Faced with environmental and social concerns, many organizations are evaluating ways to reduce their carbon footprint. Decarbonizing the United States energy supply is a government priority, and there is a countrywide net zero carbon emissions goal by 2050. Offshore wind has an important role to play in this transition with the United States targeting 30 gigawatts of offshore wind generating capacity installed by 2030 (White House 2021).

Veritas Economics (Veritas) is currently evaluating offshore wind and energy storage possibilities in New England. The evaluation relies on a flexibly constructed analysis tool to perform screening-level assessments of various wind energy generation approaches. Using this tool, analysts at Veritas input information about wind speed, wind farm configuration, development costs, energy prices, distance from interconnection, and tax credits to identify primary drivers for decision making and develop next-step strategies. Because the tool is custom made, refinements based on client requests are straightforward.

Figure 1 depicts the interface of Veritas' Wind and Storage Analysis Tool. The left side of the figure presents the model inputs, and the right side presents the tool's model flow and structure. To screen potential wind and storage options, the user loads hourly wind speed data for a possible wind energy area. This information, combined with Wind Farm Specifications of Turbine Efficiency, Blade Length, and Turbine Capacity provide the ability to evaluate the potential electricity production from a turbine in a specific location (presented in the tool as Hourly Turbine Energy).

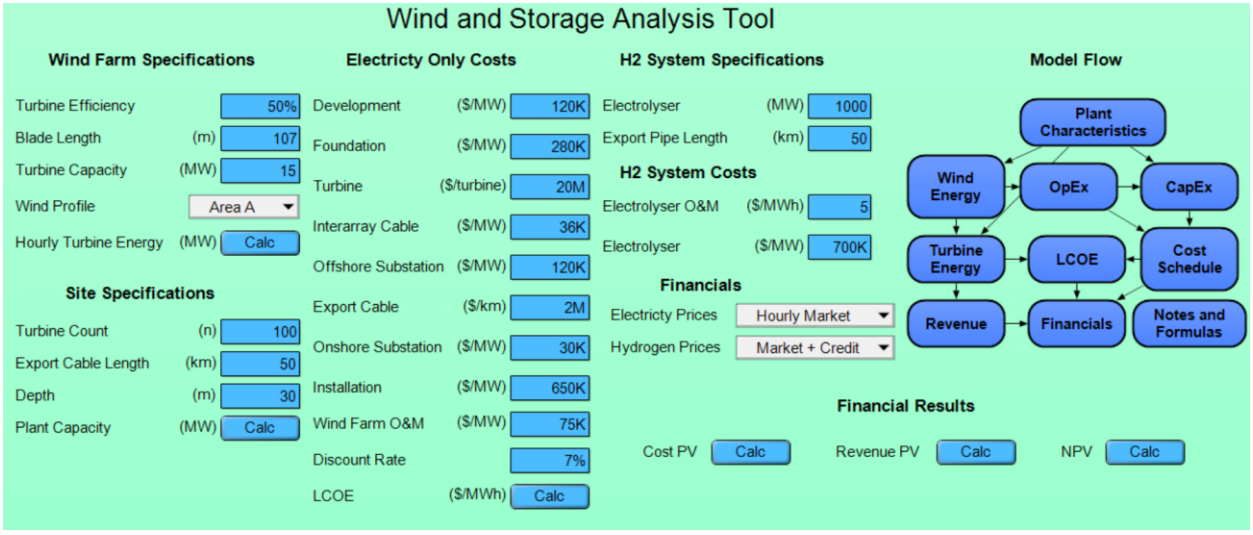

Figure 1 – Inputs, Model Flow, and Outputs of Veritas' Wind and Storage Analysis Tool

Figure 2 depicts the hourly energy produced by a turbine with 107 meter blades, 50 percent efficiency, and a capacity of 15 MW. Total annual output is 46,460 MWh.

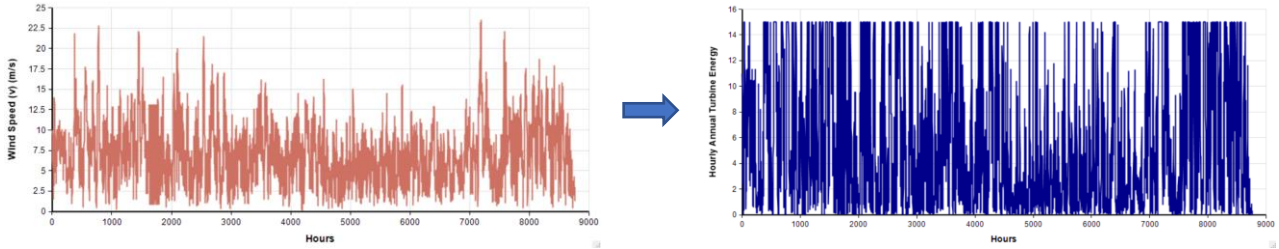

Figure 2 – Relationship Between Wind Speed and Electricity Production for a Specific Location and Turbine Characteristics

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With sufficient energy potential identified, the tool is able to evaluate the economic viability of a wind energy area by specifying additional physical information and unit costs and calculating the levelized cost of electricity (LCOE). This information is contained in the "Site Specifications" and "Electricity Only Costs" sections of the interface.

Given an offshore wind project with a suitable LCOE for electricity production, the tool is then able to evaluate alternative green hydrogen projects that can be developed in conjunction with offshore wind development. To complete this evaluation, the next step is to specify cost and revenue information for green hydrogen production and electricity under the "H2 System Specifications," "H2 System Costs," and "Financials" sections of the interface. As Figure 3 shows, this information allows identifying screening level financial metrics for green hydrogen production alternatives: electricity production, piped hydrogen, compressed hydrogen, and piped hydrogen or electricity production.

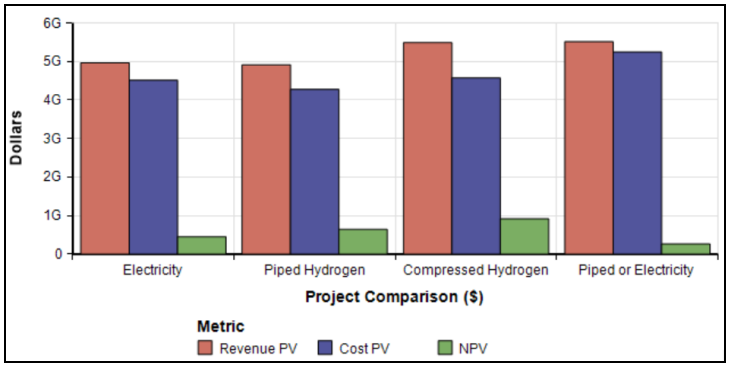

Figure 3 – Revenue, Costs, and Profits of Green Hydrogen Production Alternatives

Information from the Wind and Storage Analysis Tool may also be used as an input to Veritas' Electricity Policy Simulation Model (EPSM), a sophisticated electricity modeling system designed to assist policy makers and corporate strategists in their evaluations of alternative electricity-system and resource-allocation choices. The United States power market is an intricate system of plants, utilities, and Independent Service Operators. The relationship between these entities varies widely based on location and scenario, as do the technological specifications of the plants involved. Veritas developed EPSM to be able to precisely simulate power markets nationwide (Veritas Economics 2011).

EPSM can be used to evaluate resource changes and environmental policies at the national, regional, or local level. It can also be used to evaluate the choice among new electricity generation alternatives or the impacts of demand changes at specific locations. Results from the model include the physical, economic, and financial performance of the electricity system and of its elements and institutions.

EPSM is populated with up-to-date plant and market-specific data at a granular level to provide output that is site and scenario specific. EPSM solves by simulation, based on established behavioral rules for each supplier in a market. The interactions of these agents, given their technological, economic, and financial constraints, determine the system, element, and institutional outcomes. Physical characteristics of all thermal generating units as well as the technological, economic, and financial constraints are integrated into the model in order to get optimized solutions that follow real-world criteria.

EPSM incorporates the physical characteristics of all thermal generating units, including heat rate, capacity, and fuel type. The interannual, temporal decay in the efficiency of these generation assets is calibrated to historical data. The transmission, generation, and sale of power varies greatly by location. EPSM has the capability to take these variable market factors into account through capacity, generation, load, fuel inputs, heat rates, and marginal costs at the plant or system level. EPSM models scenarios at the hourly level to produce output with the highest level of detail. This means that changes in generation, fuel consumption, emissions, and costs can be evaluated incrementally as well as hourly.

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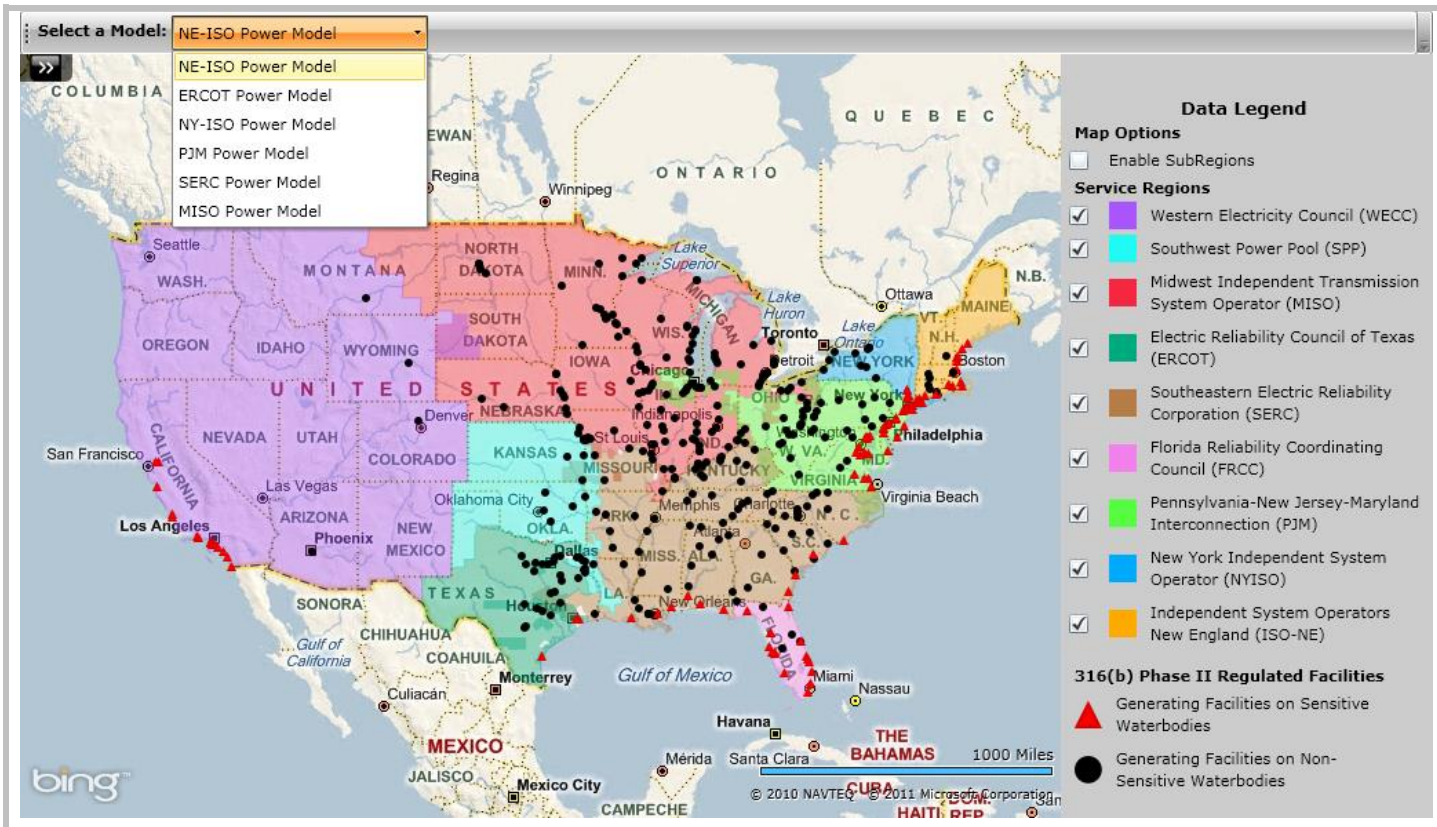

User Interface of Veritas' Electricity Policy Simulation Model

This profit-maximized solution allows for the analysis of socioeconomic, technological, financial, and environmental impacts. These analyses allow for objective, strategic, and well-informed decision making. Veritas has used EPSM in the following applications throughout the United States:

- **Conducting Power System Modeling to Evaluate the Effect of Increased Offshore Wind Development and Hydrogen Production on Electricity Prices in the Northeast United States**

  Veritas is currently evaluating offshore wind development and energy storage possibilities in New England. As part of the analysis, Veritas is integrating results from the Wind and Storage Analysis Tool into EPSM to evaluate the effect that increased offshore wind generation, hydrogen production, and excess energy storage has on electricity production, prices, and excess capacity in ISO New England, the independent Regional Transmission Organization for the Northeast.

- **Conducted Power System Modeling for Regulatory Compliance**
  Veritas used EPSM to evaluate the effect of changes in power plant configuration (i.e., changes in fixed costs from alternative regulatory compliance options) on system-level generation costs, potential premature retirement, and increased electricity prices at more than 80 electricity generating stations throughout the United States (see Bingham, Mathews, and Kinnell 2009 for an example).

- **Conducted Power System Modeling for Policy Analysis of Proposed Regulations**
  Veritas used EPSM to evaluate the financial, economic, and reliability impacts of a national closed cycle cooling retrofit requirement at existing power plants throughout the United States and to evaluate the economic and financial impacts of categorizing coal combustion residuals as hazardous substances.

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