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Weather and the Economy

Weather impacts all commercial activities. It has been estimated that 30 percent of gross domestic product is directly or indirectly impacted by weather and climate. But weather impacts vary enormously from place to place. We like to say that weather impacts are location and activity specific. For example, consider an 80-degree day in California. In San Francisco, that's considered hot enough for people to buy an air conditioner. But in Sacramento, 80 degrees causes people to pack a sweater. It is the combination of weather and location that provides powerful predictions of consumer behavior.

Predicting Consumer Demand

Weather is critical for predicting year-over-year same-store sales (see Fig. 1). We can usefully predict this well in advance of predicting the weather. Useful day-to-day weather predictions can be made out to one or two weeks depending on weather patterns. Longer-term predictions of average conditions can be made weeks to months in advance. In some situations for some regions, such as winter in the Northeast, we can make useful predictions using combinations of forecast techniques months ahead of time While year-ahead predictions of weather during a particular week are not skillful we do have exact knowledge of the past weather, and a significant component of year-over-year sales can be regressed on the previous year's weather. Basically, it is safe to say that the weather next year will be closer to the long-term average for that time of year than to this year's weather that was just observed (see Fig. 2). With appropriate analytical techniques, we can predict consumer demand location-by-location (down to the ZIP code level) and week-by-week for items with weather-driven demand like thermal underwear and windshield wiper blades.

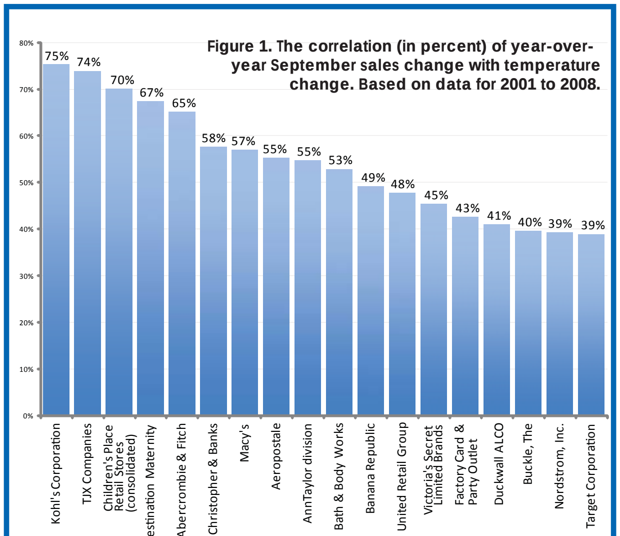


Figure 1. The correlation (in percent) of year-over-year September sales change with temperature change. Based on data for 2001 to 2008.

Wide-ranging Economic Impacts

Weather impacts many aspects of the economy in addition to consumer demand. Following are a few critical impacts:

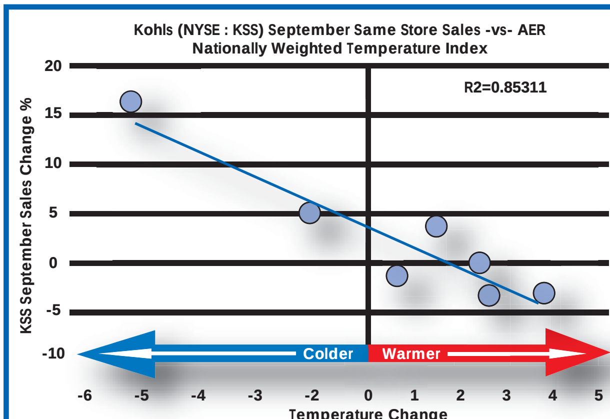
• ***Commodity demand.*** Local weather controls commodity supply and creates commodity demand. A freeze in the Florida citrus orchards reduces the supply of oranges and increases prices for suppliers in other locations. Colder winters in the Northeast increase the demand for fuel oil.

• ***Supply chain.*** Weather causes business interruptions and supply chain outages. Snow and ice can slow or shut down transportation. High heat can cause brown outs and "voluntary" cut-backs of electricity use. Ice storms can down power lines.

• ***Emergency Pre-positioning.*** Last winter, a massive ice storm left thousands without electricity for two weeks in central Massachusetts and southern New Hampshire. Utility companies share work crews across hundreds of miles in the aftermath of such an event. While it is hard to forecast such events accurately enough to pre-position work crews across substantial distances, forecasts can be used to prime advance planning so that the emergency crews will be in a state of readiness.

Weather, Location, and The Insurance Industry

The insurance industry can learn to use weather information. Location-specific weather impacts risk and loss. Hurricanes, flooding, severe wind, and other perils clearly do. But weather and climate that one would not consider hazardous can be important in evaluating risk. Consider fire risk; a dry season in Southern California followed by a few days of Santa Ana winds can lead to extremely dangerous conditions in one neighborhood, but not a few miles away. Weather knowledge is critical to responders, from firefighters to claims adjusters. Fire is just one example. Weather elements like fog, rain, and icing impact personal injury (automobile, property/casualty, workers compensation, and health).



The AER Weather Index explained ~85 percent of the variability in Kohl's Department Store September sales changes between 2001 and 2009. The 2008 sales results are omitted due to the extraordinary sales declines following the onset of the credit crisis.

For more information about the research mentioned in this article, contact: [Paul Walsh, Vice President or Steve Massa, Director, Data Services Division at +1.781.761.2288 or pwalshr@aer.com, smassa@aer.com.]

Weather and Climate: Keys to Efficient Renewable Energy

Renewable energy production in US is a fast growing business. In 2007, renewable sources accounted for about 7% of the energy consumed in the US[1]. Since 2007, both wind power and biomass (ethanol) consumption have grown by more than 20% each year. Wind power is the most active in the electric power markets with 71% of green power sales in 2008 (see Figure 1).

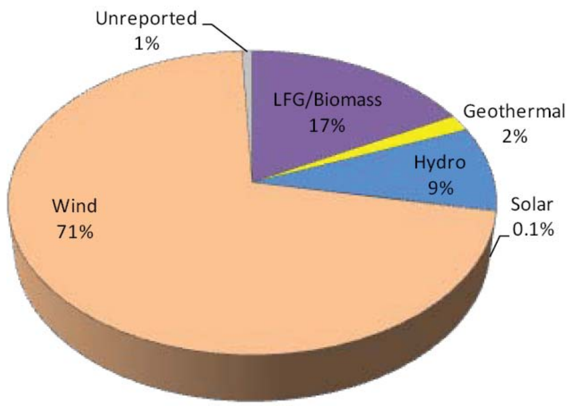


Figure 1. Estimated green power sales by renewable energy source, 2008 [2].

Some of the US renewable energy portfolio is not directly affected by weather (i.e., biomass, hydroelectric and geothermal). But solar and wind electricity production can be directly impacted by local weather and, perhaps more importantly, may be affected by short-term climate change. Solar and wind generated electricity have an immediate impact on the energy supply, since the electricity is put directly on regional electric power grids. Sudden changes in wind speed, however, can produce unwanted drops or surges in power on the grid. Texas has substantial wind power generation resources that must dovetail with the other regional power production. Well-documented so-called “wind ramp” events in these wind generating regions have produced local power crises. In some cases, the winds have dropped suddenly and the region has suffered involuntary curtailments[3].

Weather is also an important parameter for the protection of the valuable renewable generation equipment. The local weather conditions can damage wind turbines and solar panels and shorten their service life. Knowing in advance, for example, that particularly turbulent wind conditions are possible would suggest adjusting the pitch of the turbine blades to reduce damaging bending moments. Such an adjustment is likely to reduce the efficiency of the wind-to-electricity conversion during turbulent periods, but it prolongs the life of the large, delicate turbine blades by reducing the number of the high-stress fatigue cycles.

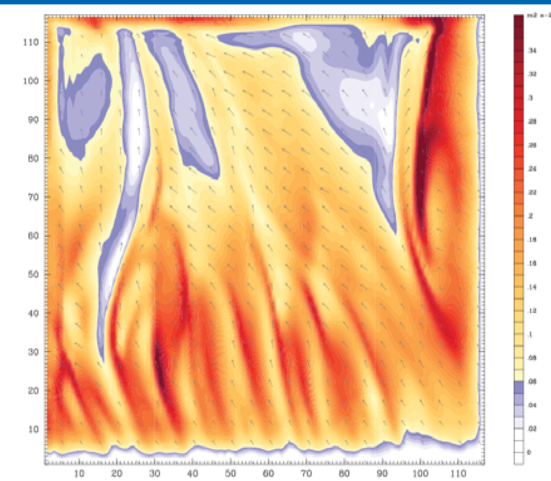


Figure 2. Simulation of turbulent kinetic energy (color field) and vector winds (gray arrows) about 50 meters about ground level. The modeling area is approximately 6 miles square and from the surface to 10 miles in the vertical.

AER is investigating the use of small-scale simulations of the three-dimensional wind to predict turbulence in and around wind farms. Figure 2 shows a short term forecast of turbulent kinetic energy approximately 50 meters above ground level over an area of about 6 miles by 6 miles. The promise and reality of renewable energy is great news for the US as we seek independence from foreign oil sources. But as more renewable energy production is brought on line, weather and climate forecasts will play a key role in making renewable energy production efficient, affordable and profitable.

For more information about the research mentioned in this article, contact: **Mark Leidner, Staff Scientist, Data Services Division at +1.781.761.2288 or mleidner@aer.com.**

[1] EIA, Renewable Energy Trends in Consumption and Electricity, 2007 Edition, http://www.eia.doe.gov/fuelrenewable.html. [2] L. Bird, C. Kreycik and B. Friedman, "Green Power Marketing in the United States: A Status Report (2008 Data)", National Renewable Energy Laboratory, NREL/TP-6A2-46581, September 2009. [3] E. Ela and B. Kirby, “ERCOT Event on February 26, 2008: Lessons Learned”, National Renewable Energy Laboratory, NREL/TP-500-43373, July 2008.

AER Presenters at the 90th Annual AMS Meeting

Wednesday, 20 January 2010

George D. Modica, R. d'Entremont, E. Mlawer, and G. Gustafson - 4:30PM, J12.3. Short-Term Solar Radiation Forecasts in Support of Smart Grid Technology.

Thursday, 21 January 2010

John F. Galantowicz, J. J. Holdzkom, T. Nehrkorn, R. P. D'Entremont, and S. Lowe - 8:30AM - 9:45AM, B218. Satellite imagery and virtual globe cloud layer simulation from NWP model fields.

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