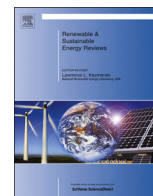




ELSEVIER

Contents lists available at ScienceDirect

## Renewable and Sustainable Energy Reviews

journal homepage: [www.elsevier.com/locate/rser](http://www.elsevier.com/locate/rser)

## A study of recent changes in Southwest Power Pool and Electric Reliability Council of Texas and its impact on the U.S. wind industry

Sandeep Nimmagadda<sup>a,\*</sup>, Atiqul Islam<sup>a</sup>, Stephen B. Bayne<sup>a</sup>, R.P. Walker<sup>b</sup>,  
Lourdes Garcia Caballero<sup>c</sup>, Albert Fisas Camanes<sup>d</sup><sup>a</sup> Department of Electrical & Computer Engineering, Texas Tech University, Lubbock, TX 79409, USA<sup>b</sup> Department of Wind Science & Engineering, Texas Tech University, Lubbock, TX 79409, USA<sup>c</sup> R&D Group, ALSTOM Wind, 78 ROC Boronat, Barcelona 08005, Spain<sup>d</sup> ALSTOM Wind NAM, 1100 Boulders, Richmond, VA 23225, USA

## ARTICLE INFO

## Article history:

Received 12 August 2013

Received in revised form

7 April 2014

Accepted 27 April 2014

Available online 20 May 2014

## Keywords:

ERCOT

FERC

NERC

SPP

Wind farm developers

Wind turbine manufacturers

## ABSTRACT

Due to the increased penetration of renewable energy resources, there has been a lot of activity in the regional transmission organizations such as development of new standards, protocol revisions, new study requirements, changes to modeling procedures etc., in the last five years with a special focus given to wind energy. The key objective of this paper is to identify the impacts and the immediate technological and market related improvements required by the wind industry as a result of such changes in Southwest Power Pool (SPP) and the Electric Reliability Council of Texas (ERCOT). The paper documents the most important activities by following the higher-priority committees, work groups and task forces in both companies along with some of the special projects or initiatives such as subsynchronous control interaction study, primary frequency response, hub concept and other modeling improvements related to wind energy. The paper provides an analysis of the impact of each change resulting in technology upgrades to wind turbines, modeling improvements by turbine manufacturers and policy/market changes affecting wind farm developers. Finally the paper provides recommendations regarding the requirements and capabilities which the future wind farms and wind turbines need to possess.

© 2014 Elsevier Ltd. All rights reserved.

## Contents

1. Introduction . . . . .	351
2. An overview of SPP and ERCOT . . . . .	352
2.1. SPP . . . . .	352
2.1.1. Wind energy status in SPP . . . . .	352
2.2. ERCOT . . . . .	352
2.2.1. Wind energy status in ERCOT . . . . .	353
3. Policy changes and technological issues in SPP affecting wind industry . . . . .	353
3.1. Standards under development . . . . .	353
3.1.1. Under frequency load shedding . . . . .	353
3.1.2. Generator loadability standard . . . . .	353
3.2. Transition to integrated marketplace in 2014 . . . . .	353
3.3. Wind to be declared as dispatchable energy resource . . . . .	355
3.4. Improvements in modeling procedures . . . . .	355
3.5. Hub concept . . . . .	355
4. Policy changes and technological issues in ERCOT affecting wind energy . . . . .	356
4.1. Subsynchronous control interaction . . . . .	356
4.2. Primary frequency response . . . . .	357

\* Correspondence to: 1612, Avenue Y, Apt 212B, Lubbock, TX 79415-325, US. Tel.: +1 806 786 3476.

E-mail addresses: [sandeep.nimmagadda@ttu.edu](mailto:sandeep.nimmagadda@ttu.edu) (S. Nimmagadda), [richard.p.walker@ttu.edu](mailto:richard.p.walker@ttu.edu) (R.P. Walker), [lourdes.garcia@power.alstom.com](mailto:lourdes.garcia@power.alstom.com) (L. Garcia Caballero), [albert.fisas@power.alstom.com](mailto:albert.fisas@power.alstom.com) (A. Fisas Camanes).

4.3. Power factor. . . . . 358  
 4.4. ERCOT modeling updates . . . . . 358  
 4.5. Wind forecasting methodology. . . . . 358  
 5. Limitations of currently available wind turbines and wind farms . . . . . 359  
 6. Research directions for future wind farms & wind turbines . . . . . 359  
 6.1. Research direction for wind turbine manufacturers . . . . . 359  
 6.2. Research directions for wind farm developers. . . . . 359  
 6.3. Research directions to meet current and future modeling requirements . . . . . 360  
 7. Conclusion . . . . . 360  
 References . . . . . 361

**1. Introduction**

The Federal Energy Regulatory Commission (FERC) and the North American Electric Reliability Corporation (NERC) are the two major organizations which regulate the electricity markets and ensure reliability of the bulk power system in USA. FERC is a federal agency in United States of America formed to provide a strong and reliable national energy infrastructure. FERC’s responsibility includes reliable infrastructure, margins and acquisitions, licensing and inspection, compliance and monitoring and has all legal authorities over the interstate sales and rate regulation of electricity [1]. NERC is a non-governmental Electric Reliability Organization (ERO) formed to ensure reliable operation by developing and enforcing appropriate reliability standards, monitoring the power system and familiarizing the industry personnel with proper training and seminar. NERC is certified by the Federal Regulatory Commission to enforce the standards, not only for the generation owners but also for all the users, property owners and operators. NERC is not directly regulated by FERC rather it is a self regulatory organization. FERC oversees the NERC operation and provides important suggestions when necessary [2]. A map indicating the NERC regions is shown in Fig. 1.

The Electric Reliability Council of Texas (ERCOT) and the Southwest Power Pool (SPP) fall under the regional entities formed by NERC and the Regional Transmission Operators (RTOs) formed by the FERC. This region of the country has been the hotbed of wind energy development for the past several years, with at least 28% of all new U.S. wind energy project construction occurring in these 8 states, each of the last four years.

Due to the increased penetration of renewable energy resources, there has been a lot of activity in the regional transmission organizations such as development of new standards, protocol revisions, new study requirements, changes to modeling procedures etc., in the last five years with a special focus given to wind energy. The key objective of this paper is to identify the impacts and the immediate technological and market related improvements required by the wind industry as a result of such changes in SPP and ERCOT. The paper documents the most important activities by following the higher-priority committees, work groups and task forces in both companies along with some of the special projects or initiatives such as sub-synchronous control interaction study, primary frequency response, hub concept and other modeling improvements related to wind energy. The paper provides an analysis of the impact of each change resulting in

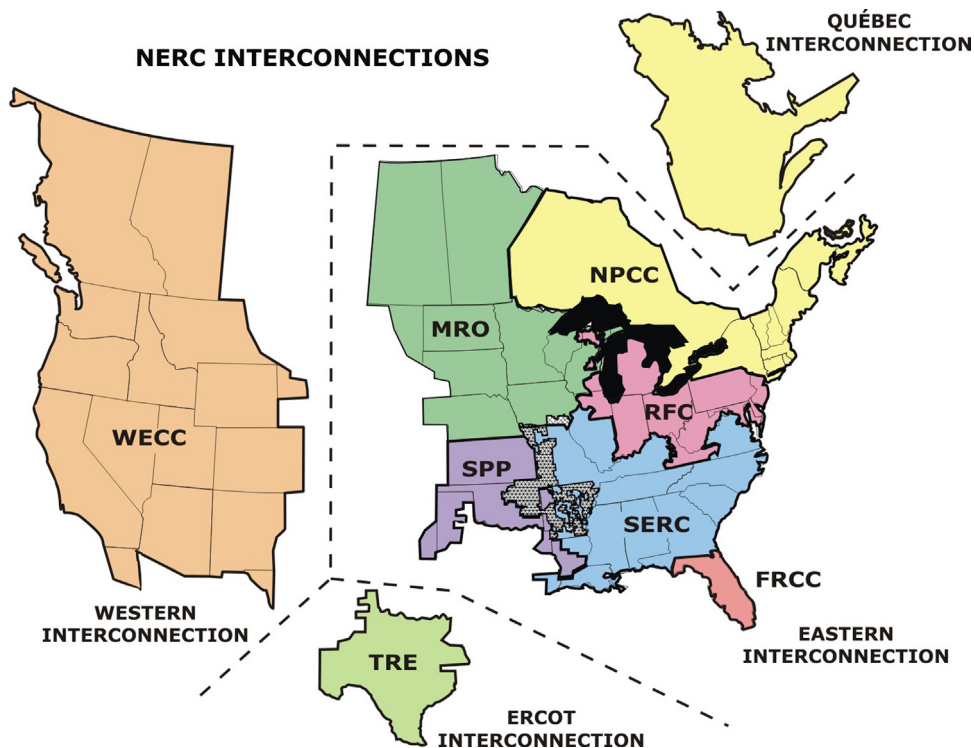


Fig. 1. NERC regions in USA [27].

Download English Version:

<https://daneshyari.com/en/article/1750352>

Download Persian Version:

<https://daneshyari.com/article/1750352>

[Daneshyari.com](https://daneshyari.com)