

Sargent & Lundy

Renewable Energy



From Concept to Operations

Technology Overview & Services Description

Wind | Solar PV | Solar Thermal | Biomass |
Microgrids & Battery Storage | Integrated Resource Planning



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About Sargent & Lundy

Sargent & Lundy is one of the oldest and most experienced full-service architect engineering firms in the world. Founded in 1891, the firm is a global leader in power and energy with expertise in grid modernization, renewable energy, energy storage, nuclear power, and fossil fuels. Sargent & Lundy delivers comprehensive project services—from consulting, design, and implementation to construction management, commissioning, and operations/maintenance—with an emphasis on quality and safety. The firm serves public and private sector clients in the power and energy, gas distribution, industrial, and government sectors.

Sargent & Lundy's roles on electric power generation projects include full-design architect-engineer, owner's engineer, lender's independent engineer/technical advisor, and consultant. Our services include specialized technical advisory and consulting services to complete engineering and program management, encompassing procurement, construction management, technology transfer, and assistance with construction. Sargent & Lundy provides professional consulting, engineering, and design services throughout the lifecycle of power generation, transmission, and energy storage projects, from project concept and development, through detailed design and procurement, to construction and operation.

Leadership and Innovation

Sargent & Lundy is a leader in the renewable energy sector, providing innovative solutions to challenges facing our clients. Several examples of our renewable energy leadership are listed below:

- Sargent & Lundy has led technical sessions and delivered presentations at major renewable energy conferences and technical meetings in the past decade; including the 2012 through 2019 American Wind Energy Association (AWEA) Wind Power conferences and the 2016 World Future Energy Summit. Presentations covered technical and financial topics, including wind and solar plant design, energy storage, wind power purchase agreements (PPAs), renewable energy integration, and more.
- Sargent & Lundy, since 2019, has been part of a North American Electric Reliability Corporation (NERC) Working Group that is focused on supporting the increasing penetration of distributed energy resources (DERs) into the bulk power system. The working group is called the System Planning Impacts from Distributed Energy Resources (SPIDERWG).
- Sargent & Lundy has been a leader in establishing the codes and standards to be used in the design of wind turbine foundations in North America. We were actively involved in the American Society of Civil Engineers (ASCE) and AWEA committee that prepared a U.S. guideline for the design of wind turbine foundations. We also delivered a presentation, "Codes and Standards for Wind Turbine Foundations: An Overview and Future Outlook," at the AWEA Wind Power conference in May 2009.
- Sargent & Lundy was the design engineer for the first large scale solar thermal plant: the 80-megawatt (MW) Luz International SEGS VIII, IX, and X solar thermal project. Sargent & Lundy designed the thermal plant, the interface with solar field, and the balance-of-plant (BOP) systems.

The project began operation in the late 1980s, and Sargent & Lundy has remained an industry leader in solar energy ever since.

- Sargent & Lundy authored a comprehensive report for the United States Department of Energy and National Renewable Energy Laboratory (U.S. DOE/NREL) in 2003, based on our independent review and analysis of parabolic trough and power tower solar technologies. Sargent & Lundy was engaged by NREL in 2010 to update this report. Sargent & Lundy is also supporting the DOE's Solar Vision Study, which began in 2009.

Based on Sargent & Lundy's many years of experience in the power industry, our clients receive knowledgeable, independent, and comprehensive support for each critical phase of evaluating and deploying renewable energy and emerging technologies.

1891

founding year

125+

years leading the industry

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Technology Overview

Wind Power

Nearly all utility-scale wind power projects today utilize three-bladed upwind horizontal-axis wind turbines. For onshore wind turbines, the maximum power output typically is between 1.5 to 5.5 MW. For offshore wind turbines, models have been introduced with maximum power output greater than 10 MW. The turbines consist of nacelles, hubs and blades, and a turbine tower. Sargent & Lundy is familiar with the various designs in the industry, including models from Acciona, Enercon, Gamesa, GE, Goldwind, Mitsubishi, Nordex, Senvion, Siemens, Sinovel, Suzlon, and Vestas. Sargent & Lundy participated in and was actively involved in the ASCE/AWEA committee that prepared a U.S. code for the design of wind turbine foundations. We participate in the AWEA Offshore Wind Working Group and the AWEA Wind Power Operations and Maintenance (O&M) Working Group. We also actively participate in the IEEE Wind Plant Collector Design Working Group. Since the early 2000s, Sargent & Lundy has provided services to the wind power industry for wind project developers, contractors, owners, lenders, and investors, including site screenings, project feasibility studies, wind resource assessments, independent engineering, interconnection planning, conceptual engineering, contract development, detailed engineering, design reviews, construction monitoring, commissioning, and O&M support. Our clients include project owners and operators, such as NextEra Energy Resources, E.ON Climate & Renewables, and EDP Renewables, as well as financial institutions, such as the JP Morgan, GE Energy Financial Services, and Development Finance Corporation (DFC).



Solar Power

Solar power is the conversion of sunlight into electricity, either directly using PV or indirectly using concentrated solar power (CSP). CSP systems use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. PV converts light into an electric current using the photovoltaic effect.

Sargent & Lundy has supported solar projects since the late 1980s, when we were the BOP engineer for the design of the SEGS VIII, IX, and X solar thermal energy facilities in California. Sargent & Lundy has a long and successful track record in both PV and CSP projects, providing owner's engineering, technical due diligence, and design of solar energy generation. Our clients include project owners and operators, such as American Electric Power, Lincoln Clean Energy, and ACWA Power, as well as financial institutions, such as the International Finance Corporation (IFC), the Standard Bank of South Africa, and the Inter-American Development Bank.

Biomass Power

Biomass fuels include a wide variety of organic materials, such as forestry byproducts, agricultural products and specially grown energy crops, municipal wastes, landfill gas, and syngas. These materials can be used as fuel in biomass power plants that generate steam and electricity.

Sargent & Lundy has worked with clients in the biomass and landfill gas power industry for over 30 years. Our involvement includes feasibility studies, fuel supply assessments, evaluations of technology options, siting evaluations, identification of "target" emission rates for air permitting activities, layouts, cost estimating, and other conceptual design activities as well as engineering plant design. Our project development activities have frequently included providing conceptual design with the ability of burning biomass. This work has involved investigating optional equipment layouts based on information gathered from steam generator suppliers, material handling vendors, and air quality control vendors in order to assure our clients that new or existing coal-fired units could also be able to fire biomass in sufficient quantities to impact carbon dioxide (CO₂) emissions. In addition, we have investigated waste to energy (WTE) projects and biomass co-firing in existing units as well as new unit designs. Our clients include NRG, Kauai Island Utility Cooperative, NOVI Energy, Exelon, Minnesota Power, and Mitsui.



Energy Storage

The use of energy storage has increased significantly in recent years and is expected to continue to increase. This has been driven, in large part, by the falling cost of battery energy storage systems, the increasing technical capabilities of battery energy storage systems, and by the increasing penetration of variable renewable energy. Sargent & Lundy has extensive experience with energy storage systems, in particular with battery storage technologies. We have worked on a wide variety of battery energy storage systems, from some of the largest battery energy storage projects in the world, to small behind the meter systems. We also have extensive experience with the integration of battery energy storage with solar projects, and other forms of generation. We assist clients with technology selection and evaluation, use case analysis, procurement, design and engineering, construction management, interconnection support, permitting support, due diligence, advisory, asset transaction services, O&M support, decommissioning support, and other related services.

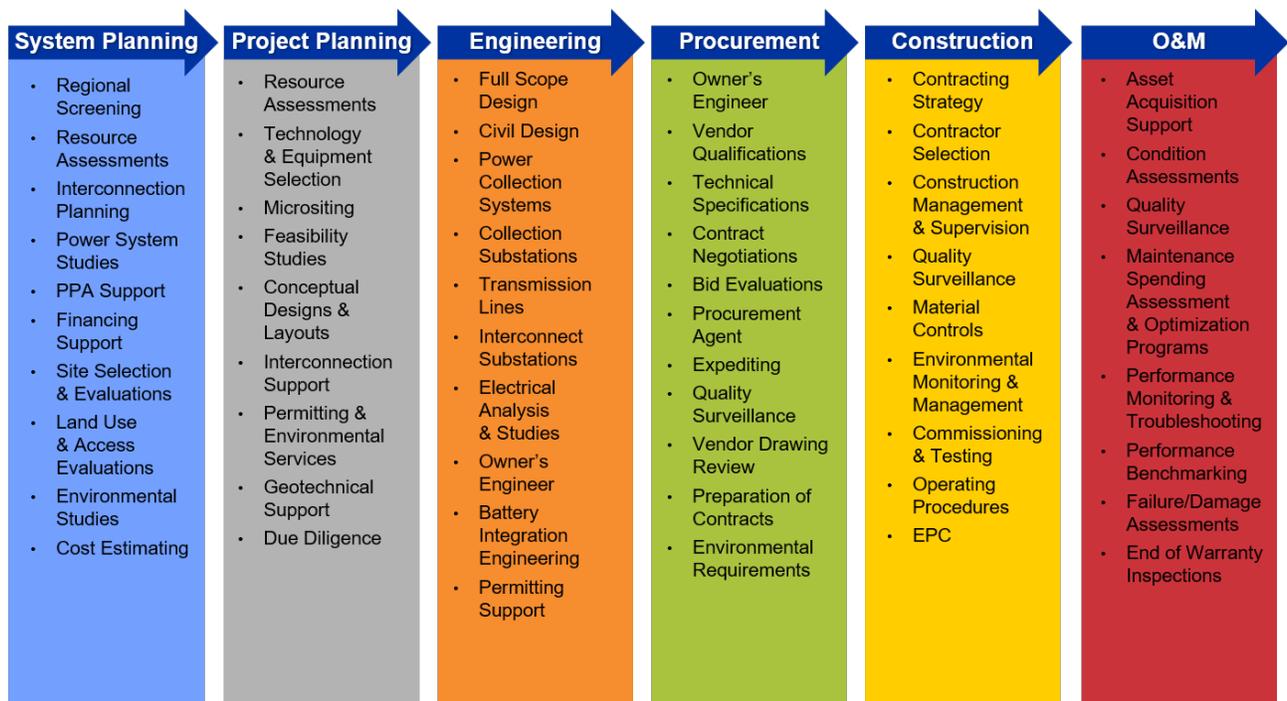
Microgrids

Microgrids are small- or medium-scale power grids that can operate independently or in conjunction with the area's main electrical grid. A microgrid can provide an ideal platform for providing reliability and resiliency, as well as realizing the smart grid benefits of increased reliability, renewable energy integration, diversification of energy sources, and flexible demand response. Sargent & Lundy has experience with microgrid planning, design, and implementation.

Services Description

Sargent & Lundy’s roles include full-design architect-engineer, owner’s engineer, lender’s independent engineer, technical advisor, or consultant. Our services range from specialized technical advisory and consulting services to complete engineering and program management, which encompasses procurement, construction management, technology transfer, and assistance with construction. We provide services through the full lifecycle of projects, as illustrated below:

From Project Inception to Operation



System Planning



System planning is an early phase of a project where the client is considering possible sources of energy and evaluating regional and environmental factors. The specific site for a project is not yet defined. The Sargent & Lundy team has the experience to provide appropriate guidance to clients about land use and possible access, to assess available resources like wind and solar, and to evaluate the interconnection options and the environmental impact for the most economical solution. Clients include project developers, utilities, and grid owners and operators.

Project Planning

Site Selection

Sargent & Lundy can assist the owner in the review and evaluation of potential renewable energy power plant sites. We provide a quantitative and qualitative comparison of the potential sites, including solar and wind resource assessments, interconnection and transmission facilities, terrain and soil conditions, transportation access, infrastructure, social/economic resources, land use, and environmental and ecological impacts. Sargent & Lundy then issues a report on the suitability of the sites for development of the desired power plant. Typically, Sargent & Lundy's project manager and a site-selection engineer visit the proposed sites to confirm that all site related features are properly addressed.

Solar & Wind Resource Assessments

Sargent & Lundy can perform an assessment of the solar or wind resource at potential project sites. Our project teams use a variety of data sources, including ground-based and satellite derived data sets as well as onsite meteorological tower data and solar monitoring station data. We evaluate the quality of data sets to process the data appropriately and use the best combination of available information.

As part of our resource assessments, we determine the long term expected mean generation and the uncertainty to provide P75, P90, P95, and P99 generation estimates. Our clients benefit from the different reports and tools we provide, such as 12x24 diagrams and 8760 data sets, which help project owners, developers, lenders, and other stakeholders plan and make decisions. Sargent & Lundy uses industry recognized software for these assessments, such as PVsyst, Helioscope, Openwind® and Windographer.

Feasibility Evaluations

Based on the site and technology selected, Sargent & Lundy can perform a feasibility evaluation addressing the following issues:

- If the project can be constructed in accordance with generally accepted engineering practices and performed in accordance with the operating and financial projections, and if the solar or wind resource is sufficient to meet targets.
- If the technology risk can be properly managed and if the technology selected for the project is sound and should provide reliable long-term service with proper O&M practices.
- If the plant can be designed, engineered, and constructed within the agreed-upon cost and schedule.
- If the O&M program, including provisions for planned major maintenance, is appropriate.
- If the capacity and availability of the plant can meet or exceed the targets.
- If the pro forma financial projections reflect projected plant performance and include appropriate estimates of future performance of the plant.

- If the plant is capable of meeting the requirements of all regulatory agencies and those required by environmental permits.

Technology Selection

Sargent & Lundy can conduct a study of renewable energy technologies to determine the feasibility of utilizing the diverse range of technologies and fuels available in today's market.

For each technology, Sargent & Lundy identifies operational experience that exists for the technology and the suitability for the project being evaluated. We also assess the technical risk factors and environmental issues associated with each technology. For technologies identified as likely viable options, we conduct a technical review to provide a detailed assessment of each technology. The purpose of the review is to outline the parameters necessary to support operation of each technology, to give an opinion on constructability, and to assess the relative ranking of feasibility of the technologies. The technologies are evaluated for compatibility with the site, operating history comparison, relative capital costs, construction duration, performance comparison, expansion capabilities, and technological risk.

Sargent & Lundy then issues a report summarizing the technology evaluation and provides a recommendation on the technology selection for the power plant based on the life-cycle costs of the various technologies. Only critical design features are compared for this evaluation. Specific design details, such as the codes that will be followed, the design live loads, equipment sizing, and the materials that will be supplied, are addressed as part of negotiations with the selected contractor.

Due Diligence Reviews & Independent Engineering Services

Sargent & Lundy's independent engineering services are tailored to the needs of clients who require expertise and industry knowledge to independently assess complex power industry financial and technical issues. Based on the client's specific needs, each due diligence review will have a defined scope and combination of services, such as:

- Technical, financial, and contract reviews to independently evaluate a power station or a utility for financing or acquisition by lenders, owners, or developers
- Independent solar and wind resource assessments
- Equipment installation and construction monitoring services
- Engineering due diligence reviews
- Asset valuations and independent forecasts of capital and O&M expenses
- Factory and performance acceptance tests and test plan development, reviews, and witnessing
- Studies and evaluations of pending industry regulations and policies
- Power technology training services
- Other services as required to achieve client objectives

Integrated Resource Planning

Integrated Resource Planning is based on a planning and selection process for new energy sources that evaluates all aspects of power supply, storage, and demand in order to provide electricity in the most competitive way. Today's challenges include the trend in many countries towards distributed energy (with its smaller power generation systems for homes, businesses, and communities), the impact of new generation on transmission system loading, and the integration of variable renewable energy. Utilities and grid operators are faced with the significant task of managing these new challenges. Sargent & Lundy has in-depth expertise to help clients optimize the management of their resources to meet future energy and capacity needs. Our clients include NYISO, ISO-NE, NIPSCO, and PSEG Long Island.

Electric System Master Planning

Sargent & Lundy evaluates the current state of utility systems and infrastructure to define a desired future state for clients. This ranges from high-level strategic plans to detailed roadmaps. Sargent & Lundy considers reliability, customer experience/engagement, DER interconnections, grid investment efficiency, greenhouse gas reduction requirements, the electrification of sectors like transportation, resilience, physical and cyber security needs, and other relevant factors. The presentations and reports are used by utility executives, regulatory bodies, and other key stakeholders.

Power Supply Planning & Power Procurement Support

This includes the development of requests for proposal (RFPs) on behalf of utilities to procure new generation, storage systems, and T&D services. RFPs can be for specific technologies and fuels, but Sargent & Lundy also develops "all source" RFPs to which developers can propose multiple solutions. Sargent & Lundy typically prepares an evaluation guide to add credibility and weight to the outcome of the RFP; this is particularly important when submitting procurement records to state public service commissions for approval and review. Sargent & Lundy can manage the RFP process by chairing regular meetings, keeping detailed records, maintaining action items, coordinating bidder Q&A, and finalizing commission approval. Examples of data managed include a detailed procurement record of the RFP, evaluation process, and bid evaluations.

In addition to the utility planning services described above, Sargent & Lundy is also active in the following tasks, studies, and services:

- Interconnection and Grid Studies
- Asset Transaction Support Services
- Asset Valuations of Power Assets
- Market Studies
- Remaining Useful Life Assessments
- Transmission Congestion Studies
- Power Supply Planning
- Grid Modernization Consulting
- Demand Side Programs
- Microgrid Planning and Design

Engineering

Specification & Bid Assistance

Sargent & Lundy can prepare an engineering, procurement, and construction (EPC) specification based on the selected technology. The EPC specification either forms the basis for an EPC contract or is used to solicit competitive bids for the project.

Sargent & Lundy can assist the owner in the review and evaluation of proposals submitted by contractors in response to the EPC specification for the power plant. The bid evaluation includes evaluation of the design criteria, scope of work, guarantees, EPC contract price, O&M costs, performance, and financial analysis. Sargent & Lundy issues a report summarizing the proposal evaluation and provides a recommendation on the EPC contractor selection.

Sargent & Lundy can assist the owner in contract negotiations with the selected EPC contractor. Typically, we propose that our designated project manager or a lead project engineer participate in the negotiations with support, if and as required, from our headquarters in Chicago or one of our regional offices.

Depending on the contractual agreements for offtake of electricity, Sargent & Lundy reviews the proposed PPA. This is to verify that the risks, liquidated damages, and contractual obligations are clear and properly assigned in the project structure and that consistency exists among the project agreements. This task is similar to a due diligence review of these documents.

Engineering & Detailed Design

Sargent & Lundy can perform the engineering and detailed design for projects utilizing renewable energy technologies, including wind power, solar power, and biomass. Sargent & Lundy applies its 125 years of power plant design expertise and experience to the complex challenges of renewable energy projects.

Typical services include the following:

- Solar PV project layout and collection system
- Solar PV project collection switchyards and interconnection substations
- Solar thermal BOP and steam turbine systems
- Wind turbine layouts and micrositing
- Wind turbine foundations, access roads, and crane pads
- Wind project power collection systems
- Wind project collection switchyards and interconnection substations
- Wind project transmission lines
- Complete biomass project design
- Design and integration of energy storage
- Microgrid design

Engineering Review of Project Design

To protect the interests of project owners and lenders, and to support project financing, Sargent & Lundy can perform independent reviews of project designs that have been prepared by the EPC contractor.

The purpose of the engineering review is to confirm that the EPC contractor can accomplish the following major goals:

- Design, engineer, and construct the facility in accordance with the contract documents and industry standards
- Provide a facility that is capable of performing substantially as expected, with regard to capacity, efficiency, and availability
- Design, engineer, and construct the facility within the agreed-upon cost and schedule
- Provide for long-term O&M of the facility

The engineering review activities are typically performed in our Chicago headquarters or one of our regional offices. Questions that arise during the engineering review are resolved through telephone conferences and written correspondence. Concerning major issues, telephone communications are used extensively to reach swift consensus between the owner, Sargent & Lundy, and the EPC contractor. The final resolutions of all issues are documented in written correspondence. To facilitate communications and resolve problems quickly, monthly project status review meetings can be held, initially at the EPC contractor's design offices and, later, at the site. Discipline engineers attending the meetings are selected based on the applicability of their discipline to the key issues existing at the time of the project review meetings.

During the engineering review period, Sargent & Lundy monitors the performance of the EPC contractor's design, engineering, procurement, and fabrication activities. Sargent & Lundy's project manager issues a monthly status report that discusses the EPC contractor's progress during the month and the status of their work. Once construction has been initiated at the site, the monthly report discusses the status of construction, including photographs of construction progress at the site. The report addresses any major areas of concern, discussing our recommendations for mitigating the effects of such problem areas. The report includes the EPC contractor's updated schedule, alongside our comments concerning this schedule, as part of the engineering review process. We also review the contractor's requests to deviate from the specification, providing our recommendations to the owner concerning acceptance of the deviations.

During the engineering review process, Sargent & Lundy promptly advises the owner and the EPC contractor of any issues that arise that may affect the facility's cost, schedule, or quality.

Licensing & Permit Support & Services

Sargent & Lundy provides licensing and permitting support for power projects under development and in operation. We can identify required permits for projects in the planning stage and can provide technical support to owners and developers for permit applications. We maintain state-of-the-art computer modeling capabilities, including models approved by the U.S. Environmental Protection Agency and our own proprietary models. When onsite data is required, we design a monitoring program that meets regulatory requirements; we then subcontract a local company to conduct the program.

We can review the permits and licenses required for the construction and operation of the facility to confirm that the facility can operate in full compliance with the permits. Our review determines whether the required permits have been identified and whether any outstanding permits need to be received in support of the construction and operation schedule. The environmental impact assessment report is reviewed to determine if the local and national requirements, as well as the requirements specified by World Bank Environmental Guidelines, are met. We identify weaknesses that may exist, determining whether clarifications to the design and permitting of the plant are required. This review will include the general accuracy and quality of the environmental assessment.

Sargent & Lundy can issue a report summarizing the results of the environmental study and discuss any environmental concerns and potential issues related to the operation of the plant within the permit limitations. The report will address the capability of the equipment and systems to comply with regulations, the compatibility of the site with environmental requirements, the consistency of qualifications set forth in permits with contractual operating requirements, and the impact of the highest foreseeable international and domestic environmental laws and regulations could have on the plant.

Procurement



In conjunction with the development of specifications for all renewable energy technologies, as well as substation material and equipment, we perform a complete range of procurement services. As owner's engineer, we can solicit the technical specifications to the vendors, perform bid evaluations, rate vendors according to their qualifications, and carry out contract negotiations. In addition, Sargent & Lundy can provide a comprehensive quality assurance program, including factory inspections and supplier expediting to ensure timely delivery at the defined quality.

Construction

Sargent & Lundy provides complete construction management, oversight, and commissioning services for renewable energy projects. Services include the organization and management of teams of qualified firms to perform all aspects of construction for complex EPC projects. We manage Sargent & Lundy-designed projects as well as installations designed by others.

Construction Management & Surveillance

Our staff is available for onsite management and quality control surveillance of all construction activities. We can provide a complete construction services team for a project or individual personnel for staff augmentation. Our experience includes monitoring construction of wind power projects, hundreds of miles of transmission lines, and erection of multi-story buildings for enclosed urban substations.



Construction Monitoring

As part of our independent or lender's engineering services, we often perform construction monitoring services by visiting the project site throughout the construction period. The first trip by the project staff is typically scheduled to coincide with the mobilization of the construction contractor at the project site. This visit will usually include a project kick-off meeting and discussions of the requirements for the contractor to follow when reporting to Sargent & Lundy during the reporting period. During the rest of the construction period, we will perform monitoring visits approximately every three months. We attempt to plan these visits to coincide with either significant milestones or with project review meetings between the mandated lead arranger, the owner, and the contractor.

During the construction monitoring visits, we verify and analyze—together with the contractor—the progress of the project in the different areas involved, including permitting, engineering, procurement, and construction of the project in the different areas of work. We will also inquire about areas of potential

economic or technical problems or delays, and we will discuss the project funding requirements, including future change orders that may be needed, with the contractor.

Our construction monitoring services are focused on ensuring common and clear understanding—between our client and other major project participants—of the schedule and budget performance. While maintaining our independence, Sargent & Lundy strives to support overall project completion by identifying issues and potential remedies for the project team to consider as soon as possible, with focused comments providing unambiguous bases for our remarks (clearly noting the contractual, industry code or standard, or other requirement that is not being met).

Testing & Commissioning Services

We provide testing services for analysis and commissioning of renewable energy technologies, substation equipment, and complete substation installations. Our approach includes close collaboration with the owner to confirm that testing criteria and procedures comply with necessary requirements and that documentation is accurate and complete.

Operations & Maintenance Support & Services

Sargent & Lundy provides O&M services to assist owners, operators, investors, and other stakeholders with reviewing and evaluating the operating performance of power generation assets. Our extensive power plant design, operations, and financial experience and expertise can help clients evaluate potential technical and financial improvements during power plant operations. We can help establish comprehensive performance improvement program scopes, schedules, and budget objectives and provide the following services:

- Assessments in support of contractual and financial obligations, such as supporting loan payments and assessing major maintenance reserve requirements
- Performance improvement identification, review, evaluation, and implementation; including assessments of plant performance relative to industry peer-group benchmarks
- Plant physical condition and life expectancy evaluations
- Operating procedure and practice review
- Organization and staffing evaluation
- End-of-warranty reviews

Our O&M services for renewable energy build on our long legacy of supporting the full range of technologies and fuels utilized for electric power generation, including solid-fuel, liquid-fuel, and nuclear power plants. Sargent & Lundy's utility-grade O&M philosophy and practices, which are focused on achieving high availability of cost-effective power production, combined with our renewable energy technical expertise in project development and implementation, provide a solid foundation for providing effective renewable energy O&M engineering and consulting services to our clients.

Client Base

Sargent & Lundy's renewable energy clients include developers, financial institutions, government, and investor-owned utilities, industrial companies, rural cooperatives, municipal and public power systems, equipment manufacturers, and others. Sargent & Lundy has designed renewable energy projects representing over 20,000 MW of generating capacity and has provided consulting and owner's engineering services for more than 25,000 MW of renewable energy projects.

Our exclusive participation in the power industry, providing a comprehensive range of engineering and consulting services, enables our clients to benefit from experience and insights that are critical to their success. Sargent & Lundy clients use our services and apply our expertise to optimize their utility- or industrial-scale applications of electric power generation technologies. Our clients rely on us to provide techno-economic feasibility evaluations, support services for asset acquisitions, complete plant design and engineering services, reviews of the commercial and technical aspects of new generation projects, asset valuations, cost estimates, and reviews of contracts and agreements. Lenders and investors considering proposed transactions have relied on our technical evaluations and assessment to identify and mitigate risks related to power project development, construction, and operations. In fact, our clients have engaged us to provide services at numerous facilities where we are not the designer of record.

Sargent & Lundy's clients span the globe. We are currently providing, or have provided, services to clients in Africa, Asia, Australia, Europe/Eastern Europe, North America, and South America.



Selected Sargent & Lundy Renewable Energy Publications and Presentations

- “Maximize Design Life: Benefits & Drawbacks of Today’s Wind Turbine Foundation Designs,” presented and authored by D. Jolivet, AWEA WINDPOWER Conference, Houston, Texas, May 2019.
- “Battery Storage News: Utility Scale Development,” seminar moderated by M. Thibodeau, The 5th Annual Powering Africa Summit, Miami, Florida, February 25–27, 2019
- “Energy Assessment & Independent Engineering Review for Wind Project Partial Repower,” authored by E. Soderlund (Sargent & Lundy) and J. O’Connor (ArcVera Renewables), presented by D. Jolivet (Sargent & Lundy) and J. O’Connor, EUCI Conference, San Diego, California, February 2019.
- “Be Specific: Determination of Site-Specific Engineering Parameters for Wind Turbine Foundations,” presented and authored by E. Soderlund, AWEA WINDPOWER Conference, Chicago, Illinois, May 2018.
- “Developing Wind Project Capital & Operating Cost Forecasts: A Benchmarking Approach,” presented and authored by S. Noonan, AWEA WINDPOWER Conference, Chicago, Illinois, May 2018.
- “Performance Anxiety: Wind Power Project Performance Guarantees,” presented and authored by A. Coologeorgen, AWEA WINDPOWER Conference, Chicago, Illinois, May 2018.
- “Staying Grounded: Grounding Transformers vs High-Speed Ground Switches,” presented and authored by B. Connaghan, AWEA WINDPOWER Conference, Chicago, Illinois, May 2018.
- “Subsynchronous Resonance in Doubly-Fed Induction Generator Based Wind Farms,” presented and authored by H.A. Mohammadpour, AWEA WINDPOWER Conference, Chicago, Illinois, May 2018.
- “Wind Project Partial Repowering: Key Considerations and Insights,” presented and authored by E. DeCristofaro, AWEA WINDPOWER Conference, Chicago, Illinois, May 2018.
- “Wind Turbine Foundation Fatigue: Causes, Symptoms, and Treatment,” presented and authored by E. Soderlund, AWEA WINDPOWER Conference, Anaheim, California, May 2017.
- “FACTS: Devices for Dynamic Reactive Power Compensation in Wind Farms,” presented and authored by P. Wiczowski, AWEA WINDPOWER Conference, Anaheim, California, May 2017.
- “Repowering: Renewing Renewable Energy,” presented and authored by A. Coologeorgen, AWEA WINDPOWER Conference, Anaheim, California, May 2017.
- “Constructing a Plan for Successful Construction,” presented and authored by A. Friedman, AWEA WINDPOWER Conference, Anaheim, California, May 2017.
- “Support Your Wind Turbines: Choosing the Optimum Foundation System,” presented and authored by E. Soderlund, AWEA WINDPOWER Conference, New Orleans, Louisiana, May 2016.
- “Wind Farms Without Borders: Top 5 Best Practices When Building in Developing Markets,” presented and authored by T. Kantarek and E. Soderlund, AWEA WINDPOWER Conference, Orlando, Florida, May 2015.

- “Contracting Strategies and Lessons Learned on International Wind Projects,” presented and authored by M. Thibodeau, AWEA WINDPOWER Conference, Orlando, Florida, May 2015.
- “Everything You Always Wanted to Know About Wind Power Purchase Agreements,” presented and authored by G. Rainey and T. Kantarek, AWEA WINDPOWER Conference, Las Vegas, Nevada, May 2014.
- “Middle East and African Renewable Energy Markets: Impacts and Opportunities,” presented and authored by M. Thibodeau, AWEA WINDPOWER Conference, Las Vegas, Nevada, May 2014.
- “What’s in the Future for Clean Tech,” M. Thibodeau (invited panel member), Global Midwest Alliance Conference, Chicago, Illinois, September 2013.
- “Wind Plant O&M: Different Approaches, Risks, and Trade-Offs,” presented and authored by M. Thibodeau, AWEA WINDPOWER Conference, Chicago, Illinois, May 2013.
- “Capacitor Bank Control in Wind Farm Substations,” presented and authored by J. Kotal, D. O’Reilly, L. Raue, AWEA WINDPOWER Conference, Chicago, Illinois, May 2013.
- “Selection Considerations for Switchgear, Outdoor Circuit Breakers, and Gas Insulated Substations,” presented and authored by D. O’Reilly, M. Braet, AWEA WINDPOWER Conference, Chicago, Illinois, May 2013.
- “Renewable Energy and Integrated Resource Planning for Utilities,” presented by P. Geenen, co-author M. Thibodeau, Solar Power-Gen Conference, San Diego, California, February 2012.
- “Integrated Resource Planning for Utilities,” presented and authored by M. Thibodeau, AWEA WINDPOWER Conference, Atlanta, Georgia, June 2012.
- “Renewable Energy and Integrated Resource Planning for Utilities,” presented and authored by M. Thibodeau, Electric Power Conference, Baltimore, Maryland, May 2012.
- “Wind Turbine Structures & Foundations - Past Present & Future,” presented and authored by S. Hagen, S. Fang, University of Illinois’ 13th Annual Structural Engineering Conference, Champaign, Illinois, April 2012.
- “Construction Quality Control – Lessons Learned,” presented and authored by D. Sleezer, AWEA WINDPOWER Conference, Dallas, Texas, May 2010.
- “Wind Energy Project Financing Challenges,” presented and authored by M. Thibodeau, Energy & Environment Conference, Phoenix, Arizona, February 2010.
- “Integration of Battery Storage with Solar PV Plants,” presented and authored by J. Patino, Energy & Environment Conference, Phoenix, Arizona, February 2010.
- “Electric Energy’s Low Carbon Future and the Tough Choices Required,” presented by M. Thibodeau, co-authors K. Davis, J. Bero, S. Hagen, Electric Power Conference, Rosemont, Illinois, May 2009.
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These and other papers are available upon request.