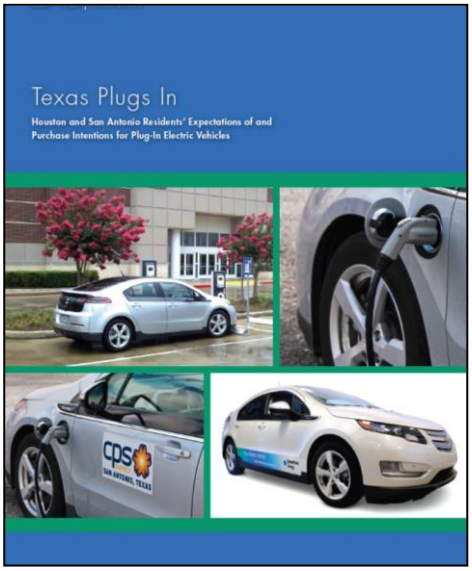
Energy Economics

Qualifications and Experience

Veritas Economics (Veritas) conducts economic analysis to understand energy, environmental, and economic challenges. Veritas applies sophisticated data collection techniques in concert with econometric, simulation, and optimization modeling to develop state-of-the-art economic models and software tools that are used to evaluate the levelized cost of electricity and capital expenditures; conduct peer-reviewed cost analyses; evaluate supply chain, workforce, economic, and power system impacts; and estimate the adoption of new technologies such as electric vehicles and residential solar. Veritas' experience ranges from modeling the economic, financial, and power system impacts of constructing and commissioning new power plants to the system-level impacts of potential policies that will affect the entire US power system. Veritas has worked on numerous cost, market, financial, reliability, and strategic-decision analyses and optimization models throughout the United States to undertake the following:

- Evaluate the Levelized Cost of Electricity (LCOE) and Capital Expenditures (CapEx) of nuclear energy and offshore wind development alternatives (Normandeau Associates, Veritas Economics, Tetra Tech 2023);
- Evaluate the supply chain, workforce, economic, and power system impacts associated with developing new nuclear energy generation (Veritas Economics 2024);
- Evaluate the effects of offshore wind development and hydrogen generation on electricity production, prices, and excess capacity (Normandeau Associates, Veritas Economics, Tetra Tech 2023);
- Conduct over a hundred peer reviewed costing studies at electricity generation locations throughout the United States; and
- Conduct power system modeling and reliability analysis using Veritas Electricity Policy Simulation Model (EPSM) to support strategic decision making regarding power plant modifications.



The following descriptions highlight some of Veritas' relevant market and financial analyses, strategic decision-making support, and optimization evaluations.

- **Evaluated Nuclear Power Costing, Scheduling, Power System, and Economic Impacts Throughout the United States** - Veritas has conducted peer-reviewed costing, economic, power system, and financial evaluations at 15 nuclear power plants throughout the United States. These projects include estimating costs for plant modifications; evaluating impacts to electricity prices, grid reliability and the environment; conducting economic impact and power system modeling; and estimating the benefits of the plant modifications.
- **Evaluated Offshore Wind and Energy Storage Possibilities in the Gulf of Maine –** Veritas used its Wind and Storage Analysis Tool (WASAT) to evaluate the economic viability, Levelized Cost of Electricity (LCOE), and Capital Expenditures (CapEx) of wind energy area alternatives in the Gulf of Maine. Veritas' WASAT is a flexibly constructed analysis tool that can perform screening-level assessments of various wind energy generation approaches. Using this tool, Veritas inputs 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. Veritas' WASAT is able to evaluate the economic viability of a wind energy area by specifying additional physical information and unit costs and calculating the LCOE of alternative projects.

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- **Michigan Nuclear Feasibility Study –** Veritas, in conjunction with Enercon, evaluated the costs; schedule; and supply chain, workforce, economic, and power system impacts associated with developing new nuclear energy generation in Michigan (Veritas Economics 2024). Veritas and Enercon evaluated numerous potential generation facility designs and reactor sizes ranging from the Westinghouse AP1000® Pressurized Water Reactor to small modular reactors (SMRs). Veritas and Enercon chose SMRs for the economic evaluation and developed cost estimates and a construction and operation schedule for a 720 megawatt unit to be installed at potential siting alternatives throughout Michigan. Veritas used Input/Output Modeling to estimate changes in jobs, employment income, and Gross State Product associated with a new nuclear plant. The input-output analysis identified the contribution that expenditures resulting from nuclear plant development would have on Michigan's economic activity.

  Veritas also used its Electricity Policy Simulation Model (EPSM) to estimate the change in electricity generation and air emissions resulting from constructing and operating a new nuclear generating facility in Michigan. Veritas used EPSM to simulate the operation of Michigan's power systems under Baseline Conditions in 2036 and then simulated changes in the power system resulting from incorporating the operation of a new nuclear generating station. EPSM's results include estimates of each unit's generation, fuel consumption, cost, and emissions.

  In order to estimate the economic impacts and air emission changes resulting from installing a new nuclear plant, siting decisions had to be made. Although the analysis did not advocate for any specific location, modeling the local economic and power system effects of a new nuclear plant required specifying a location. Figure 1 illustrates the range of potential sites that Veritas considered. As the figure shows, the siting evaluation considered a range of potential service territories and existing sites. Important location decisions include system operators, grid connections, utilities, and physical areas. Ultimately, the chosen sites for consideration were retiring coal plants because of their existing permits, plant infrastructure, and grid connections.

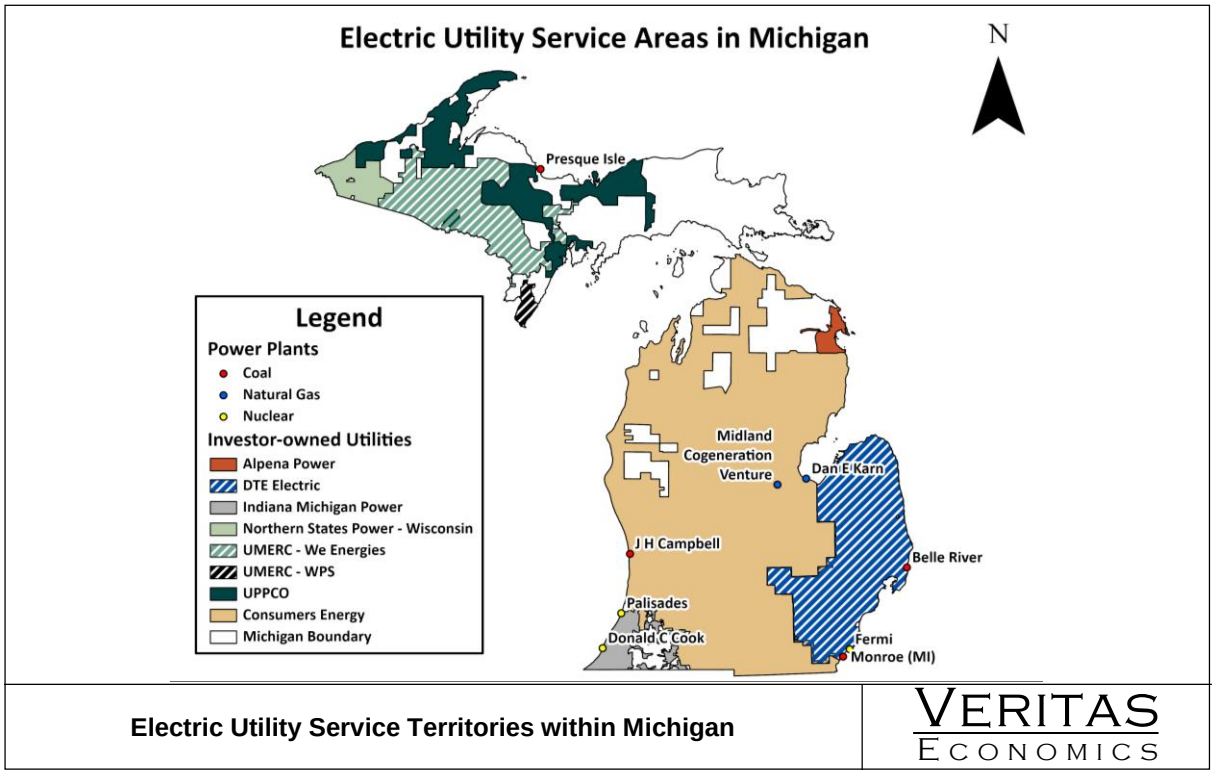

Figure 1 – Evaluation of Potential Locations for New SMR Facilities in Michigan

- **Using Power System Modeling and Reliability Analysis to Evaluate the Economic, Financial, Power System, and Reliability Impacts from Changes in the United States Power Supply –** Veritas' experience ranges from modeling the economic, financial, and power system impacts of constructing and commissioning new power plants to the system-level impacts of potential policies that will affect the entire US power system. At the heart of Veritas' economic, financial, and power system evaluations is Veritas' Electricity Policy Simulation Model (EPSM – Veritas Economics 2011). EPSM is an analytical tool designed to assist policy makers and corporate strategists in their evaluations of alternative electricity-system and resource-allocation choices. Veritas has used EPSM to evaluate electricity policies at the national, regional, or local level. Veritas has also used EPSM to evaluate choices among new electricity generation alternatives or the impacts of demand changes at specific locations. Results from EPSM include the physical, economic, and financial performance of the electricity system and of its elements and institutions. Figure 2 depicts an illustration of EPSM's reliability optimization module that can evaluate the reliability impacts from unplanned outages of individual electricity generating units. Veritas has applied EPSM in more than a hundred peer-reviewed costing studies that evaluate the economic, financial, and power system assessments at individual power plants throughout the United States.

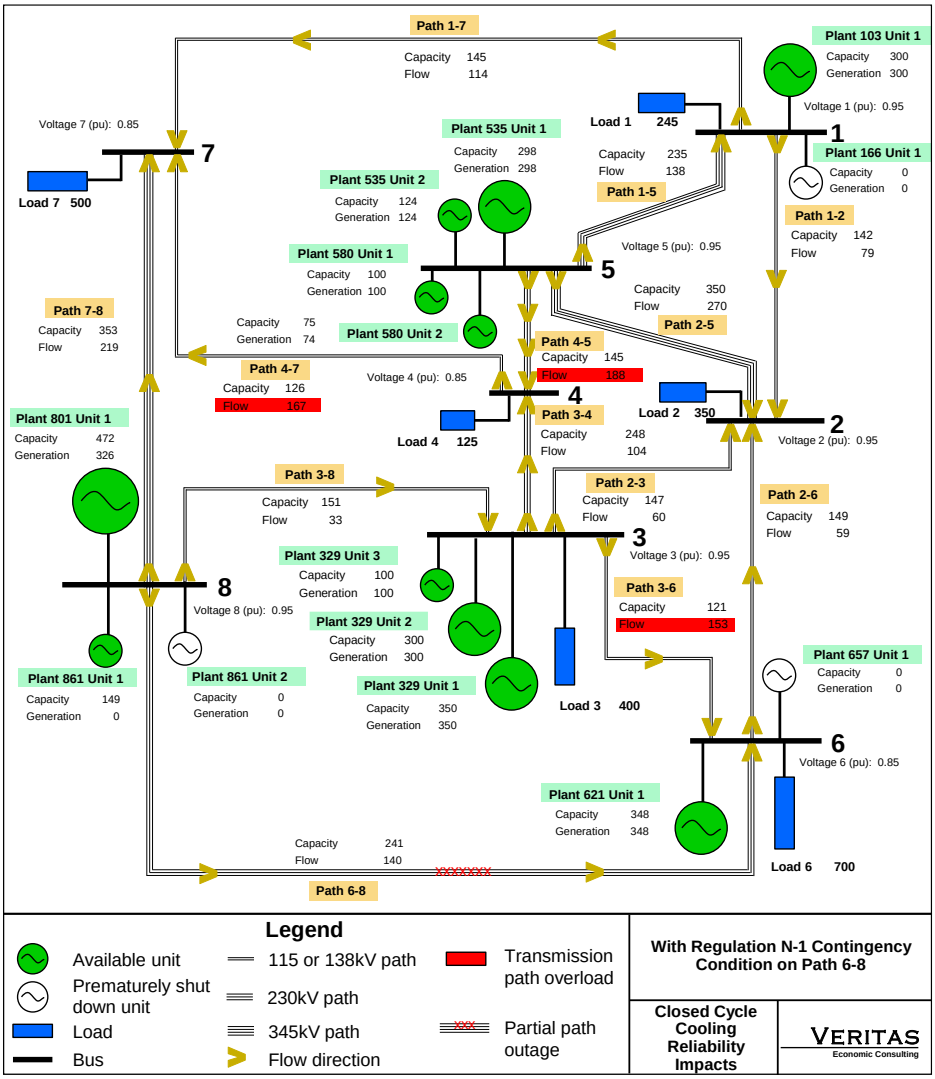

Figure 2 – Visual Depiction of the Outputs from Veritas' Reliability Impacts Optimization Module

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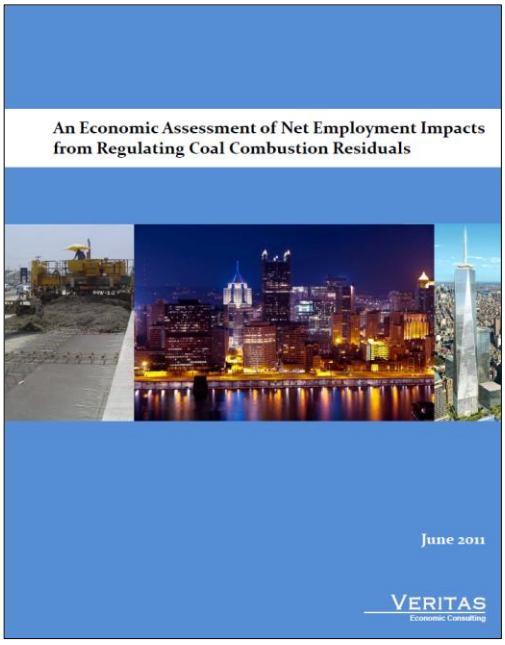
- **Conducted Economic, Financial, Reliability, and Cost Analyses for EPRI's Closed-Cycle Cooling Retrofit Research Program –** Veritas participated as a Principal Investigator in four of the five studies that comprise the Electric Power Research Institute's (EPRI) National Closed-Cycle Cooling Retrofit Research Program, a research project designed to evaluate the socioeconomic, financial, and reliability impacts and the social costs and benefits of proposed regulatory alternatives for the U.S. Environmental Protection Agency's (USEPA) 2014 316(b) Rule (79 Fed. Reg. 158, 48300–48439). As part of its research efforts, Veritas
  - Analyzed the financial, economic, and reliability impacts of a national closed-cycle-cooling retrofit requirement (EPRI 2011c). Veritas used its Environmental Policy Simulation Model (EPSM) to analyze owners' retrofit decisions and estimate the economic and financial impacts (e.g., changes in owner revenues, costs, and profits; changes in electricity prices; and changes in employment).
  - Supported the analysis of the national costs associated with a closed-cycle-cooling retrofit requirement (EPRI 2011a). Veritas modeled the hourly efficiency implications of cooling water temperature changes from a closed-cycle conversion to support the national cooling tower cost evaluation.
  - Developed a national estimate of the economic benefits of a closed-cycle-cooling retrofit requirement (EPRI 2011b). Veritas evaluated the national benefits associated with the impingement and entrainment reductions that would result from a national retrofit requirement following USEPA's Guidelines For Conducting Economic Analysis (USEPA 2016).
- **Estimated the Costs and Evaluated the Financial and Reliability Implications of Regulating Coal Combustion Residuals as Hazardous Substances** Veritas estimated the costs and evaluated the financial and reliability impacts based on expected changes to coal combustion residual management and disposal that would be mandated by USEPA through a national regulation (EPRI 2010). Veritas estimated unit-level compliance costs of the regulatory alternatives and assessed the unit-level financial impacts to owners of each regulatory alternative. Veritas used its Electricity Policy Simulation Model to assess changes to the baseline (without regulation) financial conditions of each unit under with-regulation conditions and estimated the effect of the regulation on electricity prices and reliability in the PJM, ERCOT, ISONE, MISO, NYISO, and SERC regions.
- **Conducted Power System Modeling to Evaluate the Effect of Offshore Wind Development and Hydrogen Generation in the Gulf of Maine on Electricity Production, Prices, and Excess Capacity in the Northeast United States –** Veritas evaluated offshore wind development and energy storage possibilities in the Gulf of Maine (Normandeau Associates, Veritas Economic Consulting, Tetra Tech 2023). As part of the analysis, Veritas integrated results from its Wind and Storage Analysis Tool (WASAT) into its Electricity Policy Simulation Model (EPSM) to evaluate the effect that offshore wind generation, hydrogen generation, and other energy storage would have on electricity production, prices, and excess capacity in ISO New England.
- **Estimated the Demand Impact of Alternative Rate Structures –** Veritas modeled the impact that Oklahoma Gas and Electric's (OG&E)



Smart Hours Residential Electric Service program has on electricity demand. Veritas econometrically modeled hourly kilowatt customer usage for weekdays in June through September as a function of the customers' type of Variable Peak Pricing (VPP) service, whether they have a programmable communicating thermostat (PCT), hourly weather conditions, and hourly prices.

- **Developed Veritas' Electricity Service Plan Adoption Model –** Veritas conducted economic analysis and built custom software to evaluate customers' preferences for and adoption of varying Electricity Service Plans for six service territories throughout the United States (EPRI 2019; Veritas Economics 2011). The adoption model evaluates customers preference for and likely adoption of rates that include varying combinations of time varying prices, fixed bills, variable peek pricing, demand charges, and green rates. The adoption model incorporates the results of a discrete choice experiment administered to more than a thousand electricity customers eliciting their preferences for alternative electricity service plans.

- **Developed Veritas' Electric Vehicle Adoption Model –** The Electric Power Research Institute (EPRI) builds and maintains the US Regional Economy, Greenhouse Gas, and Energy (US-REGEN) model. This model contains a Transportation Module which includes projections of US car purchasing and driving behaviors. EPRI was interested in embedding a structural dynamic model of electric vehicle adoption and use (e.g., one that is responsive to fuel prices and battery improvements) into the Transportation Module.

  Veritas created a module which combines results from Veritas and EPRI's electric vehicle preference survey with a revealed preference model of vehicle choice to develop customer preferences for new vehicle purchases and operation including electric vehicles (add reference). Choice model results are incorporated into a stock turnover model following Struben and Sterman's (2008) innovators and imitators structure. Figure 3 provides an overview of the modeling structure. The choice modeling component of Veritas' adoption model identifies new car purchases using a mathematical simulation of vehicle

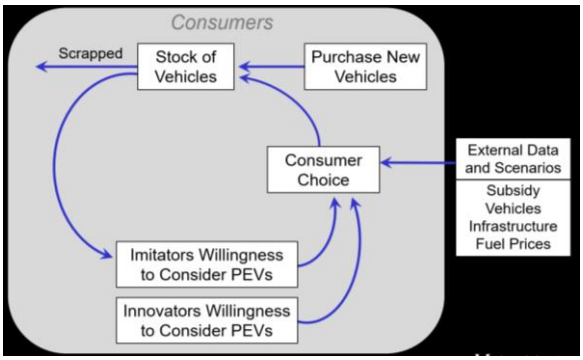


Figure 3 – Calibrated Dynamic Electric Vehicle Demand Model

choices given consumer characteristics, preferences for vehicle attributes, and vehicle choice sets. Preferences for non-electric vehicle characteristics are based on a statistically estimated model using vehicle sales and customer attribute data. Vehicle preferences are tied to the unique characteristics of electric vehicles through parameters that can be calibrated based on electric vehicle adoption estimates and relationships identified in Veritas and EPRI's electric vehicle survey research.

- **Developed Veritas Residential Solar Adoption Model** Residential solar is becoming increasingly prevalent in the United States. Because residential solar penetration has implications for electrical loads, the Electric Power Research Institute and 17 electricity service providers wanted to understand adoption rates under different residential solar cost and performance conditions. Veritas integrated baseline penetration information with econometrically modeled survey data to predict solar adoption rates under various conditions and in different locations throughout the United States. Veritas developed and administered its Residential Solar Survey to collect the data that underlies the econometric model. The model data arose from a discrete choice experiment of 7,000 electricity customers in seventeen service territories throughout the United States. Veritas incorporated the results into a software-based, dynamic residential solar adoption model that each utility could use to evaluate the residential solar adoption decisions of the customers in their service territories. The adoption model software allows utilities to conduct adoption simulations under various conditions of electricity costs, solar costs and performance, and subsidies (EPRI 2017).

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