

Texas Renewables Integration Plan (TRIP)

Prepared by the Renewable Technologies Working Group
of the ERCOT Technical Advisory Committee



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Preface

The combination of several forces has led to a rapid and significant addition of renewable energy generating capacity within the Electric Reliability Council of Texas (ERCOT) during 2007 and 2008. The ERCOT Independent System Operator (ISO) and the ERCOT stakeholders embrace the open access network paradigm adopted by the Texas Legislature; strive to effectively and efficiently implement the policy directives to integrate widespread renewable energy development; and endeavor to allow market forces, to the greatest extent possible, to provide the generation resources, ancillary services, and other technical solutions necessary to ensure adequate system security is maintained. However, those parties responsible for system planning and operational security also recognize that the widespread introduction of variable output renewable generation resources presents significant operational challenges which must be addressed in order to effectively and efficiently maintain system reliability.

Meeting the Texas Legislature's goal for increasing amounts of installed renewable energy capacity and the order of the Public Utility Commission of Texas (PUCT or Commission) designating Competitive Renewable Energy Zones (CREZs) requires a comprehensive review and potentially significant improvements to ERCOT planning models and assumptions, operational capabilities and procedures, and certain elements of the ERCOT Zonal and Nodal market designs and systems. The Texas Renewables Integration Plan (TRIP) is the guiding document for this effort.

The TRIP is the work product of the ERCOT Technical Advisory Committee (TAC) by and through its Renewable Technologies Work Group (RTWG).

The TRIP is produced annually and supplemented quarterly and presented to the ERCOT Board of Directors and PUCT for additional input and guidance. The TRIP is a living document designed to promote public awareness of renewable technologies integration activities within the ERCOT ISO which impact the ERCOT markets and the reliability of the ERCOT bulk power system.

The TRIP is also a resource for policymakers and ERCOT Directors to better understand the array of issues associated with large-scale integration of variable output renewable energy technologies; effectively plan to capture the overall benefits afforded by such technologies (e.g., reduced emissions, reduced dependence on fossil fuels, etc.); and effectively mitigate the system risks such variable generation technologies can present.

Finally, the TRIP may serve as a reference document for others around the world engaged in bulk power system planning and operations which incorporate a significant penetration level of renewable energy generation technologies. The ERCOT market is currently a world leader in renewable power production and it is a goal of the TAC that others may learn from the ERCOT Region's experience in this area.

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Section I.

Texas Renewables Integration Plan Overview

The Texas Renewables Integration Plan (TRIP) is a work product of the Electric Reliability Council of Texas (ERCOT) Technical Advisory Committee (TAC) by and through its Renewable Technologies Work Group (RTWG) and is the guiding document describing the efforts of the ERCOT Independent System operator and market stakeholders to integrate significant levels of utility-scale and distributed renewable generation technologies into the ERCOT system.

A. TRIP Purpose and Procedure

The TRIP serves several purposes:

- communicate issues of interest related to the integration of renewable resources in a competitive electricity market to market participants and industry stakeholders
- communicate the long-term plan for ERCOT activities related to renewable technologies integration to market participants and industry stakeholders
- communicate progress on renewable technologies integration and raise issues for resolution to Texas policy makers and ERCOT ISO decision makers
- document the renewable technologies integration activities within the ERCOT Region as a resource for electric power industry stakeholders
- document “lessons learned” through the ERCOT renewable technologies integration effort to preserve institutional memory and better inform ongoing integration activities.

The RTWG has adopted the following process for developing and maintaining the TRIP:

Issues Identification

The RTWG will identify those issues related to renewable technologies integration to be included in the TRIP. These issues may be raised in a variety of ways – through the normal course of business in the stakeholder process, by individual market participants, by ERCOT Staff observations of operational practices, or as directed by policy makers, just to name a few. To facilitate the identification of issues which should be addressed in the TRIP, the RTWG has appointed a liaison to the ERCOT Reliability and Operations Subcommittee (ROS) and the ERCOT Wholesale Market Subcommittee (WMS) to interface with those subcommittees on the activities and issues being addressed by the RTWG. In addition, the RTWG Chair reports monthly to the TAC on RTWG activities. The TAC, in turn, reports quarterly to the ERCOT Board of Directors and the PUCT. As issues are identified, each will be given a discrete identification number so they may be tracked through the stakeholder process toward resolution.

Issues Prioritization

For each identified issue, the RTWG will recommend a priority for issue resolution. The current categories of prioritization are Near-Term, Long-Term, Undetermined, and Complete. It is anticipated that the prioritization scheme will become more detailed as the TRIP is more completely developed and will be integrated into ERCOT's Project Prioritization process when applicable. Prioritization of issues is expected to assist ERCOT and market participants with the allocation of resources to renewable technologies integration efforts in a timely, methodical, and coordinated manner.

Escalation of Critical Issues

Some identified issues present immediate concerns for system reliability or market impacts and the RTWG will always escalate these issues to the top of the priority list for rapid resolution. At the outset of the ERCOT stakeholders' focused effort to address wind penetration issues in early 2008, several such issues were identified and resolved within a few months, such as:

- development and implementation of a conservative, independent wind production forecast for daily use in system capacity adequacy studies,
- imposing ramp rate limitations on Wind Generation Resources (WGRs), and
- defining a Low-Voltage Ride-Through (LVRT) requirement for new wind generation units interconnecting to the ERCOT system.

Issues Tracking

All issues identified by the RTWG and included in the TRIP will be tracked on the RTWG Issues List. This list is a spreadsheet which is updated not less than quarterly (but usually monthly). For each identified issue, the RTWG Issues List includes:

- the issue identification number
- a brief description of the issue
- the stakeholder group to which the issue is assigned for resolution
- the issue priority ranking
- the mechanism for issue resolution, if known (such as PRR, OGRR, etc.)
- the current status of the issue, including keeping track of completed issues to preserve institutional knowledge
- any cross-references to other ERCOT documents addressing the issue to enable full-spectrum issues tracking

Issues Communication

To ensure transparency and broad communication of all renewable technologies integration issues with market participants and policymakers, the following activities are performed on a regular basis:

- Designated RTWG member reports RTWG activities to the WMS and ROS monthly;
- Designated RTWG member reports relevant WMS and ROS activities to the RTWG monthly;

- The RTWG Chair (or designate) reports RTWG activities to TAC monthly;
- The TAC Chair (or designate) reports on the TRIP to the ERCOT Board of Directors and to the PUCT quarterly;
- The current and archived versions of the RTWG issues list will be made available on the publicly-accessible area of the ERCOT web site; and
- The RTWG in coordination with ERCOT staff, will facilitate periodic workshops and training seminars on renewable technology issues for industry stakeholders and interested parties.

B. TRIP Input Process

TAC and the RTWG welcome input to the TRIP from a variety of sources. All meetings of TAC and its subgroups are open to public participation and the meeting locations and agendas are listed on the calendar page of the ERCOT web site at least one week in advance of the meeting. Issues related to the integration of renewable resources may be introduced for inclusion in the TRIP at a meeting of the RTWG, WMS, ROS, or TAC. Additionally, TAC will seek the input of the ERCOT Board of Directors and PUCT at least quarterly. At the direction of TAC, the RTWG maintains the responsibility for incorporating identified issues into the TRIP and accompanying RTWG Issues List.

C. TRIP Change Control Process

All proposed changes or updates to the TRIP should be made through the RTWG which will update the TRIP quarterly. As a Work Group of the TAC, the RTWG operates on a consensus-based paradigm with reporting to TAC of majority and minority positions when consensus cannot be achieved. Each quarter, the RTWG will present a proposed update of important information related to the integration of renewable resources into the ERCOT market to the TAC for approval. Following TAC approval, each quarterly update will be posted in a publicly-accessible area of the ERCOT web site and previous versions of the quarterly update will be archived for informational purposes.

D. TRIP Structure

Issues Identification, Organization, and Tracking

The TRIP is organized around the renewable technology integration issues identified by the RTWG. These issues, once identified and defined, are organized by issue category such as system planning, system operations, market design, etc. and added to the RTWG Issues List for tracking. Issues are prioritized for resolution depending upon several factors including significance to system reliability, time required to complete associated tasks, resource availability, and any other dependencies as determined by the RTWG.

Considerations

In development of the TRIP, the RTWG and TAC will consider the stated or likely impacts of public policy decisions which impact the installation of new renewable generation capacity, the technical capabilities and limitations of different renewable

technologies, and the principles and structure of the ERCOT market design and market systems functionality.

Strategies and Tasks

For each identified issue, the TRIP will specify a strategy to address the issue and will detail the specific tasks required to resolve the issue. Each task is assigned to a responsible party and the RTWG Issues List will track the completion of all tasks to ensure progress and promote visibility.

Schedule

For each identified issue, the TRIP will specify a schedule for issue resolution, including timelines for required studies, systems projects implementation, market testing, etc. The priority assigned to the issue and the resources available to identify and implement a solution are inputs to the schedule.

Metrics

Where appropriate and useful, the TRIP may identify metrics to accomplish one or more of the following purposes:

- reporting metrics to inform the renewable technologies integration process
- reporting metrics to gauge the success of integration efforts
- performance metrics to measure compliance with operational requirements.

Resolution

Resolved issues are reported to the ERCOT Board and PUCT in the quarterly updates. A complete list of resolved and tabled issues is also included in the TRIP and the RTWG Issues List to preserve institutional memory.

Follow Up

Where appropriate, the TRIP describes processes for monitoring, evaluating, and reporting on the effectiveness of renewable technology implementation solutions developed through the TRIP.

Section II.

Public Policy Considerations

The TRIP sets forth both reactive and proactive approaches to the public policy decisions made by jurisdictional entities. The ERCOT TAC does not make or seek to influence public policy regarding any electric power generation technology. However, the TRIP must be responsive to public policy directives where required and raise awareness and provide solutions to the impacts of public policy directives on the introduction of new technologies onto ERCOT transmission and distribution systems and into ERCOT markets.

A. Federal Policy Considerations

Production Tax Credit (PTC)

Under present law, an income tax credit of 2.1 cents/kilowatt-hour is allowed for the production of electricity from utility-scale wind turbines. This incentive, the renewable energy production tax credit (PTC), was created under the Energy Policy Act of 1992. Through the American Recovery and Reinvestment Act (passed in February 2009), Congress acted to provide a three-year extension of the PTC through December 31, 2012. Additionally, wind project developers can choose to receive a 30% investment tax credit (ITC) in place of the PTC for facilities placed in service in 2009 and 2010, and also for facilities placed in service before 2013 if construction begins before the end of 2010. The ITC then qualifies to be converted to a grant from the Department of Treasury. The Treasury Department must pay the grant within 60 days of an application being submitted.

Wind energy development in ERCOT has been driven by the PTC. When adjusted for capacity factor, the capital costs of wind energy projects are relatively high as compared to traditional thermal resources and the PTC is necessary for wind projects to be competitive. Wind project development cycles are directly correlated to the renewal of the PTC. In the years which the PTC lapsed, wind project development was scaled back significantly. The TRIP anticipates PTC availability through 2012 will lead to additional wind resource development in the near-term.

Investment Tax Credit (ITC)

Under present law, a federal-level investment tax credit (ITC) is available to help consumers purchase small wind turbines for home, farm, or business use. Owners of small wind systems with 100 kilowatts (kW) of capacity or less can receive a credit for 30% of the total installed cost of the system. The ITC, written into law through the Emergency Economic Stabilization Act of 2008, is available for equipment installed from October 3, 2008 through December 31, 2016. The value of the credit is now uncapped, through the American Recovery and Reinvestment Act of 2009.

A wind project developer may elect to receive either the ITC or the PTC. The ITC is expected to be more beneficial than the PTC for wind projects with relatively lower capacity factors or relatively higher capital costs. The ITC may allow wind projects to be developed in areas which were previously considered un-economic. The ITC also applies to solar, biomass, landfill gas and geothermal energy projects. The ITC is set at 10% for geothermal, micro-turbines and Combined Heat and Power (CHP) projects. The availability of the ITC and its cash-grant option will likely contribute to additional renewable resource development in the ERCOT region.

B. State Policy Considerations

In 2005, the Texas legislature passed Senate Bill 20 adding PURA 39.904(g) which set a goal of 5,880 MW of installed renewable generating capacity by January 1, 2015, and a target of 10,000 MW by January 1, 2025. The bill also required the PUCT to

- designate Competitive Renewable Energy Zones (CREZs) throughout the state based on renewable energy resources and developer commitments and
- develop a plan to construct the transmission capacity necessary to deliver this electricity from renewable energy resources to major load centers.

In PUCT Docket No. 33672 (concluded in 2008), the Commission designated five geographic areas as CREZs (including two in the Texas panhandle, an area normally served by the Southwest Power Pool (SPP). This raised a jurisdictional issue between the PUCT and FERC, which regulates the SPP. The Commission, in its Final Order, required wind developers in the two CREZs located in the SPP footprint to obtain FERC approval to connect their projects to the ERCOT electric grid rather than the SPP.

In addition, the Commission also selected ERCOT staff's transmission plan "Scenario 2" which called for the construction of 2,334 miles of new transmission designed to serve 18,456 MW of wind generation. The Commission found that certain transmission lines were critical in relieving current transmission congestion in areas with existing wind generation (and part of the designated CREZs), and ordered that those "priority" lines be constructed first.

Another docket, PUCT Docket No. 36146 was used to assign certain transmission upgrade projects to a default transmission service provider (TSP) designated by the Commission. The transmission providers for the remaining projects were then selected by the Commission as part of PUCT Docket No. 35665, based on several factors including the size of the TSP, its financial position, and the proximity of projects to the existing certificated service area of each TSP. Municipal utilities were not awarded any transmission projects due to the PUC's lack of jurisdiction over those entities. Only two incumbent TSPs were assigned the priority projects, and Certificate of Convenience and Necessity (CCN) applications are due to be filed by the TSPs by October 7, 2009. The remainder of the CCN applications are expected to be due by mid-2010 so as to ensure completion of all CREZ-related transmission facilities (including substations) by the end of 2013. The Commission staff is also planning to recommend to the Commission that it

establish a "no earlier than" date for filing of CREZ-related CCN applications to ensure that the Commission staff is not inundated with too many CCN applications in a short period of time. The staff is concerned that it will not be able to process the significant number of CCN applications for CREZ-related projects (estimated to be more than thirty) in the 181 days as required by PURA § 39.203(e).

[Insert language about distributed renewable generation, energy efficiency and advanced metering policies at the state level.]

C. Related ERCOT Policy Implementation Activities

Advanced Metering Systems (AMS)

Based on state legislation and PUCT rules that allow utilities to install advanced meter networks and recover their costs in the form of a surcharge, Oncor and Centerpoint have received approval to deploy advanced meter networks throughout their entire territory (PUCT Docket Nos. 35718 and 35639). AEP has requested that its request for a surcharge and AMS deployment plan be approved by the PUCT, and is currently in a review process (PUCT Docket No. 36928). Once advanced meters and supporting infrastructure are installed, the large majority of residential and small commercial consumers that are metered on monthly intervals today will be metered on fifteen-minute intervals.

Together with ERCOT data aggregation system improvements, these 15-minute measurements will allow load to be settled at the real-time price in effect when energy was consumed, rather than using estimated load profiles. By using the measurement and communication capabilities of an AMS, REPs can help their customers manage their individual energy consumption using products that let consumers better respond to price signals. The AMS system will also facilitate demand response to market prices, which may include smart appliances and on-off control of water heaters, pool-pumps, and other devices. As these meters and communication systems become more widely installed, more loads will become price responsive (i.e., increasing elasticity of demand). This load response can help stabilize the market by both increasing demand when prices are relatively low and decreasing demand when prices are relatively high. By responding to prices, loads controlled via an AMS can provide additional reserves that can allow the ERCOT system to incorporate more renewable resources while maintaining adequate system reliability.

Competitive Renewable Energy Zones (CREZs)

ERCOT has had a significant role in providing data and studies needed by the PUCT pursuant to the Texas Legislature's requirement to create CREZs. The key activities have included:

- Engagement of a meteorological consulting firm (AWS TrueWind) to assess the zones in Texas that were candidates for commercial production of electricity from wind;

- Preparation of feasible transmission plans to provide an initial estimate of costs and benefits of developing the wind generation potential in different CREZ and combinations of CREZ; and
- Preparation of a detailed transmission design for four different levels of development of CREZ selected by the PUCT.

With the designation of the Transmission Service Providers (TSPs) that will construct the transmission plan selected by the PUCT, ERCOT and the TSPs are currently heavily involved in the detailed design of the CREZ transmission facilities. Stakeholder input associated with the CREZ transmission plan will be provided through the Regional Planning Group process.

Voltage Control Issues

Some critical CREZ implementation activities, such as approval of Code of Conduct filings by certain new TSPs await regulatory decisions before stakeholder work can commence (detailed generation interconnect studies cannot be performed until ERCOT is permitted to share Generation Interconnect Request information with the affected TSPs). These specific interconnect studies will provide additional detailed information to assist in the specific routing and location of CREZ facilities.

Several key CREZ-related detailed design and coordination issues are the subject of stakeholder and ERCOT focus at this time. One issue is coordination of the reactive design and subsequent management of reactive assets to control voltages. With the addition of many new high voltage transmission facilities to West Texas, periods of low amounts of wind generation will have the tendency to raise voltages in the West Congestion Zone and high levels of wind generation will have a tendency to lower voltages in the West Congestion Zone as well as further east. These voltage issues can be easily managed if properly anticipated and the design and operation of the transmission system are coordinated. There have been several meetings between ERCOT and TSPs regarding this issue. This type of coordination in ERCOT is not unique; however there are additional voltage management challenges associated with CREZ development. For example, the transmission system developed for the CREZ will be composed of many different TSPs with the potential for significant impacts on one TSP's facilities as compared to another TSP's facilities. Traditional interconnected operations in ERCOT have always required coordination of many design and operational processes. However, the design of voltage control reactive systems as well as their daily operation have been primarily handled by individual TSPs. Individual TSPs have communicated their designs to other TSPs and ERCOT has provided periodic analysis to coordinate voltage management. However, the fundamental responsibility for voltage management has resided with the individual TSPs. The large number of TSPs involved in the CREZ transmission construction results in a much higher degree of interconnectivity and has required much tighter coordination of the design and operation of the transmission system in West Texas.

Variable Output of Wind Generators

Another issue concerns the variable output from wind generators, including substantial reductions in power production over a relatively short time period (a few hours). The variability in wind generator output is similar to the variability in load. As load changes during the day (and night), there is a significant tendency for transmission voltages at various locations to vary as well. The voltage variations that might be caused by changing customer load are managed by switching a variety of reactive devices on and off at the distribution system level including many distribution substations, and at some transmission substations.

The remainder of the voltage issue is managed automatically by adjusting generator reactive output. This coordinated approach prevents unacceptable variations in the transmission system due to changes in customer loads. There has always been some management of voltage due to changes in generation; especially when generators go off line or come on line. The voltage management issues impacting conventional generators has been largely addressed by switching static devices. However, wind generation in West Texas provides additional challenges to voltage management primarily due to the rather large concentration of generation in a limited geographic area and the tendency for these generators to all increase or decrease their output at about the same time. This not a totally new problem but there is a difference of degree and a bit of a new perspective with voltage variations due to changing generation output coupled with changing customer loads.

Additional ERCOT-related Issues

As noted above; ERCOT and the TSPs have recognized the voltage control challenge. ERCOT included substantial voltage control facilities in their designs for the CREZ transmission plan options. The ERCOT transmission plan for Scenario 2 is currently being refined by the TSPs and ERCOT working together to identify potential operating issues and provide necessary facilities to manage those issues.

Routing and substation locations is another issue under discussion by ERCOT and the market participants, primarily TSPs and wind project developers. Individual transmission line design and routing studies being prepared for transmission line CCN applications depends on the precise location of substations. The precise location of substations is also needed to facilitate coordination with interconnecting TSPs as well as to support detailed interconnection studies. The ERCOT CREZ design selected by the PUCT consists of “straight line” transmission line routing and “reasonable” locations for substations that need to be adjusted in response to the latest information available.

Another issue relates to the appropriate timing of filing of CCN applications to facilitate completion of the CREZ-related transmission facilities by the 2013 deadline. ERCOT staff, in consultation with the TSPs, has been evaluating the specific sequence for submitting CCN applications for each of the CREZ facilities. This evaluation does not consider the sequencing of default or priority transmission projects since the need for immediate action on those facilities has already been determined by the Commission.

Market participants and ERCOT are also concerned about CREZ-related construction outage issues. The construction of the CREZ facilities will result in many significant outages of existing transmission facilities in West Texas. An estimate of the outages that will be required to facilitate the construction of CREZ facilities is as follows:

- i. Five existing 345 KV circuits will be rebuilt or significantly altered;
- ii. Three new 345 KV substations will be built in existing 345 circuits;
- iii. Fifteen existing 345 KV substations will require significant work to connect in new 345 KV circuits;
- vi. Fifteen existing 345 lines will be crossed by new 345 KV lines;
- iv. One hundred existing 138 KV lines will be crossed by new 345 KV lines

Some of the required outages may be quite short; some may be quite extended. In some cases, the specifics of the CREZ construction plan could have a significant effect on the length of the outage. For example, if a new CREZ transmission line crosses an existing line at a tower location, an outage of one to three weeks may be required to construct the crossing. On the other hand, if the existing transmission line is crossed mid span, an outage of only a day or two may be possible. Another example might be the need to take a several month outage to string a second 345 conductor on existing structures unless the second conductor is strung while the existing circuit is left in service.

Furthermore, the construction outages will have a significant negative impact on wind generation output as well as energy prices. The lost energy production from low cost wind generation may justify additional cost to reduce or minimize CREZ-related construction outage times if the outages can be forecast early enough in the process to identify economic opportunities as well as mitigate the effect of the outage on the ERCOT market.

The objective of completing all CREZ construction by 2013 as well as the procedural processes required before construction is begun leads to the possibility that many of the CREZ-related construction outages could be scheduled at essentially the same time each year, i.e., during spring and fall seasons. If the outage requirements are not anticipated and mitigated, they may have an impact on the ability to meet the CREZ construction schedule.

Although the TRIP addresses renewable technology integration issues beyond the scope of the PUCT's CREZ plan, many of the assumptions made and recommendations developed in the TRIP are necessarily driven by the CREZ implementation process.

Section III.

Technical Considerations

A. Approach to Emerging Technologies

As new renewable technologies come into the ERCOT market, the RTWG will examine issues related to the integration of those technologies into the ERCOT grid. Issues deemed worthy of consideration will be assigned to the appropriate standing ERCOT stakeholder subcommittees (e.g., the Wholesale Market Subcommittee or the Reliability and Operations Subcommittee) to develop any changes in existing ERCOT Protocols, Operating Guides, procedures or processes to effectively accommodate these emerging renewable technologies.

To ensure proper understanding of the issues related to a particular renewable or storage technology, the RTWG will develop whitepapers to explore methods to implement and deploy such technologies in the competitive ERCOT electricity market. These whitepapers will be used by the assigned stakeholder subcommittee to determine any necessary changes in ERCOT Protocols or Operating Guides to effectively integrate new renewable resources into the market. All whitepapers will be included as an appendix to the TRIP.

B. Maintaining and Institutionalizing Technical Knowledge

The RTWG will work closely with ERCOT staff to determine appropriate training to ensure that all market participants are aware of any changes in the ERCOT Protocols or Operating Guides related to the integration of emerging renewable resources into the ERCOT market structure. The RTWG will assist ERCOT in developing and scheduling workshops associated with emerging renewable technologies. The TRIP will be used as a mechanism to catalog and store all presentations made at any workshop.

C. Incorporating Technical Knowledge into ERCOT Functions

The role of the RTWG is to provide the technical expertise, from a market participant perspective, in the development of any PRRs, NPRRs, OGRRs or NOGRRs related to the implementation of renewable generation or storage technologies into the ERCOT market system. The RTWG will provide a focus point for ERCOT, market participants and regulators to provide feedback and evaluation of solutions related to the integration of renewable resources.

D. ERCOT and Stakeholder Resource Requirements

The RTWG will evaluate and prioritize development of solutions to the issues raised related to the integration of renewable resources while recognizing potential resource availability or limitations of both ERCOT staff and market participants. Two major projects that could impact implementation of solutions to renewable resource issues

today are the Competitive Renewable Energy Zone (CREZ) transmission plan implementation and the Nodal market design implementation. Quarterly TRIP reports to the ERCOT Board and PUCT may include recommendations for application of resources to renewable energy technology implementation solutions such as major studies to be performed or major systems projects to be implemented.

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Section IV.

Market Design Considerations

A. Approach to Emerging Technologies

The ERCOT market design, together with the policies and rules established by the PUCT have resulted in a very vibrant, open, and active wholesale and retail electric market. One of the cornerstones has been an open transmission access policy that has clearly encouraged generation developers to enter the ERCOT market. Generation using older, more conventional technologies has not been provided rights to the transmission system which would prevent new technology generation from being developed. As a result of this open access policy, almost 25,000 MW of more efficient combined-cycle combustion turbine generation was built in less than five years in ERCOT, displacing less efficient, conventional steam turbine gas-fired generators. In addition, over 5,000 MW of new wind generation has been constructed in the last two years bringing the total wind generation in ERCOT to 8,000 MW.

There is every reason to believe that the current ERCOT market, in conjunction with state and federal incentives, will result in other renewable technologies developing quickly as their economic value becomes competitive. The key generation and storage technologies that are likely to be added to the system include: solar photovoltaic (PV), solar concentrating, batteries (large scale located at substations), “smart grid or smart metering”, plug-in hybrid vehicle batteries and compressed air energy storage (CAES).

In each of these new technologies, there are likely to be issues that may require adjustments in the market design to accommodate their unique operating characteristics and to take advantage of their unique capabilities. The Texas Nodal market design may not properly assign value to some of the new technology capabilities. The specific market design changes that may need to be considered are:

- price for energy storage at a nodal price rather than at the zonal price used for loads;
- voltage control services as a competitively-provided service;
- governor response service as a competitively provided service;
- a new quick response (e.g., 10 or 15 minute) service in addition to or in lieu of the current 30 minute response Non-Spin Reserve Service (NSRS);
- new settlement structures to accommodate ancillary services provided in a more distributed way or from a mobile platform such as a plug-in hybrid vehicle batteries;
- a new immediate response service to respond to system power needs for the loss of generation.

At the present time, no need for any of the above potential market design changes has been identified. The Renewable Technologies Working Group (RTWG) is becoming

more aware of the potential issues associated with integrating those technologies into the ERCOT market and will be developing white papers to address those issues. The following basic introductory presentations have been made to the RTWG:

1. Compressed Air Energy Storage presented by Steve Isser, Good Company and Associates;
2. Substation battery technology and demonstration projects presented by C.J. Thompson, AES Corporation;
3. Automobile battery use for regulation service presented by Amardeep Dahnju, Center for Carbon-Free Power Integration, University of Delaware;

B. Texas Nodal Market Transition

The development of the Texas Nodal Protocols has benefitted from the experiences of ERCOT and market participants with the Texas Zonal market. There has also been significant benefit derived from reviewing the experience from other electric markets in the United States and the rest of the world. The Texas Nodal market design addresses many known commercial and operating problems. Following is a brief discussion of some of the key lessons learned and the Nodal market design changes that will assist the integration of wind generation.

Texas Zonal Market Operational Time Delay

The variability of wind generation exacerbates the operational time delay problem that already exists in today's Zonal market design. The Zonal market design and the software implementation have resulted in a time delay of at least 20 minutes and as much as 35 minutes from the time information is gathered and corrective generation deployments are ordered. Wind generation levels can change significantly in this time period. As a result, ERCOT operators must manually take action if system conditions are changing too quickly for the software to keep up. On the other hand, the Texas Nodal market design will reduce the standard time delay to less than 6 minutes (or even less if system conditions warrant).

Variable Output Limits

A wind generator can produce no more energy than the wind will allow. As a result, the effective capacity of wind generation is constantly changing. The Texas zonal software does not effectively accommodate continuously changing generating capacity limits when calculating solutions to local transmission congestion problems. As a result, ERCOT operators must intervene to manually dispatch wind generation to resolve local congestion. However, the Texas Nodal market design has incorporated a requirement for wind generation to send a signal to ERCOT every four seconds indicating the maximum output that the wind generation can achieve. This signal is used to adjust the wind generators offer curve in real time to reflect the actual capability of the wind generator and allow the dispatch algorithm to calculate the deployment orders needed to resolve congestion problems automatically.

Performance Metrics for Wind Generators

The Texas Zonal market design has detailed performance requirements for controllable generation response to dispatch instructions. The Texas Zonal market design and software have few specific performance requirements for wind generation and major changes in software would be required to establish such performance metric equivalents to those included in the Nodal market design. For example, the Texas Nodal market design has specific requirements and performance metrics for wind generation response to dispatch orders and penalties for non-compliance.

Day-ahead Capacity Adequacy

The Texas Zonal market model is based upon a balanced schedule that requires market participants to provide sufficient generation to meet their expected load. The mismatch between market participant day-ahead load schedules and ERCOT's load forecasts can result in the purchase of Replacement Reserve Service (RPRS) by ERCOT. The original Zonal market software did not account for the uncertainty associated with the availability of wind generation. However, the Zonal market procedures for acquiring RPRS have been revised to include a procedure for discounting the amount of wind generation. From the very outset, the Texas Nodal software was designed to include special provisions to discount the amount of wind generation used when determining Reliability Unit Commitments (RUC) in the day-ahead environment.

As more is being learned about the specific needs to integrate large amounts of wind generation, appropriate changes are being developed for the Zonal market. These revisions are being reviewed to determine their applicability for the Nodal market design. Most of the revisions to the Zonal Protocols thus far have been applicable to only the Zonal market design and are not needed or have already been included in the Nodal market design. Many of the Zonal market revisions specify additional design and operational requirements applicable to wind generators and are applicable in the Nodal market design as well. In addition, there are some possible changes in Nodal market software that have been identified. These changes are currently under discussion and evaluation by ERCOT and market participants. At this time, no specific changes to the current Nodal market software related to wind generation have been developed, so any improvements that are contemplated will likely be scheduled for post Nodal go-live implementation.

C. Ancillary Services

The addition of large amounts of variable output generation (i.e., wind generation) adds an additional component of variability to the existing variability of load. This increased variability of "net load" (i.e., load less wind generation) must be managed by the dispatchable conventional generation resources. In addition, the uncertainty in the amount of wind generation from one hour to the next adds to the needs for additional reserve capacity. In 2007, ERCOT commissioned a study to evaluate the effect on ancillary services due to the addition of up to 15,000 MW of wind generation. As a result of that study, ERCOT has established new procedures to determine the amount

of Non-Spin Reserve Service (NSRS) to acquire, which include the uncertainty in the amount of both load and wind generation for the upcoming day. In addition, ERCOT is developing an operational security tool that will make a probabilistic hourly evaluation of the adequacy of generation to meet load requirements. The ancillary service study also noted the possible value of adding a shorter term (e.g., 10 minute) reserve service in addition to or in lieu of the existing 30 minute NSRS. The new procedures for acquiring NSRS seem to be working well so neither ERCOT nor market participants presently see any immediate need to investigate any additional or replacement reserve service.

D. Performance Metrics

As noted above, the Nodal market design has incorporated appropriate performance metrics into the software from the outset. The Zonal market design has a key flaw in the time delay between gathering data and executing corrective action. Many of the operational and reporting problems associated with integrating wind generation into the Zonal market design are due to this fundamental time delay issue. There are some procedural changes and metrics that have been established for the Zonal market in an effort to ensure that wind generation is providing the best information possible to ERCOT. The key changes that have been made or that are in progress to address wind generation operational issues in the Zonal market design are:

1. Use of a balancing offset by ERCOT to account for the difference between real time system-wide wind generation and the portfolio-specific generation provided in market participant resource plans;
2. Establishing a requirement for wind generators to update their schedule every hour using a forecast at least as accurate as the ERCOT provided forecast;
3. Limiting the time when wind generators can update their resource plans in order to provide a stable and consistent reference point for ERCOT operations; and
4. Reviewing and modifying existing metrics to ensure they are address identified ERCOT operational issues.

As solutions to identified integration issues are implemented, it is the intent of the RTWG to consider specific related metrics to monitor the effectiveness of these solutions and identify additional areas of improvement. Where solutions to identified issues also require certain activities, technical capabilities or performance requirements for renewable resources, the RTWG will also consider whether additional performance metrics should be developed to enable compliance monitoring by ERCOT, the Texas Regional Entity and the PUCT.

DRAFT

Section V.

Key Issues and Strategies for Resolution

A. Texas Nodal Market Transition Issues

Because of the implementation of the Nodal market design and its subsequent impact on resources for both ERCOT and market participants, the RTWG recognizes that any system changes necessary to integrate renewable resources into the ERCOT market structure must be measured against any possible delay in implementing the Nodal market design. Thus, the RTWG will avoid recommending any changes to the existing zonal market design or the new Nodal market design that would impact cost or schedule of the Nodal market implementation. It is the intent of the RTWG to not siphon off any ERCOT staff involved in the Nodal market design to work on renewable resource issues.

B. Application of ERCOT and Stakeholder Resources to TRIP Activities

It is the intent of the RTWG to utilize the processes being developed for processing market design changes for the post-Nodal Go-Live environment. That is, changes required for integrating new renewable resources identified by the TRIP, unless absolutely necessary to maintain adequate ERCOT system reliability, will be processed and scheduled for implementation after the Nodal Market design is in operation. For such changes, the RTWG will follow the ERCOT budget process for any projects requiring major resources (ERCOT staff, contract resources, tools, systems changes, etc.).

C. Market Design (MD) Issues

MD-1: Ancillary Services Cost Allocations Applicable to Wind

Description: As renewable technologies integration issues related to ancillary services are identified and resolved, the RTWG will, where appropriate, evaluate the cost allocation methodology for the affected ancillary services.

Priority: Near-Term

Status: Open. This issue was previously opened in October 2008 following a request of the ERCOT Board to consider a methodology to allocate the cost of additional NSRS procured under ERCOT's procedure as modified that month. This issue was closed in January 2009 following a report that NSRS costs fell following implementation of the new NSRS procurement methodology and a TAC recommendation that ancillary services costs were properly allocated under existing Protocols. This issue was reopened in March 2009 at the Board's request. Where applicable, the RTWG will consider cost allocation methodologies as renewable technologies integration issues related to ancillary services are identified and resolved.

MD-2: Ancillary Services Procurement Optimization for 2009

Description: Develop any ancillary services cost allocations applicable to wind generation resources (see also MD-6).

Priority: Not Applicable

Status: Complete – ERCOT Board has approved the 2009 Ancillary Services Procurement methodology (see Appendix).

MD-3: Non-Spin Requirements

Description: Determine if additional Non-Spin Service procurements are required to accommodate increased amounts of wind generation in ERCOT.

Priority: Near-Term

Status: Included in MD-4 (see description below).

MD-4: New Ancillary Service Products Needed for Reliability

Description: Determine if new ancillary services are needed to reliably integrate the large amounts of wind generation interconnecting to the ERCOT system.

Priority: Long-Term

Status: RTWG to develop a whitepaper on the issue by _____.

MD-5: Benefits of Storage Technologies

Description: Determine benefit and potential applications of storage technologies in the ERCOT market.

Priority: Long-Term

Status: RTWG to develop a whitepaper on the issue by _____.

MD-6: Ancillary Service Procurement Methodology

Description: Determine impact and possible changes in amounts of ancillary services to be procured to ensure reliability with increasing amounts of wind generation being installed in the ERCOT market.

Priority: Near-Term

Status: Complete - ERCOT Board has approved the 2009 Ancillary Services Procurement methodology (see Appendix).

Follow-up: This item requires a follow-up evaluation (perhaps under a new issue number) to ensure that the changes made to NSRS procurement are efficient and effective.

MD-7: Wind Generating Resources Providing Ancillary Services

Description: Determine possible changes in the ERCOT Nodal Protocols to allow Wind Generation Resources to provide ancillary services.

Priority: Undetermined

Status: List of questions will be developed and reviewed by RTWG by _____.

MD-8: Reactive and Voltage Requirements Applicable to Wind Generators

Description: Review of current ERCOT Protocols to ensure reactive and voltage control requirements are applicable to all generating technologies, including wind generation.

Priority: Near-Term

Status: ERCOT staff to prepare a draft PRR for consideration by _____.

MD-9: Wind Generation Dispatch in the Nodal Protocols

Description: Review of Nodal Protocols to ensure proper treatment of wind generation in regard to dispatch response.

Priority: Near-Term

Status: Draft NPRR to be developed by _____.

MD-10: Wind Generation Performance Metrics in the Nodal Protocols

Description: Review of Nodal Protocols to ensure proper treatment of wind generation in regard to performance metrics when negative pricing exists.

Priority: Near-Term

Status: Draft NPRR to be by _____.

MD-11: Wind Generation and Base Point Deviation in the Nodal Protocols

Description: Review of Nodal Protocols to ensure proper treatment of wind generation in regard to Base Point deviation.

Priority: Near-Term

Status: Draft NPRR to be developed by _____.

MD-12: Wind Generation Resource LSL as a Percentage of HSL

Description: Establish a minimum percentage for the Low Sustained Limit (LSL) of the High Sustained Limit (HSL) for a wind generation resource.

Priority: Not Applicable

Status: Completed - PRR 773 approved by the ERCOT Board in December, 2008.

MD-13: Use of State of the Art Wind Forecast

Description: Requires Wind Generation Resources to use of a state-of-the-art wind production forecast (AWS Truewind) in their daily resource plan submittals. Responds to an issue raised by ERCOT that no means existed to evaluate the suitability of WGR QSE Resource Plans for the purposes of assessing systemwide capacity adequacy.

Priority: Not Applicable

Status: Completed - PRR 763 approved by the ERCOT Board in July, 2008. PRR 763 requires QSEs representing WGRs to utilize an independent wind production potential forecast developed by AWS TrueWind designed to produce an 80% probability of exceedance (POE) during the hour in which ERCOT takes a "snapshot" of all QSE Resource Plans for the purpose of conducting the Day Ahead systemwide capacity adequacy study. The 80% POE is a conservative wind forecast designed in such a way that wind units should fail to produce as much energy as forecast only 20% of the time. This approach should ensure ERCOT does not overly rely on wind generation to meet system needs. PRR 763 also requires WGR QSEs to substitute the AWST 80% POE forecast for their Resource Plans anytime ERCOT conducts an intra-day capacity adequacy study.

Follow-up: RTWG will evaluate effectiveness of PRR 763 and the AWST 80% POE for capacity adequacy study purposes by (date to be determined).

D. System Operations Issues

SO-1: Inventory of Wind Generation Facilities

Description: Develop forms and collect wind turbine data from Wind Generation Resources to improve ERCOT's modeling and operations databases.

Priority: Near-Term

Status: Data has been collected and is being analyzed by the Wind Operations Task Force (WOTF).

SO-2: Nodal Tools to Integrate Wind Generation

Description: Determine tools applicable to the Nodal Protocols to successfully integrate wind generation into the ERCOT markets.

Priority: Undetermined

Status: _____

SO-3: Wind Generation Response and SCE

Description: Determine proper wind generation response to down balancing instructions from ERCOT and also address SCE issues.

Priority: Long-Term

Status: Issue assigned to QSE Managers Working Group.

SO-4: Smart Grid Implications for Renewable Resources

Description: Determine how development of a "smart grid" could benefit and improve integration of renewable resources into the ERCOT grid.

Priority: Long-Term

Status: RTWG to develop a whitepaper on the issue by _____.

SO-5: Operational Studies Related to Wind Generation

Description: Determine appropriate operational studies to investigate impact of wind generation ramp rates and forecasting during low load periods.

Priority: Long-Term

Status: RTWG to develop a whitepaper on the issue by _____.

SO-6: Testing Reactive Capability of Wind Generation

Description: Determine the appropriate testing methodology to measure the reactive capability of wind generation.

Priority: Near-Term

Status: ERCOT Operations to develop an OGRR by _____.

SO-7: Wind Generation and High System Frequency

Description: Determine impact of wind generation on high system frequency events and develop possible solutions.

Priority: Near-Term

Status: Issue assigned to the Wind Operations Task Force (WOTF)

SO-8: Wind Generation and System Inertia

Description: Determine impact of wind generation on system inertia and develop possible solutions.

Priority: Long-Term

Status: Issue assigned to the Performance Disturbance Compliance Working Group (PDCWG).

SO-9: SCADA Control of Generator Circuit Breakers

Description: Develop guidelines for better control of generator circuit breakers via SCADA.

Priority: Near-Term

Status: Issue assigned to the Operations Working Group (OWG).

SO-10: Voltage Management Practices Applicable to Wind Generation

Description: Develop appropriate voltage management practices for ERCOT and Transmission Service Providers that would apply to wind generation resources.

Priority: Near-Term

Status: RTWG to develop a whitepaper on this issue by _____.

SO-11: Technology-Specific Procedures and Protocols Changes

Description: Evaluate renewable technology-specific changes in existing ERCOT Protocols, Operating Guides, Interconnection Agreements and interconnection procedures which recognize unique characteristics of various renewable generation technologies. Where necessary and appropriate, develop recommendations to allow entry of emerging renewable technologies and supporting technologies such as energy storage into ERCOT markets.

Priority: Near-Term

Status: Issue assigned to the Reliability and Operating Subcommittee (ROS).

SO-12: Low-Voltage-Ride-Through for Wind Generators

Description: Develop low-voltage-ride-through requirements for wind generators.

Priority: Near-Term

Status: Complete – OGRR 208 approved by the ERCOT Board in November, 2008. OGRR 208 requires generating resources to remain in-service during all transmission faults with normal clearing (no more than nine (9) cycles), and within seven (7) cycles for single phase faults. In addition, generation resources are required to remain interconnected during three-phase faults on the transmission system for a voltage level as low as zero volts with a duration no more than nine (9) cycles for 69 kV faults, seven (7) cycles for 138 kV faults, and four (4) cycles for 345 kV faults, as measured at the transmission voltage side of the generator step-up transformer.

Follow-up: ERCOT will conduct a study to implement LVRT requirements and make associated recommendations. Study results are due to the ROS in June 2010. See Issues SP-02, SP-03, SP-05 and SP-08.

SO-13: Performance Metrics for Wind Generation

Description: Several issues of near-term importance were identified in Wind Workshop I in March 2008 regarding the operational performance of wind generators and QSEs representing wind generators. Stakeholders noted that wind units and wind portfolios have been excluded from several performance measures applicable to other resource types, largely because the metrics had been developed for conventional generation technologies. The growing level of wind penetration on the ERCOT system suggests some wind-specific performance metrics should be developed in order to ensure compliance with best practices necessary to maintain system reliability. Specific performance metrics to be developed in the near term include:

- Improve ERCOT capacity adequacy planning process to better account for wind generation variability. See Issue MD-13.
- Clarify the required Low Sustainable Limit for WGRs as a percentage of the WGR's High Sustainable Limit to better define the amount of Down Balancing Energy Service available from WGRs. See Issue MD-12.
- Define appropriate ramp rate limitations for WGRs. See Issue SO-05.
- Define performance requirements for wind QSE Resource Plan updates to better synchronize with ERCOT operational requirements such as utilization of the Balancing Energy Offset.
- Develop performance standards for submission of meteorological information from WGRs to ERCOT to improve system forecasting and response to events.

Priority: Not Applicable

Status: The following PRRs have been adopted by the Board of Directors:

- PRR 763 Use of WGRPP in Resource Plan (approved June 2008). Completes Issue MD-13.
- PRR 771 Ramp Rate Limitation for New WGRs (approved December 2008). Addresses in part Issue SO-16.
- PRR 773 Setting the LSL Requirement for WGRs (approved December, 2008). Completes Issue MD-12.
- PRR 788 Ramp Rate Limitation for Existing WGRs (approved February, 2009). Completes Issue SO-16.
- PRR 793 WGR QSE Scheduling Metric (approved February, 2009).
- PRR 794 WGR QSE Meteorological Data Telemetry Requirement (approved February, 2009).

SO-14: Impact of Transmission Outage Planning on Wind Generation

Description: Examine possible ways to improve transmission outage planning to better coordinate with wind generation operations.

Priority: Long-Term

Status: RTWG to develop a whitepaper on this issue by _____.

SO-15: Communications between Wind Farms and TSPs

Description: Examine possible improvements in real-time communications between wind farms and transmission service providers (TSPs).

Priority: Near-Term

Status: This issue has been assigned to the Operating Guide Revision Task Force (OGRTF).

SO-16: Wind Generation Ramp Limits

Description: Develop appropriate ramp rate limits for wind farms

Priority: Not Applicable

Status: Complete – PRR 771 (relating to new wind farms) was approved by the ERCOT Board in December 2008 and PRR 788 (relating to existing wind farms) was approved by the ERCOT Board in January, 2009.

SO-17: Mid-Term and Short-Term Load Forecast Weather Sensitivity

Description: Determine if ERCOT mid-term and short-term load forecast is highly sensitive to weather changes and was a determining factor in the February 26, 2008 low system frequency event.

Priority: Not Applicable

Status: Complete – Issue resolved as result of ERCOT Operations response to questions raised by Performance Disturbance Compliance Working Group (PDCWG). The Wind Operations Task Force (WOTF) determined that this was not a determining factor in the February 26, 2008 low system frequency event.

SO-18: Reserved

SO-19: Improve Commercially Sensitive Constraints (CSC) Process

Description: Evaluate increasing the frequency of ERCOT CSC studies to more accurately determine congestion problems that affect wind generation.

Priority: Not Applicable

Status: Complete – ERCOT implemented hourly CSC limits in June, 2008.

SO-20: Dynamic Transmission Line Ratings

Description: Evaluate cost and benefits of using dynamic transmission line ratings in ERCOT's planning processes to allow more efficient use of transmission lines serving wind farms.

Priority: Not Applicable

Status: Complete – The ERCOT Regional Planning Group (RPG) has agreed to consider dynamic line rating solutions for evaluating transmission congestion problems.

SO-21: Evaluate Emergency Electric Curtailment Plan (EECP) Steps

Description: Determine if the existing EECF steps need to be modified to take into account the increasing amount of variable wind generation in the ERCOT system.

Priority: Not Applicable

Status: Complete – PRR 769 was approved by the ERCOT Board in November, 2008 and NPRR 142 was approved by the ERCOT Board in January, 2009.

SO-22: Reserved

SO-23: Impact of Advanced Meters on Integration of Renewable Resources

Description: Examine impact of advanced metering capabilities on integration and deployment of renewable resources and demand-side management technologies.

Priority: Long-Term

Status: Assigned to the Demand-Side Working Group (DSWG)

SO-24: Settlement of Advanced Meters in the Nodal Market

Description: Determine appropriate settlement timeline to accommodate use of advanced meters in the Nodal market design.

Priority: Not Applicable

Status: Complete – Nodal Protocols establish a 15-minute settlement period for all advanced meters.

SO-25: Generator Governor Response for Wind Generators

Description: Determine proper generator governor response requirements for wind generators in the Nodal market design.

Priority: Short-Term

Status: Assigned to Wind Operations Task Force (WOTF).

SO-26: Impact of Solar Generation on System Operations

Description: Determine potential impact of new solar generation on ERCOT system operations through appropriate studies of solar ramp rate capabilities, forecasting of solar energy production, voltage and reactive control capabilities.

Priority: Long-Term

Status: RTWG to develop a whitepaper on this issue.

SO-27: Manual Curtailment of Wind Generation to Resolve Local Congestion

Description: Determine if changes can be made in the existing zonal systems to allow for automating curtailment of wind to resolve local congestion problems.

Priority: Not Applicable

Status: Complete – ERCOT and market participants discussed extensively and determined that there is no cost-effective solution for the zonal market system. The Nodal market system will address this issue fully.

SO-28: SPS Actuation for N-0 Conditions

Description: Determine possible changes to eliminate actuation of special protection systems (SPS) caused by variable output of wind farms.

Priority: Near-Term

Status: ERCOT to submit an OGRR addressing this issue by _____.

SO-29: Transmission Outage Planning for CREZ

Description: Determine ways to accommodate large amounts of transmission outages associated with the CREZ buildout while still providing adequate transmission service to existing wind farms and maintaining adequate system reliability.

Priority: Near-Term

Status: The ERCOT Regional Planning Group (RPG) has this issue under discussion.

SO-30: Application of Wind Generation Forecast to PASA

Description: Determine how the ERCOT wind generation output forecast could be used to improve the Projected Assessment of System Adequacy (PASA).

Priority: Near-Term

Status: RTWG to address this issue.

SO-31: Tension Monitors on Transmission Lines

Description: Determine the need (if any) to install tension monitors on certain existing transmission lines that will be affected by construction of CREZ transmission facilities.

Priority: Near-Term

Status: The ERCOT Regional Planning Group (RPG) has this issue under discussion.

SO-32: Real-Time Wind Generation Capacity

Description: Determine the value of having a real-time value of available wind generating capacity for use by ERCOT operations.

Priority: Near-Term

Status: CMWG to develop appropriate PRR/OGRR to address this issue by _____.

SO-33: Real-Time Wind Turbine Availability

Description: Determine the value of having a real-time indication of the availability of each wind turbine for use by ERCOT operations.

Priority: Near-Term

Status: CMWG to develop appropriate PRR/OGRR to address this issue by _____.

E. System Planning

SP-01: Verify Wind Turbine Technical Data

Description: Create and maintain an inventory of installed wind turbine characteristics.

Priority: Not Applicable

Status: Complete – ERCOT completed its survey of wind turbine equipment in the first quarter of 2009.

SP-02: Wind Turbine Computer Models

Description: Collect and verify accuracy of computer models for each type of wind turbine installed on the ERCOT grid.

Priority: Near-Term

Status: Information to be collected as part of the ERCOT Low-Voltage Ride-Through (LVRT) study, which is planned for completion before the end of 2009.

SP-03: Wind Turbine Fault Tolerance

Description: Prepare a study of the fault tolerance of wind turbines installed on the ERCOT grid.

Priority: Near-Term

Status: Included in the ERCOT Low-Voltage Ride-Through (LVRT) study, which is planned for completion before the end of 2009.

SP-04: Voltage Transient and Small Signal Stability Study

Description: Update ERCOT voltage transient and small signal stability study and prepare a West Zone to North Zone transfer study.

Priority: Near-Term

Status: The ERCOT Regional Planning Group (RPG) has this issue under discussion.

SP-05: Impact of Wind Turbines on System Inertia

Description: Determine the potential impact on system reliability of large amounts of wind turbine generating capacity on ERCOT's system inertia requirements.

Priority: Long-Term

Status: To be addressed by ERCOT after completion of the LVRT study.

SP-06: Variable Frequency Transformers

Description: Determine potential for variable frequency transformers (VFTs) to solve stability problems caused by the addition of large amounts of remotely-located generation capacity (e.g., wind generation).

Priority: Long-Term

Status: RTWG to develop a whitepaper on this issue by ____.

SP-07: Voltage Control Process

Description: Develop a process to better control voltage in areas with large amounts of wind generation

Priority: Long-Term

Status: RTWG to develop a whitepaper on this issue by ____.

SP-08: Low Voltage Ride-Through (LVRT) Study

Description: Prepare a study of the system reliability and associated requirements applicable to all generators for voltage ride-through capability.

Priority: Near-Term

Status: ERCOT has selected a consultant to prepare the study which is due for completion and submission to ROS by June of 2010.

F. Workshops and TrainingWT-01: Resource Plan and Schedule Update Process

Description: Determine potential improvements to the Resource Plan and Resource Schedule update process to improve performance and reliability.

Priority: Undetermined

Status: This topic to be included in Wind Workshop III.

WT-02: Wind Workshop III – Summer 2009

Description: Develop list of topics and speakers for the ERCOT Wind Workshop III to be held in June 2009.

Priority: Near-Term

Status: ERCOT staff and RTWG working on a draft agenda and list of proposed speakers.

WT-03: Wind Turbine Operator Training

Description: Develop list of topics for use in development of a training session for wind turbine generator operators.

Priority: Long-Term

Status: ERCOT training staff and RTWG to address this issue by the fourth quarter of 2009.

WT-04: Wind in the Nodal Market

Description: Develop presentation for use in the Wind Workshop explaining how wind generation will be treated in the Nodal market design.

Priority: Short-Term

Status: Draft presentation has been prepared and is under review by RTWG.

Section VI.

Appendices

- A. TRIP Activities Timeline**
- B. RTWG Issues List**
- C. RTWG White Papers**
- D. TRIP Quarterly Summaries**
- E. RTWG Workshop and Training Seminar Presentations¹.**