Aug 16th, 10:30 AM - 10:55 AM

Assessment of wind energy for Nevada using towers and mesoscale modeling

Darko Koracin

Desert Research Institute, Darko.Koracin@dri.edu

Follow this and additional works at: <https://digitalscholarship.unlv.edu/res>

Part of the [Oil, Gas, and Energy Commons](#)

Repository Citation

Koracin, Darko, "Assessment of wind energy for Nevada using towers and mesoscale modeling" (2007). *UNLV Renewable Energy Symposium*. 8.

<https://digitalscholarship.unlv.edu/res/2007/aug16/8>

This Event is protected by copyright and/or related rights. It has been brought to you by Digital Scholarship@UNLV with permission from the rights-holder(s). You are free to use this Event in any way that is permitted by the copyright and related rights legislation that applies to your use. For other uses you need to obtain permission from the rights-holder(s) directly, unless additional rights are indicated by a Creative Commons license in the record and/or on the work itself.

This Event has been accepted for inclusion in UNLV Renewable Energy Symposium by an authorized administrator of Digital Scholarship@UNLV. For more information, please contact digitalscholarship@unlv.edu.

Assessment of wind energy for Nevada using towers and mesoscale modeling

Darko Koracin, Richard L. Reinhardt, Marshall B.
Liddle, Travis McCord, Domagoj Podnar, and
Timothy B. Minor

*Desert Research Institute,
2215 Raggio Parkway, Reno, NV 89512*

Background (I)

- Nevada imports virtually all energy
 - Nevada legislature mandates utilities (Nevada Power and Sierra Pacific companies) to produce 15% of energy by 2015 from renewable sources
 - Nevada is 21st state by the wind energy potential
 - Wind resource in Nevada is highly variable in time and space
-
-

Background (II)

- Nevada's Congressional Delegation initiated assessment of Nevada's renewable energies.
 - Desert Research Institute of the Nevada System of Higher Education was funded through the Department of Energy – National Renewable Laboratory to estimate wind power density in Nevada using meteorological tower measurements and computer modeling.
 - Sierra Pacific Resources – industry partner.
-
-

United States - Wind Resource Map

Reference – existing Wind Resource Map
(TrueWind/DOE NREL)

DRI Wind Energy Projects – DOE/NREL Funding

- (1) Nevada Wind Assessment

Analysis of 80 Remote Automated Weather Stations

Mesoscale modeling – annual cycle (2001/2002) with 9 and 3 km resolution over Nevada.

Period: Sep 2001 – Aug 2002

DRI Wind Energy Projects – DOE/NREL Funding

- (2) Nevada Wind Assessment (II)

(a) Four 50m wind towers installed in western Nevada near Tonopah

(b) Mesoscale modeling – annual cycle (2001/2002) with 2 km resolution over Nevada.- improving wind power density maps

(c) UNLV – Microscale modeling
(D. Pepper)

Period: Aug 2003 – July 2004

Meteorological towers

Topographical map of the area around the four 50 m towers near Tonopah, Nevada.

Wind speed measurements are at five levels (10, 20, 30, 40, and 50m)

*Use: Direct wind speed measurements at hub and blade heights;
model evaluation*

DRI Wind Energy Projects – DOE/NREL Funding

- (3) Tall wind tower deployment

(a) A 80m communication tower equipped with standard and sonic anemometers at three levels near Tonopah.

(b) Mesoscale modeling – b1) Turbulence measurements and modeling; b2) Downscaling of wind forecasts from 30 km to several hundred meters resolution.

DRI Wind Energy Projects – DOE/NREL Funding

(4a) Wind towers in southern Nevada

Proposal approved, but funding is not available yet.

- One 120 m wind tower (Searchlight)
 - Four 50m towers (Bullfrog Mountain, Amargosa Valley, Indian Springs, and Goodsprings)
 - Mesoscale modeling – Model evaluation: winds, turbulence, downscaling
-
-

DRI Wind Energy Projects – DOE/NREL Funding

(4b) Adaptive-grid OMEGA modeling

Proposal approved, but funding is not available yet.

- DRI, UNLV, and Meso Inc.
- High-resolution modeling with variable resolution; highest resolution in the areas of interest.

Comparison: SODAR vs. tower data at 50 m tower - Tonopah

Model evaluation – surface stations

Comparison between MM5-simulated and RAWS-measured wind speed for the Brawley Peaks station.

Model evaluation – surface stations

RAWS

MM5

RAWS

MM5

Histograms of wind speed (left) and wind direction (right) at the Brawley Peaks station for the annual period (1 August 2003 – 31 July 2004).

Model evaluation – 50 m tower

Model evaluation – wind power density at 50 m (tower)

Comparison between MM5-simulated and tower wind speed and direction at 50 m (left panels) and corresponding wind power density (W/m^2) (right panel) for the Luning-7W tower for December 2003.

Model evaluation – 50 m tower

Measured

Comparison between the measured and MM5-simulated wind speed histograms for the Luning 7W tower at 50 m for the period from August 2003 to July 2004.

MM5

3 way Wpd Comparison of MM5, Truewind and Tower Data, Aug 2003--Jul 2004 (WE2)

Three-way comparison of the wind power density at the four tower locations computed from the tower data, atmospheric model results for the period from August 2003 to July 2004, and the TrueWind estimates.

Percentage differences of the wind power density from MM5 (green) and TrueWind (brown) versus the towers with (left-hand side) and without (right-hand side) the Tonopah tower location.

MM5 - Wind Power Density (W/m²) – Annual mesoscale simulations

90m

10m

Annual mean wind power density map (classes) for Nevada for 2003/2004 cycle at 90m computed from the numerical mesoscale model results

2 - Marginal

3 - Fair

4 - Good

5 - Excellent

6 - Outstanding

7 - Superb

Current and planned modeling – wind variability, winds aloft, short-term and long-term forecasting

Animation – wind power density class for every day in April 2004 at 4am and 4pm local time

Reference – existing
Wind Resource Map

Average wind power (in W/m^2) for level 5 (94 m), August 2003-July 2004
Values near stations are averaged values from Truewind data

Annual wind power density (W/m^2) estimated from the numerical mesoscale model results for eastern Nevada and single point True Wind map estimates.

Wind power density (W/m^2) over Nevada at 50 m as estimated from the MM5 simulations from 1 September 2001 through 31 August 2002 (WE1_01_02) (left panel) and from 1 August 2003 through 31 July 2004 (WE2_03_04) (right panel).

Differences in the wind power density (W/m^2) between the annual cycle of MM5 simulations for 2001/2002 (left panel) and 2003/2004 (right panel) with the TrueWind results over Nevada at 50 m.

CONCLUSIONS

- The MM5 results compared well with the tower data
- The model results for both annual cycles show similar results
- Greatest wind power density simulated over the Sierra Nevadas and mountainous regions
- Central Nevada characterized by lower wind power density
- TrueWind generally shows higher values for wind power density than MM5
 - TrueWind is lower than MM5 over the mountains

The results of this study suggest that the synthesis of the data from the network of tower observations and high-resolution mesoscale modeling is a crucial tool for assessing the wind power density in Nevada and more generally other topographically developed areas. Future efforts should also be directed at obtaining data from additional tower networks and at higher elevations as well as evaluating models to predict winds and turbulence at blade heights for mid-size and large wind turbines.

Questions?