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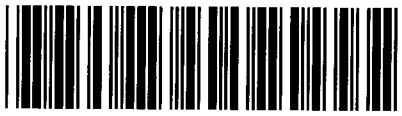

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PUBLIC UTILITY COMMISSION

SOAH DOCKET NO. 473-16-2751
PUC DOCKET NO. 45624

APPLICATION OF THE CITY OF GARLAND TO AMEND A CERTIFICATE OF CONVENIENCE AND NECESSITY FOR THE RUSK-TO-PANOLA DOUBLE-CIRCUIT 345-KV TRANSMISSION LINE IN RUSK AND PANOLA COUNTIES	§	**BEFORE THE STATE OFFICE OF ADMINISTRATIVE HEARINGS**

Direct Testimony of

Dr. Shams Siddiqi

on Behalf of
Luminant Energy Company LLC
and Luminant Generation Company LLC

April 27, 2016

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INDEX TO THE DIRECT TESTIMONY

OF DR. SHAMS SIDDIQI

DIRECT TESTIMONY OF DR. SHAMS SIDDIQI

I. BACKGROUND

Q. **PLEASE STATE YOUR NAME, BUSINESS ADDRESS, AND CURRENT EMPLOYMENT POSITION.**

A. My name is Dr. Shams Siddiqi. My business address is 11412 Bee Caves Road, Suite 202, Austin, Texas 78738. I am the President of Crescent Power, Inc., an energy consulting firm specializing in the Electric Reliability Council of Texas (ERCOT) market and other deregulated electricity markets.

Q. **ON WHOSE BEHALF ARE YOU PROVIDING TESTIMONY?**

A. I am testifying on behalf of Luminant Energy Company LLC and Luminant Generation Company LLC (collectively, Luminant).

Q. **WHAT ARE YOUR PROFESSIONAL QUALFICATIONS?**

A. I graduated from Bangladesh University of Engineering & Technology in 1988 with a B.S. in Electrical & Electronic Engineering. I earned my M.S. and Ph.D. degrees in Electrical Engineering from the University of Texas at Austin in 1989 and 1993, respectively. I have over 25 years of experience related to electricity markets and was a key designer of the ERCOT Nodal Market, including such features as the Day-Ahead Market, the Constraint Competitiveness Test, the Congestion Revenue Rights (CRR) market, Two-Step Mitigation in Security Constrained Economic Dispatch (SCED), and other Mitigation and Credit policies.

I am the founder and President of Crescent Power, Inc. (CPI), an energy consulting firm specializing in the ERCOT market and serving ERCOT market participants since 1998. CPI provides consulting services and expert advice to utilities, marketers, generators, retail electric providers, and independent system operators on:

- developing competitive market strategies and providing in-depth training on market design issues;
- designing deregulated market structures and representing clients at ISO stakeholder processes and regulatory commission proceedings;
- performing asset valuations, price and generation forecasts, and transmission risk analysis
- soliciting, evaluating, negotiating and contracting power purchase/sale agreements including full requirements and complex pricing contracts;
- managing power portfolios to hedge price and volumetric risk; and
- providing expert testimony on these topics.

Before founding Crescent Power, I worked for over 12 years on wholesale power issues for the Lower Colorado River Authority (LCRA), managing LCRA's intermediate- to long-term power portfolio and representing LCRA at ERCOT and the Public Utility Commission of Texas (PUCT or Commission). I also worked for six years as researcher at the University of Texas at Austin on projects dealing electricity pricing and market design, and analyzing the ERCOT market for the PUCT.

I have also published many refereed papers in journals such as *IEEE Transactions on Power Systems* advancing the field of power system economics. My resume is attached as Exhibit SS-1.

Q. **HAVE YOU PREVIOUSLY TESTIFIED BEFORE THE COMMISSION?**

A. Yes. I testified on behalf of South Texas Electric Cooperative, Inc. and Brazos Electric Power Cooperative, Inc., in PUCT Docket No. 31540, *Proceeding to Consider Protocols to Implement a Nodal Market in the Electric Reliability Council of Texas Pursuant to Subst. R. 25.501.*

II. PURPOSE OF DIRECT TESTIMONY

Q. **WHAT IS THE PURPOSE OF YOUR DIRECT TESTIMONY IN THIS PROCEEDING?**

A. The purpose of my direct testimony is to address Preliminary Order Issues regarding the reasonable conditions that the Commission should impose in this proceeding to protect the public interest. Specifically, my testimony presents my analysis and conclusions with respect to the Southern Cross Transmission, LLC (Southern Cross or SCT) Project as it pertains to this application and the issues specific to the appropriate treatment of merchant Direct Current (DC) Tie projects to be addressed in this docket. This direct testimony and the attached exhibits were prepared under my direction and control and are true and correct.

Q WHAT EXHIBITS ARE YOU SPONSORING?

A I am sponsoring Exhibits SS-1, Resume of Dr. Shams Siddiqi, and Exhibit SS-2, Transmission System Near the Southern Cross DC Tie.

Q. **WHAT RECOMMENDATIONS DO YOU MAKE REGARDING THE PUBLIC INTEREST?**

A. I recommend that the Commission:

(1) either (i) issue a directive to ERCOT to address the price formation issue related to ERCOT-directed curtailment of exports or emergency imports during emergency conditions over all tie lines, or (ii) condition its approval of the Southern Cross tie line on ERCOT mitigating price reversal and suppression during ERCOT-directed curtailment of exports or emergency imports over the tie line during emergency conditions; and

(2) condition its approval of the Southern Cross tie line on ERCOT developing a transmission constraint management plan (CMP) applicable to imports over the tie line to resolve congestion

created by such imports and provide policy guidance as to how a CMP shall be implemented to resolve such congestion.

III. BACKGROUND ON SCT PROJECT AND PUBLIC INTEREST REVIEW

Q. **PLEASE EXPLAIN THE LEGAL AND REGULATORY CONTEXT FOR YOUR TESTIMONY IN THIS PROCEEDING.**

A. On February 25, 2016, the City of Garland (Garland) filed an application with the Commission for a Certificate of Convenience and Necessity (CCN) for a new transmission line in Rusk and Panola counties, Texas. Garland states that this project is the subject of a final order by the Federal Energy Regulatory Commission (FERC) in Docket No. TX11-01-001 (*Southern Cross*), and Garland therefore claims that Public Utility Regulatory Act (PURA) §§ 37.051(c-2) and (i) apply to this application. Under PURA, the PUCT, in approving an application filed under these provisions, may prescribe reasonable conditions to protect the public interest that are consistent with the FERC's final order in *Southern Cross*.

Q. **HOW IS THE PUBLIC INTEREST IMPLICATED BY NEW, LARGE MERCHANT TIE LINES LIKE THE SCT PROJECT?**

A. Large new merchant tie lines such as Southern Cross are likely to have significant impacts on price formation and resource dispatch practices in the ERCOT region. The lack of clear rules and protocols on how these impacts will be addressed creates uncertainty and concerns for ERCOT market participants and could impact future resource investment decisions.

The price formation issue arises from ERCOT's ability to take out-of-market reliability actions of curtailing exports and ordering imports over tie lines during Energy Emergency Alert (EEA) conditions. This price formation issue exists today with regard to existing tie lines and should be

addressed in the current market; however, resolving this issue is even more critical with the addition of new large tie lines like Southern Cross.

The resource dispatch issue arises from inadequate existing transmission capability to accommodate the output of existing generators and the new imports over the tie line, particularly during peak load times when such generation and energy import benefit consumers and system adequacy the most. The resource dispatch issue is further exacerbated by the fact that tie line imports are not dispatchable by ERCOT's Security Constrained Economic Dispatch (SCED). Of course, economic transmission upgrades within ERCOT can alleviate such transmission constraints; however, it is challenging for ERCOT to evaluate such upgrades since ERCOT does not model the non-ERCOT regions that are connected on the other side of the tie line. Since such transmission constraints may not be relieved for a long period of time, due to their likely inability to meet modeled economic transmission upgrade criteria, a transmission constraint management plan (CMP), such as special protection scheme (SPS), may help accommodate the resulting flows. The use of SPSs in ERCOT, particularly the ones that rundown generation, is well established and supported by significant precedent. Imposing an appropriate CMP would benefit ERCOT consumers, those resources adversely impacted by the constraints, and the tie line importers. Providing the market and tie line importers the assurance that a CMP exists and, as a policy matter, will be implemented in time to accommodate existing generation and tie line imports alleviates many of the concerns of ERCOT market participants about the consumer benefits of such a tie line and the resource dispatch issues surrounding the congestion created by non-dispatchable tie line imports.

IV. PRICE FORMATION ISSUE RELATED TO TIE LINES

Q. PLEASE DESCRIBE THE PRICE FORMATION ISSUE RELATED TO THE TIE LINES IN MORE DETAIL.

A. Large new merchant tie lines such as Southern Cross are likely to have significant impact of price formation in the ERCOT region. The price formation issue arises from ERCOT's ability to take out-of-market reliability actions of curtailing exports and ordering imports over tie lines during Energy Emergency Alert (EEA) conditions.

ERCOT Nodal Protocols Section 6.5.9.4, Energy Emergency Alert, specifies the actions available to ERCOT during EEA conditions. Specifically, paragraph (6) of this section states:

> During the EEA, ERCOT has the authority to obtain energy from non-ERCOT Control Areas using the DC Ties or by using Block Load Transfers (BLTs) to move load to non-ERCOT Control Areas. ERCOT maintains the authority to curtail energy schedules flowing into or out of the ERCOT System across the DC Ties in accordance with NERC scheduling guidelines.

Section 6.5.9.4.2, EEA Levels, further specifies that ERCOT will declare an EEA Level 1 when Physical Responsive Capacity falls below 2,300 MW and is not projected to be recovered above 2,300 MW within 30 minutes without the use of the actions that are prescribed for EEA Level 1 including the use of available DC Tie import capacity that is not already being used.

Such ERCOT out-of-market reliability actions will have price reversal and suppression issues during emergency conditions—exactly when scarcity price signals are critical for the proper operation and appropriate long-term investment decisions in the energy-only ERCOT market.

Q. HAS ERCOT ALREADY TAKEN SOME ACTION TO ADDRESS THE PRICE REVERSAL ISSUE YOU DESCRIBE?

A. Yes. Nodal Protocol Revision Request (NPRR) 626, Reliability Deployment Price Adder, was approved by the ERCOT Board on August 12, 2014, to meet, according to ERCOT, "the PUCT's objective of mitigating price reversal and suppression during the deployment of Load Resources, Emergency Response Service (ERS), and Reliability Unit Commitment (RUC)."

Q. WOULD THE SAME APPROACH BE APPROPRIATE HERE?

A. Yes. The same approach and price adder calculation put into place by NPRR 626 can and should be used to mitigate price reversal and suppression for ERCOT-directed tie line export curtailment and emergency imports. Since NPRR 626 is already implemented in ERCOT, the incremental cost and time required to add the impact of ERCOT-directed tie line export curtailment or emergency imports should be relatively minimal, making this fix easy to implement. To be clear, such price adder calculation would only be done for ERCOT-directed out-of-market reliability action and not for all the market imports and exports that are an integral part of normal market activity.

Q. HOW DO YOU RECOMMEND THE COMMISSION RESOLVE THE PRICE FORMATION ISSUE DESCRIBED ABOVE?

A. The price formation issue relates to all tie lines and needs to be addressed in the current market regardless of new tie line additions. Therefore, a Commission directive to ERCOT is essential on this issue to allow for expeditious implementation of such changes related to highly charged price formation issues. Alternatively, since Southern Cross is a proposed large new tie line and will most likely have significant price formation impacts on the ERCOT market, Commission should condition its approval

of the tie line to ERCOT mitigating price reversal and suppression during ERCOT-directed curtailment of exports or emergency imports over the tie line during emergency conditions.

Q. **WHY IS THIS RECOMMENDATION IN THE PUBLIC INTEREST?**

A. My recommendation regarding the price formation issue mitigates price reversal and suppression during ERCOT-directed curtailment of exports or emergency imports over tie lines during emergency conditions, and thus maintains appropriate scarcity price signals. Such signals are critical for proper operation and long-term investment decisions in the energy-only ERCOT market.

V. RESOURCE DISPATCH ISSUE RELATED TO TIE LINES

Q. HOW DO PROPOSED TIE LINES LIKE THE SOUTHERN CROSS IMPACT RESOURCE DISPATCH IN ERCOT?

A. Large new merchant tie lines such as Southern Cross are likely to have significant impact of resource dispatch in the ERCOT region. When transmission capability is inadequate to accommodate the output of existing generators and the new imports over the tie line, a serious resource dispatch issue arises—particularly during peak load times when such generation and energy import benefit consumers and system adequacy the most. The situation is made worse by the fact that tie line imports are not dispatchable by SCED. Even output schedules submitted for generation resources are converted into energy offer curves, mitigated under the two-step SCED mitigation if necessary, and may be dispatched at levels different from their submitted output schedules. But none of those provisions apply to tie line schedules.

Q. PLEASE DESCRIBE HOW THE SOUTHERN CROSS TIE LINE WOULD IMPACT RESOURCE DISPATCH IN ERCOT.

A. The Southern Cross DC tie would connect to the new Rusk substation, which would connect to Martin Lake, Mt Enterprise, Stryker Creek and Trinidad 2 substations. Exhibit SS-2 depicts the transmission network for this area. Export to the rest of the ERCOT grid from this area having supply from this DC tie (up to 2,000MW of import net of losses), Martin Lake plant (2,410MW), Gateway plant (846MW), and Stryker plant (669MW) are constrained by the 1631 MVA Martin Lake to Shamburger line, 1631 MVA Martin Lake to Elkton and 1631 MVA Martin Lake to Tyler Grande line sharing common structure, 1072MVA Stryker to Trinidad 1 line, 1072 MVA Rusk to Trinidad 2 line, and 524 MVA, 527 MVA, and 750 MVA autotransformers at Stryker Creek, Lufkin and Nacogdoches, respectively.

Under base N-0 constraint limits, there seems to be sufficient transmission export capability to flow the total supply from this area (5,925MW). Of course, the physics of power flows, reactive power flows, and losses on the lines would reduce the transmission system's capability to flow real power as compared to the lines' MVA ratings. Under N-1 single contingency criteria used by ERCOT to operate the grid, the outage of lines sharing a common structure are treated as a single contingency. The N-1 security constrained transmission export capability, assuming a simple summation of the MVA ratings of 345kV lines and transformers in the area under the contingency outage of both Martin Lake to Elkton line and Martin Lake to Tyler Grande, is in the vicinity of 5,576 MVA. This implies the ability to accommodate significantly less than the total DC Tie import capacity, ignoring power flow equations, reactive power flows, and losses; however, when using a power flow, this theoretical ability to

accommodate the DC tie imports is significantly reduced further.

Q. HOW DO SCARCITY CONDITIONS AFFECT RESOURCE DISPATCH UNDER THE SCENARIO YOU HAVE DESCRIBED?

A. This situation is much worse during the critical summer peak hours when taking into account reactive power flows, losses, and dynamic ratings for the lines which reduce their capacities. During such scarcity conditions, the system and consumers in ERCOT are likely to benefit the most from this supply and yet cannot avail it due to transmission constraints.

Q. HOW DO YOU PROPOSE TO RESOLVE THE RESOURCE DISPATCH PROBLEM CAUSED BY INADEQUATE TRANSMISSION CAPACITY?

A. Until this constraint is relieved by transmission build-out, it would be reasonable and appropriate to resolve the constraint using a transmission constraint management plan (CMP), which could include the use of a Special Protection Scheme (SPS). An SPS could be designed to first runback and, if necessary, trip supply in this area to relieve transmission system overloads. Such an SPS could allow for the use of the base N-0 transmission capacity to export energy from this area to the rest of the ERCOT grid thus allowing for the full use of all supply resources in this area. The implementation of such a CMP would be beneficial to ERCOT consumers, tie line importers and resources within this area.

Of course, economic transmission upgrades within ERCOT can alleviate such transmission constraints. However, it is challenging for ERCOT to evaluate such upgrades since ERCOT does not model the non-ERCOT regions that are connected to the other side of the tie line, nor does ERCOT planning analysis take into account scarcity pricing since it only considers estimated production cost savings. In addition, the number of modeled hours when such constraints are binding may not be sufficient to justify economic transmission upgrades based solely on estimated

production cost savings. Thus, these constraints during critical scarcity hours may continue to exist for many years.

Q. PLEASE SUMMARIZE YOUR RECOMMENDATIONS RELATED TO THE RESOURCE DISPATCH ISSUE.

A. A simple analysis of peak hour operation of Southern Cross with full tie line capacity import described above shows that the transmission system is unable to accommodate the resulting flows without the use of a constraint management plan. Since such constraints may not be relieved for a long period of time, a transmission constraint management plan, such as special protection scheme, may help accommodate the resulting flows—benefiting ERCOT consumers, those resources adversely impacted by the constraints, and the tie line importers. Thus, the Commission should condition its approval of new tie lines, including Southern Cross, on the development of a CMP applicable to imports over the tie line to resolve congestion created by such imports and with policy guidance that such a CMP shall be implemented to resolve such congestion. Of course, ERCOT would not need to review and approve such a CMP until the tie line is energized and may modify the CMP as appropriate to address system conditions at the time of implementation. However, providing the market and tie line importers the assurance that a CMP exists and, as a policy matter, will be implemented in time to accommodate existing generation and tie line imports alleviates much of the concerns of ERCOT market participants about the consumer benefits of such a tie line and the resource dispatch issues surrounding the congestion created by non-dispatchable tie line imports.

Q. **WHY IS THIS RECOMMENDATION IN THE PUBLIC INTEREST?**

A. My recommendation regarding the resource dispatch issue provides tie line importers and the ERCOT market with clear policy direction on

resolving congestion created by tie line imports using transmission constraint management plan and thus alleviates much of the concerns of ERCOT market participants about the consumer benefits of such a tie line and the resource dispatch issues surrounding the congestion created by non-dispatchable tie line imports during critical scarcity conditions.

VI. CONCLUSION

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

A. Yes.

STATE OF TEXAS §
§
COUNTY OF TRAVIS §

BEFORE ME, the undersigned authority, on this day personally appeared Dr. Shams Siddiqi, who, having been placed under oath by me, did depose as follows:

My name is Shams Siddiqi, Ph.D. I am of legal age and a resident of the State of Texas. The foregoing testimony offered by me is true and correct, and the opinions stated therein are, to the best of my knowledge and belief, accurate, true and correct.

Shams Siddiqi

SUBSCRIBED AND SWORN TO BEFORE ME by the said Shams Siddiqi this 27th day of April, 2016.

JORGE AGUILAR
Notary ID # 130504042
My Commission Expires
January 20, 2020

Notary Public, State of Texas

My Commission Expires:
January 20, 2020

Shams Siddiqi, Ph.D.

11412 Bee Caves Rd, Suite 202, Austin, Texas 78738
Phone: 512.619.3532
E-mail: shams@crescentpower.net
Website: www.crescentpower.net

Qualifications

Key designer of the retail-deregulated Electric Reliability Council of Texas (ERCOT) Zonal and Nodal markets. Experience in developing strategies and advising companies on participating in competitive electricity markets. Participate, represent clients, and provide expert testimony in the regulatory processes at the Public Utilities Commission of Texas and ERCOT.

Extensive experience in managing portfolios of power plants and energy contracts, contracting power purchase agreements, structuring financial and insurance products to manage risk, designing deregulated market structures, providing expert testimony on these topics, and developing requirements for software systems related to participation in deregulated markets.

Extensive experience analyzing transmission congestion related risks, forecasting prices at various locations and generation patterns, and valuing generation assets.

Advanced degrees in Electrical Engineering with concentration in Market Design, Power Portfolio Management, and Electricity Pricing. Strong background in Economics, Engineering Economics, Power Systems Analysis, and Large-scale Systems Optimization. Published numerous refereed papers that make significant contributions to the field of Power Economics.

Education

The University of Texas at Austin

Doctor of Philosophy, May 1993

Major: Electrical Engineering

Dissertation: *Reliability Differentiated Pricing and Optimal Planning for Electrical Power Systems.*

The University of Texas at Austin

Master of Science in Engineering, December 1989

Major: Electrical Engineering

Thesis: Real-Time Pricing of Reactive Power.

Bangladesh University of Engineering and Technology

Bachelor of Science, July 1988

Major: Electrical Engineering

Thesis: Optimization of Power System Operation.

Experience

Crescent Power, Inc. Austin, Texas 78738

President, Energy Consulting Services November 1998 to present

- Assist clients in managing their power portfolio and structuring deals, developing corporate strategies for the competitive market, providing price forecasts, and evaluating financial and insurance products to manage risk.
- Analyze transmission congestion related risks, forecast prices at various locations and generation patterns, and value generation assets.
- Assist clients on electricity market design issues and the design of systems for supporting markets.
- Participate, represent clients, and provide expert testimony in the regulatory processes at the Public Utilities Commission of Texas and ERCOT.
- Provide consulting services to clients for a) the development of competitive electricity market structures, b) preparing market participants to participate in these markets and c) developing strategies for participating in these markets.
- Represent clients' interests in the design of the ERCOT electricity market – principal designer of many of the advanced features of the ERCOT Zonal market and the current ERCOT Nodal market.
- Provide Expert Testimony on contractual and market design related issues.

Lower Colorado River Authority Austin, Texas 78703

Manager, Power Acquisition & Marketing March 1997 to January 2008

- Represented LCRA at ERCOT and the Public Utility Commission of Texas.
- Managed the short to intermediate-term power portfolio consisting of power plants & contracts.
- Acquired power resources and marketed excess power.
- Issued requests for proposals, structure and evaluated deals and building power plants, and negotiated contracts – negotiated and renegotiated contracts that resulted in significant savings for the LCRA.
- Coordinated with Fuel Price Risk Management group to manage the integrated energy portfolio.
- Developed analytical techniques and models to determine electricity forward and option prices.
- Developed analytical approaches to value and help structure outage insurance products.
- Analyzed regional and national energy issues for threats and opportunities.

Lower Colorado River Authority Austin, Texas 78703

Senior System Planner, Electric Resource Planning July 1994 to February 1997

- Analyzed both long term and short term energy issues and recommended strategic

courses of action.
- Managed long-term electricity price and financial risk through managing the power resource portfolio.
- Developed analytical approaches and modeling techniques and performed integrated resource planning.
- Evaluated power purchase/sale proposals, demand-side management, supply-side resources.
- Developed marginal costing method and performed marginal cost analysis.
- Developed innovative pricing schemes to price unbundled attributes of electricity.
- Developed LCRA positions in industry restructuring proceedings at PUCT and FERC.

The University of Texas at Austin Austin, Texas 78712
Research Associate, Center for Energy Studies May 1993 to June 1994
- Developed the Comprehensive Electrical Systems Planning model (EPRI Project) that extends the integrated resource planning framework to include transmission and associated technologies.
- Developed tractable computational schemes for decomposing the problem in space, in time, across operating states, and across the decision variables.
- Determined appropriate economic signals for the investment alternatives.

The University of Texas at Austin Austin, Texas 78712
Graduate Research Assistant, Center for Energy Studies September 1988 to April 1993
- Performed policy evaluation and analysis for the Public Utility Commission of Texas.
- Modeled most large electric utilities of Texas using PROMOD, PROSCREEN, EGEAS and LMSTM.
- Performed optimal expansion planning and DSM evaluation using various software tools.
- Developed the Real-time Pricing of Reactive Power method, Reliability Differentiated Pricing policy for pricing electricity, transmission and wheeling services, spinning reserve purchase, and firm capacity purchase (sale) from neighboring utilities, independent power producers, and cogenerators.

Publications

"Project Valuation and Power Portfolio Management in a Competitive Market"
IEEE Transactions on Power Systems, Vol. 15, No. 1, Feb. 2000, pp.116-121.
"Innovative Market Design and Mitigation Methods in the ERCOT Nodal Market"
Presented at the IEEE Power Engineering Society General Meeting 2007, June 26, 2007, Tampa, Florida.
"Resource Adequacy in the "Energy-Only" ERCOT Market"
Presented at the IEEE Power Engineering Society General Meeting 2007, June 27, 2007, Tampa, Florida.
"Uniform and Pay-as-bid Pricing in an Electricity Market with Inelastic and Elastic Demand"
22nd Annual North American Conference of the USAEE/IAEE, Vancouver, Canada, October 4, 2002.
(with Y-S. Son, R. Baldick, and K.H. Lee)
"Reanalysis of Nash Equilibrium Bidding Strategies in a Bilateral Electricity Market"

IEEE Transactions on Power Systems, Vol. 19, No. 2, May, 2004, pp.1243-1244. (with Y-S. Son, & R. Baldick)

"Advanced Pricing in Electrical Systems, Part I: Theory"
IEEE Transactions on Power Systems, Vol. 12, No. 1,
February, 1997, pp. 489-495. (with M. L. Baughman & J. Zarnikau)

"Advanced Pricing in Electrical Systems, Part II: Implications"
IEEE Transactions on Power Systems, Vol. 12, No. 1,
February, 1997, pp. 496-502. (with M. L. Baughman & J. Zarnikau)

"Reliability Differentiated Pricing of Spinning Reserve"
IEEE Transactions on Power Systems, Vol. 10, No. 3,
August, 1995, pp. 1211-1218. (with M. L. Baughman)

"Real-time Pricing of Reactive Power: Theory and Case Study"
IEEE Transactions on Power Systems, Vol. 6, No. 1,
February, 1991, pp. 23-29. (with M. L. Baughman)

"Reliability Differentiated Real-Time Pricing of Electricity"
IEEE Transactions on Power Systems, Vol. 8, No. 2,
May, 1993, pp. 548-554. (with M. L. Baughman)

"Optimal Pricing of Non-Utility Generated Power"
IEEE Transactions on Power Systems, Vol. 9, No. 1,
February, 1994, pp. 397-403. (with M. L. Baughman)

"Time, Space, and Reliability Differentiated Marginal Costs"
NERA Marginal Cost Working Group Meeting, Key West, FL, Apr. 24-26, 1995.

"Value-based Transmission Planning and the Effect of Network Models"
IEEE Transactions on Power Systems, Vol. 10, No. 4,
November, 1995, pp. 1835-1842.(with M. L. Baughman)

"Integrating Transmission into IRP, Part I: Analytical Approach"
IEEE Transactions on Power Systems, Vol. 10, No. 3,
August, 1995, pp. 1652-1659.(with M. L. Baughman & J. Zarnikau)

"Integrating Transmission into IRP, Part II: Case Study Results"
IEEE Transactions on Power Systems, Vol. 10, No. 3,
August, 1995, pp. 1660-1666.(with M. L. Baughman & J. Zarnikau)

Comprehensive Electrical Systems Planning
EPRI Project RP3581-03, February 1994. (with M. L. Baughman and J. Zarnikau)

Electric Utility Resource Planning & Production Costing Projects, Final Report for FY 1990-1991, 1991-1992, 1992-1993. Center for Energy Studies, The University of Texas at Austin, Presented to the Public Utility Commission of Texas, 1991, 1992 & 1993.(with others)

Long-Term Electric Peak Demand & Capacity Resource Forecast for TX, 1992
Center for Energy Studies, The University of Texas at Austin
Presented to the Public Utility Commission of Texas, January, 1993. (with others)

Reliability Differentiated Pricing and Optimal Planning of Electrical Power Systems
Dept. of Electrical and Computer Engineering, The University of Texas at Austin
Ph. D. Dissertation, May 1993.

Real-time Pricing of Reactive Power
Dept. of Electrical and Computer Engineering, The University of Texas at Austin
M. S. E. Thesis, December 1989.

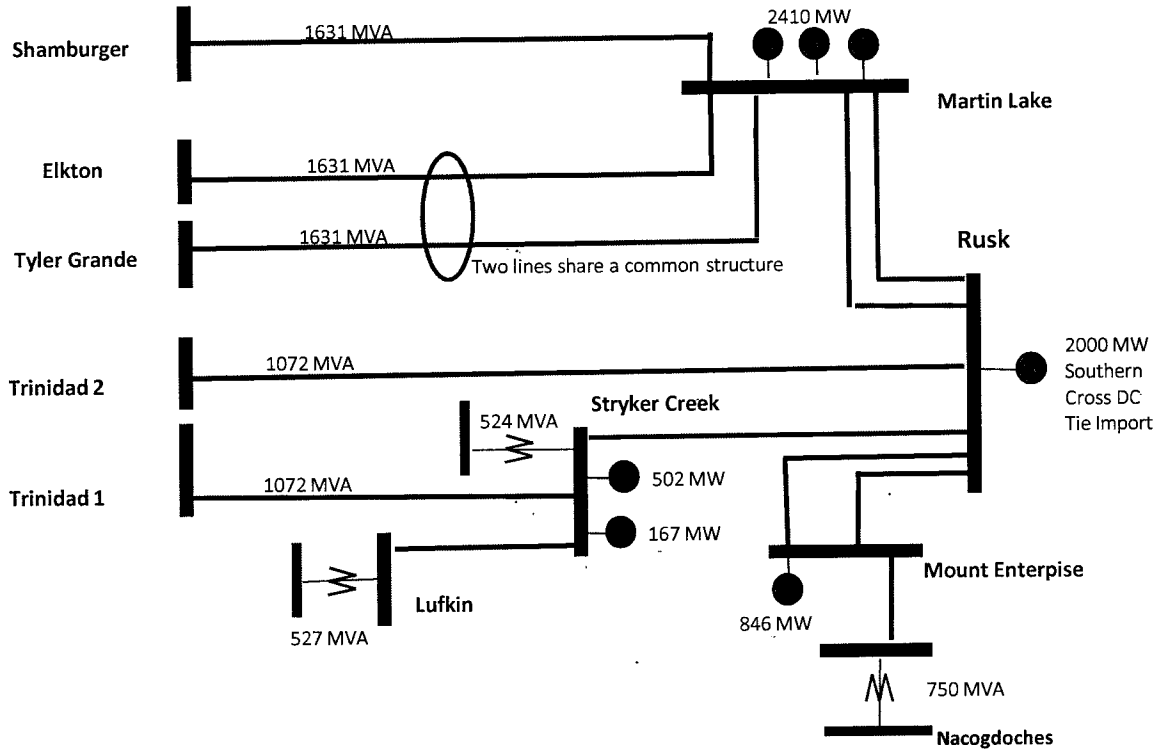
1997 Integrated Resource Plan, 1995 Integrated Resource Plan
Resource Management Department, Lower Colorado River Authority
Austin, Texas, September 1997 and November 1995.

1995 Marginal Cost Study
Electric Planning & Regulatory Department, Lower Colorado River Authority
Austin, Texas, December 1995.

1996 Transfer Pricing
Electric Planning & Regulatory Department, Lower Colorado River Authority
Austin, Texas, March 1996.

"The LCRA Transfer Pricing Mechanism"
Presented at NERA Marginal Cost Working Group Meeting, Philadelphia, PA, Oct. 21-23, 1996.

Exhibit SS-2 Transmission System Near the Southern Cross DC Tie



Transmission System Near the Southern Cross DC Tie