from the location that the electricity is actually used. Power plants tend to be quite large, each often being capable of serving hundreds of thousands of homes. Power must be transported from these large power plants to the homes and businesses where it is used. Power is transmitted over great distances by the high voltage transmission network to substations where it is converted to lower voltages. Transmission lines normally operate at voltages between 69,000 volts (69 kV) and 765,000 volts (765 kV). These voltages are much too high to be used in homes and businesses. Transformers at substations convert transmission voltages to successively lower voltages that ultimately supply the distribution lines that fan out from distribution substations to deliver power to the customer. One final transformer reduces the distribution voltage to voltages typically used by customers; e.g., most smaller businesses and residential customers typically use power at 220 volts.

Path of Least Resistance

Electricity flows from the source (power plant) to the sink (end user) in accordance with the laws of physics. Power will flow most freely along the path of least resistance. Transmission systems are interconnected and provide multiple paths for power to flow. This complicates the analysis of transmission systems. Power will flow across multiple parallel transmission paths as it moves from the power plant to the end user. It will also come from multiple power plants. The transmission system can be viewed as a collector of power from the various power plants on the system and as a supplier of power to the various distribution substations connected to it. It is important to remember that power will flow from multiple power plants to the point of end use along multiple parallel paths, with the paths of lesser resistance taking more of the power flow, even if doing so will overload a transmission facility. Power flow models simulate the operation of the transmission network based on its physical parameters, the location and size of power plants, the location and size of load, and the laws of physics.

Increasing Line Capacity

The maximum amount of power that can be carried by a transmission line depends on the voltage and current that the line is designed for. At a given voltage, the larger the conductors, the more power it can carry. If an existing line is running at full capacity, the capacity can be increased by reconductoring the line, that is, to remove the old conductors and replace them with larger conductors capable of handling higher current flows. This assumes that the existing structures are able to support the additional weight of the larger conductors. If not, reconductoring may require substantial rebuilding of the line.

The other way to increase the amount of power a line can carry is to increase the voltage at which it operates. Higher voltages require more insulation (larger insulators between the towers and the conductors) and increased clearances (wider rights of way and taller towers). For an existing line, upgrading the voltage may be difficult if clearance requirements cannot be met; e.g., the line was built on small structures or through land uses that do not allow widening the rights of way.

Losses occur in all transmission lines. The resistance of the conductor to current flowing through it causes the conductor to heat up. These losses increase as the square of the current flowing through the line, so that doubling the current quadruples the losses. For a given conductor size, doubling the voltage (e.g., from 69 kV to 138 kV) will halve the current for any given power level and result in one-fourth of the losses. All else equal, the higher the voltage at which a transmission line operates, the more power it can carry and the lower the losses.

The Electrical System in Northeastern Kentucky

The area of interest related to the proposed Cranston-Rowan project is generally defined by facilities located to the east of a line from Cincinnati to Lexington and to the north of Berea. Power plants and transmission lines in this quadrant affect the power flows in the Cranston-Goddard-Rowan area, and are important in assessing the need for the proposed Cranston-Rowan project. EKPC and Kentucky Utilities (KU) operate highly intertwined and interdependent transmission and generation systems in northeastern Kentucky. American Electric Power (AEP) serves the most eastern portions of Kentucky, but is relatively less interwoven with EKPC. Cinergy and Ohio Valley Electric Corporation operate along the Ohio River in northern Kentucky, while TVA is in southern Kentucky.

Ohio River Power Plants

Many power plants are concentrated on both sides of the Ohio River to the north. The most significant of these relative to the proposed Cranston-Rowan line is the EKPC's Spurlock site near Maysville, Kentucky, consisting of Spurlock 1 & 2, Gilbert 3, and a planned Spurlock 4. The three existing units comprise 1128 MW of baseload coal-fired power plants, which is about one-half of EKPC's generating capacity. The fourth unit, which is planned to be in service in 2008, would add another 278 MW. Due to the concentration of power plants along Kentucky's northern border, power tends to flow to the south. The same is true on EKPC's system, specifically fed by the Spurlock site at the north edge of the area served by EKPC.

Area Transmission

Please refer to Appendix B for EKPC and area transmission maps. Map 1 shows the EKPC generation and transmission systems in Kentucky. Map 2 is a more detailed map showing the critical overload and outage facilities related to the proposed Cranston-Rowan project and the alternatives considered by EKPC.

EKPC's Spurlock site is connected through 345 kV and 138 kV transmission systems. The 345 kV line between Spurlock and Avon (southeast of Lexington) is a strong path for power flow to the south, and is a critical line. Outage of the Spurlock-Avon 345 kV line results in overloads in KU's Goddard-Rodburn 138 kV line (which the Cranston-Rowan line is designed to correct). EKPC has indicated that two Cinergy 345 kV connections from Spurlock to the north, across the Ohio River to Cinergy's Zimmer and Stuart power plants, normally carry little power but are there to maintain system stability.

EKPC's 138 kV lines at the Spurlock site connect to the north, west, southwest and southeast. Of most relevance to the Cranston–Rowan area are the Spurlock-Flemingsburg-Goddard 138 kV line (added to the plans after 2002 and energized in 2005) and the Spurlock-Plumville-Goddard 138 kV line. Also in the area is KU's Kenton-KU Goddard-Rodburn 138 kV line. The KU Goddard substation has an intertie to EKPC's Goddard substation at the 138 kV level, but this intertie will be opened when the Cranston-Rowan line (or equivalent alternative) is completed.[1] The KU Goddard-Rodburn 138 kV segment is a critical line in that it overloads in the case of the outage of the Spurlock-Avon 345 kV line. It is also critical in that the outage of the KU Goddard-Rodburn 138 kV line results in overloads on EKPC's Goddard-Hilda 69 kV line and in low voltages along the Hilda-Elliottville 69 kV line. The outage of the Rodburn-Rowan 138 kV line also results in overloads on EKPC's Goddard-Hilda 69 kV line and in low voltages along the Hilda-Elliottville 69 kV line. With the completion of the Spurlock-Flemingsburg-Goddard 138 kV line, EKPC now has a looped feed to Goddard, providing higher reliability to the Goddard area.

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[1] "Review of Cranston-Rowan 138 kV Transmission Project", Rusch Exhibit III of Prepared Testimony of Robert J. Rusch, Case No. 2005-00089, page 1.

The Goddard substation becomes a stronger source for loads located further south and east. However, even with EKPC's 138 kV loop to Goddard, power flowing to the southeast toward Morehead, Kentucky is split along EKPC's Goddard-Hilda-Rowan 69 kV line and KU's Goddard-Rodburn 138 kV line and EKPC's Goddard-Cranston 138 kV line. The Rodburn and Rowan substations are located near Morehead. There is a 138 kV loop to the Rodburn substation via KU's 138 kV line running southwest to a substation near Winchester. This line provides some relief to Rodburn (in case of outage of the KU Goddard-Rodburn 138 kV line), but it requires bringing up generation at the JK Smith power plant south of Winchester. The practical result is that the outage of the KU Goddard-Rodburn 138 kV line eliminates the stronger of the parallel paths carrying power from Spurlock to the southeast, shifting power flow to the lower capacity Goddard-Hilda 69 kV line and causing it to overload. Building the Cranston-Rowan line would complete a parallel 138 kV path from Goddard to Rowan and would provide a loop source to the Cranston area as well.

EKPC currently operates a 138 kV line from Rodburn (an extension of the KU 138 kV lines) through Rowan and on to the Skaggs substation near Keaton, Kentucky. This is a radial feed line, meaning that the outage of the 138 kV Rowan-Skaggs line will shift power flow to the underlying 69 kV system. When loads in the area served by the Skaggs substation are large enough, the underlying 69 kV system will be unable to handle the outage of the 138 kV Rowan-Skaggs line. EKPC believes this eventually would lead to an eastern EKPC 138 kV loop.

Other Key Power Plants

With power generally flowing from the north to the south and southeast, it stands to reason that overloads on the transmission system would be reduced if power plants to the south were brought on line. EKPC owns and operates the Dale Station coal-fired power plant and the JK Smith Station gas-fired power plant located in central eastern Kentucky southeast and southwest of Winchester, respectively. In addition, EKPC also owns and operates the Cooper Station coal plant further south near Somerset, Kentucky. While the

Cooper and Dale Stations are baseload coal and likely to be on line when loads are high enough to cause transmission problems, the JK Smith Station consists of peaking units that may be on to meet system loads. If power purchases are not available, the JK Smith units will be operating at time of high load. If purchased power is available and lower cost than operating the Smith combustion turbines, the Smith turbines will not be dispatched, which would exacerbate the situation.

KU's Brown Station has both coal-fired and gas-fired capacity. Brown Station is located to the south of Lexington, near Danville, Kentucky, and as such, is in a position to reduce loading on the transmission lines to the north of there. If the Brown Station is fully on, it will offset southerly power flows from the Ohio border, and thus alleviate transmission line overloading. Similarly, the outage of a Brown Station coal plant will exacerbate transmission line overloading in the Goddard-Cranston-Rowan area.

Forecasts of Electricity Demands

In the preceding sections, MSB has described generally the generation and transmission systems in eastern Kentucky. Of course, the existence and severity of transmission system problems depend on the load levels. This section characterizes the electric loads served by EKPC and by the transmission system in the vicinity of the proposed Cranston-Rowan transmission project. The EKPC system load information provides insights into the amount of transmission capacity needed and the overall transmission loading that is projected. Load growth more localized to the proposed project is very important in assessing the need for the project. Transmission systems can serve both regional and local reliability functions. Because the need for transmission improvements depends on the geographic pattern of loads as well as the overall system loads, specific transmission needs may be driven by specific local growth patterns. In this case, MSB examined the member cooperative growth in electric demand as well as EKPC system growth to assess the need for the proposed line. The need for transmission infrastructure improvements can also be affected by very localized growth hotspots, even within the member cooperative.

EKPC System Peak Demands

EKPC currently serves 16 member distribution cooperatives serving 475,000 retail customers. EKPC will begin to serve a 17th distribution cooperative in April 2008. EKPC is winter peaking, i.e., its peak demands occur during the winter season. Neighboring utilities peak during the summer, meaning that capacity is often available for purchase from neighboring utilities during the winter period.

Figure 1 shows the peak winter and summer demands for the EKPC system. The winter peak demands are graphed corresponding to the year shown on the x-axis. Thus the peak demand for the winter 1981-82 season (e.g., from November 1981 through March 1982) is graphed as the 1982 value.

Figure 1

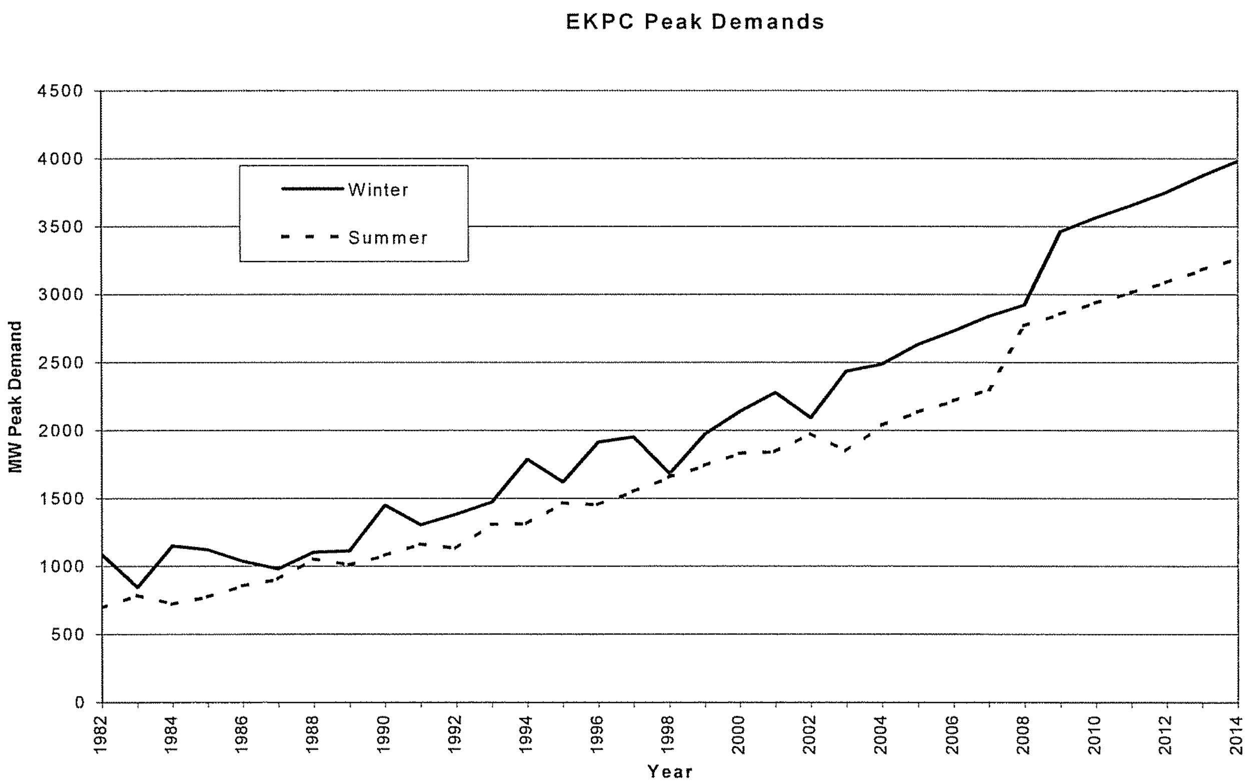

Figure 1 shows actual demands through 2003, and forecasts from 2004 onward. The step increase in 2008 corresponds to the addition of the Warren RECC as the seventeenth member distribution cooperative to be served by EKPC.[2]

EKPC forecasts winter peak demand to grow 6.8% annually over the 2004-2009 time frame, and 4.8% annually over the 2004-2014 time frame. EKPC forecasts summer peak demands to grow at 7.0% annually over the 2004-2009 time frame, and 4.8% annually over the 2004-2014 time frame.[3] The forecasted values are similar to EKPC's recent growth as can be seen in Figure 1.

EKPC System Energy Demands

Figure 2 shows the annual energy requirements for the EKPC system. Figure 2 shows actual demands through 2003, and forecasts from 2004 onward.[4] The step increase in 2008 corresponds to the addition of the Warren RECC to be served by EKPC.

EKPC forecasts energy requirements to grow 6.5% annually over the 2004-2009 time frame, and 4.6% annually over the 2004-2014 time frame. The forecasted values are similar to EKPC's recent growth as can be seen in Figure 2.

EKPC expects the large commercial sales component to grow fastest (7.0% per year from 2004 through 2014). EKPC expects small commercial sales and residential sales to grow at 4.8% per year and 4.2% per year, respectively, over the 2004-2014 period.[5]

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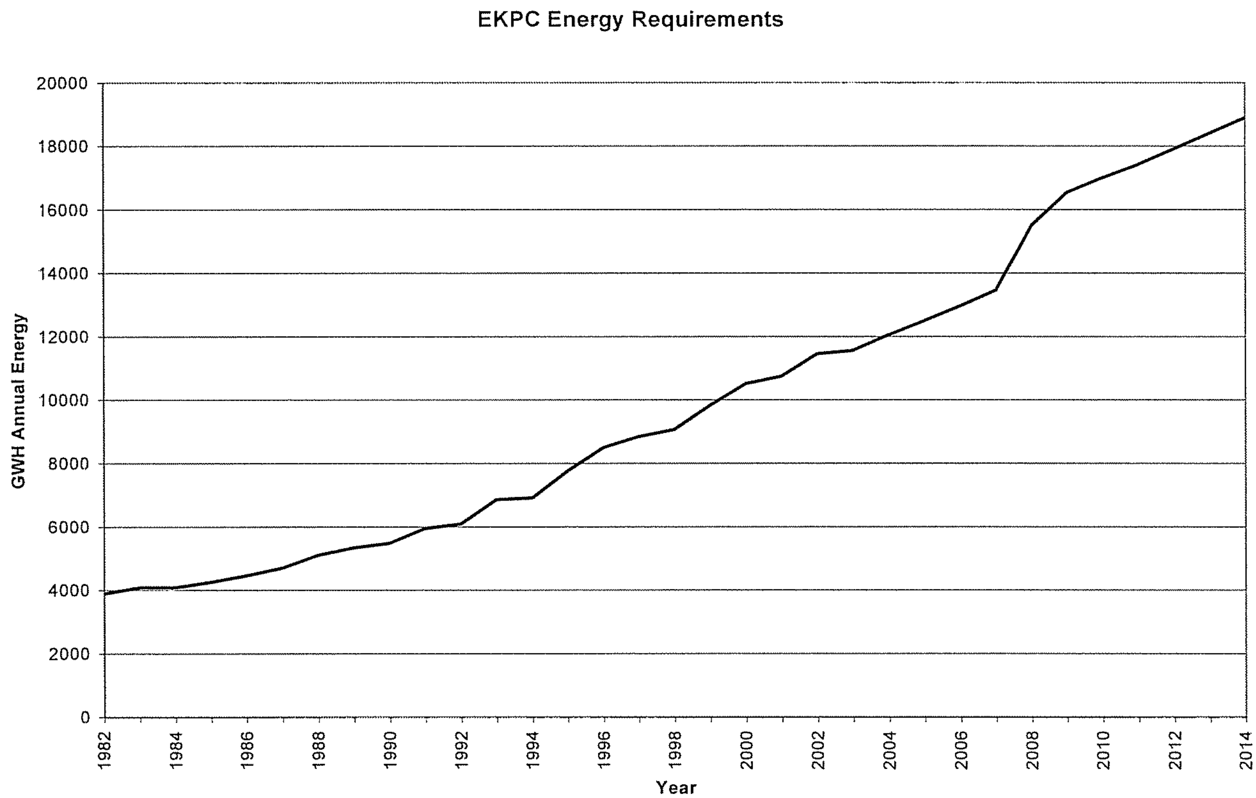
[2] Historical and projected winter and summer peak demands were obtained from "East Kentucky Power Cooperative 2004 Load Forecast Report Executive Summary", filed as Exhibit 2, PSC Case No, 2005-00053, January 31, 2005, pages 1-5.

[3] Ibid., page 2.

[4] Ibid., page 6.

[5] Ibid., page 2.

Figure 2



EKPC System Load Shape

EKPC's load factors (the ratio of average load to peak load) averaged around 52% over the historical 1982-2003 period. In the last 10 years, the load factor improved to about 55%. In the 2004-2014 forecast period, the load factor is projected to be an average of 55%.[6]

Local Member Cooperative Peak Demands

There are five member cooperatives in the vicinity of the proposed Cranston-Rowan line, whose service reliability the proposed Cranston-Rowan line may affect, or whose power requirements may affect the need for the proposed Cranston-Rowan line. These are the Fleming-Mason Energy Cooperative, Clark Energy Cooperative, Big Sandy RECC, Grayson RECC, and Licking Valley RECC. Overall, these member cooperatives are experiencing lower growth than the EKPC system as a whole. EKPC indicated that the fastest growth is occurring further west, closer to the triangle formed by Cincinnati, Lexington and Louisville.[7]

The aggregate non-coincident summer and winter peak demands of the five local cooperative members are shown in Figure 3. The demands in Figure 3 are historical through 2003 and projected beginning 2004.[8] As with the EKPC system, the local cooperatives in aggregate are winter peaking. Forecasted growth in peak demands is consistent with, but lower than historical growth in peak demand. The historical rate of growth over the period 1990 – 2003 was 5.0% and 4.7% per year for winter peak demand and summer peak demand, respectively. Winter and summer peaks are projected to grow at 2.5% and 2.3% per year, respectively, over the 2004 –2014 time frame.

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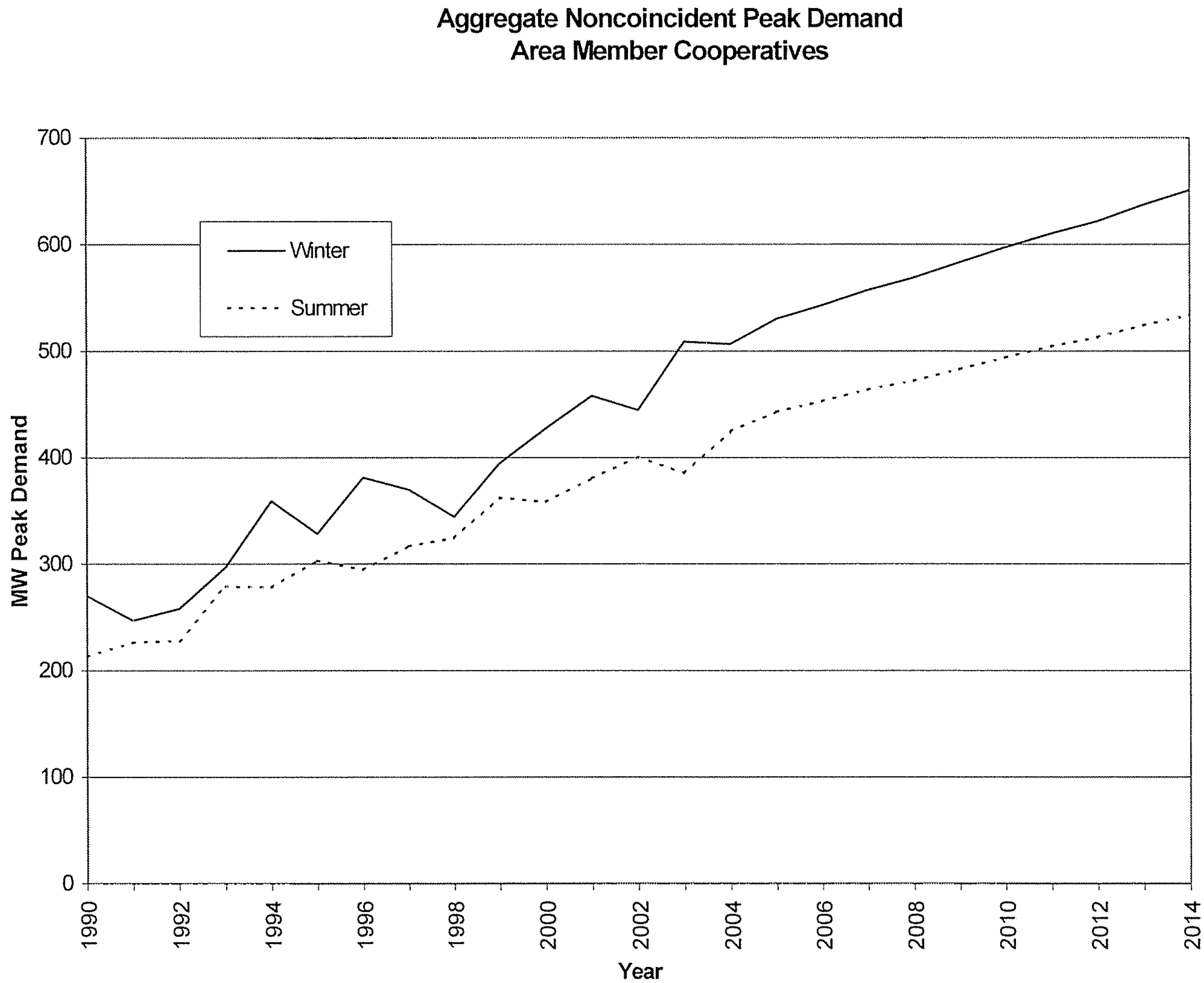
[6] Ibid., page 6.

[7] Interview with EKPC on May 10, 2005. EKPC represented by Sherman Goodpaster, Mary Jane Warner, Darrin Adams, Jim Lamb, and Robert Rusch. Also attending were Charles Bright and Elie Russell of the Kentucky Public Service Commission Staff and Jerry Mendl of MSB Energy Associates, Inc.

[8] EKPC response to MSB Information Request No. 8.

Figure 3



Local Member Cooperative Energy Requirements

Figure 4 shows the historical (through 2003) and projected annual aggregate energy requirements for the five local member cooperatives.[9] The forecasted future energy requirements are consistent with but significantly lower than historical growth in energy requirements. The historical rate of growth was 5.8% per year over the period 1990 –

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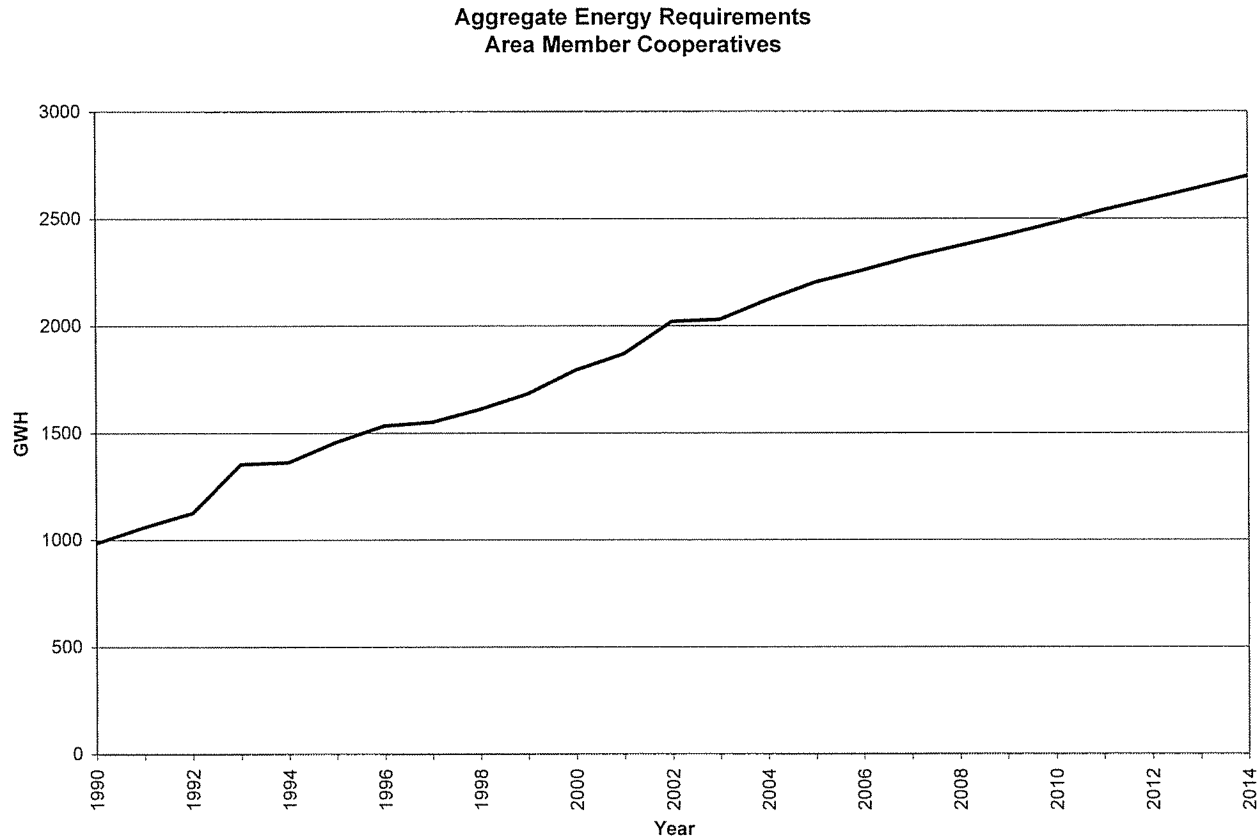
[9] Ibid.

2003. The projected rate of growth in aggregate energy requirements for the period 2004-2014 is 2.4% per year.

Figure 4



The member cooperatives differ substantially in the mix of customers they serve. Residential customers tend to have low load factors while industrial customers have relatively high load factors. Overall, about 55% of the electricity sold to retail customers by the five member coops is sold to residential customers. An additional 18% is sold to small commercial customers, while the remaining 28% is sold to large industrial customers.[10]

[10] Ibid.

Local Member Cooperative Load Shapes

The load shape can help determine the nature of the transmission problem and the alternatives that are viable to resolve it. For example, if the load levels at which transmission problems begin to appear are exceeded only for few hours per year, the problems may not be as severe, and the solutions may be different, than if those load levels or above are experienced 1,000 hours per year.

Table 1 provides an indication of how much of the time the local member cooperatives in aggregate were near their peak load in 2003. The cumulative hours in Table 1 represent the average (over the five member cooperatives) of the cumulative number of hours each member cooperatives is at or above the specified percentage of each cooperative's annual peak demand.[11] Generally, the more time that the cooperatives are at near-peak loads, the more time that the transmission system is at risk to transmission problems associated with peak load conditions.

Table 1

Aggregate Average Load Shape in 2003

% of Annual Peak Demand	**Average Cumulative Hours Load is at or Above Specified Fraction of Peak Demand**
100%	7
95%	20
90%	63
85%	177
80%	430
75%	878
70%	1573

Source: EKPC response to MSB information request.

[11] EKPC response to MSB Information Request No. 10.

Table 1 shows that there are a substantial number of hours that loads are at near peak conditions. For example, the average number of hours at which loads are at or above 80% of annual peak load ranges is 430 hours. If transmission line overloads persisted at 80% of peak load, the large number of hours at those loads would rule out being able to utilize peak load reduction strategies to prevent overloads.

Local Substation Growth "Hotspots"

Growth in the vicinity of the Hilda substation is expected to be above the system average.[12] The Hilda substation is affected both by low voltages and the Goddard-Hilda 69 kV line by thermal overloads. Increasing loads at Hilda will exacerbate the problems.

EKPC Generation Planning Approach

The location of power plants relative to loads is important to determining the adequacy of the transmission system. But not all power plants are running at all hours of the day. As a result of the economic dispatch of power sources, some power plants may not be run at times, and the transmission system may be more stressed under those conditions than when all plants are running. In some cases it may be appropriate to redispatch the power plants to ensure the integrity of the transmission system, even though it might result in higher generation costs. EKPC is currently redispatching some of its power plants to mitigate transmission problems.

Baseload, Peakers and Purchases

EKPC's power supply strategy is to build baseload plants (operate continuously except when out of service for maintenance) and peaking plants (operate only when needed to meet peaks). Baseload plants are characterized by higher up front capital costs to build the plants to utilize fuels with lower fuel costs. Baseload plants tend to be coal or nuclear steam plants. Conversely, peaking plants are characterized by low up front capital costs

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[12] EKPC response to MSB Information Request No. 9.

but higher fuel costs. Peaking plants tend to be gas-fired combustion turbines. Relatively speaking, baseload plants are expensive to build but cheap to operate, while peaking plants are cheap to build and expensive to operate. For peak or near peak loads that occur fairly infrequently (e.g., less than 500 hours a year), peaking units are often the choice. Peaking units are also often used to secure firm capacity (so that the company knows its peak loads can be met), but not run if power is available to be purchased at the time of peak at prices lower than the operating cost of the peaking units.

Build for Summer, Buy Increment for Winter

EKPC's supply plans call for building enough baseload and peaking plants to meet its projected system *summer* peaks, and buying enough additional firm capacity to meet its reserve margin requirements. Since the neighboring electric utilities are summer peaking, EKPC does not rely on the availability of power at economic prices to meet its own system summer peak. On the other hand, EKPC does rely on firm purchase power to meet its winter peaks because excess capacity is available and economic in the winter from the summer peaking utilities. EKPC's supply plans for the winter call for supplementing its own generation (built for summer peaks) with firm capacity purchases.

EKPC's system then consists of:

- Baseload units (coal-fired steam units at Spurlock Station, Cooper Station, and Dale Station).
- Peaking units (gas-fired combustion turbines at JK Smith).
- Purchased power.

EKPC's supply strategy is to run its baseload units as much as possible, backing them down as needed to minimum load levels during low load periods (nighttime, weekends). When the market price of power is more expensive than operating EKPC's combustion turbines, EKPC's economic dispatch would run the combustion turbines. When the market price of power is less expensive than operating EKPC's combustion turbines, EKPC's economic dispatch would purchase power rather than run the combustion turbines.[13]

What this means is that at least two dispatch scenarios should be considered in the power flow models to assess the adequacy of the transmission system. One scenario is running the combustion turbines at JK Smith at full capacity, simulating the situation where purchase power is not available or uneconomic. The other scenario is to have the combustion turbines off, simulating the situation where purchase power is available at prices lower than the operating cost at JK Smith.

Impact of Generation dispatch

As previously mentioned, backing down Spurlock and bringing up JK Smith can alleviate transmission problems. While non-economic dispatch can alleviate transmission problems, there is a cost if the more expensive to operate JK Smith combustion turbines are operated instead of the lower cost coal plants or purchased power. While an operating guide utilizing non-economic dispatch may help maintain service reliability, it is possible that the foregone opportunities to buy cheaper power or dispatch the cheapest power plant would cost as much or more than making transmission system improvements.

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[13] Information about EKPC's approach to generation planning and dispatch came from "IRP Update Report" filed as Exhibit 3, PSC Case No, 2005-00053, January 31, 2005, page 9. Further information was obtained during the May 10 Interview and the May 17 Interview by Telephone. Sherman Goodpaster, Darrin Adams, and Chuck Dugan represented EKPC in the May 17 Interview. Charles Bright of the Kentucky Public Service Commission Staff and Jerry Mendl of MSB Energy Associates also participated in the Telephone Interview.

Generally speaking:

- Increasing generation at Spurlock increases power flows to the south and east of Spurlock.
- Increasing generation at Smith backfeeds power flow to points north of Smith and reduces flow to south and east of Spurlock.
- Purchasing power from the north increases flows to south and east.
- Regional power transfers from the north increases flows to the south and east.

EKPC's Transmission Planning Approach

EKPC's approach to transmission planning is similar to that used by other electric utilities and will reasonably provide for reliable service. EKPC models the transmission system based on its physical parameters and assumptions about power plant output and load levels. These power flow models calculate voltage levels and the amount of power flowing through each component of the transmission system. To accurately represent the transmission system, each transmission substation is individually modeled based on individually forecasted substation loads. EKPC used the coincident peak substation loads (loads at each substation at the time of EKPC system peak) for the power flow models. Service reliability is compromised when the power flow runs indicate that there are serious overloads or low voltage problems, and especially when voltage collapse can cause widespread blackouts.

When problems are indicated by the power flow runs, potential solutions must be identified in order to ensure service reliability. Generally electric utilities identify solutions that improve the transmission infrastructure. Sometimes, solutions involving operating procedures (e.g., redispatching the power plants to alleviate line loading) can be identified. While these may be acceptable as interim solutions, EKPC, like most utilities, believes that they are not permanent solutions and should not be considered a planned substitute for appropriate infrastructure improvements.[14]

[14] Op. Cit., May 10 Interview.

Single Contingency Planning

Transmission components can fail. Single contingency planning means that the transmission system is designed to operate without problems (overloads, low voltage) even if any one element of the transmission system fails. EKPC, like most electric utilities, plans its transmission system to function even with the outage of any one transmission line, transformer or other component. Power flow models generally run a system intact case, and then remove one element at a time to test for transmission system performance under single contingency outage conditions.

Occasionally in areas with large critical loads or extensively shared transmission components subject to common mode failure (e.g., a long double circuit transmission line serving the same area), double contingency outages are considered. EKPC did not consider double contingency outages in connection with the proposed Cranston-Rowan transmission line.

Radial Lines

Transmission systems are normally built with looped lines to provide multiple paths to reliably serve load. Think of it as a square with the power source on one corner and the load on another, and the sides of the square are the connecting transmission lines. If one of the looped lines fails, power can flow to the load on the other one. Radial lines are not looped. If the line fails, power does not reach the load and service is interrupted. The Goddard-Cranston 138 kV line is a radial line. If that line fails, Cranston area loads will not be served. Improving the reliability of service to the Cranston area, to eliminate a single contingency from interrupting service to the Cranston area, is one of EKPC's stated reasons for proposing the Cranston-Rowan line.

Not every radial line poses a significant threat to overall service reliability. EKPC uses a MW-mile guideline to assess the level of risk associated with radial lines. The longer the line, the more risk of exposure to outage (e.g., storm damage). The higher the load, the more significant the consequence of the outage. Some utilities also factor in the nature of the load, so for example, the outage of a health care facility is more significant than other loads. EKPC uses a guideline of 100 MW-miles on a radial line as a threshold of significance. Exceeding the 100 MW-mile guideline increases the significance to EKPC of the potential outage of the radial line. Many other utilities, including Kentucky utilities, do not use a numeric index to guide decisions on radial lines. MSB believes that as a guideline, EKPC's quantitative approach and the 100 MW-mile threshold is reasonable as long as it is not the sole determinant whether to build a loop to eliminate a radial line.

Thermal Overloads

Thermal overloads refer to a component exceeding its rating. Overloading the component results in heat buildup and temperature increases. The heat is from the electric power losses, caused by the passage of current against the resistance in the conductor. The electric power losses increase as the square of the current flow, and are more significant as the power level approaches the rated maximum.

Since heat from the conductor is harder to dissipate when the air temperature is higher, thermal limits are based on summer conditions. EKPC uses a summer normal rating, which is not to be exceeded when all facilities are in service, for each transformer and transmission line. It also uses a summer emergency rating, which is not to be exceeded during the outage of any transmission component or generating unit, for each transformer and transmission line.

Low Voltage

Low voltage conditions can cause customers' lights to dim, motors to stall, or sensitive equipment to be damaged. EKPC's low voltage criterion as applied in the power flow studies conducted for the Cranston-Rowan transmission proposal is that voltages on the low side of distribution substations should not be less than 92.5% of nominal voltage.

Summary of Section I

Regarding the forecasts of demand for electric power:

- EKPC forecasts growth in system peak demand and energy to continue at levels similar to recent historic growth rates.
- EKPC forecasts that it will remain winter peaking while neighboring utilities are summer peaking.
- The five member cooperatives in the area served by the proposed Cranston-Rowan line forecast moderate growth in electrical demands. The forecasted growth rates over the next decade are substantially less than historic growth rates over the past decade.
- The aggregate load shape of the five member cooperatives suggests that loads are at peak or near peak (80% of peak) for hundreds of hours per year.

Regarding EKPC's power supply strategy:

- EKPC relies on owning baseload coal units and peaking combustion turbine units sufficient to meet summer peak loads.
- EKPC relies on purchasing additional capacity to meet winter peak loads, which is possible because its utility neighbors are summer peaking with excess capacity in the winter.
- EKPC relies on purchasing economy energy when market prices are lower than the cost of operating its combustion turbines.

Regarding the transmission network:

- EKPC's strategy to buy capacity and energy requires a transmission network capable of transporting electric power reliably when it is available and economic to purchase.
- Power flows generally from the north to the south into and across Kentucky.
- In the proposed project area, power flows generally to the south and east.

Section II Transmission System Adequacy - Without Cranston-Rowan Line

Assessing the adequacy of EKPC's transmission system without the proposed Cranston-Rowan transmission line is a key part of characterizing the nature of the problem. This section defines the problem in terms of which transmission system components become overloaded or experience low voltages and under what circumstances. Identifying the problems that would occur in the absence of taking action leads is an assessment of the *need to take* ***some*** *action*, and is the focus of Section II. In Section III, MSB provides an assessment of the alternatives and thus an assessment of the *need to take the* ***specific*** *action* proposed by EKPC (to build the Cranston-Rowan 138 kV transmission line).

Section II analyzes power flow modeling results to build upon the general overview presented in Section I. MSB reviewed power flow results and related information from the testimony and exhibits presented in this docket by witnesses for EKPC. MSB also reviewed information supplied by EKPC in response to MSB information requests. MSB reviewed an assessment[15] of the expected performance of EKPC's transmission system in the summer of 2005 prepared for the East Central Area Reliability Coordination Agreement (ECAR), a region in the North American Electric Reliability Council (NERC). Kentucky is part of ECAR, and system performance reports for summer and winter are conducted to ensure that potential problems affecting system operations and service reliability are identified and solutions developed.

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[15] East Kentucky Power Cooperative Assessment of Expected System Performance 2005 Summer Conditions, May 4, 2005, also referred to as the Summer 2005 Assessment.

System Intact Analyses

No problems with low voltages or overloads relevant to the Cranston-Rowan project were identified in the April 2002 Final Report[16] when all transmission elements were in service.

In the 2004 Operational Update,[17] EKPC identified four instances in which overloads would occur in winter 2004-05 when all transmission elements were in service. The EKPC-KU 138 kV interconnection at the Goddard substation overloads for two cases - the economic dispatch case (with all generation at EKPC's coal units and JK Smith combustion turbines on) and for the reduced load case (JK Smith off, load reduced by approximately 20%). In the third instance, the KU Goddard-Rodburn 138 kV overloads under the reduced load case. The fourth element to overload is the Rodburn-Morehead 69 kV line under the economic dispatch case. It is not clear whether, or to what extent, the overloads in the 2004 Operational Update runs are due to the changed network configuration. The 2004 Operational Update included the Spurlock-Flemingsburg-Goddard 138 kV line, which results in Goddard being a stronger source. EKPC indicated that KU and EKPC have agreed to open the interconnection at Goddard to relieve problems, but cannot do so until the completion of the Cranston-Rowan project.

The 2004 Operational Update did not identify any low voltage problems when all transmission elements were in service.

The Summer 2005 Assessment did not identify any overloads when all transmission elements were in service under the economic dispatch case.[18] The Summer 2005

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[16] "Final Report, Justification of Cranston-Rowan 138 kV Line", April 23, 2002, filed as Rusch Exhibit I of Prepared Testimony of Robert J. Rusch, Case No. 2005-00089.

[17] The 2004 Operational Update is also known as the "Review of Cranston-Rowan 138 kV Transmission Project", Rusch Exhibit III of Prepared Testimony of Robert J. Rusch, Case No. 2005-00089.

[18] East Kentucky Power Cooperative Assessment of Expected System Performance 2005 Summer Conditions, May 4, 2005, Executive Summary, page 2.

Assessment confirmed the conclusions drawn from the 2002 Final Report and the 2004 Operational Update.

Tables 1-A and 1-B in Appendix A summarize the overload and low voltage conditions that could occur even with all transmission elements in place. The fact that problems can occur under plausible generation scenarios, at load levels 80% of peak, and potentially when plausible amounts of power are being transferred across Kentucky suggest that the problems in the Cranston-Rowan area are quite severe.

Single Contingency Outage Analyses

Many more problems were identified when power flow runs were made with one element out of service. MSB's analysis of the single contingency outage power flow results led to the following observations. First, the 2004 Operational Update confirmed that the problem areas and causes identified in the April 2002 Final Report were still valid. Second, the 2004 Operational Update identified other limiting facilities and other critical outage facilities, suggesting that the transmission problem is significant because there are both more facilities that can overload and more events that can trigger those facilities to overload than were previously identified. Third, the overload and low voltage problems occur at 80% of peak load as well as at peak load. Thus the number of hours that the transmission components are at risk is quite large. Fourth, north-south regional power transfers exacerbate the incidence and severity of overloads and low voltages across Kentucky. Fifth, the overload and low voltage problems get worse as loads grow.

2004 Operational Update Confirms 2002 Final Report

Table 2 shows the limiting facilities in the Rowan area as well as the facilities that when individually taken out of service, cause the limiting facilities to overload. The magnitude of the overloading will depend on the generation scenario and outaged facility being considered. Table 2 also shows the range of overloads on the limiting facilities.

Comparing the 2002 Final Report results to the 2004 Operational Update, both of the limiting facilities of the 2002 Final Report also resurface in the 2004 Operational Update. However, the number of outaged facilities that will cause the limiting facility to be overloaded is substantially larger in the 2004 Operational Update. The severity of the overload is also higher in the 2004 Operational Update than the 2002 Final Report.

Table 2

Comparison of Overloads Common to Both
The 2002 Final Report and 2004 Operational Update

Limiting Facility	Outaged Facility	Range of Overload (%)
2002 Final Report		
KU Goddard-Rodburn 138	Spurlock-Avon 345	101 – 118
Goddard-Hilda 69	KU Goddard-Rodburn 138	108 – 110
2004 Operational Update		
KU Goddard-Rodburn 138	Big Sandy-Bussyville 138, Brown Ghent 345, Clark-Fawkes 138, Spurlock-Avon 345, Avon-Dale 138, Goddard 138/69 Transformer	102 – 136
Goddard-Hilda 69	KU Goddard-Rodburn 138, Kenton-Rodburn 138, Rodburn-Rowan 138	101 – 127

Source: EKPC Rusch Testimony Exhibits I and III.

The details underlying Table 2 are contained in Table 1-C in Appendix A.

Similarly, the 2004 Operational Update also confirmed the findings of the 2002 Final Report with regard to low voltages. The 2002 Final Report identified cases in which the outage of the KU Goddard-Rodburn 138 kV line or the Rodburn-Rowan 138 kV line resulted in low voltages at the Hilda and Elliottville substations. Voltages ranged from

86.3% to 91.2% of nominal voltage. The 2004 Operational Update confirmed the earlier study, finding outages of the Rodburn-Rowan 138 kV line leading to low voltages (approximately 89.7%) at Elliottville and Rowan substations. Additional details regarding the low voltage conditions are set forth in Table 1-D in Appendix A.

Other Problem Areas

The 2004 Operational Update also identified several other limiting facilities for overloads in the Rowan area as well as additional outaged facilities that result in overloads. As the number of outaged facilities that results in overloads increases, so does the probability that one of them will be out of service, which in turn increases the risk that an overload will occur. More limiting facilities and more outaged facilities suggest an increasingly stressed transmission system with increasing chances for failure.

Table 3

Additional Limiting Facilities and Outaged Facilities Identified in 2004 Operational Update that Were Not in the 2002 Final Report

Limiting Facility	Outaged Facility	Range of Overload (%)
Goddard 138/69 Transformer	KU Goddard-Rodburn 138, Kenton-Rodburn 138	106
KU Goddard-EKPC Goddard 138 Interconnect	Kenton Wedonia 138, Kenton Spurlock 138	103 – 110
Morehead Rodburn 69	Rodburn Rowan 138, Rowan-Skaggs 138	114 – 121
Rodburn 138/69 Transformer	Rodburn-Spencer Road 138, Rodburn-Rowan 138, Rowan-Skaggs 138	101 – 139

Source: EKPC Rusch Testimony, Exhibit III.

Table 3 summarizes the additional limiting elements and outage facilities identified in the 2004 Operational Update. The details supporting Table 3 are contained in Table 1-C in Appendix A.

Problems at Near Peak Loads

The significance of the transmission problems identified under peak load conditions is compounded if those problems also persist at near-peak load levels. If a transmission problem exists at peak load but quickly diminishes as load levels decline, the exposure to the problem is reduced. Load shape information in Table 1 shows that the highest loads occur for a small number of hours. The duration of time a utility is exposed to transmission overloads and low voltages decreases if the problem occurs only at load levels very near to the peak load. In addition, the annual duration of the problems can affect or limit the kinds of alternatives that may be viable, e.g., load management to reduce peak loads and operating guidelines requiring non-economic dispatch are not practical if they would have to be exercised for many hours each year.

The question is at what load levels do the transmission problems begin to occur. Studies done by EKPC do not directly address the question of the load levels at which transmission problems begin to occur, but do address whether they exist at the 80% of peak level.[19] EKPC conducted power flow studies for two generation scenarios that differed in the load levels. Both scenarios assumed that all the coal plants were on line but none of the combustion turbines at JK Smith. The scenarios varied in the amount of load being modeled and the amount power purchased to meet load; the load and amount of purchased power was 405 MW less for the 80% of peak load case than the peak load case. By comparing these two otherwise identical scenarios, MSB observed that transmission problems occurred at 80% of peak load, and that their severity was similar to that at peak load.

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[19] "Review of Cranston-Rowan 138 kV Transmission Project", Rusch Exhibit III of Prepared Testimony of Robert J. Rusch, Case No. 2005-00089, page 2.

Table 4 compares the 10 conditions in which an outaged facility resulted in an overload at a limiting facility for both the 100% of peak load and 80% of peak load scenarios. The severity of the overload in each case is slightly less for the 80% load scenario than the 100% load scenario. However, the severity of the overload is also similar in each case. Over the ten cases, the average overload for the 100% load scenario is 127%, compared to 122% for the 80% load scenario.

Table 4

Comparison of Overloads at 80% and 100% of Peak Load

Limiting Facility	**Outaged Facility**	**% Overload at Peak**	**% Overload at 80% of Peak**
KU Goddard-Rodburn 138	Big Sandy-Busseyville 138	125	121
KU Goddard-Rodburn 138	Brown-Ghent 345 kV	126	123
Rodburn 138/69 kV Transformer	Rodburn-Spencer Rd 138 kV	139	136
Goddard-Hilda 69 kV	KU Goddard-Rodburn 138	127	118
Goddard-Hilda 69 kV	Kenton-Rodburn 138 kV	126	118
Goddard-Hilda 69 kV	Rodburn-Rowan 138 kV	111	101
KU Goddard-Rodburn 138	Spurlock–Avon 345 kV	136	133
KU Goddard-Rodburn 138	Avon-Dale 138 kV	135	131
KU Goddard-Rodburn 138	Goddard 138/69 kV Transformer	136	131
KU Goddard-EKPC Goddard 138 kV Interconnect	Kenton-Spurlock 138 kV	110	109
	Average Overload	127	**122**

Source: EKPC Rusch Testimony, Exhibit III.

The severity of the overload is only slightly less at 80% of peak load than it is at 100% of peak load. It is likely that overloads would exist at load levels even less than 80% of peak load. Given the load shapes in Table 1, loads could be at or above the 80% level over 400 hours per year, depending on the member cooperative. At the 70% level, the hours would be much higher, nearly 1600 hours per year.

The number of hours is too large to exercise non-economic dispatch or load control as alternatives to transmission infrastructure improvements.

Impact of Regional Power Transfers

Given the previous discussion of the general flow of power from north to south (and to the southeast in the Cranston-Rowan area) it would be reasonable to assume that power flows and resulting transmission problems would be exacerbated by the presence of regional power transfers, especially those moving power from the north to the south.

EKPC in fact corroborated that assumption in response to MSB's information request, indicating that the loading on the Goddard-Rodburn 138 kV line responds by about 1% to north to south regional power transfers across Kentucky. While transfer levels are occasionally in the 5,000 to 10,000 MW range, ECAR member companies agreed to a 4,000 MW level to assess a stress case for the transmission assessments.[20] That would place about 40 MW of additional flow on the Goddard-Rodburn 138 kV line due to the regional transfer.

The Summer 2005 Assessment stress case superimposed the 4,000 MW power transfer across Kentucky from the north. Although the Summer 2005 Assessment did not reveal any overloads or low voltages under normal dispatch (JK Smith and all coal units on line), the stress case resulted in 36 overloads under single contingency outage conditions. The KU Goddard-Rodburn 138 kV line is one of the facilities of particular concern, along

[20] EKPC response to MSB Information Request No. 22.

with the Avon 345/138 kV transformer and the Avon-Boonesboro North Tap 138 kV line. Overloads ranged from 100.4 to 133.1 percent.[21]

The Summer 2005 Assessment also revealed low voltage problems under single contingency outage conditions for the stress case. Many of those low voltage problems occurred in the Rowan County area.[22]

Problems Get Worse as Loads Grow

Section I discussed the load growth forecasts for EKPC and especially the five member cooperatives local to the Cranston-Rowan project. More specifically, these cooperatives place growing demands on the transmission network to the south and east of the KU Goddard-Rodburn 138 kV line and other transmission elements in the immediate area that are subject to overloading and low voltages. In addition, increased power supplies from the north create stronger sources that try to increase flows on the elements already prone to overloading and low voltages.

Adding capacity at JK Smith tends to reduce the loading on limiting facilities in the vicinity of the Cranston-Rowan project. EKPC indicated that the flow on the KU Goddard-Rodburn 138 kV line decreases by about 6% of an increase in generation at JK Smith and decreasing supplies from the north.[23] To meet projected loads, EKPC intends to build 485 MW of peakers at JK Smith,[24] which would reduce flows on the KU Goddard-Rodburn line by about 30 MWs while they were running. EKPC also plans to build Spurlock 4 as a baseload coal unit,[25] which will tend to further load the KU Goddard-Rodburn line and other nearby transmission elements. Spurlock 4 is likely to be

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[21] East Kentucky Power Cooperative Assessment of Expected System Performance 2005 Summer Conditions, May 4, 2005, Executive Summary, page 2.

[22] Ibid., page 3.

[23] EKPC response to MSB Information Request No. 22.

[24] EKPC response to MSB Information Request No. 23. This is substantively the same information filed by EKPC in response to Kentucky PSC Administrative Case No. 2005-00090.

[25] Ibid.

running much more often that the JK Smith combustion turbines. A planned baseload unit at JK Smith should help to reduce the flows on the limiting facilities in the vicinity of Rowan.

Ultimately, it seems that load growth will create large needs for power. That power will be generated to a substantial degree to the north of the Rowan area, and thus will tend to increase power flows across the already stressed transmission facilities.

One can get a sense of the effect of EKPC's growing demands for electricity by comparing the overload and low voltage conditions for 2005 and 2010 as contained in the 2002 Final Report.

Table 5

Effect of Load Growth on Transmission System Overloads

Limiting Facility	**Outaged Facility**	**Range of Overload (%)**
2005		
KU Goddard-Rodburn 138	Spurlock-Avon 345	101 – 118
Goddard-Hilda 69	KU Goddard-Rodburn 138	108 – 110
2010		
KU Goddard-Rodburn 138	Spurlock-Avon 345	109– 133
Goddard-Hilda 69	KU Goddard-Rodburn 138	105 – 128

Source: EKPC Rusch Testimony, Exhibit I.

Table 5 summarizes information on overloads as presented in the 2002 Final Report,[26] comparing results for 2005 and 2010. It shows that the same elements are still

[26] "Final Report, Justification of Cranston-Rowan 138 kV Line", April 23, 2002, filed as Rusch Exhibit I of Prepared Testimony of Robert J. Rusch, Case No. 2005-00089, Appendix A.

overloading, but that the severity of the overload has worsened. The more detailed information from which Table 5 was derived can be found in Table 1-C in Appendix A.

Similarly, Table 6 summarizes the low voltage cases presented in the 2002 Final Report for 2005 and 2010. Table 6 shows that as the demand for power grows, so does the severity of the low voltage conditions experienced under single contingency outage conditions. The more detailed information from which Table 6 was derived can be found in Table 1-D in Appendix A.

Table 6

Effect of Load Growth on Transmission System Low Voltages

Limiting Facility	**Outaged Facility**	**Range of Low Voltages (% of Nominal)**
2005		
Hilda 12.5 kV	KU Goddard-Rodburn	87.0 – 91.0
Elliottville 12.5 kV	KU Goddard-Rodburn	87.5 – 91.2
Hilda 12.5 kV	Rodburn-Rowan 138	86.3 – 90.6
Elliottville 12.5 kV	Rodburn-Rowan 138	87.0 – 90.9
2010		
Hilda 12.5 kV	KU Goddard-Rodburn	84.5– 87.1
Elliottville 12.5 kV	KU Goddard-Rodburn	84.0 – 87.3
Hilda 12.5 kV	Rodburn-Rowan 138	86.2– 89.8
Elliottville 12.5 kV	Rodburn-Rowan 138	87.6 – 90.4

Source: EKPC Rusch Testimony, Exhibit III.

Discussion

The transmission problem that the Cranston-Rowan line has been proposed to resolve is a very localized one in that a few transmission elements, especially the KU Goddard-

Rodburn 138 kV line and the Goddard-Hilda 69 kV line tend to overload. Low voltage conditions occur in the area at the Hilda and Elliottville 12.5 kV busses.

Fundamentally the problems are local reliability issues. Eliminating overloads and low voltages is necessary to maintain reliability and quality of service. Similarly, eliminating the radial feed to the Cranston substation will improve service reliability there.

These problems are primarily driven by load growth in the area and points south and east of the area that will contribute to increasing power flows on these already stressed lines. Peak demands are projected to grow at about 2.5% per year in the next decade, which is about one-half of the growth rate experienced in the last decade. The overloads and low voltages already exist, and added growth, even if more moderate than in the recent past, will only exacerbate the problems.

The local overload and low voltage problems are also exacerbated by the construction of the Gilbert 3 and proposed Spurlock 4 power plants at the Spurlock site. These power plants are being constructed to help meet EKPC's overall system growth, including growth in the local area. Because the plants are located to the north, the transmission system in the Goddard-Rodburn area is part of the flow path for power from the Spurlock site specifically and from the north in general.

The local overload and low voltage problems are made worse when power output at Spurlock is increased, or when power is purchased from the north. Part of EKPC's strategy for supplying power is based on its ability to purchase economy energy, often from Cinergy or other markets to the north. If the Goddard-Cranston-Rowan area transmission system is loaded to the extent that local overload and low voltage problems preclude the purchase of power from the north or preclude the full output from the Spurlock plant, EKPC will not be able to make full use of its more economic resources. In that way, the local problems contribute to the regional costs borne by all EKPC customers.

Similarly, the flows across the KU Goddard-Rodburn line and other area lines are reduced when the output of the JK Smith plant is increased. JK Smith currently consists of about 600 MW of combustion turbines, which are more costly to operate than EKPC's coal units and oftentimes more costly than purchasing power from the regional power markets. To relieve overloads and low voltages at or in the vicinity of the Goddard-Rodburn transmission line, EKPC would have to bring on JK Smith even when it is uneconomical to do so, which again would contribute to the regional costs borne by all EKPC customers. However, not all of the costs for non-economic dispatch of JK Smith would be properly attributable to the Goddard-Rodburn area transmission. According to the Summer 2005 Assessment, overloads on the Avon 345/138 kV transformer, the Avon-Boonesboro North Tap 138 kV line and the Goddard-Rodburn 138 kV line were of particular concern under the stress case.[27] The Summer 2005 Assessment went on to say because those facilities can significantly overload, "it is imperative that CT generation in the central Kentucky area be dispatched to avoid excessive loading on these facilities if the critical contingencies were to occur."[28] Thus it is likely that the JK Smith plant would have been online in spite of the problems in the Goddard-Rodburn area, at least until other transmission issues (e.g., overloads on the Avon-Boonesboro North Tap 138 kV line) are resolved.

There is another regional aspect that should be considered, not so much as driving the need for action regarding the local overloads and low voltages at and around Goddard-Rodburn, but as having a collateral impact. The collateral consideration is for the role that whatever solution to the local problems would play in the regional need for increased transmission support. Currently, EKPC has a strong looped 138 kV source to Goddard, strong 161 kV and 138 kV sources near Stanton in Powell County, and a radial feed from the Rowan County substation to the Skaggs substation (in Lawrence County near Keaton). As growth continues in eastern Kentucky, the ability of the radial 138 kV line and the underlying 69 kV system to reliably serve loads will be reduced. EKPC

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[27] East Kentucky Power Cooperative Assessment of Expected System Performance 2005 Summer Conditions, May 4, 2005, Executive Summary, page 2.

[28] Ibid., page 3.

anticipates the need to complete a 138 kV Eastern Loop at some future time. The segments still to be added to this conceptual loop are to build the Cranston-Rowan 138 kV line, convert Skaggs-Maggard 69 kV line to 138 kV, build a Maggard-Maytown Junction 138 kV line, and build a Maytown Junction-Powell County 138 kV line.[29] It is reasonable to consider the consistency of individual projects, such as the proposed Cranston-Rowan line and its alternatives, as part of a cohesive long-range plan.

The overloading and low voltage problems are not short term or transitory in nature, but will persist and increase until a permanent resolution is implemented.

Summary of Section II

The problems with transmission in the Goddard-Cranston-Rowan area are fundamentally local, reliability-driven problems. The problems are characterized by:

- Severe thermal overloads on the KU Goddard-Rodburn 138 kV line and the Goddard-Hilda 69 kV line.
- Low voltages along the Hilda-Elliottville 69 kV line.
- Risk of loss of supply to the Cranston area due to radial 138 kV feed.

The overload/low voltage problems are caused or exacerbated by:

- Growth in demand for electricity in the local area.
- Growth in regional demands for electricity increasing power flows on critical lines.
- Increased EKPC generation capacity at Spurlock site in 2005.
- EKPC's economic strategy to purchase power, which increases power flows on critical transmission lines.
- Planned further expansion of baseload generating capacity at Spurlock site in 2008.

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[29] Appendix B, Map 2, provided by EKPC in response to MSB Information Request No. 3.

- Regional power transfers from the north to the south across Kentucky.

Section III Potential Solutions

This section examines the potential solutions analyzed by EKPC and also identifies other possible solutions. Potential solutions would typically include transmission solutions as well as non-transmission solutions. Transmission solutions would include creating parallel power flow paths with the limiting facility by building new lines (or upgrading existing ones). This shifts loads to the new line, and unloads the limiting facility. Transmission solutions would include reconductoring or rebuilding existing lines to upgrade them. Upgrading existing lines which are limiting facilities can raise the capacity enough so that the rebuilt line is no longer a limiting facility. Transmission solutions might also include identifying alternate substations at which to connect lines and alternate voltages at which to operate.

Non-transmission solutions would include building new large power plants in locations to alleviate transmission needs and building distributed generation (smaller and more closely located to the load). Redispatching existing generation may also be a viable non-transmission option to eliminate overloads or low voltages. Non-transmission alternatives would also include load management and energy efficiency programs to reduce usage on the customer side of the meter. Customer owned generation on the customer side of the meter could also be an effective tool to reduce transmission problems.

New Lines

There are limited options available to build a circuit that would relieve flows on the KU Goddard-Rodburn 138 kV line. As can be seen from Map 2 in Appendix B, Rodburn is at the far edge of a KU 138 kV loop, of which the KU Goddard-Rodburn segment is a part. A radial 138 kV line extends to the southeast from Rodburn through Rowan to Skaggs, but that provides no opportunity to support the Rodburn Substation or to relieve power flowing from Goddard to Rodburn. Since Goddard is the nearest strong source, the logical choice is to create a parallel flow path between Goddard and Rodburn or

Rowan. Conceivably, tapping KU's Rodburn to Clark County 138 kV line anywhere along its path with a 138 kV line to Goddard would create a parallel flow path to relieve the KU Goddard-Rodburn overloads. However, that would use a portion of KU's lines and would not provide EKPC with its own direct connection to the 138 kV line to Skaggs. In addition, it would be much longer overall than EKPC's proposed Cranston-Rowan line. Since EKPC owns the Rowan substation, it makes sense to terminate the new line at Rowan, barring any extraordinary circumstances making that impractical. The Cranston Substation is the nearest 138 kV terminal, being connected by a radial 138 kV line from EKPC's Goddard Substation. Thus although some other options for termination points may exist electrically, based on line length and ownership/operational control objectives, EKPC's choice of Cranston and Rowan Substations as termination points for a new line are reasonable.

EKPC considered two alternatives involving construction of new transmission lines. Both utilized the Cranston and Rowan termination points and 138 kV lines.

Cranston-Rowan 138 kV Line – Proposed

The proposed Cranston-Rowan 138 kV line is a direct route, virtually the shortest possible way to complete a parallel flow path between Goddard and Rodburn. The advantages of the proposed line are:

+ It eliminates all of the overloads described in Section II except for overloads of the Rodburn-Morehead 69 kV line and the Rodburn 138/69 kV transformer. The overload of the Rodburn-Morehead 69 kV line occurs both with the system intact and under two single contingency conditions. Operating procedures exist to prevent the overloads from occurring. The Rodburn 138/69 kV transformer overloads in four contingency cases, but all four are covered by operating procedures. Tables 2-A and 2-C in Appendix A summarize the power flow results regarding thermal overloads.

- + The proposal eliminates all of the low voltage problems described in Section II. Tables 2-B and 2-D in Appendix A summarize the low voltage results regarding thermal overloads.
- + By eliminating the transmission problems, the proposal improves reliability and is a step toward reducing costs associated with non-economic dispatch and foregone opportunities to purchase economy energy. It may not totally remove limitations on dispatch or purchase power because there are constraints elsewhere in Kentucky that require operating procedures to ensure transmission adequacy. Although the full benefit of the proposal in that regard may not be immediately available, it is reasonable to believe that significant constraints elsewhere on the system will eventually be corrected.
- + The proposal provides a second 138 kV source to the Cranston Substation.
- + The proposal provides a second 138 kV source to the Rowan Substation.
- + The proposal is consistent with the future Eastern Kentucky 138 kV loop EKPC has conceptualized.
- + The proposal, barring extraordinary routing or licensing costs, appears to be the less costly of the alternatives EKCP has considered.
- + The proposal meets the projected loads through 2010.

Cranston Tap–KU Line Alternative

EKPC also developed the Cranston Tap–KU line alternative consisting of a new 138 kV line and reconductoring existing 138 and 69 kV lines. The new 138 kV line would traverse the shortest distance from the Cranston Substation to the existing KU Goddard-Rodburn 138 kV line. It taps into the KU Goddard-Rodham line there, splitting the power flow from Goddard to the Cranston Tap down two paths – the existing Goddard-Rodburn line to the Cranston Tap and the existing Goddard–Cranston/new Cranston–Cranston Tap line. That will relieve power flows on the northern part of the KU Goddard-Rodburn line, but will require reconductoring the southern part of the line from Cranston Tap to Rodburn in order to handle the power flows. This alternative also calls for reconductoring the 69 kV Goddard-Hilda line.

EKPC has indicated that the Cranston Tap-KU Line alternative performs equivalently well through the 2010 planning period, but that is not their preferred alternative due to cost.[30] MSB is not convinced that this alternative is electrically viable because of construction and operational concerns. The Cranston Tap-KU Line alternative has several drawbacks relative to the proposed Cranston-Rowan line.

- The Cranston Tap-KU Line alternative stops short of completing a second circuit to Rowan Substation.
- The concerns with the outage of the KU Goddard-Cranston 138 kV line still exist for the south end of the line – from Cranston Tap to Rodburn. The outage of that segment of the line will take out both circuits from Goddard (the one through Cranston and the existing KU Goddard-Rodburn138). Electrically, it is a repeat of the current situation, which would overload the Goddard-Hilda 69 kV line. That overload is prevented by reconductoring the Goddard-Hilda 69 kV line, which is apparently why the line performs adequately through the 2010 planning period. But that doesn't mean the solution will last as long or be as robust. As an indication of that, the un-reconductored Goddard-Hilda 69 line in the preferred alternative is loaded to about 50% for the outage of the KU Goddard-Rodburn 138 kV line.[31] In contrast, the reconductored Goddard-Hilda 69 line in the Cranston Tap-KU Line alternative is loaded to about 80% for the outage of the Cranston Tap-Rodburn 138 kV line.[32]
- For reasons that EKPC expressed in regard to the alternative they considered of reconductoring the KU Goddard-Rodburn 138 kV line,[33] it would be difficult to take the Cranston Tap-Rodburn line out of service to reconductor it in the Cranston Tap alternative. It would create operational problems that put the EKPC

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[30] May 10 Interview, Testimony of Mary Jane Warner, Kentucky PSC Case No. 2005-00089, April 21, 2005, page 5.

[31] "Final Report, Justification of Cranston-Rowan 138 kV Line", April 23, 2002, filed as Rusch Exhibit I of Prepared Testimony of Robert J. Rusch, Case No. 2005-00089, Appendix B1, page B-4.

[32] Ibid., Appendix B2, page B-3.

[33] EKPC response to MSB Information Request No. 15.

system at increased risk, since they would be in the mode of the single contingency outage when the Cranston Tap-Rodburn line is out of service for reconstruction. The construction and operational problems associated with reconductoring the KU Goddard-Rodburn 138 line are explained more fully later in this report discussing the alternatives of upgrading existing lines.

– While the 138 kV path from Spurlock to Goddard is already looped at each stage, the looping would break down to a single circuit at Cranston Tap. This reduces flexibility and reliability.
– It fails to meet EKPC's conceptual plan to build an EKPC 138 kV Eastern Loop. The Cranston Tap- Rodburn segment would be KU's and would have to be operated in a coordinated fashion.

Cranston-Parallel Line Alternative

MSB recommends developing more information on a modification of the Cranston Tap-KU Line alternative. Rather than tapping into the existing KU Goddard-Rodburn line, the modification would continue the line on a parallel shared right of way to Rodburn.

This potential "Cranston-Parallel Line" alternative would use the same Cranston-Cranston Tap route that EKPC offered. It would then parallel the existing KU Goddard-Rodburn 138 to the Rodburn Substation. The Cranston-Parallel Line alternative has some advantages over EKPC's Cranston Tap –KU Line alternative. Those advantages follow.

+ It would be electrically very similar to the proposed Cranston-Rowan line, which MSB believes is more robust than the Cranston Tap-KU Line alternative offered by EKPC.
+ It would not require taking the critical KU Goddard-Rodburn line out of service to reconductor it.
+ It would avoid the cost of reconductoring any part of the KU Goddard-Rodburn line.
+ It would avoid the cost of reconductoring the Goddard-Hilda 69 kV line.

+ It would avoid the cost of capacitor banks at Elliottville and Rowan.
+ It would avoid the cost of siting and building a switching station at the Cranston Tap location.
+ It would complete a second circuit to the Cranston area.
+ It would complete a second circuit to Rodburn.
+ It would be consistent with the concept of the EKPC Eastern 138 kV loop.
+ The portion running parallel to the KU Goddard-Rodburn line would be built on separate structures and as independent circuits. While there would be some risk of common mode failure taking out both circuits, the risk would be less than relying on a single larger circuit to handle the power flows.

The drawbacks to the Cranston-Parallel Line alternatives are:

- It does not provide a second circuit to Rowan. A second circuit would eventually serve Rowan when the conceptual 138 kV loop is fully implemented. If it is determined that a second circuit to Rowan is needed sooner, it may be possible to over-build a 138 kV line on the Rowan-Hilda 69 kV from the point that the 69 kV line intersects with the Goddard-Rodburn 138 to Rowan.
- The feasibility of sharing a corridor with the existing line in this area has not been studied.
- The costs of constructing this alternative have not been determined.
- It is longer than the proposed Cranston-Rowan 138 line (9 miles compared to 6.9 miles), which increases costs, although it probably requires less new corridor, which decreases costs.

MSB believes that a small amount of additional information would greatly assist in determining the viability of the Cranston-Parallel Line alternative. First would be an assessment of the feasibility of sharing a corridor with the existing KU Goddard-Rodburn 138 kV line from the Cranston Tap location to Rodburn. Second would be an assessment of cost. It appears that nearly $3 million of costs could be trimmed off of EKPC's

Cranston Tap-KU Line alternative.[34] It is likely that the 4.3 miles of 138 kV line parallel to the existing line could be built for less than $3 million,[35] making the Cranston-Parallel Line alternative less expensive than the Cranston Tap-KU Line alternative. It is quite possible that the cost of building a parallel line would be less than building a new line because of reduced incremental right of way requirements, reduced clearing and increased ease of access during construction. If the existing right of way passes through heavily developed or congested areas that would tend to increase the construction costs. The cost assessment should answer whether the Cranston-Parallel Line alternative is less costly than the Cranston Tap-KU Line alternative and the Cranston-Rowan proposed line. If the parallel corridor is feasible and the costs are not prohibitive, then the third area EKPC should assess is whether there are any unexpected electrical benefits or problems with terminating the Cranston-Parallel Line alternative at Rodburn.

Upgrading Existing Lines

Since the KU Goddard-Rodburn line is a critical limiting facility, it is a prime candidate to be upgraded. Increasing its capacity would eliminate the overloads discussed in the preceding section. Lines can be upgraded by increasing conductor size to carry more current or to increase insulator size and clearance to operate at higher voltage.

Upon review, MSB determined that neither approach to upgrading the KU Goddard-Rodburn 138 kV line is feasible.

Upgrading Voltage of Existing KU Goddard-Rodburn Line

Upgrading the voltage can make sense when there are other lines the higher voltage present. The KU Goddard-Rodburn 138 kV line is already the highest voltage in the

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[34] "Final Report, Justification of Cranston-Rowan 138 kV Line", April 23, 2002, filed as Rusch Exhibit I of Prepared Testimony of Robert J. Rusch, Case No. 2005-00089, Appendix C, page C-3.

[35] If the cost per mile were the same as the proposed line going cross-country on new right of way, the estimated cost would be about $1.8 million.

area, which is served by 69 kV and 138 kV facilities. For that reason alone, a voltage upgrade is not feasible. Even if it other higher voltage lines were already in the area, there would be significant construction and operational problems to overcome, similar to those described in the following discussion of reconductoring. Upgrading the voltage would require bigger insulators, wider rights-of-way and higher structures to achieve clearance. This would probably require the line to be completely rebuilt.

Reconductoring the Existing KU Goddard-Rodburn Line

Reconductoring the 15.8 mile KU Goddard-Rodburn 138 kV transmission line to a larger conductor would increase its current and power carrying capability. It would tie into the rest of the 138 kV system already present at Goddard and Rodburn substations, and would not require wider right of way or pole height to attain clearance. EKPC considered this alternative, and rejected it because:[36]

- It would require a long outage of the KU Goddard-Rodburn 138 kV, which would result in overloads on the Goddard-Hilda 69 kV line. It is the same effect that the outage of the KU Goddard-Rodburn 138 kV line has in the power flow analyses summarized in Appendix A Tables 1-C and 1-D.
- During the construction outage, KU and EKPC would have experienced the first contingency outage. Operating procedures would require running JK Smith extensively to stay within the limits of operation for the next contingency.
- The construction period would be of long duration because the line would probably have to be totally rebuilt. Reconductoring would add significantly more weight (from the larger conductors) and would probably require the replacement of most support structures. Rather than being able to build upon existing structures, the existing line would probably have to be completely removed and then a new line built in the old right of way.

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[36] Testimony of Mary Jane Warner, Kentucky PSC Case No. 2005-00089, April 21, 2005, page 4. Also Testimony of Robert J. Rusch, Kentucky PSC Case No. 2005-00089, April 21, 2005, page 3. Also EKPC response to MSB Information Request No. 15.

- During the reconstruction, the Rodburn area would be served from the Fawkes-Clark County-Rodham 138 kV line. An outage of that line would leave the Rodburn area with no source other than the 69 kV system that is already overloaded with the outage of the existing KU Goddard-Rodburn 138 kV line.
- Reconductoring the KU Goddard-Rodburn line would not provide a second 138 kV source to Cranston.
- Reconductoring the KU Goddard-Rodburn line would not provide a second 138 kV source to Rowan.
- Reconductoring the KU Goddard-Rodburn line would not contribute to the development of an EKPC 138 kV Eastern Loop.

MSB concurs with EKPC's decision to reject reconductoring the KU Goddard-Rodburn 138 kV line for the reasons stated above.

Converting the Existing Goddard-Hilda-Rowan Line to 138 kV

EKPC identified the KU Goddard-Rodburn line reconductoring alternative, the proposed Cranston-Rowan 138 kV line alternative and the Cranston Tap-KU line alternative. EKPC indicated that "no additional alternatives were identified which would result in transmission system performance that complies with NERC, ECAR, LGEE and EKPC criteria and that also compare economically with the alternatives evaluated."[37] That statement would apply to other rebuild alternatives.

There are few opportunities for rebuilds given that there are only two lines connecting the Goddard area with the Rodburn/Rowan area, and one of those was ruled out. MSB cannot at this time rule out the other rebuild option, which is upgrading the voltage on the Goddard-Hilda-Rowan 69 kV line to 138 kV. This potential alternative has several advantages:

+ It would utilize existing rights-of-way.

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[37] EKPC response to MSB Information Request No. 17.

+ It would leave the existing KU Goddard-Rodburn 138 kV line intact, thus avoiding the construction and operational issues described above.
+ There are 138 kV busses at the Goddard and Rowan substations, so that it would not be introducing a new voltage level.
+ It would resolve overload issues on the current 69 kV line, which occur for outages of the KU Goddard-Rodburn 138 kV line or for outages of the Rodburn-Rowan 138 kV line.
+ It would provide a second 138 kV source to Rowan.
+ It would be consistent with and complete another segment in the conceptual EKPC Eastern 138 kV loop.
+ Rebuilding the 69 kV line to 138 kV between Goddard and Rowan would inherently be less risky because the outage of that line does not constitute a first contingency outage that causes any other facility to overload. In the comprehensive studies performed by EKPC (and summarized in Appendix A), there is no single contingency that resulted in overloads or low voltages associated with the outage of any segment of the Goddard-Hilda-Rowan 69 kV line.
+ It could be built in segments to minimize the risk of local outage. For example the 69 kV Goddard-Plummers Landing segment could be taken out of service, with Plummers Landing and Hilda being served at 69 kV from Rowan during the construction of the Goddard-Plummers Landing segment. When the reconstruction of that segment to 138 kV standards was complete, it could be energized at either 69 kV or 138 kV to supply Plummers Landing while the next segment from Plummers landing to Hilda was taken out of service for reconstruction. Hilda would still be served from Rowan at 69 kV until the reconstruction to Hilda at 138 kV standards was complete. Then the Hilda-Rowan segment would be rebuilt.

There are several disadvantages to the alternative of rebuilding the existing Goddard-Hilda-Rowan 69 kV line to 138 kV.

– It would not provide a second source to the Cranston area.

- The higher voltage would require wider rights of way, which may be difficult to acquire along some parts of the existing line.
- The higher voltage would require higher ground clearance, which may require taller structures. The line may have to be substantially removed and rebuilt.
- At about 18 miles, it is longer than other alternatives.
- MSB has no information regarding the cost at this time.
- No power flow studies modeling the performance of the transmission system in eastern Kentucky with this rebuild in service have been performed.

MSB believes that a small amount of additional information would greatly assist in determining the viability of the Goddard-Hilda-Rowan line voltage upgrade. First is the cost of rebuilding the line. It would require knowing the current condition of the existing line and an assessment of the fraction of structures that could be used and simply reinsulated to the higher voltage. It would also require an assessment of incremental right of way requirements. If the costs are favorable compared to the proposal, the second piece of further analysis EKPC should perform is an assessment of the electrical viability of the Goddard-Hilda-Rowan line upgraded to 138 kV. This would include ways to address the lack of a second source for the Cranston area.

Wheeling Power on Neighboring Systems

Wheeling power on neighboring systems is not an alternative in this case. The EKPC and KU transmission systems in the Goddard-Rowan-Cranston area are already heavily interdependent. Depending on the contingency, limiting facilities can be on the EKPC system (e.g., Goddard-Hilda 69 kV) or on the KU system (e.g., KU Goddard-Rodburn 138 kV). The problem is that the area systems do not have sufficient capability to reliably serve area needs. Thus there is no viable wheeling alternative to resolve the local reliability problems.

Redispatching

As previously described, the power flows on the KU Goddard-Rodburn 138 kV line can be relieved by backing down the output of the Spurlock plant and increasing output at the JK Smith plant. Bringing up the generation at the JK Smith plant also will increase voltage levels around Rodburn. Thus, it would be electrically possible to mitigate the Rowan area reliability problems through redispatching the EKPC system as long as there was unused capacity available at JK Smith to offset power from Spurlock. However, this is not an economical solution.

The actual number of hours per year that the EKPC system would have to be redispatched would depend on a number of factors. One of those would be the load level above which the transmission system is at risk. Earlier in this report, it was shown that overloads occurred when load levels were at 80% of peak when JK Smith generation was off. Another factor would be the status of KU's Brown power plant. Located near JK Smith, the Brown plant affects the system similarly to the JK Smith plant – reducing output at Brown exacerbates the low voltage and overload problems in the Goddard-Rowan-Cranston area. A third factor is the need to bring up generation not only in case of a contingency outage, but also in anticipation of the outage. For example, if the next contingency outage poses the risk of catastrophic failure, precautionary measures such as bringing up generation may be necessary. The situation is further complicated by the fact that there are interactions with other parts of KU's and EKPC's systems (e.g., Avon-Boonesboro North Tap 138 kV line) that may require JK Smith to be operated irrespective of the power flows on the Goddard-Rowan area lines. If other parts of EKPC's system require redispatching, upgrading the transmission infrastructure in the Goddard-Rowan area will not eliminate the need to redispatch JK Smith.

Because of these complications, MSB did not attempt to calculate the number of hours JK Smith would need to be redispatched per year. However, it is instructive to approximate the magnitude of costs associated with redispatching the EKPC system to prevent transmission problems. Spurlock is a coal-fired power plant while JK Smith is gas-fired. Assuming a coal plant with a heat rate of approximately 9,000 BTU/kWh and a fuel cost of $1.50 per MBTU and a gas combustion turbine with a heat rate of 10,000 BTU/kWh and a fuel cost of $6.00/MBTU, the differential cost between gas and coal is about $0.04 per kWh. Under these assumptions, each kWh of power redispatched from Spurlock to JK Smith adds over 4 cents to EKPC's system power cost. Further assuming that JK Smith would be redispatched when load levels reached 80% of peak in order to reduce power flows, area loads of about 500 MW (Figure 3) and average load shapes as shown in Table 1, the cost of redispatch would be approximately $8 million per year. This is a hypothetical calculation that does not attempt to adjust for the amount of time JK Smith would be economically dispatched, nor for the smaller price differential that may exist between purchased power and JK Smith. Although this is a hypothetical, MSB concluded that the annual costs of redispatching EKPC generation under current conditions could be substantial and could exceed the cost of constructing the proposed Cranston-Rowan line. As loads continue to grow, without improvements in transmission infrastructure the number of hours that redispatch would be required would increase. As a result, MSB concludes that redispatch is not a viable alternative.

This assessment is predicated on the fact that JK Smith is gas-fired and more expensive to operate than the coal-fired Spurlock plant. If a coal-fired baseload unit were built at JK Smith, dispatching it ahead of Spurlock would result in little or no cost penalty. It is possible that generation under economic dispatch could then relieve the loading on the Goddard-Rowan-Cranston area and that there would be no cost penalty.

Large Power Plants

The location of large power plants can and does affect the power flows and voltage conditions on the transmission network. Normally, power plants are much more costly to build than transmission, and it is generally not cost effective to consider building a large power plant in order to avoid building a transmission line. However, if a power plant needs to be built to meet power supply needs, the benefits to the transmission system could influence the location of that power plant. EKPC has indicated a need for a series of power plants to be built to keep pace with growing demands for electricity.[38] EKPC is planning to build 485 MW of gas-fired combustion turbines at the JK Smith site to begin operation between April 2007 and April 2008. EKPC is also planning for another coal-fired baseload plant, Spurlock 4, to be in service in April 2008.

JK Smith is the proposed site of a baseload coal plant EKPC is planning to bring on line in April 2009.[39] Putting a baseload source at JK Smith should allow it to moderate the power flows on critical lines – the equivalent of bringing the JK Smith combustion turbines up, but without the economic penalty. Since EKPC is planning on this baseload plant at Smith, it raises the question whether the proposed Cranston-Rowan line is necessary if there is baseload capacity at Smith.

EKPC has done no power flow studies to address the impact of the JK Smith baseload power plant on the need for Goddard-Cranston-Rowan area transmission improvements. The only power flows EKPC performed that address the post 2009 time frame were done in the original April 2002 Final Report previously referred to. These power flows included Spurlock 4 and more purchases from the north, both of which would exacerbate line loading and voltage problems in the Goddard-Rowan-Cranston area. The power flows did not include any of the now-planned 485 MW of new combustion turbine capacity or the planned baseload plant at JK Smith.

MSB believes it is unlikely that the baseload capacity at JK Smith in 2009 can reasonably eliminate the need for transmission system improvements. EKPC is proposing the power plants to meet growth in EKPC system demands. The growth in demand puts more stress on the transmission network. To some degree, greater loads and stress on the transmission network probably offset the transmission benefit of additional generation capacity at JK Smith. Even if the baseload capacity at JK Smith could relieve the transmission-loading problem, it would not be available until 2009. This means that the

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[38] EKPC response to MSB Information Request No. 23.

[39] Ibid.

redispatch costs would be incurred up an additional three years while the plant is being built. The three years of redispatch would likely be more expensive than the cost of the transmission line.

MSB concluded that building a large power plant is not a viable alternative to the proposed transmission improvements in this case.

Load Management

Load management can in some instances control the peak loads sufficiently to defer or avoid the need to build transmission or generation projects. Load management as used in this report refers to direct load control methods and is aimed at shifting or shedding load at the time of peak (or other critical times) through voluntary curtailment of customer service or an interruption of a controlled n appliance/process. Examples include thermal energy storage systems, controlled water heaters, and interruptible tariffs.

Load management can work most effectively when the transmission problems occur only at peak or very near peak hours, that is, when the problems occur only a limited amount of time each year. For this case, the magnitude of load reduction that would be needed and the number of hours load would have to be controlled make load management impractical. While it could help reduce the peak loads and EKPC's long term construction needs, load management is not a viable alternative to the transmission improvements in this case.

Energy Efficiency

Energy efficiency programs focus on appliances and processes that use less energy whenever they are in use. As such, not only will they reduce overall electrical energy consumed, they also will reduce the peak load to the extent they are on during time of peak. Properly designed energy efficiency programs can be useful in reducing overall growth of peak loads and energy requirements.

Given the depth to which loads would have to be reduced to resolve the transmission problems (loads would have to be reduced by at least 20%) and given that the need is immediate (problems currently exist) energy efficiency is not a viable replacement to the proposed project. It usually takes time to develop the infrastructure to implement energy efficiency programs on a large scale. MSB has no information from its review of EKPC that energy efficiency programs could achieve a 20% reduction in peak demand in the areas of Kentucky served by EKPC, and especially in the areas served by the five local member cooperatives.

MSB concluded that energy efficiency programs are at this point not a viable alternative to the proposed Cranston-Rowan line because of the immediacy of the transmission problems and the magnitude of demand reduction that would be required.

Distributed Generation

Distributed generation refers to small generators, typically 15 MWs or less, located near to the load. Distributed generation reduces the need for large power plants. Distributed generation, being located nearer to the load, can reduce transmission losses and the need for transmission system improvements. Distributed generation can be implemented as customer owned and controlled (on customer side of meter reducing net load), utility owned and controlled (on utility side of meter adding to the supply), or somewhere in between (e.g., customer owned but utility co-controlled, etc).

In the context of the Cranston-Rowan case, distributed generation could relieve loading on transmission in the Goddard-Cranston-Rowan area if distributed generation were located to the south and east of there. MSB has no information upon which to assess the long-term viability of distributed generation as an alternative to the Cranston-Rowan line. The ability to implement distributed generation depends on identifying viable host sites and willing owners. EKPC indicated that the member cooperatives are in contact with their customers and talk amongst themselves about customer self-generation activities, but there isn't evidence that this is part of a concerted effort to encourage distributed generation.

Based on past experience, MSB concluded that distributed generation is not a viable alternative to the Cranston-Rowan transmission line in the short-term. This is not to say that there are no potential hosts and sites for distributed generation; there may well be. However, MSB's experience is that it takes time, often years, to identify and develop such sites. Given the immediacy and magnitude of the transmission problem, the sites would have to have been already identified and the projects designed in order to be a viable and reliable alternative to the proposed Cranston-Rowan line. There is no evidence that any distributed resources projects are being considered or developed, much less that any projects are far enough along in development to be counted as a viable alternative to the proposed transmission line.

Summary of Section III

The local nature of the transmission overload and low voltage problems identified in Section II limit the number of transmission alternatives that could be developed. The immediacy of the transmission problems identified in Section II and the magnitude of the load reductions or supply additions limit the number of non-transmission alternatives to the proposed project that could be viable. EKPC considered three alternatives in developing its proposal. MSB considered several others.

- EKPC determined that the Cranston-Rowan 138 kV line alternative is electrically viable. MSB concurs that the proposed Cranston-Rowan alternative is electrically viable.
- EKPC determined that the Cranston Tap-KU Line 138 kV alternative is as electrically viable as the proposed Cranston-Rowan 138 kV line, but rejected the alternative because of cost. MSB does not agree that the Cranston Tap-KU Line 138 kV alternative is as electrically viable as the proposed Cranston-Rowan 138 kV line, but agrees that it is more costly.

- MSB identified the Cranston-Parallel Line 138 kV alternative, a modification of EKPC's Cranston Tap-KU Line alternative that has the potential of being electrically more viable and less expensive than the Cranston Tap-KU Line alternative. EKPC should further analyze the Cranston-Parallel Line 138 kV alternative, particularly the feasibility of paralleling the existing corridor, the cost, and the electrical benefits or problems with terminating at Rodburn.
- EKPC briefly considered reconductoring the existing KU Goddard-Rodburn 138 kV line as an alternative, but rejected it for a number of reasons including construction problems and system operability during construction. MSB concurs that those problems make upgrading the KU Goddard-Rodburn 138 kV line alternative impractical.
- MSB identified the alternative of upgrading the voltage on the Goddard-Hilda-Rowan 69 kV line to 138 kV. EKPC should develop further information on this potential alternative, particularly regarding the cost and electrical viability.
- MSB concluded that wheeling power on neighboring systems was not a viable alternative.
- MSB concluded that redispatching EKPC's generation could provide relief to the transmission problems, but that it would be very costly and not a viable alternative to making improvements to the transmission system.
- MSB concluded that building large power plants, including strategically building baseload capacity at the JK Smith site, is not a viable alternative.
- Because of the immediacy of need and size of reduction, MSB concluded that implementing load management is not a practical alternative to replace the proposed transmission improvements.
- Because of the immediacy of need and size of reduction, MSB concluded that implementing energy efficiency is not a practical alternative to replace the proposed transmission improvements.
- Because there is no evidence that distributed generation sites and projects are being implemented, and because of the immediacy of need and size of contribution required, MSB concluded that distributed generation is not a practical alternative to replace the proposed transmission improvements.

Section IV Conclusions

MSB concluded that EKPC's proposed Cranston-Rowan transmission line is an electrically and economically viable alternative.

MSB concluded that three potential alternatives should be considered. Each potential alternative requires some additional information before a determination can be made whether it is electrically and economically viable.

- One potential alternative is the Cranston Tap-KU Line alternative identified by EKPC. MSB cannot ascertain that this potential alternative is electrically and economically viable until EKPC provides additional information to adequately address the construction, operational and cost issues identified by MSB.

  Construction: EKPC should explain how it would be able to take the existing KU Goddard-Rodburn 138 kV line out of service during construction without jeopardizing service reliability or incurring redispatch costs. (The KU Goddard-Rodburn outage is a first contingency outage that triggers extensive low voltage and overload problems.)

  Operational: EKPC should explain how it would compensate for the reduced flexibility and accelerated need for additional transmission system improvements associated with protecting against loss of the reconductored Cranston Tap-Rodburn line (a single contingency outage that is equivalent to the outage of the existing KU Goddard-Rodburn 138 kV line).

  Cost: EKPC should revise its cost estimates for this alternative to include costs of redispatch and accelerated further transmission improvements associated with construction and operational issues identified by MSB.

- One potential alternative identified by MSB is the Cranston-Parallel Line alternative, which is a modification of EKPC's Cranston Tap-KU Line alternative that eliminates its construction, operational and cost issues. It is highly probable that this potential alternative is electrically viable. It is also probable that this alternative is less costly than EKPC's Cranston Tap-KU Line alternative. MSB cannot ascertain that the potential Cranston-Parallel Line alternative is economically viable until EKPC provides additional information:

Feasibility of corridor sharing: EKPC should assess whether it is feasible to construct a new 138 kV line that shares or parallels the existing KU Goddard-Rodburn line from the vicinity of Cranston Tap to Rodburn.

Cost: EKPC should assess the cost of building the new 138 kV line in a shared or parallel corridor in light of improved construction access and potentially reduced incremental right of way.

Confirm electrical performance: Assuming the feasibility and cost assessments are favorable, EKPC should confirm that the electrical performance of a 138 kV termination at Rodburn is satisfactory. Adequate performance is highly probable based on studies EKPC has already performed on its identified alternatives.

- Another potential alternative identified by MSB is the Goddard-Hilda-Rowan upgrade to 138 kV alternative. MSB cannot ascertain that this potential alternative is economically or electrically viable. This potential alternative does not provide the Cranston area with a second source, but it may eliminate area overloads and low voltage problems at substantially lower costs than the proposal and other potential alternatives. EKPC should provide an assessment of:

  Cost: EKPC should assess the cost of upgrading the existing 69 kV line to 138 kV, which would require an assessment of existing line condition, the necessity to replace structures rather than reinsulating them, and the incremental right of way required.

  Electrical performance: Assuming the cost assessment is favorable, EKPC should analyze electrical performance, including other alternatives to providing a second source to the Cranston area.

Appendix A

Table 1 Power Flow Summary Without Cranston-Rowan Transmission Line

Table 2 Power Flow Summary With Cranston-Rowan Transmission Line

Table 3 Power Flow Summary With Cranston Tap-KU Line Alternative

Appendix A Table 1-A: Summary – System Intact w/o Cranston-Rowan Line - Thermal Overloads

Limiting Facility	% Overload[A]	Outaged Facility	Generation Scenario[B]	Time Frame	Source[C]	Comments
Rodburn-Morehead 69 kV	111	NA	0	Win 04-05	Update 04	Operating procedure exists to address this problem
KU Goddard-EKPC Goddard 138 kV Interconnect	103	NA	0	Win 04-05	Update 04	
KU Goddard-EKPC Goddard 138 kV Interconnect	119	NA	7a	Win 04-05	Update 04	
KU Goddard-Rodburn 138 kV	115	NA	7a	Win 04-05	Update 04	

Appendix A Table 1-B: Summary – System Intact w/o Cranston-Rowan Line - Low Voltages

Limiting Facility	% Nominal Voltage[D]	Outaged Facility	Generation Scenario[B]	Time Frame	Source[C]	Comments

Appendix A Table 1-C: Summary – Single Contingency w/o Cranston-Rowan Line - Thermal Overloads

Limiting Facility	% Overload[E]	Outaged Facility	Generation Scenario[B]	Time Frame	Source[C]	Comments
KU Goddard-Rodburn 138	101.6%	Spurlock-Avon 345 kV	0	Sum 05	FR 2002	
KU Goddard-Rodburn 138	109.3%	Spurlock-Avon 345 kV	3	Sum 05	FR 2002	
KU Goddard-Rodburn 138	115.6%	Spurlock-Avon 345 kV	6	Sum 05	FR 2002	
KU Goddard-Rodburn 138	101.4%	Spurlock-Avon 345 kV	0	Win 05-6	FR 2002	
KU Goddard-Rodburn 138	108.0%	Spurlock-Avon 345 kV	3	Win 05-6	FR 2002	
KU Goddard-Rodburn 138	117.5%	Spurlock-Avon 345 kV	6	Win 05-6	FR 2002	
Goddard-Hilda 69 kV	110.3%	KU Goddard-Rodburn 138	6	Sum 05	FR 2002	
Goddard-Hilda 69 kV	108.0%	KU Goddard-Rodburn 138	6	Win 05-6	FR 2002	
KU Goddard-Rodburn 138	102	Big Sandy-Busseyville 138	0	Win 04-05	Update 04	
KU Goddard-Rodburn 138	125	Big Sandy-Busseyville 138	7	Win 04-05	Update 04	
KU Goddard-Rodburn 138	121	Big Sandy-Busseyville 138	7a	Win 04-05	Update 04	
KU Goddard-Rodburn 138	102	Brown-Ghent 345 kV	0	Win 04-05	Update 04	
KU Goddard-Rodburn 138	126	Brown-Ghent 345 kV	7	Win 04-05	Update 04	
KU Goddard-Rodburn 138	123	Brown-Ghent 345 kV	7a	Win 04-05	Update 04	
KU Goddard-Rodburn 138	107	Clark-Fawkes 138 kV	0	Win 04-05	Update 04	
Rodburn 138/69 kV Transformer	119	Rodburn-Spencer Rd 138	0	Win 04-05	Update 04	Operating procedure exists to address this problem
Rodburn 138/69 kV Transformer	139	Rodburn-Spencer Rd 138	7	Win 04-05	Update 04	Operating procedure exists to address this problem
Rodburn 138/69 kV Transformer	136	Rodburn-Spencer Rd 138	7a	Win 04-05	Update 04	Operating procedure exists to address this problem
Goddard-Hilda 69 kV	108	KU Goddard-Rodburn 138	0	Win 04-05	Update 04	
Goddard-Hilda 69 kV	127	KU Goddard-Rodburn 138	7	Win 04-05	Update 04	
Goddard-Hilda 69 kV	118	KU Goddard-Rodburn 138	7a	Win 04-05	Update 04	
Goddard-Hilda 69 kV	109	Kenton-Rodburn 138 kV	0	Win 04-05	Update 04	
Goddard-Hilda 69 kV	126	Kenton-Rodburn 138 kV	7	Win 04-05	Update 04	

Goddard-Hilda 69 kV	118	Kenton-Rodburn 138 kV	7a	Win 04-05	Update 04	
Morehead-Rodburn 69 kV	114	Rodburn-Rowan 138 kV	0	Win 04-05	Update 04	Operating procedure exists to address this problem
Goddard-Hilda 69 kV	112	Rodburn-Rowan 138 kV	0	Win 04-05	Update 04	
Goddard-Hilda 69 kV	111	Rodburn-Rowan 138 kV	7	Win 04-05	Update 04	
Goddard-Hilda 69 kV	101	Rodburn-Rowan 138 kV	7a	Win 04-05	Update 04	
Rodburn 138/69 kV Transformer	101	Rodburn-Rowan 138 kV	0	Win 04-05	Update 04	Operating procedure exists to address this problem
KU Goddard-Rodburn 138	108	Spurlock–Avon 345 kV or Avon 345/138 transformer	0	Win 04-05	Update 04	
KU Goddard-Rodburn 138	136	Spurlock–Avon 345 kV or Avon 345/138 transformer	7	Win 04-05	Update 04	
KU Goddard-Rodburn 138	133	Spurlock–Avon 345 kV or Avon 345/138 transformer	7a	Win 04-05	Update 04	
KU Goddard-Rodburn 138	102	Avon-Dale 138 kV	0	Win 04-05	Update 04	
KU Goddard-Rodburn 138	135	Avon-Dale 138 kV	7	Win 04-05	Update 04	
KU Goddard-Rodburn 138	131	Avon-Dale 138 kV	7a	Win 04-05	Update 04	
KU Goddard-Rodburn 138	109	Goddard 138/69 kV Transformer	0	Win 04-05	Update 04	
KU Goddard-Rodburn 138	136	Goddard 138/69 kV Transformer	7	Win 04-05	Update 04	
KU Goddard-Rodburn 138	131	Goddard 138/69 kV Transformer	7a	Win 04-05	Update 04	
Morehead-Rodburn 69 kV	121	Rowan-Skaggs 138 kV line or Skaggs 138/69 kV transformer	0	Win 04-05	Update 04	Operating procedure exists to address this problem.
Rodburn 138/69 kV Transformer	105	Rowan-Skaggs 138 kV line or Skaggs 138/69 kV transformer	0	Win 04-05	Update 04	Operating procedure exists to address this problem
Goddard 138/69 kV Transformer	106	KU Goddard-Rodburn 138	7	Win 04-05	Update 04	

Goddard 138/69 kV Transformer	106	Kenton-Rodburn 138 kV	7	Win 04-05	Update 04	
KU Goddard-EKPC Goddard 138 kV Interconnect	103	Kenton-Wedonia 138 kV	7	Win 04-05	Update 04	
KU Goddard-EKPC Goddard 138 kV Interconnect	110	Kenton-Spurlock 138 kV	7	Win 04-05	Update 04	
KU Goddard-EKPC Goddard 138 kV Interconnect	109	Kenton-Spurlock 138 kV	7a	Win 04-05	Update 04	
None	None	NA	0	Sum 05	ECAR 05	Base case in ECAR study appears similar to original dispatch scenario 0. Reported no single contingency overloads of EKPC facilities.
4 facilities overloaded	100.4 – 133.1	36 instances triggered overloads		Sum 05	ECAR 05	Stress case, with 4000 MW north to south power transfer. Some of the overloads are not in or related to the Goddard-Cranston-Rowan area.
KU Goddard-Rodburn 138	121.4	Spurlock-Avon 345 kV	0	Sum 10	FR 2002	
KU Goddard-Rodburn 138	133.4	Spurlock-Avon 345 kV	6	Sum 10	FR 2002	
KU Goddard-Rodburn 138	109.3	Spurlock-Avon 345 kV	0	Win 10-11	FR 2002	
KU Goddard-Rodburn 138	120.0	Spurlock-Avon 345 kV	6	Win 10-11	FR 2002	
Goddard-Hilda 69 kV	117.3	KU Goddard-Rodburn 138	0	Sum 10	FR 2002	
Goddard-Hilda 69 kV	128.1	KU Goddard-Rodburn 138	6	Sum 10	FR 2002	
Goddard-Hilda 69 kV	105.4	KU Goddard-Rodburn 138	0	Win 10-11	FR 2002	
Goddard-Hilda 69 kV	113.5	KU Goddard-Rodburn 138	6	Win 10-11	FR 2002	

Appendix A Table 1-D: Summary – Single Contingency w/o Cranston-Rowan Line - Low Voltages

Limiting Facility	% Nominal Voltage[D]	Outaged Facility	Generation Scenario[B]	Time Frame	Source[C]	Comments
Hilda 12.5 kV	91.0	KU Goddard-Rodburn 138	0	Sum 05	FR 2002	
Elliottville 12.5 kV	91.2	KU Goddard-Rodburn 138	0	Sum 05	FR 2002	
Hilda 12.5 kV	90.3	KU Goddard-Rodburn 138	6	Sum 05	FR 2002	
Elliottville 12.5 kV	90.0	KU Goddard-Rodburn 138	6	Sum 05	FR 2002	
Hilda 12.5 kV	89.3	KU Goddard-Rodburn 138	0	Win 05-6	FR 2002	
Elliottville 12.5 kV	90.3	KU Goddard-Rodburn 138	0	Win 05-6	FR 2002	
Hilda 12.5 kV	87.0	KU Goddard-Rodburn 138	6	Win 05-6	FR 2002	
Elliottville 12.5 kV	87.5	KU Goddard-Rodburn 138	6	Win 05-6	FR 2002	
Hilda 12.5 kV	90.2	Rodburn-Rowan 138 kV	0	Sum 05	FR 2002	
Elliottville 12.5 kV	90.7	Rodburn-Rowan 138 kV	0	Sum 05	FR 2002	
Hilda 12.5 kV	90.6	Rodburn-Rowan 138 kV	6	Sum 05	FR 2002	
Elliottville 12.5 kV	90.9	Rodburn-Rowan 138 kV	6	Sum 05	FR 2002	
Hilda 12.5 kV	87.8	Rodburn-Rowan 138 kV	0	Win 05-6	FR 2002	
Elliottville 12.5 kV	88.4	Rodburn-Rowan 138 kV	0	Win 05-6	FR 2002	
Hilda 12.5 kV	86.3	Rodburn-Rowan 138 kV	6	Win 05-6	FR 2002	
Elliottville 12.5 kV	87.0	Rodburn-Rowan 138 kV	6	Win 05-6	FR 2002	
Elliottville 69 kV	Approx. 89.7	Rodburn-Rowan 138 kV	0	Win 04-05	Update 04	
Rowan 138 kV	Approx. 89.7	Rodburn-Rowan 138 kV	0	Win 04-05	Update 04	The update did not specify whether this resulted in low voltages on the 69 kV line from Rowan to Hilda. The 69 kV line from Rowan to Elliottville experiences low voltages.
Unspecified	Approx. 89.7	Rodburn-Rowan 138 kV	7a	Win 04-05	Update 04	The update did not specify the location of the low voltages than to say similar to previous results, implying Elliottville and Rowan
One facility, unspecified	89.6	NA	0	Sum 05	ECAR 05	Base case in ECAR study appears similar to original dispatch scenario 0. Reported one single-contingency low voltage condition.
Multiple unspecified	NA	NA		Sum 05	ECAR 05	Stress case, with 4000 MW north to south power transfer. Reported that low voltage problems occurred

						in the Rowan County area.
Hilda 12.5 kV	87.1	KU Goddard-Rodburn 138	0	Sum 10	FR 2002	
Elliottville 12.5 kV	87.3	KU Goddard-Rodburn 138	0	Sum 10	FR 2002	
Hilda 12.5 kV	84.5	KU Goddard-Rodburn 138	6	Sum 10	FR 2002	
Elliottville 12.5 kV	84.0	KU Goddard-Rodburn 138	6	Sum 10	FR 2002	
Hilda 12.5 kV	85.9	KU Goddard-Rodburn 138	0	Win 01-11	FR 2002	
Elliottville 12.5 kV	87.1	KU Goddard-Rodburn 138	0	Win 01-11	FR 2002	
Hilda 12.5 kV	85.2	KU Goddard-Rodburn 138	6	Win 01-11	FR 2002	
Elliottville 12.5 kV	86.0	KU Goddard-Rodburn 138	6	Win 01-11	FR 2002	
Hilda 12.5 kV	89.8	Rodburn-Rowan 138 kV	0	Sum 10	FR 2002	
Elliottville 12.5 kV	90.4	Rodburn-Rowan 138 kV	0	Sum 10	FR 2002	
Hilda 12.5 kV	89.3	Rodburn-Rowan 138 kV	6	Sum 10	FR 2002	
Elliottville 12.5 kV	90.0	Rodburn-Rowan 138 kV	6	Sum 10	FR 2002	
Hilda 12.5 kV	86.7	Rodburn-Rowan 138 kV	0	Win 01-11	FR 2002	
Elliottville 12.5 kV	87.9	Rodburn-Rowan 138 kV	0	Win 01-11	FR 2002	
Hilda 12.5 kV	86.2	Rodburn-Rowan 138 kV	6	Win 01-11	FR 2002	
Elliottville 12.5 kV	87.6	Rodburn-Rowan 138 kV	6	Win 01-11	FR 2002	

Notes for Appendix A Tables 1, 2 and 3:

A Overload as a percent of summer normal thermal rating for system intact conditions.

B Generation scenarios are defined as follows:

0 – All EKPC Spurlock, Cooper and Dale coal generation is on, all JK Smith combustion turbines is on; simulates the lack of economy power for purchase by EKPC

3 – KU Brown 3 is off, 441 MW imported from the north (Cinergy)

6 – Like scenario 0, except only one JK Smith combustion turbine is on in 2005, two in line in 2010; simulates economy purchases of power by EKPC

7 – All coal on, all JK Smith off; simulates economy purchases of power by EKPC in Update runs

7a – All coal on, all JK Smith off, loads reduced by 405 MW; simulates system at 80% of peak load

C. Sources of the information summarized are defined as follows:

FR 2002 – "Final Report Justification of Cranston-Rowan 138 kV Line", April 23 2002, Case No. 2005-00089, Rusch Exhibit 1. These analyses all assumed the existence of the Inland T project near Spurlock, and thus the base transmission configuration differs from the "Update" analyses.

Update – "Review of Cranston-Rowan 138 kV Transmission Project", 2004, Case No. 2005-00089, Rusch Exhibit 3. These analyses all reflected the existence of the Spurlock-Flemingsburg-Goddard 138 kV project, which replaced the Inland T. Thus these analyses are similar to, but somewhat different than those done in FR 2002.

ECAR 05 – "East Kentucky Power Cooperative Assessment of Expected System Performance 2005 Summer Conditions", May 4, 2005

D Percent of nominal voltage as measured at the low voltage side of the distribution substation.

E. Overload as a percent of summer emergency thermal rating for single contingency conditions.

Appendix A Table 2-A: Summary – System Intact with Proposed Cranston-Rowan Line - Thermal Overloads

Limiting Facility	% Overload[A]	Outaged Facility	Generation Scenario[B]	Time Frame	Source[C]	Comments
Rodburn-Morehead 69 kV	117	NA	0	Win 04-05	Update 04	Operating procedure exists to address this problem

Appendix A Table 2-B: Summary – System Intact with Proposed Cranston-Rowan Line - Low Voltages

Limiting Facility	% Nominal Voltage[D]	Outaged Facility	Generation Scenario[B]	Time Frame	Source[C]	Comments

Appendix A Table 2-C: Summary – Single Contingency with Proposed Cranston-Rowan Line - Thermal Overloads

Limiting Facility	% Overload[A]	Outaged Facility	Generation Scenario[B]	Time Frame	Source[C]	Comments
None	None	All	All	Sum 05	FR 2002	
None	None	All	All	Win 05-6	FR 2002	
Rodburn 138/69 kV Transformer	128	Rodburn-Spencer Rd 138	0	Win 04-05	Update 04	Operating procedure exists to address this problem
Rodburn 138/69 kV Transformer	132	Rodburn-Spencer Rd 138	3	Win 04-05	Update 04	Operating procedure exists to address this problem
Morehead-Rodburn 69 kV	125	Rowan-Skaggs 138 kV line or Skaggs 138/69 transformer	0	Win 04-05	Update 04	Operating procedure exists to address this problem
Morehead-Rodburn 69 kV	118	Rowan-Skaggs 138 kV line or Skaggs 138/69 transformer	3	Win 04-05	Update 04	Operating procedure exists to address this problem
Rodburn 138/69 kV Transformer	108	Rowan-Skaggs 138 kV line or Skaggs 138/69 transformer	0	Win 04-05	Update 04	Operating procedure exists to address this problem
Rodburn 138/69 kV Transformer	107	Rowan-Skaggs 138 kV line or Skaggs 138/69 transformer	3	Win 04-05	Update 04	Operating procedure exists to address this problem
None	None	All	All	Sum 10	FR 2002	
None	None	All	All	Win 01-11	FR 2002	

Appendix A Table 2-D: Summary – Single Contingency with Proposed Cranston-Rowan Line - Low Voltages

Limiting Facility	% Nominal Voltage[D]	Outaged Facility	Generation Scenario[B]	Time Frame	Source[C]	Comments
None	>92.5	All	All	Sum 05	FR 2002	
None	>92.5	All	All	Win 05-6	FR 2002	
None	>92.5	All	All	Sum 10	FR 2002	
None	>92.5	All	All	Win 01-11	FR 2002	

Appendix A Table 3-A: Summary – System Intact with Cranston-Tap-KU Line Alternative - Thermal Overloads

Limiting Facility	% Overload[A]	Outaged Facility	Generation Scenario[B]	Time Frame	Source[C]	Comments
						Data not available

Appendix A Table 3-B: Summary – System Intact with Cranston-Tap-KU Line Alternative - Low Voltages

Limiting Facility	% Nominal Voltage[D]	Outaged Facility	Generation Scenario[B]	Time Frame	Source[C]	Comments
						Data not available

Appendix A Table 3-C: Summary – Single Contingency with Cranston-Tap-KU Line Alternative - Thermal Overloads

Limiting Facility	% Overload[A]	Outaged Facility	Generation Scenario[B]	Time Frame	Source[C]	Comments
None	None	All	All	Sum 05	FR 2002	
None	None	All	All	Win 05-6	FR 2002	
				Win 04-05	Update 04	Data for Update 04 not available for this alternative
None	None	All	All	Sum 10	FR 2002	
None	None	All	All	Win 01-11	FR 2002	

Appendix A Table 3-D: Summary – Single Contingency with Cranston-Tap-KU Line Alternative - Low Voltages

Limiting Facility	% Nominal Voltage[D]	Outaged Facility	Generation Scenario[B]	Time Frame	Source[C]	Comments
None	>92.5	All	All	Sum 05	FR 2002	
None	>92.5	All	All	Win 05-6	FR 2002	
				Win 04-05	Update 04	Data for Update 04 not available for this alternative
Hilda 12.5 kV	92.4	KU Cranston Tap-Rodburn 138	0	Sum 10	FR 2002	
Hilda 12.5 kV	92.4	KU Cranston Tap-Rodburn 138	6	Sum 10	FR 2002	
None except above	>92.5	All except above	All	Sum 10	FR 2002	
None	>92.5	All	All	Win 01-11	FR 2002	

Appendix B

Map 1 East Kentucky Power Cooperative Transmission System Map

Map 2 Cranston-Rowan County Critical Overload and Outage Facilities