Renewable Energy Technologies: A Feasibility Study

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Abstract

Interest in energy solutions from renewable sources has grown significantly in the last decade, and finding ideal sources of renewable energy has become a topic of great importance. Capacity, current land use, legislation, load demand, cost, and environmental impacts all factor into the efficient use of a renewable resource. We aim to compile a comprehensive set of locations that are feasible sites for wind and solar development.

Background

Due to the creation of Renewable Portfolio Standards, states are now concerned with renewable energy solutions. State ISOs are requiring comparable, reliable data to participate in intermittent energy generation. Many factors, however limit the feasibility of wind and PV solar development :

•**Current Land/Water Use:** Buildings, national parks, shipping lanes, military operations, and agriculture

•**Environmental Impacts**: Bird sanctuaries, prairie chickens, and aquatic ecosystems

•**Legislation:** Federal vs. state waters, environmental protection laws, and land-use/development laws

•**Capacity and Load Demand**: How much energy can the site produce and will it be able to reliably meet the demand?

•**Geographical Factors:** Mountainous regions, water depth, etc.

Figure 1: Areas That Should be Off-Limits to Renewable Energy Development, National Resources Defense Council

Data

The National Renewable Energy Laboratory has publicly available wind speed and solar irradiance data:

•The Eastern Wind Integration and Transmission Study(EWITS): Time-series wind speed data estimates for several thousand sites in the United States from 2004-2006

•US Solar Radiation Resource Maps: Direct and Diffused Irradiance interpolated from 239 sites to find Global Irradiance or Insolation and Actual AC Output of Photovoltaic (PV) and Concentrating Solar Power (CSP)

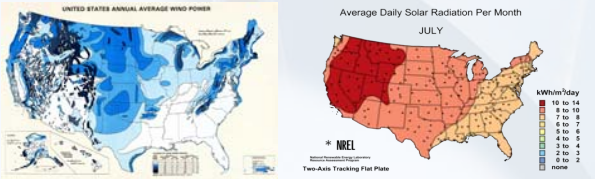

Figure 2: Wind and Solar Resources Data Maps, NREL

Wind

Current efforts to determine capacity:

•**Building a Database**

- •Too many files: 1 Excel file/site-year
- •Calculate capacity factors for each site for each year based off of average wind speed
- •Export information into one Microsoft Access database

•**Dividing States Into Zones**

- •Find sites within each state that should have similar capacity factors
  - •Similar latitude and topology
- •Average capacity factors within a zone and calculate standard deviation
- •Use standard deviation within a zone to determine reliability of data for that zone

Solar

• **Building Reliable Data for Capacity**

- • Gather data with minimal error for Insulation and Actual Output based on tilt, tracking, and temp.
- •Using SAM (Solar Advisor Model), create performance ratings for PV modules and CSP systems including Inverter losses and others
- • Calculate capacity factors for PV and CSP technology
- • Check deviation over time at each site for reliability

•**Applying Capacity Factors to Project Development**

- •Model site selection for CSP:
  - Insolation of > 6kWh/s^2/day with slope < 1%
  - Divide useable area into 2km^2 CSP cells
  - Rank by CF and assign to existing electrical cap

• **Finding Firming Applications to Increase Capacity**

- • PV Smart Grid responds to needs for stored energy
- • Capacity factor for CSP at 20% , 40-45% with storage

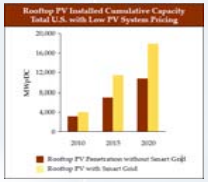

Figure 4. Estimated Increase in PV Capacity with Control and Firming, Navigant Consulting

Future Plans

The majority of our recent work has involved manipulating data and familiarizing ourselves with the power industry. In the future, we want to continue identifying potential sites for wind or PV solar development based on capacity factors, determine feasibility for those sites, and eventually create a point system for ranking a site's feasibility for wind and PV solar development.

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