SYNCHRONOUS INTERCONNECTION COMMITTEE

March 11, 1999

Mr. Gene Preston
4710 Fawn Run
Austin, TX 78735

Subject: ***Feasibility Investigation for AC Interconnection between ERCOT and SPP/SERC***

Dear Mr. Preston: Gene

The Synchronous Interconnection Committee (SIC) would like to express its appreciation for the support offered by your company in the preparation of the "Feasibility Investigation for AC Interconnection between ERCOT and SPP/SERC" (Report). Preparation of this Report was a major undertaking for an independent five member committee and would not have been possible without the considerable assistance from many within the electric power industry.

The Report has been delivered to the 76th Texas Legislature. We understand that a number of the members of the Legislature focusing on the electric industry restructuring have begun review of the Report's findings. To date, no formal discussions of the Report's findings have been scheduled.

We have enclosed a copy of the three-volume final Report. This copy was left unbound to facilitate copying and distribution within your company. Additional copies can be purchased from the Public Utility Commission of Texas and at Print Depot in Austin. There are no restrictions on reproduction of the Report.

Again, thanks for the very valuable contributions made to the SIC.

Sincerely,

John Allen Moore, Chairman
Synchronous Interconnection Committee

Enclosures

Report to the 76th Texas Legislature

Volume I

Executive Summary

Feasibility Investigation for AC Interconnection between ERCOT and SPP/SERC

January 1999

Prepared by
Synchronous Interconnection Committee

SYNCHRONOUS INTERCONNECTION COMMITTEE

January 29, 1999

The Honorable Ken Armbrister
Chairman
Senate State Affairs Committee
380 Sam Houston Building
Austin, TX 78711

The Honorable David Sibley
Chairman
Senate Economic Development Committee
370 Sam Houston Building
Austin, TX 78711

The Honorable Steve Wolens
Chairman
Committee on State Affairs
E2.108
State Capitol
Austin, TX 78769-2910

Honorable Members of the Texas Legislature

Subject: Report to the 76th Texas Legislature - ***Feasibility Investigation for AC Interconnection between ERCOT and SPP/SERC***

Dear Members:

Enclosed herewith is the Synchronous Interconnection Committee's (SIC) two-volume report ***Feasibility Investigation for AC Interconnection between ERCOT and SPP/SERC*** to the Texas Legislature. The report was prepared in response to the directive contained within Section 2.056(a) of the Public Utility Regulatory Act of 1995. Individual copies of the full report have been provided to each member of the Legislature.

The report is presented in two volumes due to the voluminous data-intensive nature of the Committee's work product and a desire to provide a separate *Executive Summary* of the Committee's findings. Volume I - *Executive Summary* highlights the approach taken to prepare the work and the findings from the technical, economic, and legal investigations. Volume II - *Report and Appendices* presents a comprehensive summary of the investigations of the broad range of issues analyzed.

The thrust of the SIC's work has been to analyze and consider, to the extent the SIC's time and/or resources have allowed, whether AC interconnections can be established in a technically feasible and economically desirable manner. The submission of this report completes the work effort begun over two years ago. The investigation of AC interconnections between ERCOT and the SPP/SERC involved a complex set of technical, economic, and legal issues. It also involved many contemporary issues facing the evolving electric utility marketplace. Due to the complexities of the issues and uncertainties surrounding the evolving electric marketplace, the SIC was unable to conclusively establish that AC interconnection is, or is not, desirable either as a candidate transmission investment or as an instrument of policy to promote competition in future electricity markets. The SIC's findings do, however, bring into sharper focus many important and contemporary issues raised by AC interconnection.

The SIC consists of a five person committee of independent professionals with engineering, economic, and legal backgrounds. The committee members are not employees of any interested party (utility, power marketer, merchant plant developer) directly participating in the restructuring of the electric industry. All are active participants in today's electric industry through professional relationships.

The work of the SIC involved a broad range of participants active in the regional electric industry. The SIC is very appreciative of the considerable support and contributions provided by many interested utilities, power marketers, various state agencies, consumer organizations, and universities and associated research organizations. We also want to recognize the strong support provided by the Public Utility Commission of Texas. Without the outstanding contributions by these many parties, considerable work effort associated with the SIC's investigations would not have been possible.

The SIC has been honored to serve as a vehicle to further the investigation of the ERCOT AC interconnection issue. Should the Legislature determine that additional consideration of the issue is warranted, we have provided a few suggestions on how it might choose to undertake subsequent investigations. Also, the committee members would welcome the opportunity to participate in future discussions regarding the work and findings of the SIC.

Respectfully Submitted by:
SYNCHRONOUS INTERCONNECTION COMMITTEE

William Avera, Ph.D., Co-Chairman

John Allen Moore, Co-Chairman

Martin L. Baughman, Ph.D.

Mark W. Smith, J.D.

Mo-Shing Chen, Ph.D.

Enclosure

cc: Governor George Bush
Lt. Governor Rick Perry
Public Utility Commission Commissioners

Feasibility Investigation for AC Interconnection between ERCOT and SPP/SERC

Executive Summary

Table of Contents

REPORT TO THE 76TH TEXAS LEGISLATURE

VOLUME I

FEASIBILITY INVESTIGATION FOR AC INTERCONNECTION BETWEEN ERCOT AND SPP/SERC

EXECUTIVE SUMMARY

ES.1 BACKGROUND

The Synchronous Interconnection Committee ("SIC") was formed in response to the 74th Texas Legislature's directive in Section 2.056(b) of the Public Utility Regulatory Act of 1995 that:

> The commission [Public Utility Commission], with the advice and consent of the governor, shall appoint a five-person interstate connection committee to investigate the most economical, reliable, and efficient means to synchronously interconnect the alternating current electric facilities of the electric facilities of electric utilities within the Electric Reliability Council of Texas reliability area to the alternating current electric facilities of the electric facilities of electric utilities within the Southwest Power Pool reliability area. The committee shall report an estimate of the cost and benefit to effect the interconnection, an estimate of the time to construct the interconnecting facility, and the service territory of the utilities in which those facilities will be located. The committee shall submit its report to the legislature by September 1, 1997, at which time the committee shall be dissolved.

The SIC is comprised of the following members:

William Avera, PhD, CFA, Committee Co-Chairman
President, FINCAP, Inc.
Former Professor, Economics and Finance

Former Director of Economic Research, Public Utility Commission of Texas
Recognized expert on economic and financial issues

Martin L. Baughman, PhD
Professor, Department of Electrical Engineering
The University of Texas at Austin
Specialist in the economics of power systems planning and operations

Mo-Shing Chen, PhD
Professor of Electrical Engineering
The University of Texas at Arlington
Director Energy Systems Research Center
Nationally recognized expert on electrical systems analysis

John Allen Moore, Committee Co-Chairman
Director and Managing Executive Consultant
Resource Management International, Inc.
Consultant to utility industry on power supply, transmission, and policy issues

Mark W. Smith, J.D.
Partner: Brown McCarroll & Oaks Hartline, L.L. P.
Former Administrative Law Judge, Public Utility Commission of Texas
Public Utility Law practice

The SIC first met in August of 1996. Mr. Smith replaced Mr. Stephen Wakefield early in 1998 following Mr. Wakefield's resignation. The SIC members serve without compensation and at their own expense. The SIC members have no direct affiliation with electric industry participants (utilities, non-utility producers, power marketers, etc.), but all work in the industry as consultants and advisors to a broad range of industry participants.

ES.2 CONTEXT OF INVESTIGATION - AN INDUSTRY IN TRANSITION

The electric utility industry is presently undergoing sweeping change. Historically, transmission services have been provided principally by vertically integrated monopolies that produce, transmit, and deliver electricity to the final consumer. The transmission facilities required by each provider were paid for primarily by the provider's own system customers.

A reexamination and restructuring of this historical paradigm has been necessitated by growing recognition that the creation of a competitive market for the provisioning of generation services is both workable and desirable. Proposals to restructure the way transmission services are provided have been or are being developed across the country. A great deal of attention has been devoted to developing institutional and market structures that will allow competition in the supply of generation to work while coordinating the operation and use of the transmission facilities so as not to degrade system reliability.

In 1996 the Federal Energy Regulatory Commission ("FERC") issued Orders 888 and 889 mandating that transmission providers "unbundle" their transmission services from generation and distribution activities and open their transmission facilities to use by third-party wholesale electricity providers and users. Order 888 imposes a "comparability" requirement under which the owners of transmission facilities must provide transmission service to third-party users on the same terms and conditions as apply to the provision of transmission services to the owners themselves. Order 889 mandates the creation of systems to provide timely information about the availability and pricing of transmission services to all transmission system users in a non-discriminatory manner. Taken together, these FERC orders make it possible for competitive providers of generation services to enjoy open access to potential markets and equal access to information about service availability and costs.

At the state level, the Texas Legislature in 1995 took similar steps to bring wholesale electric competition to Texas. The legislature enacted PURA 95 authorizing the entry of new players into the wholesale power market: power marketers, who buy and resell power but own no electrical facilities, and exempt wholesale generators, who own generation facilities but no transmission or distribution facilities. These new competitors must comply with nominal Public Utility Commission of Texas ("PUCT") registration and reporting requirements but are otherwise free of state regulation. As of April 1998, over 75 power marketers and exempt wholesale generators have registered with the PUCT.

PURA 95 also opened up the ERCOT transmission system for use by all wholesale providers on an equal basis. During the fall of 1995 and much of 1996 and 1997, the PUCT debated and ultimately adopted an open access transmission rule and then approved a multitude of new utility transmission tariffs establishing non-discriminatory rates, terms, and conditions for the use of the ERCOT transmission system. The establishment of open transmission access at both the state and national levels has given rise to potentially significant changes in the patterns of use of existing transmission facilities, both within and without ERCOT. These changes make particularly pertinent PURA 95's directives that synchronous interconnection of ERCOT with the rest of the nation be thoroughly examined.

ES.3 SIC APPROACH TO THE INVESTIGATION

The initial meeting of the SIC was held on August 19, 1996. The legislative directive contained in Section 2.056(b) of PURA 95 was reviewed at that time and alternative game plans for conducting the work of the SIC were discussed. As a result of research by the PUCT legal staff, the SIC committed to conduct its business in accordance with provisions of the Open Meetings Act. The schedules and agenda for all SIC meetings have been published in the *Texas Register* to allow full public participation. Additionally, meeting notices and agendas have been distributed by e-mail to all interested parties. The SIC has held more than twenty open meetings and workshops to gather information and to seek input from interested parties. Many interested parties have participated in the process, including representatives from numerous utilities and power marketers within ERCOT and the Southwest Power Pool ("SPP"). Extensive public comment has been received on the economic, regulatory, and reliability implications of synchronous interconnection and that comment is reflected in this final report. Minutes from each meeting have been prepared and published. Meeting minutes, and other documents submitted to the SIC are on file and publicly available at the PUCT under Project 14894.

No funds were appropriated for the SIC effort. As a result, the SIC studies over the last two years have been supported by voluntary contributions of time and money from public and private entities. The resources vital to our investigations and reports were made available by the PUCT, other state agencies, universities, and associated research organizations, utilities, power marketers, consultants, law firms, and consumers. The total value of the resources contributed is conservatively estimated at $2 million, primarily representing labor hours and technical analyses.

Additionally, it is important to recognize that the findings and opinions expressed in this Executive Summary and attached *Report and Appendices* document reflect the positions of the SIC. Considerable assistance was provided by the PUCT staff to facilitate the SIC work activity, provide meeting space for a majority of the SIC meetings, and to prepare the Market Concentration Analysis under the direction of the SIC, but the PUCT has not formally reviewed or endorsed the SIC's work effort or findings.

ES.4 OVERVIEW OF THE REPORT

Volume I of this report is the Executive Summary.

Volume II of this report contains the unredacted analyses and associated appendices and is approximately 500 pages in length. Much of the material is necessarily technical in nature due to the technical complexity of the issues addressed. Volume II is divided into the following seven chapters:

- Background
- Cost and Benefit Issues
- Legal and Regulatory Issues
- Reliability, Cost, and Schedule Analyses
- System Security Issues
- Energy Trade Analyses
- Market Concentration Analysis

The thrust of the SIC's work has been to analyze and consider, to the extent the SIC's time and resources have allowed, whether synchronous interconnection can be established in a technically feasible and economically desirable manner. Although the SIC lacked the necessary resources to definitively "determine *the most economical, reliable, and efficient means* to synchronously interconnect . . ." the facilities of ERCOT with SPP/SERC as initially envisioned by the Legislature, the SIC has investigated and analyzed a "strawman" interconnection configuration described below, which the SIC believes to be a representative and useful interconnection case study. In addition, the SIC analyzed technical and policy issues associated with interconnection.

The SIC is unable to conclusively establish that synchronous interconnection is, or is not, desirable either as a candidate transmission investment or as an instrument of policy to promote competition in future electricity markets. Synchronous interconnection could be desirable if it is considered but one component of a coordinated program of policy and investment designed to enhance competition and reduce concentration in the future markets for generation services. Any potential benefits of synchronous interconnection could, however, be rendered unachievable either intentionally or unintentionally by actions of market participants and/or state or federal regulators if appropriate market structures are not created and vigilance is not exercised.

Synchronous interconnection can be reliably accomplished only through multiple large capacity connections put into service simultaneously. Since ERCOT and the surrounding power pools have been planned and operated without interconnection, significant construction of new transmission lines and improvement of existing lines would be necessary. A large additional investment in transmission facilities is necessary before synchronous operation is possible. Due to reliability considerations, synchronous interconnection cannot be accomplished in a piecemeal or gradual fashion; a considerable level of synchronous interconnection must be placed in service simultaneously to assure the ability of the interconnection to reliably handle the inter-grid transfers.

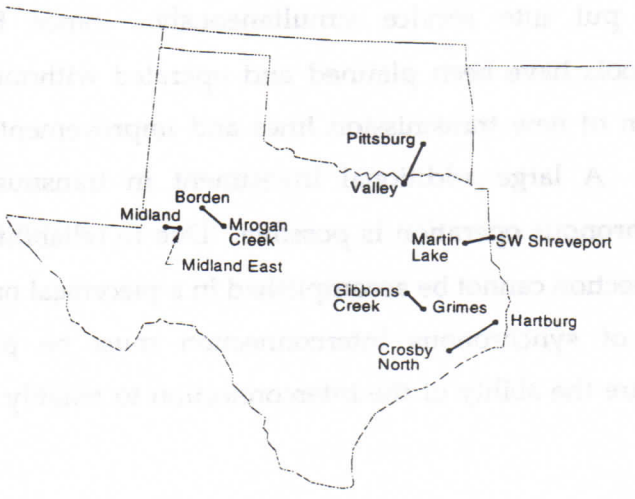
Through its efforts over the last two years, the SIC has confirmed that synchronous interconnection is a complex and controversial issue for the electric industry of Texas, with strongly-held views by a plethora of interested parties. Determining the optimal means of accomplishing synchronous interconnection has proven to be beyond the scope of a voluntary committee without funding or dedicated staff. However, the SIC's findings, which are summarized throughout this report, hopefully bring into sharper focus the host of complex technical, economic, legal, and regulatory issues raised by synchronous interconnection.

ES.5 THE "STRAWMAN" CONFIGURATION STUDIED

The one candidate synchronous interconnection configuration studied by the SIC consists of nine transmission circuits to be installed at six different locations along the interface between ERCOT and SPP/SERC. Three of the six inter-ties consist of double circuits. This interconnection configuration constitutes a "strawman" proposal in that the set is but one of many possible interconnection configurations. The approximate locations of the proposed additional facilities needed to effect this interconnection configuration are shown on Figure ES-1.

Figure ES-1

Strawman Synchronous Interconnection



Though many other interconnection configurations could have been studied, this configuration was selected for study for a variety of reasons. The following outlines a number of the factors used to establish the interconnection "strawman" as the basis for this investigation.

- The six specific inter-ties were suggested as appropriate candidates by one or more of the various industry representatives who made presentations to the SIC on March 25, 1997.
- The proposed inter-ties facilitate movement of power in all directions across the ERCOT-SPP/SERC interface-- east, north and west.
- The proposed inter-ties tend to minimize potential operating problems on low voltage transmission lines because all of the inter-ties are at voltages of 230KV or higher.
- All of the inter-ties are sited a considerable distance away from the two existing back-to-back high voltage direct current ("HVDC") ties that presently connect ERCOT with SPP/SERC. One of the HVDC ties, located in north Texas near the Oklaunion Generating Station, is rated at 220 MW. It commenced service in 1984. The other, located in the northeastern corner of Texas between the Welsh Power Station and the Monticello Generating Station, is rated at 600MW and began service in 1995. Because parallel operation of AC and DC lines in close proximity can create control problems, the proposed sitings of the AC inter-ties minimize any interference with the operation of the existing HVDC ties and allow continued use of the HVDC ties as designed.
- The three double circuit inter-ties hypothesized are situated between relatively strong electrical buses on each side of the ERCOT interface. Each of these buses is considered relatively strong because each connects to at least two existing high-voltage interconnections in their respective systems, even when excluding the proposed inter-ties, thus providing for reliable movement of power to and from the interface between ERCOT and SPP/SERC.

- The remaining three single circuit interconnections tie together existing high voltage facilities that are already in very close proximity, thus providing very low cost interconnection opportunities in their respective locations.

For all of these reasons, the SIC found this interconnection configuration to constitute an appropriate case study. The detailed findings of the SIC resulting from this case study are summarized below.

ES.6 KEY FINDINGS- INTERCONNECTION COST AND SCHEDULE

Synchronous Interconnection Costs. The SIC solicited costs estimates for the equipment and facilities needed to effect the interconnection proposal described above. Representatives of the companies whose facilities would be interconnected were asked to provide these estimates. Representatives of TU Electric ("TU"), Houston Lighting & Power ("HL&P"), Central and South West Corporation ("CSW"), Southwestern Public Service Company ("SPS") and Entergy responded. The total estimated facilities cost for the interconnections shown on Figure ES-1 range from approximately $300,000,000 to $350,000,000 in 1997 dollars. An additional $300 million of costs is estimated for other transmission infrastructure facilities, including voltage compensation devices, needed to support full utilization of the inter-ties. The infrastructure facilities in question are transmission facilities (lines or transformers) that are not located at the inter-ties, but that are nonetheless affected by power transfers over the inter-ties and that must be upgraded to enable trade over the inter-ties.

In addition to the facilities costs, synchronous interconnection may impose additional operating costs as well for utilities and other owners of electric generating facilities. In order to maintain reliability, generators may have to adjust operations to accommodate the operations of utilities elsewhere on the interstate grid. The magnitude of these additional costs is difficult to quantify due to uncertainties as to the operating characteristics of the interconnected grid.

The additional operating costs are likely to have two components. First, additional personnel time and equipment may be required to enable the ERCOT ISO and other participants to coordinate operations with power producers outside of the ERCOT region. While these coordination costs may run into hundreds of thousands, even millions of dollars, the amount is likely to be small relative to the other costs and benefits of synchronous interconnection. Second, additional generation costs may be necessary. For example, synchronous interconnection may make it economical for there to be substantial amounts of power flow over the transmission networks of the ERCOT and the SPP/SERC systems in ways not anticipated at the time the networks were originally designed. This in turn may necessitate alteration of generation dispatch from a "least-cost" configuration to maintain secure system operations under these conditions. These additional security related requirements and costs are discussed more fully below.

Synchronous Interconnection Schedule. The SIC solicited schedule estimates for completing the routing studies, right-of-way acquisition, permitting, design, and construction of the AC interconnections described above. Replies were received from TU, HL&P, CSW, Entergy, and New Century Energies. Estimates of the time required to perform the studies and complete the installation of the facilities range from approximately 3 years to 6.5 years.

Funding of Synchronous Interconnection Investments. The facilities for interstate connection and the required infrastructure improvements could fall outside the traditional paradigm of transmission funding by utilities. If the traditional approach to utility financing of these investments is to be followed, the utilities will construct the required facilities and recover the associated costs from their customers or other users of the facilities. However, there is an issue as to whether sufficient economic incentives exist for the utilities to construct new transmission facilities in an environment where transmission owners must provide open access service to all potential users. Moreover, this issue is not unique to synchronous interconnection and is being debated in Texas and elsewhere relative to all new transmission investment generally .

ES.7 KEY FINDINGS- LEGAL AND REGULATORY IMPACTS

The PUCT, unlike most other state commissions, has jurisdiction over and actively regulates the wholesale rates and services, including bulk transmission rates and services, of many utilities whose power flows are technically interstate in nature. The PUCT's jurisdiction over these rates and services is a function of both state and federal law. At the state level, the Texas Legislature, in enacting and periodically amending the Public Utility Regulatory Act, has expressly authorized the PUCT to regulate wholesale power and transmission rates and services of Texas utilities. At the federal level, the utilities which comprise ERCOT (with the exception of WTU and CP&L) are exempt from FERC regulation as "public utilities" under a specific exemption in the Federal Power Act ("FPA"). The combination of these circumstances enables the PUCT to exercise, within ERCOT, jurisdiction over transmission and wholesale power rates and services that would in other circumstances lie exclusively with FERC. The PUCT's unique regulatory authority over these rates and services within ERCOT is tacitly acknowledged by Congress in the FPA.

Synchronous interconnection of ERCOT with the SPP/SERC will, in certain circumstances, result in the loss of the PUCT's current jurisdiction over transmission and wholesale power rates and services within ERCOT. The specific procedural steps taken to accomplish synchronous interconnection will determine whether the PUCT's current jurisdiction is retained following interconnection. If the Texas Legislature or the PUCT orders or otherwise requires synchronous interconnection without first obtaining a FERC §210 interconnection order, the PUCT's current jurisdiction over wholesale rates and services effectively will be ceded to FERC. If, however, the Commission petitions for and obtains a FERC order requiring synchronous interconnection pursuant to FPA §210, the scope of the PUCT's current jurisdiction will be preserved, and synchronous interconnection should not have any appreciable legal or regulatory impact upon ERCOT utilities, their shareholders, ratepayers, or other interested parties. If the PUCT petitions FERC for issuance of a FPA §210 Order, it is far from certain that FERC would grant that request. Such an order could not be issued by FERC unless it first found that:

1) issuance of the order is in the public interest; 2) the order would encourage overall conservation of energy or capital, or optimize the efficiency of use of facilities and resources, or improve the reliability of the electric utility system to which the order applies; and, 3) the continued reliability of any electric systems affected by the order would not be unreasonably impaired, after considering consistently applied regional or national reliability standards, guidelines, or criteria.

If the PUCT's current wholesale jurisdiction is forfeited to FERC, transmission and wholesale power rates and services within ERCOT will be affected in a number of ways. For example, the center of wholesale regulation would physically move from Austin to Washington, D.C. Federal law and rules pertaining to wholesale transmission and energy sales would apply as opposed to state law and PUCT rules. Although FERC and the PUCT share common regulatory objectives with respect to bulk transmission and wholesale rates, those shared objectives would not, however, result in the implementation of identical regulatory policies by the two agencies.

The areas of substantive difference between FERC and PUCT regulation that would be felt most immediately concern are: 1) wholesale rates; 2) transmission pricing terms and conditions; 3) required approvals for the sale, transfer and/or merger of utilities and utility assets; and, 4) terms and conditions for utility recovery of stranded investment.

Regarding wholesale rates, FERC's ratesetting practices differ significantly from those of the PUCT. Furtherfore, as to policy, FERC has implemented comprehensive policy governing the ability of public utilities to make market-based sales of power and energy that has no comparable PUCT counterpart.

With respect to transmission pricing terms and conditions, the Texas Commission has adopted a unique pricing methodology for ERCOT transactions that is based upon a weighting of the "vector absolute megawatt mile" (VAMM) method of assessing impacts and the "load-ratio share" methodology. Although FERC has traditionally used "postage stamp" pricing within individual utility control areas and "contract path"

pricing where multiple control areas are required to complete a power of sale, it is now encouraging the use of region-wide transmission pricing administered by regional independent system operators. The pricing differences resulting from application of the PUCT and FERC methodologies are quite significant. FERC policy differs, not only in terms of pricing methodology, but also with respect to the appropriate definition of ancillary services to be offered transmission customers, and with respect to the necessity of abrogating or reforming existing transmission agreements to conform to current rules.

With respect to the sale, transfer and/or merger of utilities and utility assets, current state law merely requires that the utility report the transaction to the PUCT within a reasonable time. In contrast, FERC approval of the sale, acquisition, or merger of utilities is required under federal law. The requirement that FERC approval be secured constitutes a significant additional regulatory burden on ERCOT utilities. Additionally, compliance with FERC merger policies may prove significantly more difficult than satisfaction of the public interest standard required under state law.

With respect to utility stranded investment, FERC has addressed wholesale stranded investment at great length in Order No. 888 and in the stranded cost rule adopted in that order. In contrast, no determination has been made by the PUCT or the Texas Legislature as to the methodology to be used to quantify or to secure the recovery of wholesale stranded investment by ERCOT utilities. It is highly unlikely that the PUCT or the Texas Legislature would choose to follow identical policy to that formulated by FERC were the PUCT to retain its current jurisdiction over wholesale rates and services within ERCOT. This issue is of sufficient import that it should be carefully taken into consideration in evaluating how best to achieve synchronous interconnection, should synchronous interconnection be desired.

ES.8 KEY FINDINGS- ENERGY TRADING BENEFITS

As a general economic principle, the larger the area over which goods may be traded, the greater the potential gains from trade. Applying this principle to the market for

electricity would suggest that, as the size of the area expands where electricity can be traded, the larger the potential economic benefits are from electricity exchanges. Interconnecting electric systems over larger geographic areas creates opportunities for power transfers to take advantage of generating cost differences and diversity in the timing of regional peak demands.

Although expansion of ERCOT beyond its current boundaries would offer the advantage of geographic scope, partial realization of that advantage is already possible given the 820 MW of export/import capacity provided by ERCOT's existing DC inter-ties with SPP/SERC. Therefore, for purposes of evaluating potential energy trading benefits attributable to synchronous interconnection, it is the incremental benefit obtainable from additional trade made possible by the synchronous inter-ties that is relevant. Analysis of the incremental benefit attributable to the "straw man" synchronous interconnection proposal was therefore undertaken by the SIC.

At the outset, the SIC recognized that a number of uncertainties could affect how future electricity markets might evolve. The SIC also recognized the existence of substantial uncertainty as to the technical characteristics of any AC interconnection. Consequently, several different trade scenarios were analyzed. In each scenario, the data were changed to reflect alternative assumptions about future electricity market conditions and/or technical characteristics of the AC interconnections. In each case, the production cost savings attributable to the AC interconnection were calculated as the difference between

a) the total production costs in ERCOT and interconnected regions that occur when only the existing DC interconnections are in place, and

b) the total production costs that occur in these same regions when the proposed AC interconnections are in place.

Altogether 16 different cases were analyzed using two different pricing policies for transmission for the years 1996 and 2003.

The amount of the annual production cost savings attributable to increased trade ranged from less than $10 million per year to over $250 million per year, depending upon the assumptions used. The most important assumptions were: 1) the transmission pricing policies assumed to be in effect, primarily in SPP and neighboring regions; 2) the forecast of future fuel prices, particularly natural gas; and 3) the amount of generating capacity in ERCOT and SPP/SERC that could be considered "must-run" for system security or other non-economic reasons. Table ES-1 presents the base case production cost savings and reveals the sensitivity of the savings to alternative assumptions.

TABLE ES-1

Summary of Annual Production Cost Savings Attributable to Increased Electricity Trade with AC Interconnection

(Dollars in millions)

Case/Sensitivity	Year 1996	Year 2003
Base Case	$12.6	$4.1
Alternative Transmission Pricing in SPP	107.5	31.0
Higher Natural Gas Prices	129.6	42.7
More "Must-Run" Generating Units	8.3	4.1

Another source of potential benefit is the opportunity to export Texas natural gas "by wire." Information presented to the SIC by representatives of the natural gas industry and the Texas Railroad Commission suggests that natural gas produced in Texas could be converted to electricity and then sold on the national grid. The economics of these transactions are presently less than clear due to the dynamic nature of gas markets.

ES.9 KEY FINDINGS- TECHNICAL AND RELIABILITY

An interconnected AC network is a complicated system that is subject to various reliability and stability problems due to the electrical interactions of its many

components. Adding AC interconnections will increase the electrical complexity of the system and may threaten reliability and lead to power outages. The human and economic cost of power outages, especially extended outages over a wide geographic area, can be huge as was demonstrated by the Northeast blackout in 1965 and the WSCC blackouts in 1996, or impact only a regional area as was witnessed in the recent blackouts in El Paso and the Rio Grande Valley.

The primary reliability threats in a transmission system are a) voltage collapse; b) transient instability; c) dynamic instability; and d) cascading line, transformer, and/or generator outages, particularly in response to some electrical system disturbance or outage contingency. Any of the four conditions cited can lead to system segmentation and/or failure, and interruption of service to the customer.

Voltage Collapse. Voltage collapse can occur when a load and the transmission system delivering power to it require such a large amount of reactive power that it exceeds the capability of the reactive power sources to supply the needs, or when the system is operating near its stability margin and it experiences a critical disturbance. The process of voltage instability is usually triggered by some form of disturbance, such as a line or generator outage, or other change in operating conditions, such as energy trading, which creates increased demand for reactive power. The situation may be mitigated by reducing load/power transfer, and/or by switching on local shunt capacitors, if available, to serve as sources of reactive power. Additional investment in reactive power resources may be needed in the near future and in the long run. The additional cost of reactive power to maintain a minimum level of security requires clear definition of the cost responsibility by the marketplace entities (generators, transmission providers, loads, etc.)

The SIC concluded that even without synchronous interconnection the ERCOT system is already only marginally secure against voltage collapse. With synchronous interconnection, however, the configuration of generator use may change significantly in response to new energy trading patterns that are made economical. This may make

generator "must run" considerations far more important for system security in the future.

Transient and Dynamic Stability. The concept of system stability revolves around whether generator electro-mechanical oscillations that may follow a disturbance and affect system voltages, currents, and power flows will automatically dampen and restore to a stable, steady, and secure operating condition. If not, the system is considered unstable. The types of disturbances that can trigger stability problems include sudden transmission line outages, transformer outages, generator failures, load changes, transmission line faults (shorts across lines or from line to ground), lightning striking equipment, and a host of other contingencies.

Transient stability relates to the ability of the system to remain stable for the first oscillatory swing after a fault (in the first few tenths of a second). Dynamic stability has to with the longer term ability of the system to remain stable for the duration of many oscillations after a disturbance (from seconds to minutes). Due to time and resource constraints, the SIC did not study the effects that synchronous interconnection might have on the transient or dynamic stability of the ERCOT, SPP/SERC, or the combined systems.

Cascading Outages. If the equipment loadings are such that when one item of equipment fails it overloads more items of equipment, in turn causing them to trip out of service which then leads to more overloads, and so forth, then system reliability is threatened by cascading outages. As an example, the condition might be precipitated by a transmission line failure caused by a falling tree branch. In response to the outage, all remaining transmission line flows adjust to carry the flow that was on the outaged line, leading to another line overload that, in turn, trips, and so forth, until the whole system cascades into failure. These cascading overloads are an obvious threat to secure system operation, and were the main reason for the spread of the Great Northeast Blackout in 1965. The SIC examined the effects of a multitude of outage contingencies on line flows both with and without synchronous interconnections so that the incremental impacts of the synchronous interconnection could be determined.

Based upon the line flow impacts, the SIC concluded that the straw-man AC interconnection proposal, if installed, was capable of accommodating inter-regional power transfers at the level of 1500-2500MW, depending upon the trading partners. These flows could be accommodated with no greater impacts than were already being experienced now with DC interconnection, although it was realized that some line loading problems might be geographically rearranged with AC interconnection. Synchronous interconnection would create additional power transfer capability within ERCOT for moving more power from north to south, and within SPP, for moving more power from south to north.

Reliability Benefits. Synchronous interconnection can also lead to reliability benefits. With synchronous interconnection ERCOT will be able to withstand some kinds of disturbances and outage contingencies better than if no AC inter-ties were installed. For example, the decline in frequency and the required response of the remaining generation units will be less with synchronous interconnection if either north ERCOT or south ERCOT suffers the loss of its largest generating plant. Synchronous interconnection may also reduce the amount of reserve capacity needed within ERCOT. This is because the availability of power from other regions will allow ERCOT systems to draw upon outside sources in case of shortfalls of electricity due to equipment failures and natural disasters. The ability to access outside resources can reduce the need to maintain reserve capacity because part of any unanticipated shortfall can be met with imported electricity.

ES.10 KEY FINDINGS- MARKET CONCENTRATION

Market Concentration Impacts of Synchronous Interconnection. Because highly concentrated markets may create conditions that lead to the exercise of market power by dominant providers, the SIC examined the effect of synchronous interconnection on market concentration.

An analysis of the effect of synchronous interconnection on specific market concentration measures was performed by PUCT staff under the direction of the SIC. The purpose of the analysis was to examine the existing level of market concentration within ERCOT and the degree to which market concentration may be reduced through the construction of AC transmission interconnections between ERCOT and SPP/SERC. Concentration of ownership of generating facilities is a concern because highly concentrated ownership may enable generating firms to raise prices above competitive levels. Regulatory bodies, vigorous competitors, threat of entry, and the fear of antitrust litigation serve as checks on market power.

The analysis indicates that if the straw man inter-ties had been built in 1996, they would currently be providing some mitigation of market concentration and increased customer choice in much of ERCOT. In the 2003 scenario, however, little trading takes place over the inter-ties, and its impact on market concentration within ERCOT is very low. Several factors act to reduce the value of the inter-ties in the 2003 timeframe. Some of the major factors identified were:

- A reduction in total regional reserve margin from over 27% in 1996 to 13.2% in 2003 reduces the excess capacity available for trading.
- The assumed availability of a significant quantity of efficient new generation inside and outside ERCOT provides relatively inexpensive new local sources of power, making extensive long-distance trading uneconomic.
- Distance-sensitive transmission pricing in the non-ERCOT areas makes shipping low-cost power to ERCOT from outlying areas prohibitively expensive. This problem is exacerbated by incorporation of the additional cost of the interconnection into transmission rates.

The AC inter-ties appear to have little value in terms of reducing market concentration in ERCOT under the current transmission pricing regime in SPP/SERC. A change in non-ERCOT transmission pricing could, however, significantly increase the market concentration benefits of the synchronous interconnection.

ES.11 ALTERNATIVES TO SYNCHRONOUS INTERCONNECTION

Synchronous interconnection is a major undertaking that would require considerable time to accomplish. During the course of the SIC's work, some consideration was given but no detailed investigation was completed for two alternatives that could achieve some of the benefits of synchronous interconnection, and that could be implemented either as an alternative to, or prior to, the effectuation of synchronous interconnection. The lack of investigation should not be considered as representative of the SIC's position on the feasibility of either of the two alternatives to provide benefits to interconnecting the ERCOT and SPP/SERC systems. The lack of investigation was attributed to the SIC's limited resources to conduct the investigation.

One alternative is to expand the existing DC ties and thereby increase the amount of aggregate transfer capability above the current 820 MW. Information was presented to the SIC suggesting that the existing DC ties have been of considerable value to the electric systems of Texas, and that there presently still exists unused capacity on these ties during some periods. Others have suggested that the effects of the DC inter-tie tariffs on file at FERC and the protocols for scheduling flows over the DC ties discourage use of the DC ties. The SIC did not investigate the operation of the existing DC ties or the merits of expanding the DC ties as an alternative to synchronous interconnection.

A second alternative discussed during SIC meetings is the construction of power plants at the interface between ERCOT and SPP/SERC that possess the capability to shift electric deliveries between areas according to market demands and reliability requirements. This type of generating plant can provide some of the same advantages as DC ties. The plants could operate as "virtual ties" by shifting electric deliveries between adjacent power regions. Tenaska, Inc., a Nebraska-based non-utility generating company, has announced that it intends to construct a new 800 MW power plant on the ERCOT border in northern Grimes County near College Station. The plant would have the capability to shift its deliveries of electricity between ERCOT and SERC.

Such swing capability would allow the plant to operate as a generating resource in either area to respond to market price differences or reliability requirements. PacifiCorp reported to SIC on plans for an energy storage and electric generation complex between Houston and Beaumont that would have similar capabilities to shift power deliveries between ERCOT and SERC. While border plants have many advantages, it is unclear how many sites on the border of ERCOT are suitable, given infrastructure requirements such as an available source of water, proximity to high voltage lines of adjoining power regions, and fuel transportation capability. The SIC did not study the relative merits of siting additional generating plants along the ERCOT boundary that could be switched between the adjacent regions as an alternative to synchronous interconnection. The SIC effort has required the voluntary contribution of substantial resources by interested parties.

ES.12 FUTURE CONSIDERATION OF SYNCHRONOUS INTERCONNECTION

If the Legislature elects to move forward with interconnection, additional studies of economic benefits, reliability impacts, and optimal facilities location will be required that are clearly beyond the scope of a voluntary effort. Should the Legislature determine that further investigation of synchronous interconnection is warranted, the SIC offers a few suggestions on this subsequent work:

- The level of effort should be determined, including definition of the resources required to effectively address the issues to be investigated, prior to the assignment of the responsibility for the work.
- Additional economic and technical analysis is necessary and should be required.
- Adequate resources should be committed by the Legislature including funds for the completion of comprehensive system reliability and security studies.
- The work should continue to be undertaken by an independent committee possessing an objective perspective.
- Full participation and support by all segments of the marketplace should continue to be encouraged.

- Subsequent analysis should include a comparison of the potential benefits of synchronous interconnection with potential alternatives to synchronous interconnection (additional DC interconnections, dual grid connected generation, etc.).
- The potential impact of synchronous interconnection on the Texas natural gas industry and the total Texas economy should be specifically examined by the Committee.

The creation of additional electrical interconnection(s) between ERCOT and the SPP/SERC is of potentially enormous importance to the electric industry in Texas. The ability of expanded interconnections to enhance trading opportunities between the $20 billion annual ERCOT market and the adjoining SPP and SERC markets deserves careful consideration by the Legislature. Should it be determined that synchronous interconnection between ERCOT and SPP and SERC is desirable, its considerable additional work will be required to effectively evaluate, plan, and establish the most appropriate approach. This work will also necessitate the development of new legal and regulatory positions to address funding and cost recovery.

ES.13 ACKNOWLEDGEMENTS

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