Correction to

Comparison of Peak Wind-Energy Production in Central New Mexico with Peak Electrical Consumption in Arizona and New Mexico

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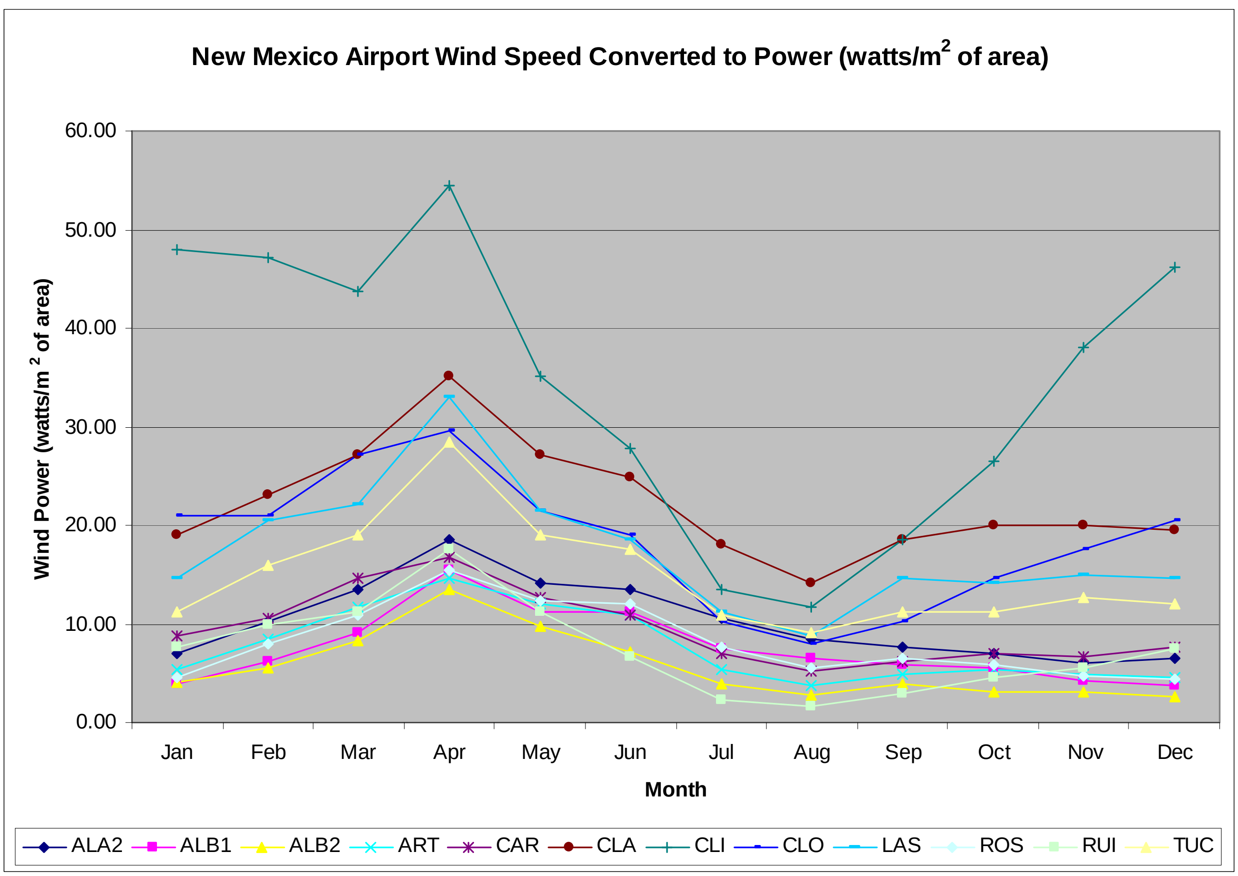
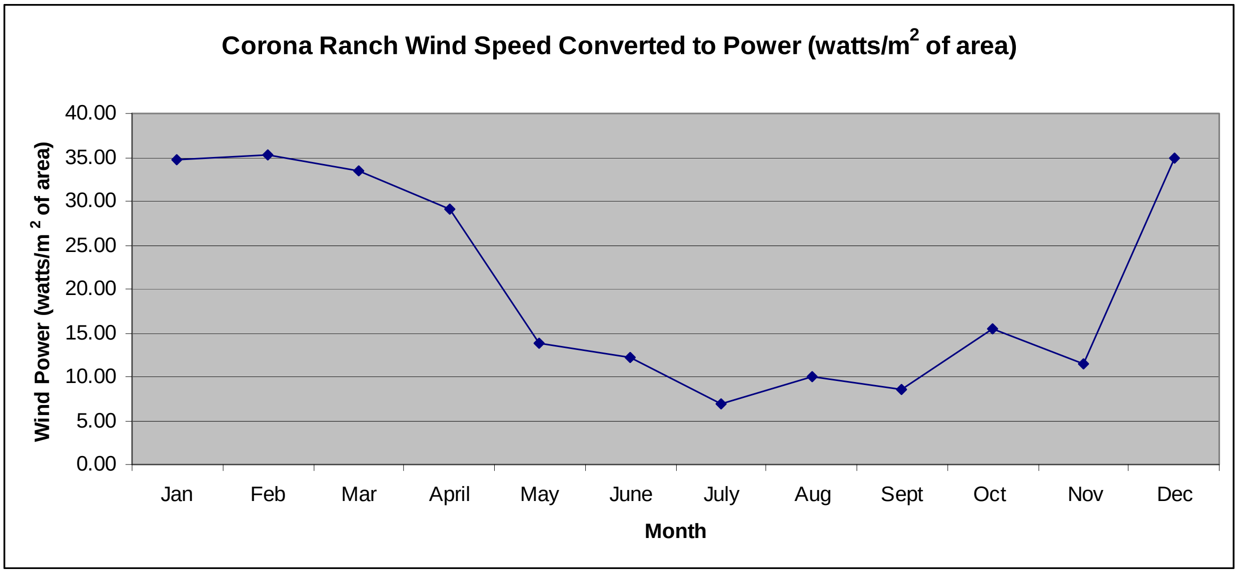
After completing our report relating wind speed to wind electrical generating capacity for Corona Ranch, New Mexico, one of us (David Omick) realized that we had used an incorrect formula to establish this relationship[1]. We had related wind electrical generation to the square of wind speed, whereas is should be related to the cube of wind speed. The net result substantially strengthens our conclusion that a negative correlation exists between peak wind-energy production in New Mexico and peak-energy consumption in Arizona and California.

Below are corrected graphs of power calculated from average monthly wind speeds for New Mexico airports and Corona Ranch. For New Mexico airports as a whole, the average drop in power from April to August is 70.3%. For Corona Ranch (close to the New Mexico wind generating area), the drop in available power from February to July is 80.6%, considerably greater than previously calculated. This further accentuates the need for conventional fossil-fuel generation to be integrated into the SunZia transmission system to stabilize power supply.





The following explains the math involved. Our original equation was as follows[1]:

$$F = \tfrac{1}{2}\rho v^2 s_f$$

where

F = force (pressure) in N/m^2 (should be joules)
ρ = density of air in kg/m^3 (0.95 for 6500 ft, the elevation of the Corona Ranch area)
v = wind speed (converted to m/s from mi/hr)
s_f = shape factor (assumed to be 1.0)

This equation is actually for kinetic energy, and kinetic energy must be converted to power, which is a function of the cube of velocity[2,3]. The basic equation for this is as follows:

$$P = FAv$$

where

P = power in watts
F = force in joules (kinetic energy calculated above)
A = area in m^2
v = velocity in m/s

Combining the first two equations gives:

$$P = \frac{1}{2}\rho A v^3$$

Because we cannot extract all of the power in wind, three additional factors are required to complete the conversion to power, summarized below. These are all scalar quantities, however, and do not affect the overall relationship between maximum and minimum power.

C_p = coefficient of performance (0.35 for a good design)
N_g = generator efficiency (80%, or 0.80, for a grid-connected induction generator)
N_b = gearbox/bearings efficiency (95%, or 0.95, if good)

This gives us the following complete equation:

$$P = \frac{1}{2}\rho A C_p v^3 N_g N_b$$

To simplify calculations we chose a value for A of 1 m^2 because we are interested in relative rather than absolute differences in power.

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[1] Wind speed and wind pressure, http://www.knmi.nl/samenw/hydra/faq/press.html, accessed August 16, 2010.

[2] Wind electricity basics, *Homepower Magazine*, http://homepower.com/basics/wind/, accessed August 23, 2010.

[3] Eric Eggleston, Wind Energy FAQ, How can I calculate the amount of power available at a given wind speed?, American Wind Energy Association, 5 February 1998, http://www.awea.org/faq/windpower.html, accessed August 23, 2010.