Title: Current Usage of Meteorology in the Energy Sector and What the Atmospheric Science Community Can Offer to Support the Changing Energy System

Authors: Justin Sharp (Sharply Focused) and Melinda Marquis (NOAA)

Abstract: The electric power system is being transformed from one based primarily on fossil fuels to one based primarily on "weather-fuels," wind and solar power. The United States has more than 75 GW installed wind capacity and 27 GW installed solar capacity.

Recognizing the need to reduce greenhouse gas (GHG) emissions, most states have passed renewable portfolio standards (RPSs). The U.S. Environmental Protection Agency's Clean Power Plan aims to reduce carbon dioxide emissions from electrical power generation. And the UNFCCC Conference of Parties (COP) 21 Paris Agreement strives to curtail GHG emissions and limit global warming.

The impacts of weather and climate on energy demand have long been considered by the energy sector; however, effects on power generation and all the resultant implications and interactions are not well-incorporated into energy sector decision making. In order to transition to wind and solar power in a cost-effective manner, we need a new framework where meteorological drivers of load and generation are considered in planning, siting, and operating power generation and transmission, as well as new market practices and policies.

The first part of this talk will examine the current use of meteorology in the energy industry with a focus on the most significant gaps. The second portion will address big-picture ideas for what the atmospheric science community can offer to support the changing energy system. Meteorological observations, weather forecasts, and climate information are needed to support the effective planning for and efficient operation of a national renewable energy system. Greater understanding of how wind and solar resources vary and co-vary with each other and with energy demand will help accommodate the variable nature of wind and solar energy.

Title: Climate, Energy, and Their Connections with Climate Adaptation and Mitigation

Author: Kristen Averyt (CIRES/University of Colorado)

Abstract: The energy sector, particularly electricity generation, is the largest source of domestic anthropogenic greenhouse gas emissions, and is thus the target of regulations, policies, and incentives focused on mitigation. As a consequence, in some places, investments in electricity portfolios are shifting to emphasize low carbon options, including renewable sources and natural gas. At the same time, the energy sector is also grappling with the compounded impacts of serving a growing population, while also adapting to the impacts of climate change. These impacts affect both energy supplies (e.g. declining water availability for thermoelectric cooling, shifting hydrographs and hydropower generation, shifting extreme weather events) and energy demands (e.g. increasing cooling degree days, increasing intensity and duration of heat waves). The interplay between energy and climate manifests differently at the operational and infrastructure investment timescales, and also varies from region to region. The complexity of these interactions provides a significant challenge, but also a unique opportunity.

Title: What Meteorological Needs and Challenges Does the Shift Toward More Distributed Generation Bring?

Author: Skip Dise (Clean Power Research)

Abstract:
The growth of customer-sited, distributed photovoltaic (PV) systems continues to increase as a result of reduced costs to the consumer, innovative business models such as third-party ownership, and state-mandated renewable portfolio standards. This expansion of installed PV systems is increasing the amount of on-site energy generation which has led to two key changes in the electrical system: (1) the ways that electric load is predicted during critical parts of the day and (2) the way distribution utilities plan and operate their network. In the load prediction case, the increased penetration of PV impacts the energy forecast and capacity deployment inconsistently across hours of the day or day of the year. This is because PV generation is variable by nature across multiple time domains: the production of a fleet of PV systems may not produce the same amount of energy today as it did yesterday. In the case of distribution grid management, the increased penetration of PV largely targets more localized impacts, such as voltage regulation and line power quality.

In California for example, where nearly 40% [1] of the nationwide solar generation occurs, the California Independent System Operator (CAISO) and state utilities will need to balance the swings in "net load" caused by the variability in solar generation by scheduling reserve resources with increasingly steep ramp rates and increasing associated costs. The net load profile presents an additional ramp-down in the morning and a bigger, steeper ramp-up before peak load in the evening. The magnitude of these additional ramps will only increase as additional BTM PV systems are installed to those already on residential and commercial rooftops, as shown in Figure 1. The absolute accuracy of current load prediction methods will continue to decrease as overall PV capacity grows within a balancing area. This will have a direct impact on the CAISO's ability to manage and purchase energy and deploy reserve capacity. Separately, on more geographically confined distribution networks like those operated by Pepco Holdings Incorporated (PHI) in Delaware and New Jersey, weather variability has the potential to impact their feeder-level voltage which leads to a feeder-specific PV hosting capacity limit as depicted in Figure 2; above which additional PV will cause regular violations in voltage limits.

Whether looking at system-wide load or more regionalized solar generation, new meteorological approaches are needed. Prediction of individual PV site behavior requires very localized irradiance and weather grids. Whereas traditional weather models are not well-suited for high resolution (i.e. sub-1-km) cloud prediction, remote detection through satellite image capture continues to show promise, as newer satellites like Himawari-8 and GOES-R deliver finer digital image grids. This talk will focus on presenting the alignment of the technology requirement to integrate distributed generation to the grid with the evolving set of meteorological tools that are currently being developed.
References:
(1) https://www.eia.gov/todayinenergy/detail.cfm?id=23972

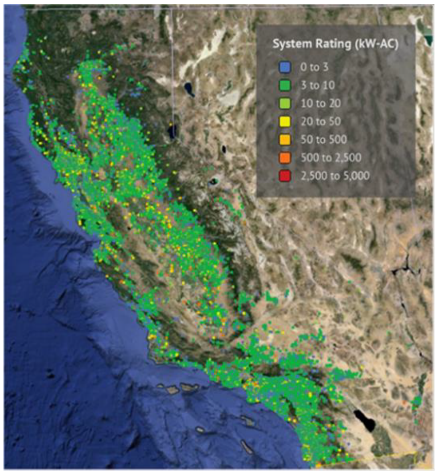

Figure 1: Distribution and capacity of BTM PV systems throughout California ISO territory.

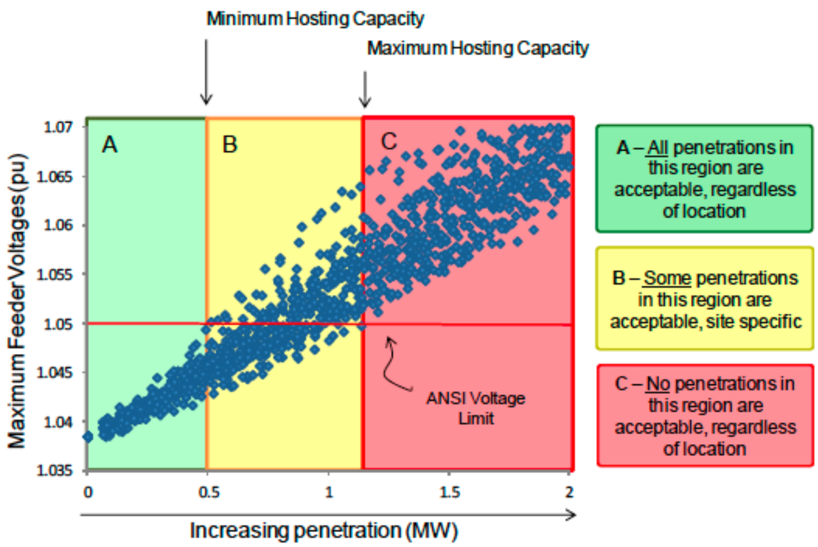

Figure 2: Feeder voltage limits determined by modeling the circuit response with growing levels of PV.

Title: Challenges in Funding Solar Forecasting on a National Level

Author: Tassos Golnas (Department of Energy)

Abstract: While deployment of solar power generation has been on a dramatic growth curve, its cost-effective integration becomes an increasing priority. Imparting a dispatchable character to solar generation is one of the solutions identified by DOE SunShot and the improvements in solar irradiance and power forecasting are a necessary component. Still, with a limited budget and a rapidly changing energy ecosystem, selection of the most impactful areas of research remains a challenge.

Title: Looking to 2030: Forecasting the Grid

Author: Bryan Hannegan (National Renewable Energy Laboratory)

Abstract: A future electric grid that is reliable, affordable and sustainable will require significantly greater amounts of renewable energy, most likely from inherently variable wind and solar resources. At the same time, uses of electricity are themselves becoming more variable as consumers interact with the energy system in new and different ways (active building management, electric transportation, etc.). To incorporate higher numbers of these emerging clean energy technologies and manage them effectively, operators of the electric grid will need to have more accurate forecasts not only of renewable energy production, but also the state of the electric grid itself in order to manage the delivery of energy services to meet consumer needs in an optimal way. This presentation will describe the current state of knowledge of grid forecasting, and highlight ongoing efforts to develop a capability to forecast grid state with skill.