Renewable Energy

Project Experience

Wind | Solar PV | Concentrating Solar | Biomass
Geothermal | Hydroelectric | Energy Storage
Hybrid Power Plants & Microgrids
About Sargent & Lundy

Sargent & Lundy provides engineering, design, and consulting services for the global power industry and is a leader in the renewable energy sector, providing innovative solutions to challenges facing our clients. Benefiting from a long history of supporting the conventional power industry, Sargent & Lundy has worked on and has significant experience with all renewable energy technologies—solar photovoltaic (PV), concentrating solar power (CSP), wind power, biomass, landfill gas, waste-to-energy, geothermal, hydroelectric power, battery energy storage, hybrid power plants, and microgrids. Sargent & Lundy provides a full range of engineering and consulting services for firms and organizations involved in the renewable energy industry.

Sargent & Lundy’s staff of over 2,000 people enables the firm to conduct projects around the globe. We serve the worldwide power markets through our headquarters in Chicago, Illinois, and numerous satellite offices in various locations in the United States (in Arizona, California, Delaware, Maryland, New Jersey, North Carolina, and Tennessee), as well as through international and joint venture offices in Canada, India, Saudi Arabia, and the UAE. In addition, we have strategic partners in South America and Africa supporting our project activities in these regions. We offer state-of-the-art facilities and resources throughout our organization.
Wind Power

Since the early 2000s, Sargent & Lundy has provided services to the wind power industry. We provide a wide range of services for wind project developers, contractors, owners, lenders, and investors, including full plant design, site screenings, project feasibility studies, wind resource assessments, independent engineering, interconnection planning, conceptual engineering, contract development, detailed engineering, design reviews, construction monitoring, commissioning, and operations and maintenance (O&M) support. We have experience with a variety of wind turbine generators, including models from Acciona, Clipper, Enercon GmbH, Gamesa, GE, Goldwind, Kenersys, Mitsubishi, Nordex, Senvion (formerly Repower), Siemens, Sinovel, Suzlon, and Vestas. Sargent & Lundy participated in and was actively involved in the American Society of Civil Engineers (ASCE) / American Wind Energy Association (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 O&M Working Group. We also actively participate in the IEEE Wind Plant Collector Design Working Group.

The following recent projects provide an overview of Sargent & Lundy’s wind energy experience.

**Due Diligence and Independent Engineering**

**Overseas Private Investment Corporation**

- 2014-2017 | Independent engineering review as lender’s technical advisor to support financing of a 36-megawatt (MW) wind project in Jamaica. Sargent & Lundy performed a technical review of the project, which included the project financial statement, wind resource assessment, wind turbine technology and suitability, wind turbine foundations, power collection system, SCADA system, interconnection, key project contracts, and construction monitoring.

- 2013-2018 | Independent engineering review as lender’s technical advisor to support financing of three 50-MW wind projects in Pakistan. Sargent & Lundy performed a technical review of the projects, which included the project financial statement, wind resource assessment, wind turbine technology and suitability, wind turbine foundations, power collection system, SCADA system, interconnection, key project contracts, and construction monitoring.
2013-2014 | Independent engineering review as lender’s technical advisor to support financing of a 114-MW wind project in Peru. Sargent & Lundy performed a technical review of the project, which included the project financial statement, wind resource assessment, wind turbine technology and suitability, wind turbine foundations, power collection system, SCADA system, interconnection, and key project contracts.

2011 | Independent engineering review as lender’s technical advisor to support financing for a 5-MW wind project on an island in the Caribbean. Sargent & Lundy performed a technical review of the project, which included the project financial statement, wind resource assessment, wind turbine technology and suitability, wind turbine foundations, power collection system, SCADA system, interconnection, and key project contracts.

Confidential Clients

2017-2018 | Independent engineering evaluations to support planning for the repowering of three wind projects. Sargent & Lundy’s scope included a full analysis of the wind turbine foundations, foundation inspections, tower inspections, wind resource assessment, turbine suitability review, contracts review, and electric balance-of-plant (BOP) design and construction review.

2018 | Acquisition due diligence. Performed technical and financial due diligence for a development-stage wind power project located in Argentina.

2017 | Independent engineering evaluations to support tax equity investment for two repowered wind projects. Sargent & Lundy’s scope included a full analysis of the wind turbine foundations, foundation inspections, tower inspections, wind resource assessment, turbine suitability review, contracts review, and electric BOP design and construction review.

2017 | Acquisition due diligence. Performed technical and financial due diligence of 11 development-stage wind power projects located in the U.S.

2017 | Acquisition due diligence. Performed an assessment of future O&M expenses at two wind projects in the Central U.S.

2016-2017 | Independent engineering review to support tax equity investment of two wind projects in Texas being repowered.

2016 | Asset acquisition due diligence services to support the client’s evaluation of a wind power in Hawaii. Sargent & Lundy evaluated the wind resource, wind turbine selection, project feasibility and economics, and provided bid model inputs.

2011-2012 | Asset acquisition due diligence services to support the client’s evaluation of investing in a wind power project in Canada. Sargent & Lundy performed a technical review of the project, which included the project financial statement, wind turbine technology and suitability, project construction plan and schedule, interconnection and grid congestion, and key project contracts.

NextEra Energy Resources

2013-2018 | Independent engineering services for numerous O&M budget reviews for operating wind projects to support loan agreement obligations.

2017 | Independent engineering evaluations to support tax equity investment for ten repowered wind projects. Sargent & Lundy’s scope included a full analysis of the wind turbine foundations, foundation inspections, tower inspections, and electric BOP design and construction review.

2016 | Independent engineering evaluation and completion verification of the Oliver III Wind Project (99 MW) in North Dakota and the Osborn Wind Project (201 MW) in Missouri to support tax equity investment. Sargent & Lundy’s scope included review of BOP design and construction, interconnection facilities, and project contracts, as well as verification of construction completion.
2016 | Independent engineering evaluation and completion verification of the Rush Springs Wind Project (250 MW) in Oklahoma and the Javelina II Wind Project (200 MW) in Texas to support tax equity investment. Sargent & Lundy’s scope included review of BOP design and construction, interconnection facilities, and project contracts, as well as verification of construction completion.

2015 | Independent engineering evaluation and completion verification of the Carousel Wind Project in Colorado to support tax equity investment. Sargent & Lundy’s scope included review of wind turbine technology, BOP design and construction, SCADA systems, project contracts, and construction completion verification.

2015 | Independent engineering evaluation of the Javelina Wind Project in Texas to support tax equity investment. Sargent & Lundy’s scope included review of BOP design and construction, SCADA systems, project contracts, and construction progress.

2015 | Independent engineering evaluation and completion verification of the Breckinridge Wind Project in Oklahoma to support tax equity investment. Sargent & Lundy’s scope included review of wind turbine technology, BOP design and construction, SCADA systems, project contracts, and construction completion verification.

2014 | Independent engineering evaluation of the Limon III Wind Project in Colorado to support project financing. Sargent & Lundy’s scope included review of BOP design and construction, SCADA systems, and project contracts.

2014 | Independent engineering evaluation of the Mammoth Plains Wind Project in Oklahoma to support project financing. Sargent & Lundy’s scope included review of BOP design and construction, SCADA systems, and project contracts.

2014 | Independent engineering evaluation of the Seiling I and II Palo Duro wind projects to support project financing. Sargent & Lundy’s scope included review of BOP design and construction, SCADA systems, and project contracts.

2013 | Independent engineering evaluation of the 162-MW North Sky River Wind Project in California to support project financing. Sargent & Lundy’s scope included review of BOP design and construction, SCADA systems, and project contracts.

2013 | Independent engineering evaluation of the Pioneer Plains Wind Portfolio, consisting of two wind energy projects (161-MW total) in Oklahoma to support project financing. Sargent & Lundy’s scope included review of the financial model, wind turbine technology, BOP design and construction, SCADA systems, and project contracts.

2012-2013 | Independent engineering evaluation of two wind energy projects (220-MW total) in Arizona and Michigan to support project financing. Sargent & Lundy’s scope included review of the financial model, wind turbine technology, BOP design and construction, SCADA systems, project contracts, plant O&M, and construction monitoring.

2012 | Independent engineering evaluation of two wind energy projects in Colorado (400-MW total) to support project financing. Sargent & Lundy’s scope included review of the financial model, wind turbine technology, BOP design and construction, SCADA systems, project contracts, plant O&M, and construction monitoring.

2011 | Independent engineering review of seven wind projects (totaling over 1,000 MW) to support financing. The plants, located in California, Oklahoma, and Texas, utilize GE and Siemens wind turbines. Sargent & Lundy’s scope for each facility included review of the financial model, turbine technology, BOP design and construction, SCADA systems, project contracts, and plant O&M.

2009-2010 | Independent engineering review of the Mountain Prairie and Peace Garden portfolios to support financing of four wind energy plants in the Midwestern U.S. The facilities utilize GE 1.5-MW and Siemens 2.3-MW wind turbine generators. Sargent & Lundy’s scope for each facility included review of the foundations, power collection and SCADA systems, and BOP EPC contracts.

2008-2009 | Independent engineering review of the Heartland I and II portfolios to support raising third-party capital for five wind energy plants in the Midwestern U.S. The facilities utilize GE 1.5e1 wind turbine generators. Sargent & Lundy’s scope for each facility included review of the foundations, power collection and SCADA systems, and BOP EPC contracts.

2007 | Independent engineering review of the Northern Frontier portfolio to support raising third-party capital for five wind energy plants in the Midwestern and Rockies regions of the U.S. The Facilities utilize GE 1.5 and Siemens 2.3e wind turbine generators. Sargent & Lundy’s scope for each facility included review of the foundations, power collection and SCADA systems, and BOP EPC contracts.

**Blattner Energy**

2007-2018 | Independent reviews and evaluations of wind turbine foundation designs for more than 50 projects, including the Brady, Palo Duro, Steele Flats, North Sky River, Limon, Pheasant Run, Ashtabula, Crystal Lake, McAdoo, Story County, Capricorn Ridge, and Peetz wind energy projects.

**Fagen, Inc.**

2009-2018 | Independent reviews and evaluations of wind project electrical and foundation designs for more than 10 projects.

**Patrick & Henderson**

2007-2018 | Independent reviews and evaluations of wind turbine foundation designs for more than 12 projects.

**GE Energy Financial Services**

2017 | Independent engineering evaluations to support tax equity investment for 12 repowered wind projects. Sargent & Lundy’s scope included a full analysis of the wind turbine foundations, foundation inspections, tower inspections, and electric BOP design and construction review.


2014 | Construction monitoring review of Pattern Energy’s Panhandle Wind Project in Texas to support financing.

2013 | Independent engineering review of Pattern Energy’s Panhandle Wind Project in Texas to support financing.

**Macquarie Capital**

2015 | Independent engineering review of Big Sky Wind Project in northwestern Illinois as lender’s technical advisor to support financing of project.

**Standard Bank of South Africa**

2011-2014 | Independent engineering review of MetroWind Van Stadens Wind Farm, which is being developed under the South African Renewable Energy Independent Power Producer Program. Sargent & Lundy’s scope included pre-construction due diligence and construction monitoring.

2011-2012 | Independent engineering reviews of several proposed wind energy projects. Provided lender’s technical advisory services to support project development and bidding into the South African Renewable Energy Independent Power Producer Program.

**SunEdison / TerraForm Power**

2014 | Asset acquisition due diligence of four wind projects—three in Maine and one in Hawaii—to support the client’s acquisition of First Wind.

**E.ON Climate & Renewables**

2011-2014 | Wind project financial modeling support.

2012-2013 | Independent engineering review of wind turbine foundation designs on three projects, including complex geotechnical and foundation issues.
ContourGlobal

- 2014-2015 | Independent engineering review of the 114-MW Inka wind project in Peru to support bond offering. Sargent & Lundy performed a technical review of the project, which included the project financial statement, wind resource assessment, wind turbine technology and suitability, wind turbine foundations, power collection system, SCADA system, interconnection, and key project contracts.

Xcel Energy

- 2013 | Evaluated, scored, and ranked 64 proposals that were submitted to Xcel Energy seeking funding from their Renewable Development Fund. The technologies involved included ground and rooftop solar PV, utility-scale wind, small wind, biomass and biogas, anaerobic digestion, battery storage, fuel cells, and hydrogen production.

International Finance Corporation (IFC) and European Bank for Reconstruction and Development (EBRD)

- 2012-2013 | Independent engineering review of the 142.5-MW Bares Wind Project in Turkey to support financing. Sargent & Lundy’s scope included reviews of project financial projections, contracts, wind turbine selection, designs and the construction plan and schedule. Sargent & Lundy monitored construction progress and start-up on behalf of the project lenders.

BP Wind Energy

- 2010 | Independent engineering review to support raising third party capital for Goshen II Wind Project in Idaho. Facility utilizes GE 1.5xle wind turbine generators. Sargent & Lundy performed technical review of project, including project financial statement, wind turbine technology and suitability, wind turbine foundations, power collection system, SCADA system, interconnection and grid congestion, and key project contracts.

BBVA Securities

- 2010-2012 | Independent engineering review to support financing for the Glen Dhu Wind Project in Nova Scotia, Canada. The facility utilizes Enercon E-82 2.3-MW wind turbines. Sargent & Lundy performed a technical review of project, which included the project financial statement, wind resource assessment, wind turbine technology and suitability, wind turbine foundations, power collection system, SCADA system, interconnection and grid congestion, and key project contracts.

Exelon

- 2010 | Technical due diligence services to support the acquisition of a 700-MW portfolio of 36 operating wind projects. Sargent & Lundy’s scope included a fatal flaw analysis, a review of operating performance, a design review, and the provision of technical and financial input into the financial model used to develop the acquisition bid.

EDF Renewable Energy (formerly enXco Development Corporation)


Enerjisa Enerji

- 2009-2010 | Independent engineering review of a wind energy project in Turkey to support project financing. The facility utilizes Siemens SWT-2.3-101 wind turbine generators. Sargent & Lundy’s review included the project financial statement, wind resource assessment, wind turbine technology and suitability, wind turbine foundations, power collection system, SCADA system, interconnection and grid congestion, and key project contracts.
AES

- 2008-2009 | Independent engineering review to support raising third-party capital for the Armenia Mountain Wind Project in Pennsylvania. The facility utilizes GE 1.55e wind turbine generators. Sargent & Lundy performed complete technical review of the project, which included the wind resource assessment, project financial statement, turbine foundations, power collection system, SCADA system, and key project contracts.

Avangrid Renewables (formerly Iberdrola Renewables) / AWS Truewind

- 2008-2009 | Independent engineering review of the Aeolus VI portfolio of five wind projects owned by Iberdrola Renewables.

Owner’s Engineering

PSEG Long Island

- 2015-2018 | Sargent & Lundy provided consulting services to support the selection and development of a planned 90-MW offshore wind project. We reviewed the technical and economic feasibility of the offshore wind project and helped our client negotiate a power purchase agreement (PPA) with the wind project developer. Sargent & Lundy is monitoring the project development and will monitor the project construction.

- 2017 | Assisted client with the evaluation and selection of bids submitted under terms of requests for proposals (RFPs) for the South Fork “Reforming the Energy Vision” (power station) project. Developed evaluation models; handled bid administration; performed quantitative and qualitative technical, economic, and financial analyses of bids; and provided recommendations for stakeholder decision-making.

Lincoln Clean Energy


- 2017 | Owner’s engineering services to support operational readiness, including developing O&M procedures, for a 250-MW wind project in Texas.

NextEra Energy Resources

- 2015-2018 | Wind turbine foundation design assessments and analysis for five operating wind projects to support repowerings and life extensions.

American Capital Energy & Infrastructure

- 2014-2016 | Owner’s engineer to support the development of the 150-MW Taiba Wind Project in Senegal.

Confidential Clients

- 2018 | Performed wind project O&M cost and performance benchmarking study for large U.S. wind owner-operator.

- 2015-2017 | Sargent & Lundy provided consulting services to a Northeastern U.S. utility for an offshore wind project. Sargent & Lundy reviewed the technical and economic feasibility of the offshore wind project and helped our client negotiate a PPA with the wind project developer.

- 2015 | Sargent & Lundy performed a site screening, site evaluation, and wind resource study client in Central U.S. Sargent & Lundy studied approximately 20 sites located in four different states. In addition to the wind resource, Sargent & Lundy evaluated environmental restrictions, land availability, civil engineering considerations, and other relevant site selection matters.

- 2015-2018 | Performed numerous wind project decommissioning projects for various clients. Services included preparing decommissioning plans, decommissioning cost estimates, and decommissioning field oversight.

- 2015 | Wind resource assessment and site evaluation for a wind project in Kenya.

- 2012 | Site selection and wind resource evaluation for a 30-MW wind project in the Caribbean.
2012 | Cost estimating, scheduling, and project planning services to a client for a 30-MW wind project in Central America.

2011 | Site selection and project feasibility study for a 2-MW wind project for a municipal utility located in the Midwestern U.S. Sargent & Lundy evaluated suitable wind turbine models, estimated annual energy production, and developed project development plans.

Mainstream Renewable Power

2010 | Consulting and owner’s engineering services to support the development and implementation of a wind project in Illinois. Sargent & Lundy provided advisory services for negotiation of the interconnection agreement and performed the transmission power flow study.

BBVA Securities

2010 | Developed a pro forma financial model for the project lenders to support financing for the Glen Dhu Wind Project in Nova Scotia, Canada.

Energía Eólica de Honduras, S.A.

2009 | Consulting services to support development and implementation of a 100.5-MW project in Honduras. Sargent & Lundy provided review of the client’s draft BOP agreement and developed exhibits for the agreement, including the contractor’s scope of work, technical specifications for all BOP components and systems, and completion criteria for all major systems and stages of construction.

BP Wind Energy

2009 | Consulting and BOP design review services to support development and implementation of the Titan 1 wind energy project.

2008-2009 | Construction consulting services to support development and implementation of the Fowler Ridge wind energy project.

2008 | Consulting and BOP design review services to support development and implementation of the Flat Ridge wind energy project.

Gestamp Wind North America

2009 | Supplied interconnection advisory services and prepared interconnection request forms, including wind turbine technical information and a one-line diagram, for the client’s project under development in the Midwestern U.S.

E.ON Climate & Renewables

2008-2009 | Geotechnical and structural design consulting to guide the client in selecting the optimal wind turbine foundation type for the Stony Creek wind energy project.

2008 | Consulting and BOP design review services to support development and implementation of the Panther Creek, Inadale, and Pyron wind energy projects.

Third Planet Windpower

2008-2009 | Consulting services to assist the client with EPC contractor oversight during construction and with evaluating non-conformances at the Loraine Windpark project.

REpower USA (now Senvion)

2008 | Review and evaluation of the wind turbine foundation design for Phase 1 of the Windy Point Wind Project in Washington. The project utilizes P&H type foundation design.
Half Moon Power

- 2008-2009 | Consulting services to support the development and implementation of multiple projects in the Midwestern U.S. Sargent & Lundy’s services included conceptual project siting and layout, and the preparation of interconnection requests.

City of New Ulm

- 2008-2009 | Coordination and management of the development of a small wind energy project in Minnesota, including feasibility studies, contract development, and wind turbine selection.

Design

NextEra Energy Resources

- 2017-2018 | Engineering and design services for 115/34.5-kilovolt (kV) and 230/34.5-kV collector substation and 15-mile 115-kV and 10-mile 230-kV transmission lines for the 300-MW Emmons Logan Wind Farm in North Dakota.
- 2017-2018 | Engineering and design services for 161/34.5-kV collector substation and 20-mile, 161-kV transmission line for the 100-MW Heartland-Divide Wind Farm in Iowa.
- 2017-2018 | Engineering and design services for 345/34.5-kV collector substation and 35-mile, 345-kV transmission line for the 200-MW Dodge County Wind Farm in Minnesota.
- 2016-2017 | Engineering and design services for five-mile, 345-kV transmission line for the 150-MW Huron Wind Farm in Michigan.
- 2016-2017 | Engineering and design services for 20-mile, 345-kV transmission line for the 200-MW Pratt Wind Farm in Kansas.
- 2016-2017 | Engineering and design services for 15-mile 138-kV transmission line for the 100-MW Mt. Storm Wind Farm in West Virginia.
- 2015-2016 | Engineering and design services for 5-mile 230-kV transmission line for the 150-MW Oliver III Wind Farm in South Dakota.
- 2015-2016 | Engineering and design services for 60-mile 345-kV transmission line for the 200-MW Ninnescah Wind Farm in Kansas.
- 2015-2016 | Engineering and design services for 20-mile 345-kV transmission line for the 250-MW Rush Springs Wind Farm in Oklahoma.
- 2015-2016 | Engineering and design services for 40-mile 230-kV transmission line for the 200-MW Crowned Ridge Wind Farm in South Dakota.
- 2014 | Engineering and design services for 30-mile 345-kV transmission line for the 200-MW Javelina Wind Farm in Texas.
- 2014 | Engineering and design services for 38-mile 230-kV transmission line for the 199-MW Cedar Bluff Wind Farm in Kansas.
- 2014 | Engineering and design services for 7-mile 230-kV transmission line for the 150-MW Carousel Wind Farm in Colorado.
- 2014 | Engineering and design services for 12-mile 138-kV transmission line for the 99-MW Breckenridge Wind Farm in Oklahoma.
- 2013 | Engineering and design services for 5-mile 345-kV transmission line for the 200-MW Mammoth Plains Wind Farm in Oklahoma.
Enel Green Power North America

- 2017-2018 | Engineering and design services for 345-kV interconnection switchyard for the 250-MW HillTopper Wind Farm in Illinois.

EDP Renewables (formerly Horizon Wind)

- 2015-2016 | Engineering and design services for 115/34.5-kV collector substation, 115-kV transmission line, and 34.5-kV collection system for the 78.8-MW Arkwright Summit Wind Farm in New York.
- 2015-2016 | Engineering and design services for 345/34.5-kV collector substation, 345-kV transmission line, and 34.5-kV collection system for the 250-MW Hidalgo Wind Farm in Texas.
- 2015 | Engineering and design services for 115/34.5-kV collector substation and 34.5-kV collection system for the 77.7-MW Jericho Rise Wind Farm in New York.
- 2015 | Engineering and design services for modification of collector substation and 34.5-kV collection system for a new project under development.
- 2008-2010 | Engineering and design services for three 345/34.5-kV collector substations, 345-kV transmission line, and 34.5-kV collection system for the 600-MW Meadow Lake Wind Farm in Indiana.
- 2008-2010 | Engineering and design services for one 345-kV interconnection switchyard, two 345/34.5-kV collector substations, 345-kV transmission line, and 34.5-kV collector system for the 300-MW Top Crop Wind Farm in Illinois.
- 2007-2009 | Engineering and design services for two 345/34.5-kV collector substations and 345-kV transmission line for the 300-MW Pioneer Prairie Wind Farm in Iowa.
- 2005-2007 | Engineering and design services for one 345-kV interconnection switchyard, two 345/34.5-kV collector substations, and 345-kV transmission line for the 397-MW Twin Groves Wind Farm in Illinois. Sargent & Lundy’s scope also included support to Horizon Wind Energy for procurement of project materials and equipment.

Xcel Energy

- 2016 | Engineering and design services for the 3.45-kV interconnection substation expansion (Chanarambie substation) for the 100-MW Stone Ray Wind Farm in Minnesota.
- 2016 | Engineering and design services for the 345-kV interconnection substation (Hawks Nest Lake Substation) and modification of the 345 kV interconnect transmission line for the 200-MW Red Pine Wind Farm in Minnesota.
- 2015 | Engineering and design services for the 230-kV interconnection substation (Peace Garden Substation) and modification of the 230 kV interconnect transmission line for the 150-MW Border Wind Farm in North Dakota.

BP Wind Energy

- 2010-2011 | Engineering and design services for one 138/34.5-kV collector substation, one 138-kV junction substation, 138-kV transmission line, and 34.5-kV collection system for the 147.5-MW Sherbino Mesa II Wind Project in Texas.
- 2010-2011 | Engineering and design services for one 345/34.5-kV collector substation, 345-kV transmission line, and 34.5-kV collection system for the 225-MW Trinity Hills Wind Project in Texas.
- 2010 | Engineering and design services for one 230/34.5-kV collector substation, 230-kV transmission line, and 34.5-kV collection system for the 200-MW Golden Hills Wind Power Project in Oregon.
- 2009-2010 | Engineering and design services for one 138/34.5-kV collector substation, 138-kV transmission line, and 34.5-kV collection system for the 100-MW Ford Ridge Wind Farm in Illinois.

Avangrid Renewables (formerly Iberdrola Renewables)

- 2009 | Engineering, design, commissioning, testing and quality inspection services for the 345-kV interconnection substation of the 200-MW Cayuga Ridge Wind Farm, as a subcontractor to Meade Electric.
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Acciona

2008 | Engineering and design services for the 100-MW Ecogrove Project 138/34-kilovolt (kV) collector substation, as a subcontractor to the Morse Group. Sargent & Lundy also provided engineering and design upgrades at six remote-end substations to support the interconnection and provided commissioning, testing, and quality control services for the collector substation and 138-kV interconnect transmission line.

Confidential Client

2006-2007 | Engineering and design of interconnection facilities and substations for three new wind power projects in Wisconsin.

Goldwind USA

2011-2012 | Engineering and design services for 138/34.5-kV collector substation and 138-kV interconnection switchyard for the 108-MW Shady Oaks Wind Farm in Illinois.

Conceptual Design and Studies

Electric Power Research Institute

2010, 2015, 2016, and 2017 | Provided the Electric Power Research Institute (EPRI) with updates to the EPRI Wind Power Technology Guide. This included development of cost and performance data for sites in the U.S. and several international locations. Levelized cost of electricity (LCOE) calculations and sensitivities were conducted.

American Capital Energy & Infrastructure

2014 | Performed a renewable energy integration assessment for the Senegal (country-wide) electric grid to assist the client with their evaluation of a wind power project acquisition.

Maui Electric Company

2013 | Performed a renewable energy integration assessment to assist the client with their efforts to expand the use of wind and solar power while maintaining reliability requirements.

NRG

2010-2011 | Conceptual engineering services for the landfall and underground portions of the 230-kV transmission interconnection for the offshore Mid-Atlantic Wind Park, including route evaluation, landfall and duct bank engineering, and support of permitting. The transmission line consists of two circuits, each serving half of the 450-MW wind farm.

Gamesa Energy

2010 | Investigation and assessment of electrical failure at the Gamesa wind power project in the U.S.; issued findings and recommendations to correct the issue and prevent reoccurrence.

BP Wind Energy

2009 | Transmission power flow study to support operation of the client’s wind energy project in the Central U.S.

Confidential Client

2009 | Conceptual design and study for integrating energy storage with the client’s wind energy project.

Cherokee Nation

2008 | Review and assessment of a wind energy project feasibility white paper.
EDP Renewables (formerly Horizon Wind)
- 2007 | Facility study for 99 MW of wind generation in Calumet County, Wisconsin.

Noble Environmental Power
- 2008-2009 | Preparation of conceptual one-line diagrams and general arrangement drawings; support of client in discussions with transmission system operator for a 350-MW wind park in Texas.

Construction Monitoring/Management

Overseas Private Investment Corporation

NextEra Energy Resources
- 2017 | Independent construction oversight of numerous wind projects during repowering.
- 2012 | Independent construction oversight on behalf of project lenders to support financing of the Tuscola Bay Wind Project in Michigan.

ContourGlobal
- 2013-2014 | Independent construction oversight of a 114-MW wind project in Peru, on behalf of bond financing arrangers.

CG Power
- 2011 | Independent construction oversight of the Power County Wind Farm in Idaho.

BBVA
- 2010-2011 | Independent construction oversight on behalf of the project lenders to support financing for the Glen Dhu Wind Project in Nova Scotia.

AES
- 2009 | Independent construction oversight on behalf of the project lenders to support financing for the Armenia Mountain Wind Project in Pennsylvania. The facility utilizes GE 1.5sle wind turbine generators.

Avangrid Renewables (formerly Iberdrola Renewables)
- 2009 | Commissioning, testing, and quality inspection services for the 345-kV interconnection substation of the Iberdrola Cayuga Ridge Wind Farm, as a subcontractor to Meade Electric.
- 2009 | Development of operating procedures for the Cayuga Ridge Wind Farm interconnection substation for the interconnecting utility.

Third Planet Windpower
- 2010 | Independent certification of the Loraine Windpark Phase I Project Completion project in Texas.
- 2008-2009 | Onsite construction management and commissioning services for the Loraine Windpark project in Texas.

Eco Energy/Acciona
- 2008 | Commissioning, testing, and quality inspection services for the 138-kV transmission line and the 138/34.5-kV substation of the Acciona Eco Energy Wind Farm, as a subcontractor to Morse Electric.
EDP Renewables (formerly Horizon Wind)

- 2007-2008 | Commissioning services for substations of the Pioneer Prairie Phases 1 and 2.
- 2007-2008 | Construction management and electrical testing and commissioning for the substation and transmission for the Twin Groves Phases 1 and 2.
- 2007-2008 | Construction management services for the interconnection substation at the Top Crop Phase I.
- 2008-2009 | Development of operating procedures for the Top Crop Phases I and II interconnection and collector substations.
- 2007-2008 | Commissioning services for the collector substation at the Meadow Lake Phase I.
- 2009 | Development of operating procedures for the Meadow Lake Phase I collector substation.

BP Wind Energy

- 2010 | Independent construction oversight on behalf of the project lenders to support financing for the 124.5-MW Goshen II Wind Project in Idaho.
- 2009 | Commissioning services for the 199.5-MW Fowler Ridge II Wind Project in Indiana.
- 2008 | Onsite construction management and commissioning services for the 301.3-MW Fowler Ridge Wind Project in Indiana.
- 2008 | Onsite construction management for the 520.4-MW Flat Ridge Wind Project in Kansas.

Operations and Maintenance Support and Services

Confidential Clients

- 2015-2018 | Performed numerous wind project decommissioning projects for various clients. Services included preparing decommissioning plans, decommissioning cost estimates, and decommissioning field oversight.
- 2015-2016 | Independent engineering review of wind turbine foundations at an operating wind power project in West Virginia to assess potential remediation options.
- 2015 | Independent engineering review of wind turbine foundations at an operating wind power project in Pennsylvania to assess potential remediation options.
- 2015 | Independent engineering review of wind turbine foundations at an operating wind project in the Midwestern U.S. Sargent & Lundy performed design calculations to assess the suitability of the original design.
- 2011 | Third-party failure analysis of wind turbine blade failures for a project in the Western U.S.
- 2010 | Third-party failure analysis of a wind turbine gearbox failure for a project in the Western U.S.
- 2010 | Engaged by an investment firm to perform technical due diligence on a wind O&M services company that the client was seeking to acquire. Sargent & Lundy evaluated the target firm’s vibration monitoring technology and provided assessments and recommendations to the client on the effectiveness and market potential of the technology.
- 2009-2010 | Technical consulting services to the client to support their negotiations with a wind turbine supplier to resolve a serial defect with critical wind turbine components.

BP Wind Energy

- 2010-2015 | Annual O&M budget reviews for the Goshen II wind project, located in Idaho.
2010 | Engaged to develop a wind turbine foundation inspection guideline for our client’s O&M personnel to use during their annual inspections and maintenance. The guidelines were developed based on Sargent & Lundy’s extensive knowledge and experience with the design and operating considerations for wind turbine foundations.

**NextEra Energy Resources**

2010 | Independent engineering review of the Langdon Wind Project plant performance, turbine reliability, and O&M procedures and practices on behalf of the project lenders. Assessed the need for O&M budget and maintenance reserve adjustments based on the initial two years of plant performance.

**Enel Green Power North America**

2010 | Technical advisory and independent engineering services to Enel Green Power North America to review and assess the causes of a wind turbine collapse. One 1.5-MW wind turbine collapsed at Enel’s wind farm in New York, U.S., after 10 years of operation. Sargent & Lundy also provided design input for the revised foundation design and remediation plan. We also performed independent engineering reviews of the revised design.

For more information:
Matthew Thibodeau | Vice President
+1-312-269-6864 | matthew.r.thibodeau@sargentlundy.com
As part of our extensive electric power industry experience, Sargent & Lundy has significant solar technology experience. Sargent & Lundy was the BOP engineer for the design of the SEGS VIII, IX, and X facilities in the late 1980s and has been active in the development of solar energy ever since. Sargent & Lundy is active in the renewable energy generation market, currently providing owner’s engineering, technical due diligence, and conceptual design of solar energy generation for our clients.

Selected Sargent & Lundy solar experience is listed below.

**Due Diligence and Independent Engineering**

**Overseas Private Investment Corporation (OPIC)**

- **2017-2018** | Independent engineer for a 50-MW solar PV project in Jordan. Services include independent solar energy yield assessment, technical due diligence in support of funding, construction monitoring, and performance testing oversight.

- **2017-2018** | Independent engineer for a 100-MW solar PV project and a 50-MW solar PV project in India. Services include independent solar energy yield assessment, technical due diligence in support of funding, construction monitoring, and performance testing oversight.

- **2016-2018** | Independent engineer for a portfolio of 100-MW solar PV projects in El Salvador. Services include independent solar energy yield assessment, technical due diligence in support of funding, construction monitoring, and performance testing oversight.

- **2015-2017** | Independent engineer for nine solar PV projects in El Salvador totaling approximately 40 MW. Services include independent solar energy yield assessment, technical due diligence in support of funding, construction monitoring, and performance testing oversight.

- **2014-2016** | Independent engineer for a 20-MW solar PV project in Jamaica that was financed by OPIC and the IFC. Services include independent solar energy yield assessment, technical due diligence in support of funding, and construction monitoring.

- **2013-2017** | Independent engineer for a 5-MW solar PV project in Tanzania being financed by OPIC. Services include technical due diligence in support of funding and construction monitoring.
Confidential Clients

- 2018 | Due diligence review of four solar PV projects in North Carolina to support client’s potential acquisition.
- 2017 | Due diligence review of four ground- and roof-mounted solar PV projects and one energy efficiency project on commercial properties to support client’s potential acquisition. Projects are located in the UAE and Jordan.
- 2015 | Due diligence review of an operating 40-MW ground-mounted solar PV project to support client’s potential acquisition. Project located in South Africa.
- 2017-2018 | Independent technical due diligence of the Cerro Dominador project in the Atacama Desert in Chile, which consists of a 110-MW CSP molten salt tower plant and a 100-MW solar PV plant.

SolarReserve / Project Lenders

- 2018 | Lender’s technical advisor for SolarReserve’s 135-MW CSP project with molten salt storage being developed in Australia. Services include independent technical due diligence in support of project financing.

Blue Amber Group

- 2018 | Providing support for Blue Amber’s potential asset investment in a 700-MW CSP project in the UAE. Services include independent technical due diligence and presentations on technology.

ACWA Power / Project Lenders

- 2018 | Lender’s technical advisor for the Dubai Electricity and Water Authority (DEWA) 700-MW CSP project being developed in the UAE. The project consists of a 100-MW central tower unit with molten salt storage and three 200-MW parabolic trough units with molten salt storage. Services include independent technical due diligence and presentations on technology in support of project financing.

SunEdison / TerraForm Power

- 2015 | Asset acquisition due diligence of two solar PV projects, located in Canada, to support the client’s potential acquisition.

Inter-American Development Bank

- 2015-2018 | Independent engineer for the Atacama 110-MW concentrating solar tower project with molten salt storage located in northern Chile. Services include independent technical due diligence and construction monitoring.
- 2015, 2017 | Independent engineer for a 100-MW solar PV project with single-axis tracking. The project is located in northern Chile. Services include independent due diligence assessment and construction monitoring.

International Finance Corporation

- 2014-2015 | Independent engineer for a 70-MW portfolio of three solar PV projects in the Philippines financed by the IFC. Services include independent solar energy yield assessment, technical due diligence in support of funding, and construction monitoring.

U.S. Department of Energy: Tonopah Solar Project

- 2010-2018 | Independent engineer for the Tonopah Solar Project in Nevada. Tonopah is a 100-MW molten salt solar tower project with 10 hours of storage. Services include independent technical due diligence, in support of funding by the DOE, construction monitoring, and operations monitoring.

U.S. Department of Energy: Mojave Solar Project

- 2010-2018 | Independent engineer for the Mojave Solar Project in California. Mojave is a 250-MW parabolic trough solar project. Services include independent technical due diligence, in support of funding by the DOE, construction monitoring, and operations monitoring.
Macquarie Capital: 30-MW PV Solar Project

2013 | Independent engineer for a 30-MW PV solar project being constructed by Silicon Ranch in Georgia. Services include independent technical due diligence, in support of funding, and construction monitoring.

U.S. Department of Energy: Rice Solar Project

2010-2011 | Independent engineer for the Rice Solar Project being developed in California. Rice is a 150-MW molten salt solar tower project with four hours of storage. Services include independent technical due diligence in support of funding by the DOE.

Standard Bank of South Africa

2011-2012 | Independent engineering reviews of proposed solar PV projects; provide lender's technical advisory services to support project development and bidding into the South African Renewable Energy Independent Power Producer Program.

Standard Bank: 75-MW PV Solar Project

2011 | Independent engineering for a 75-MW solar project being developed in South Africa. Services include independent technical due diligence in support of funding and construction monitoring.

Standard Bank: 50-MW PV Solar Project

2011 | Independent engineering for a 75-MW solar project being developed in South Africa. Services include independent technical due diligence, in support of funding, and construction monitoring.

Standard Bank and IFC: 100-MW Redstone CSP Solar Project

2011-2017 | Independent engineer for the Redstone Solar Energy Project in South Africa. Redstone is a 100-MW molten salt solar tower project with 12 hours of storage. Services included independent technical due diligence in support of funding by the consortium of lenders.

Confidential Client: PV Solar Project in Arizona

2013 | Independent engineering review of the root cause analyses and corrective actions related to the failures of pad-mount transformers at a PV solar power plant in Arizona.


Overseas Private Investment Corporation

2016-2017 | Performed independent solar resource and energy production assessments of a 100-MW solar PV project located in El Salvador to support project financing.

2015-2017 | Performed independent solar resource and energy production assessments of nine solar PV projects located in El Salvador to support project financing. The projects together total approximately 40 MW.

2014-2016 | Performed independent solar resource and energy production assessment of a 20-MW solar PV project located in Jamaica to support project financing.

Confidential Clients

2018 | Developed conceptual layout and energy estimates for an 8-MW solar PV project being developed on a Caribbean island. Sargent & Lundy evaluated fixed-tilt and single-axis tracking configurations as well as thin-film and crystalline PV module options, and we prepared cost estimates.

2016 | Developed conceptual layout and energy estimates for 20 MW solar PV project being developed near a U.S. military base in Central U.S. Sargent & Lundy evaluated fixed tilt and single axis tracking configurations, as well as thin film and crystalline PV module options.
2016 | Developed conceptual layout and energy estimates for 60 MW solar PV project being developed in central California. Sargent & Lundy evaluated fixed tilt and single axis tracking configurations, as well as thin film and crystalline PV module options.

2016 | Developed conceptual layout and energy estimates for 20 MW solar PV project being developed adjacent to coal fired power plant in Central U.S. Sargent & Lundy evaluated fixed tilt and single axis tracking configurations, as well as thin film and crystalline PV module options.

2015 | Sargent & Lundy performed a site screening and site evaluation study client in Central U.S. Sargent & Lundy studied approximately 50 sites located in six different states. In addition to the solar resource, Sargent & Lundy evaluated environmental restrictions, land availability, civil engineering considerations, and other relevant site selection matters.

SunEdison / TerraForm Power

2015 | Performed independent solar resource and energy production assessment of two operating solar PV projects, located in Canada, to support the client’s potential acquisition.

International Finance Corporation

2014 | Performed an independent solar resource and energy production assessment of three solar PV projects (70 MW in total), located in the Philippines, to support project financing.

Overseas Private Investment Corporation

2013-2014 | Performed an independent solar resource and energy production assessment of a 5-MW solar PV project, located in Tanzania, to support project financing.

Macquarie Capital

2013 | Performed an independent solar resource and energy production assessment of a 30-MW solar PV project, located in Georgia, to support project financing.

Site Evaluation, Solar Resource, and Energy Production Assessments: CSP

DEWA Mohammed bin Rashid Al Maktoum Solar Park Project Phase IV:
- Two CSP units rated at 100 MW. One unit utilizes molten salt power tower technology and the other a proven CSP technology. Sargent & Lundy performed an independent review of the project’s solar resource assessment and developed a solar performance and production model submitted with the client’s bid,

Crescent Dunes 100-MW Molten Salt Tower Project with 10 hours of storage developed by SolarReserve in Tonopah, Nevada:
- Performed an independent technical assessment of the solar resource and performance model (energy yield) for the project lenders in support of financial close.

Rice 100-MW Molten Salt Tower Project with 10 hours of storage developed by SolarReserve in California (currently on hold):
- Performed an independent technical assessment of the solar resource and performance model (energy yield) for the project lenders in support of financial close.

Redstone 100-MW Molten Salt Tower Project with 10 hours of storage developed by ACWA and SolarReserve in South Africa:
- Performed an independent technical assessment of the solar resource and performance model (energy yield) for the project lenders in support of financial close.
Atacama 110-MW Molten Salt Tower Project with 10 hours of storage developed by Abengoa in Chile:
- Performed an independent technical assessment of the solar resource and performance model (energy yield) for the project lenders in support of financial close.

Copiapó 110-MW Molten Salt Tower Project with 10 hours of storage bid by SolarReserve in Chile:
- Performed an independent technical assessment of the solar resource and performance model (energy yield) and third-party independent certification for submittal of the bid by SolarReserve.

Conceptual and Detailed Design

**U.S. Department of Energy / Solar Dynamics**
- 2017 | Developed the comprehensive conceptual design for a 250-MW dispatchable solar plant (DSP) in the Southwest U.S. The conceptual design for a molten salt power tower includes a detailed conceptual design (preliminary drawings and technical specification), performance, cost, and schedule.

**First Solar**
- 2017-2018 | Engineering and design services for the new 150-MW North Rosamond solar PV project in California.
- 2017-2018 | Engineering and design services for the new 100-MW Willow Springs solar PV project in California.

**NextEra Energy Resources / Florida Power & Light**
- 2018 | Engineering and design services for a new greenfield 500/34.5-kV solar collection substation for the 75-MW Ghost Orchard Solar Farm in Florida.
- 2017 | Engineering and design services for a new greenfield 138/34.5-kV solar collection substation for the 75-MW Krome Solar Farm in Florida.
- 2016-2017 | Engineering and design services for a new greenfield 230/34.5-kV solar collection substation for the 75-MW Indian River Solar Farm in Florida.
- 2016-2017 | Engineering and design services for a new greenfield 138/34.5-kV solar collection substation for the 75-MW Hammock Solar Farm in Florida.
- 2016-2017 | Engineering and design services for a new greenfield 230/34.5-kV solar collection substation for the 75-MW Loggerhead Solar Farm in Florida.
- 2016-2017 | Engineering and design services for a new greenfield 138/34.5-kV solar collection substation for the 75-MW Interstate Solar Farm in Florida.

**Xcel Energy**
- 2016 | Engineering and design services for modification of the 115-kV interconnection substation for the 62-MW Marshall Solar Farm in Minnesota.

**Confidential Clients**
- 2018 | Developed conceptual layout, design, and energy estimates for an 8-MW solar PV project being developed on an island in the Caribbean. Sargent & Lundy evaluated fixed-tilt and single-axis tracking configurations as well as thin-film and crystalline PV module options.
- 2016 | Developed conceptual layout, design, and energy estimates for 20 MW solar PV project being developed in conjunction with thermal power plant in Central U.S. Sargent & Lundy evaluated two different sites, and fixed tilt and single axis tracking configurations, as well as thin film and crystalline PV module options.
- 2016 | Developed conceptual layout, design, and energy estimates for 20 MW solar PV project being developed adjacent to coal fired power plant in Central U.S. Sargent & Lundy evaluated fixed tilt and single axis tracking configurations, as well as thin film and crystalline PV module options.
Owner’s Engineer Services and Technology Reviews

Confidential Clients

- 2018 | Prepared a solar PV project technical specification for a utility-scale project in the United States.
- 2018 | Providing owner’s engineering support for a 100-MW+ solar PV project being developed in the Midwestern U.S. Sargent & Lundy is currently managing the interconnection application process.
- 2018 | Serving as owner’s engineer for a 100-MW solar PV project in Mexico. Sargent & Lundy personnel will be deployed to the site during the construction and commissioning phases.
- 2017-2018 | Performed technical study and conceptual design for integration of battery energy storage into an existing solar PV project in the Southern U.S.
- 2018 | Performed site identification and site evaluation study for 20 solar projects in Michigan, each project is 2 MW in capacity. Utilized geographic information system (GIS) tools to perform the study. Managed the interconnection application process.
- 2016 | Developed conceptual layout and energy estimates for 20 MW solar PV project being developed adjacent to coal fired power plant in Central U.S. Sargent & Lundy evaluated fixed tilt and single axis tracking configurations, as well as thin film and crystalline PV module options.
- 2013 | Performed a pre-feasibility study for a 30-MW solar PV facility in South Africa. The scope included a solar resource evaluation, conceptual design, generation projection, interconnection review, and overall risk analysis.
- 2011 | Project and technical due diligence review for the client who was looking to invest in the Blythe CSP parabolic trough plant in California.
- 2011 | Developed the conceptual design for a parabolic trough plant in India. The conceptual design included a review of technology; a solar resource assessment and projection; a conceptual design including solar field size, heat transfer fluid (HTF) system, and power block; and conceptual design drawings including solar field layout, heat balance, electrical one line, control block diagram, and water balance.
- 2011 | Developed the detailed design for the solar field and HTF system. The solar field design included foundations. The HTF system design included a complete design package for purchase, installation, and commissioning.
- 2010 and 2011 | Project and technology due diligence reviews of solar thermal project(s) in the Southwestern U.S. The reviews included both technology and general project risk.
- 2008 | Issued a consolidated report on the current status of CSP technology. The information included the current market, participants, active projects and developers, current costs, cost reduction potential, and discussion of emerging technologies.

Electric Power Research Institute

- 2013, 2014, 2015, 2016, and 2017 | Provided EPRI with updates to the EPRI Solar PV Technology Guide and the Solar Thermal Technology Guide. This included development of cost and performance data for sites in the U.S. and several international sites. LCOE calculations and sensitivities were conducted.
- 2017 | Provided EPRI with a solar project decommissioning guide.
- 2009 and 2010 | Provided EPRI with plant descriptions, estimated cost, and associated technical information on solar thermal and PV electric power generation technologies. The information included current status and potential projections for development and/or commercialization activities over the next five to 15 years. Issues and activities associated with renewable power generation technologies, as they relate to planning, engineering, and project development, were discussed.
Alstom: Ashalim

2015 | Developed the technical specification and review of bids for the tower structure for the 100-MW Ashalim molten salt power tower project in Israel.

SolarReserve

2014 | Performed an independent technical assessment of the solar resource and performance model (energy yield) and third-party independent certification for submittal of the bid by SolarReserve for the Copiapó 110-MW molten salt tower project with 10 hours of storage in Chile.

Maui Electric Company

2013 | Performed a renewable energy integration assessment to assist the client with their efforts to expand the use of wind and solar power while maintaining reliability requirements.

CPS Energy

2011 | Engineering services for a technical review and construction monitoring of three 10-MW PV solar projects in Texas.

HIRCO: Feasibility of Solar Power at Existing Site

2010 | Engineering services for the feasibility of parabolic trough technology at an existing site in India, as well as an analysis of expected project costs, taking local factors into consideration.

Intermountain Power Agency: Feasibility of Solar Power at Existing Site

2009 and 2010 | Engineering services for the feasibility of various solar technologies (tower, trough, and PV) at an existing site in Utah.

Entegra Power Group: Gila River Solar Feasibility Study

2009 | Analysis of the use of both parabolic trough and PV technologies at the existing Gila River power plant site. The parabolic trough CSP configuration investigated for the Gila River plant was based on integration with the existing combined-cycle configuration. The PV configuration was based on non-tracking thin-film PV panels. The analysis included capital costs, O&M costs, water usage, land requirements, staffing, achievable performance, and technology maturity.

Agrifos Fertilizer: Renewable Energy Feasibility Study

2009 | Review and assessment of various renewable energy generation options that could be utilized at a site in southeastern Texas. Solar thermal and solar PV technologies were investigated. Performance, cost, and incentives were evaluated for the various technologies at the site.

BP America, Inc.

2007-2008 and 2011 | Assisted the client in developing their solar renewable strategy. The strategy included evaluation of solar trough and tower technologies, including current costs and potential cost reductions.

Duke Energy Generation Services

2007 | Evaluation of solar trough and tower technologies, including current costs and potential cost reductions.

Mitsui & Co., Ltd.

2007 | Comprehensive technology survey and analysis of commercially available solar thermal and solar PV technology.
**Toyota Tsusho Corporation**

- 2011 | Comprehensive technology survey and analysis of commercially available solar thermal and solar PV technology.

**SkyFuels**

- 2010 and 2011 | Independent technical review of the SkyTrough parabolic solar collector. Services consisted of a review of the design, comparative product cost assessment, and performance assessment. Sargent & Lundy evaluated the prototype testing conducted on the SkyTrough collector and provided an independent review and opinion of the test results.

**Sempra: Feasibility Study for Batteries in Large-Scale PV Plants**

- 2009 | Engineering services for the feasibility and selection of large-scale battery systems for a 50-MW thin-film PV plant in the Southwestern U.S. The study included a review of available battery technology, maturity of the technology, capital and O&M costs, and methodology to size the battery and determine optimum battery type based on technology and cost.

**Sempra: Parabolic Trough Solar Plant in Southwestern U.S.**

- 2007 and 2009 | Engineering services for the development of a large-scale parabolic trough plant in the Southwestern U.S. The services included conceptual design of the entire plant (solar and thermal), conceptual cost estimate, EPC specifications, technical input for permitting (emissions and transmission), schedules, and additional support as required.

**Southern California Edison**

- 2008 | Study of potential uses of the Mohave Site. Services included developing a conceptual design and cost estimates for a parabolic trough solar plant, power tower, and integrated solar combined-cycle plant.

**Total/Abengoa – United Arab Emirates**

- 2008 | Bid support for a solar thermal power plant in the United Arab Emirates. The services included independent technical verification that the EPC contract proposal for the bid was in compliance with the requirements identified in the RFP, including the PPA. Sargent & Lundy also provided technical assistance in preparing a competitive bid and identifying technical risks.

**Iberdrola: Parabolic Trough Solar Plant in Southwestern U.S.**

- 2008 | Conceptual design for 100-, 250-, and 500-MW parabolic trough power plants. A high-level capital cost estimate and estimate of O&M costs were developed.

**Total/Abengoa – Spain**

- 2007 and 2008 | A technical evaluation of bids for receiver tubes and mirrors for a parabolic trough project in Spain.

**InterGen: Integrated Solar Combined Cycle**

- 2008 | A feasibility study of a solar retrofit for a 501F 1x1 combined-cycle unit. The CSP technologies addressed were parabolic trough, power tower, and compact linear Fresnel receiver (CLFR). The relevant advantages and disadvantages of each type of system were identified. Evaluation areas included steam conditions achievable, technology maturity, comparative capital and O&M costs, and equipment availability.

**Mesa del Sol: Parabolic Trough Solar Plant in Southwestern U.S.**

- 2008 | High-level capital cost estimate and O&M costs for a 100-MW solar parabolic trough plant.
U.S. DOE (NREL and Sandia): Assessment of Parabolic Trough and Power Tower Solar Technologies

- 2008 and 2009 | Updated the Sargent & Lundy Report, “Assessment of Parabolic Trough and Power Tower Solar Technology Cost and Performance Forecasts” dated May 2003, for DOE and Sandia to include parabolic trough, molten salt power towers, direct steam power towers, and dish technology. Issued the draft report for industry review in April 2009.

Confidential Project: Parabolic Trough Solar Plant in Southwestern U.S.

- 2007 and 2008 | Owner’s engineering for the development of two 180-MW solar parabolic trough power plants.

Arizona Electric Power Cooperative: Apache Station

- 2007 | Functional specification for a gas turbine solar inlet chiller system.

Goldman Sachs: Parabolic Trough Solar Plant in Southwest U.S.

- 2006 | Engineering services for the development of a large-scale (600-MW) parabolic trough plant in the Southwestern U.S. Services included conceptual design and conceptual cost estimate.

Confidential Clients

- 2009-2011 | Technical due diligence review of eSolar direct steam power tower technology.
- 2010 | Technical due diligence of a solar technology supplier.
- 2008-2011 | Technical due diligence review of SolarReserve molten salt power tower technology.
- 2008 | Technical due diligence of the current three solar distributed power tower technologies being developed in the U.S. Reviewed the design concept and implementation strategy for each of the technologies.
- 2007 | Due diligence review of concentrating PV systems. Developed a conceptual cost estimate for installation of large-scale projects.
- 2007-2009 | Due diligence review of a solar technology supplier (SkyFuels) for an investment group and developer.
- 2006 | Feasibility review of Ausra’s linear Fresnel technology proposed for a 180-MW plant.

Sargent & Lundy’s solar technology experience before 2006 includes the following projects:

National Rural Electric Cooperative Association: Assessment of Renewable Energy Options to Enhance Combustion Turbine Performance

- 2005 and 2006 | The National Rural Electric Cooperative Association (NRECA) engaged Sargent & Lundy to assess renewable energy options to enhance combustion turbine performance. Our scope included a technical and financial analysis of combustion turbine enhancement through the use of solar parabolic troughs and absorption cooling of inlet air. The final deliverable included a comprehensive report and working economic model.

Southern California Edison: Study of Alternative/Complementary Generation Resources for the Mohave Power Plant

- 2005 | Southern California Edison engaged Sargent & Lundy to study alternate and complementary generation to potentially replace 885 MW of generation at the Mohave Power Plant. The study included a feasibility analysis of renewable energy: CSP (parabolic trough, power tower, Sterling dish/engine, and PVs), wind, geothermal, and biomass.
Florida Power and Light: SEGS III through IX: Due Diligence Reviews

Florida Power and Light (FPL), as one of the principal owners, engaged Sargent & Lundy to perform an independent due diligence review of the SEGS facilities. Services included:

- 2005 | A due diligence review of the SEGS III-VII for a project refinancing, including a condition assessment, reviews of O&M practices and budgets, plant performance, financial projections, and status of permitting and licensing compliance.
- 1998 | A due diligence review of SEGS VIII and IX for a project refinancing, including a condition assessment, reviews of O&M practices and budgets, plant performance, financial projections, and status of permitting and licensing compliance.

The World Bank: Feasibility Study of Integrated Solar Combined-Cycle System

1999 | Comisión Federal De Electricidad (CFE) received funding from the Global Environmental Facility (GEF) of the World Bank for the solar portion of an integrated solar combined-cycle system (ISCCS) thermal power generation project planned in Mexico. The World Bank engaged Sargent & Lundy to assess the plant feasibility based on a change in how the project was being contracted and because of technical changes. Our scope included summarization of current CSP technology development and experience; appraisal of the technical soundness of the CFE-proposed design and its status in terms of technological progress; a review of technological arrangement alternatives; an assessment of incremental costs and the economic feasibility of the CFE-proposed design; and an evaluation of technological performance risk, cash-flow risk, project financial return risk, developer financial return risk, and policy risk for the project. Our work included a review of the solar field (insolation, field configuration, and geotechnical) and the combined-cycle plant. The combined-cycle analysis included an evaluation of the absorption chillers, powered by solar generated steam, that were used for cooling the combustion turbine inlet air to maintain a constant 10°C inlet air temperature.

U.S. DOE and NREL: Assessment of Parabolic Trough and Power Tower Solar Technologies

2003 | This study for the DOE and NREL involved an assessment of the potential for developing CSP technology as an electric generating technology over the subsequent 10–20 years. We analyzed industry projections for technology improvement, progress of research and development (R&D), plant scale-up and economies of scale, economies of learning resulting from increased deployment, cost-reduction potential, and other factors. The study considered possible improvements in efficiency, tax credits, O&M cost, and total cost of produced electricity. This work provided Sargent & Lundy with an extensive network of contacts in the solar thermal industry, including persons in government, research organizations, and equipment manufacturers. The analyses considered a variety of sensitivity studies, including impacts of owners’ cost of capital (e.g., investor-owned utilities vs. other types of utilities that have lower financing costs).

CMS Generation

2000-2001 | A technology survey and analysis investigation of commercially available renewable energy technologies, which included solar thermal and solar PV technologies.

LUZ Solar Partners: SEGS Original Design Work; Various Parties: Follow-On Work

1988 | Sargent & Lundy participated in the original design of the SEGS VIII and IX—two 80-MW parabolic trough units. The units, in Harper Lake, California, have gas-fired HTF heaters, a hybrid design that was considered the lowest-cost and latest technology. Initial operation was in December 1989. Sargent & Lundy performed the design of the power block, balance-of-plant, and interface with solar field. Our efforts included the design of SEGS X, for which construction was started but not completed.
1997 | Since the original operation of the units, Sargent & Lundy has provided engineering support to the operating companies to improve the efficiency and reliability of the plant. For example, we designed the piping system for added condensate storage tanks, bypasses for the HTF heaters, and provided a study of variable-frequency drives, a structural design review, and assistance with turbine blade repairs.

Solar Chimney Projects: Gujarat and Rajasthan, India

1996 | Sargent & Lundy, through our joint venture in India, L&T-S&L, was involved in three proposed solar chimney projects in India: a 5-MW project in Gujarat and 200-MW projects in Rajasthan and Gujarat. We advised the state governments on the proposed projects. This effort included a technical, economic, and design feasibility report, and coordination with the developers.

For more information:
Matthew Thibodeau | Vice President
+1-312-260-6864 | matthew.r.thibodeau@sargentlundy.com
Biomass

Sargent & Lundy’s involvement in the biomass industry 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. This project development activity frequently included providing conceptual design with the ability of burning biomass. This work involved investigating optional equipment layouts based on information gathered from steam generator suppliers, material handling vendors, and air quality control vendors to assure our clients that new or existing coal-fired units could also be able to fire biomass in sufficient quantities to impact 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.

The summaries below discuss selected Sargent & Lundy engagements in biomass and landfill gas (LFG) projects.

**Cube Mas Energy**
- 2017-2018 | Performed an independent engineering review of the methodology used in estimating operating expenses for two LFG projects in Georgia.

**International Finance Corporation – Philippines**
- 2014-2018 | Independent engineer for a 70-MW portfolio of three biomass projects in the Philippines being financed by the IFC. Services included technical due diligence in support of funding and construction monitoring.

**Confidential Client**
- 2017-2018 | Independent engineer for potential investment in two 50-MW biomass projects being developed in the Southeastern U.S. Services included technical and financial due diligence in support of investment evaluation.

**Scimitar Global Markets**
- 2017 | Carried out the valuation of one biomass project in Ireland and one biomass project in Nevada. Both projects designed to be 48 MW in capacity and to use a gasification process utilizing a combination of refuse-derived fuel, construction waste, tires, and other biomass fuels.
Renewable Energy Project Experience

International Finance Corporation – Philippines

- 2014-2018 | Independent engineer for a 70-MW portfolio of three biomass projects in the Philippines being financed by the IFC. Services included technical due diligence in support of funding, and construction monitoring.

Confidential Project – Midwest U.S.

- 2011 | Phase 1 engineering study and report for utilizing waste fuel to be delivered to existing sites for gasifying the biomass material and using low-Btu fuel in existing boilers to offset the use of coal firing.

Kauai Island Utility Cooperative – Hawaii

- 2011 | A high-level feasibility review of installing a new boiler to replace an existing oil-fired package-type boiler in order to combust biomass at the Port Allen Station (S1) in Hawaii. Options considered were to reuse the existing steam turbine generator, replace the steam turbine and reuse the existing generator and auxiliaries, or replace the entire steam turbine generator.

NRG – Waste-to-Energy Facility

- 2010-2011 | Sargent & Lundy developed the conceptual design for a WTE facility using the AlterNRG (Westinghouse Plasma) gasification technology to produce syngas. We prepared design criteria for the plant; developed an emission profile for submittal of permits; prepared general arrangement drawings; and developed a plant cost estimate.

Biomass Products, LLC – Illinois

- 2010-2011 | Owner’s engineer support for obtaining transmission services for the proposed 25-MW Rock Falls biomass power plant. Scope included consultation regarding a proposal to the regional transmission authority and an analysis of the historical locational marginal pricing to assist in determining bid pricing. Analysis included identification and assessment of transmission service alternatives for delivery into regional transmission territories.

Buena Vista Biomass Project – California

- 2010-2012 | Lender’s engineer support of financing the conversion of the brownfield, 18-MW Buena Vista biomass project in Northern California. The scope included an initial evaluation of the technical and commercial basis for the project and subsequent periodic reviews and approvals of contractor invoices and change orders. Site visits and regular project team communications included to maintain adequate level of insight into project progress.

Confidential Project – West (Mountain) U.S.

- 2010-Present | Biomass fuel supply and co-firing (up to 10% by heat input) study. Initially, a fuel supply investigation was conducted to determine the types of fuel readily available, the quantities and sustainability of each, and the suitable delivery concepts to the station. A technical assessment was also performed to determine the method(s) of co-firing the fuels that may be readily found near the station. Material handling concepts were presented based on viable fuel alternatives identified in the fuel assessment evaluation.

NOVI Energy – Virginia

- 2010-Present | Owner’s engineer technical support for project start-up activities through EPC award for the brownfield development of a nominal 50-MW boiler facility. Scope includes development of a feasibility study to assess technology, fuel, interconnection, environmental, and site characteristics. Sargent & Lundy was retained to support permit applications, the PJM interconnection application, development of EPC specifications, EPC bid evaluations, and guidance for economic incentives. Sargent & Lundy performed detailed design in civil/structural areas outside of the power block and general owner’s engineering support during project implementation. We supported the owner’s application for the Department of Treasury’s 1603 ARRA Grant funding, providing detailed cost estimate breakdowns and general grant application guidance.
Confidential Project – Midwest (East North Central) U.S.

- 2009-2010 | In conjunction with a re-powering study, Sargent & Lundy evaluated the conversion of two existing pulverized-coal- (PC)-fired boilers to burn biomass with a percentage of refuse-engineered fuel. Deliverables included site arrangement drawings, a cost estimate, a complete new biomass material handling system layout and flow diagrams, a fuel alternatives assessment, a conversion technology assessment (co-firing or switching to 100% biomass), a performance optimization, a project schedule, and emissions estimates for permitting input.

Confidential Project – Midwest (East North Central) U.S.

- 2009-Present | Biomass conversion of two existing PC-fired boilers to burn biomass with a percentage of refuse-engineered fuel. Deliverables include site arrangement drawings, a cost estimate, a complete new biomass material handling system layout and flow diagrams, a fuel alternatives assessment, a conversion technology assessment (co-firing or switching to 100% biomass), a performance optimization, a project schedule, and an emission estimates for permitting input.

Confidential Project – West (Pacific) U.S.

- 2009-2010 | Biomass conversion study for large coal-fired unit, including evaluating co-firing from 10–100% biomass. The report provided layouts, estimated costs, estimated emissions, and an evaluation of a new biomass material handling system (wood chips, grasses, pellets, and torrified biomass) and fuel supply for type and quantity available.

Confidential Project – South (South Atlantic) U.S.

- 2009-2010 | Biomass conversion study for two older PC-fired boilers to burn 100% biomass, including material handling layout integration with an existing system. More than 15 material handling options were under consideration, involving various degrees of long-term and short-term storage, rail and truck delivery, and assessment of additional truck traffic. Deliverables included estimated cost, boiler technology selection (stoker vs. bubbling fluidized bed [BFB], or standalone gasifier), and emissions and unit performance projections, and emission estimates. Also developed a detailed conversion scope and inputs to the air permit application.

ecoPower Generation LLC – 50-MW Biomass Facility

- 2009-2010 | Owner’s engineer technical support for project start-up activities for the greenfield development of a nominal 50-MW fluidized bed boiler facility to burn wood waste from a local Kentucky lumber industry and forestry. Scope included technology assessment and selection; conceptual design; technical support to the permitting process; site planning, including material handling unloading storage and reclaim operations; and permit support and consultation for economic feasibility.

City of New Ulm – Minnesota, U.S.


Associated Electric Cooperative Inc. – Missouri

- 2010 | Evaluated biomass co-firing options at five existing coal-fired units, ranging in size from 175 MW to 715 MW and utilizing pulverized coal and cyclone technologies. Scope included fuel analysis, co-firing technology options for both boiler types, performance calculations, material handling design considerations, emissions and permitting impacts, economic analysis, and implementation schedule analysis.
Dairyland Power Cooperative – Wisconsin, U.S.

- 2009-2011 | Evaluation of the availability of various biomass fuels for use at multiple stations in the client’s fleet; also considered combustion alternatives applicable to each unit. Technologies included modifications to support several co-firing options; boiler conversions to stoker/BFB; and external combustion alternatives, such as Dutch ovens and full and partial gasifiers producing syngas. Different material handling options were identified for each of these firing options due to the different sizing requirements of the technologies. The study identified estimated quantities of each biomass type within reasonable distance from each site. Additional scope includes developing a test burn for several biomass fuel types and selecting the candidate unit for testing, as well as identifying fuel suppliers and temporary material handling equipment required for the test burn.

South Mississippi Electric Power Association

- 2009-2010 | Study of various renewable energy options potentially available to serve load requirements of South Mississippi Electric Power Association’s (SMEPA’s) member cooperatives. Performed an evaluation of biomass fuel alternatives, including review of potential renewable energy legislation; an investigation of renewable fuel sources and technologies; and a feasibility study on the use of potentially viable renewable fuels at existing SMEPA generating units, including integration of biomass handling with existing facilities. Technologies included modifications to support several co-firing options; boiler conversions to stoker/BFB; and external combustion alternatives, such as Dutch ovens and full and partial gasifiers producing syngas. We also performed an economic evaluation of these renewable project alternatives.

Confidential Project – Midwest (West South Central) U.S.

- 2009-2010 | A biomass conversion study for two large coal-fired units, which included evaluating co-firing from 10% biomass. The report included material handling layouts, estimated costs, estimated emissions, and evaluations of the material handling system preparation equipment costs (wood chips, grasses, pellets, and torrified biomass) and the fuel supply for type and quantity available.

Confidential Project – Midwest (West North Central) U.S.

- 2009-2010 | Independent engineer assessment of an operating biomass unit with a single boiler and steam turbine. The assessment included reviews of fuel supply, system performance, environmental compliance, operations, staffing, and PPA and FSAs. Fuel consists of 100% biomass from multiple sources, including wood, harvest, and poultry farm byproducts.

Antilles Energy Cooperative – Lower Somerset Renewable Energy Facility

- 2009 | Owner’s engineer support for project start-up activities for the conversion of an existing generating facility from fuel oil to a biomass feedstock of poultry litter and agricultural feed. Feedstock processing included gasification for combustion, liquefaction-to-liquid biofuel products, and associated process stream cleanup. Sargent & Lundy assisted in developing the project’s commercial structure, defining the plant’s division of responsibilities and preliminary permit scoping, and generating an integrated project schedule.

Confidential Client – Existing CFB Unit

- 2008-2009 | Study of material handling issues associated with receiving and unloading wood chips at the site and conveying to the boiler. Target biomass fuel consumption was ~20% on a yearly average basis, maximum of 40%, by heat input of wood chips.
Renewable Energy Project Experience

Cleveland-Cliffs Northshore Mining – Silver Bay

- 2008-2009 | Evaluated co-firing up to 25% biomass (heat input) from a product line called Renewafuel, owned by the parent company. Evaluated methods of burning the fuel, as defined by the Renewafuel specifications, in Unit 2 at the Silver Bay Unit 2 boiler. (Renewafuel proprietary fuels are a blend of renewable feedstock and can be sized for boiler- or furnace-specific applications. Densified and custom-sized pellets allow immediate use in most existing solid fuel systems, with minimal capital improvements. The densified biofuel is consistent in size, heat value, and moisture content, so it is easier to store and use than raw biofuels.)

Also, Sargent & Lundy reviewed installation of new burners dedicated to the biomass fuel alone. We reviewed several standalone combustion options (e.g., Dutch ovens, gasifiers), which minimized the impact to the existing mills and burners. All options reviewed included evaluation of a new material handling system.

We also evaluated unit performance impacts and estimated changes to sulfur dioxide (SO$_2$), nitrogen oxide (NO$_x$), particulate matter (PM), mercury (Hg), and carbon dioxide (CO$_2$) emissions. We estimated capital expenditures, O&M costs, and completed an overall plant economic evaluation, including projected cash flow.

Entergy – Little Gypsy

- 2008 | Feasibility study of circulating fluidized bed (CFB) boilers (2x330 MW each) to repower an existing steam turbine fired on biomass. The evaluation included environmental considerations, performance assessments, and economic analyses based on a 2010 service date. We also reviewed the quantity and type of biomass near the site.

Tondu Corporation – Filer City

- 2008 | Evaluated NO$_x$ control options for two ~30-MW (each) stoker boilers. The boilers co-fired biomass (wood chips).

MidAmerican Energy – System-wide Biomass Evaluation

- 2008 | Evaluated the availability of various biomass fuels for use at several coal-fired stations in the client’s fleet. The study involved assessment of boiler operations, air quality control equipment, and material handling and the impact of onsite space requirements. Sargent & Lundy also studied sensitivity of providing up to 10% biomass fuel to each unit. We estimated emissions with the different types of fuels studied, including SO$_2$, NO$_x$, PM, Hg, and CO$_2$, and provided economic analysis of the capital expenditures, O&M expenses, delta fuel costs, and sensitivity on the value of CO$_2$ credits.

A separate study reviewed the technologies available for a 100% biomass-fired steam generator supplying a separate steam supply, including the appropriate material handling system, which is different from that used to prepare the fuel for direct injection into the boiler. The approximate size was 30–35 MW, including stokers, CFB boilers, and small gasification units.

City of Escanaba and Wisconsin Public Power, Inc.

- 2006-2008 | Siting and project feasibility study for new solid fuel generating unit of up to 300 MW to be located in Escanaba, Michigan, and jointly owned and operated by the City of Escanaba and Wisconsin Public Power, Inc. The fuel considered was a blend of coal and petroleum coke, with up to 8% heat input provided by wood chips.

Confidential Client – British Columbia, Canada

- 2007 | Conceptual design of the power block, including material handling layouts for a nominal 200-MW greenfield CFB unit, with the capability of firing up to 40% wood chips. The wood source considered for the study was the Pine Bark Beetle Kill affecting forests in British Columbia. Layouts were prepared for wood truck unloading, storage, reclaim, and preparation to feed an existing CFB boiler. Sargent & Lundy supported the air permit application on behalf of the client. Our scope included developing performance values, such as heat rate, emissions, waste quantities, and water consumption, along with estimated bus bar costs.
Credit Suisse First Boston – Aokam Perdana Timber Complex, Malaysia


CLECo – Rodemacher Unit 3

- 2007 | A feasibility study of 2x330-MW CFB boilers under construction to burn biomass. Sargent & Lundy’s evaluation included environmental considerations, performance assessments, and economic analyses based on a 2010 service date. We also reviewed the quantity and type of biomass near the site.

Upper Peninsula Power Company

- 2003-2004 | A siting and technology screening study for the use of wood waste. Sargent & Lundy evaluated the best locations on the transmission system, identifying the generation technology and capacity options to be used as the basis for the site evaluations and in developing the conceptual designs and cost estimates. Options centered on steam generating units capable of burning a mix of wood waste and Powder River Basin (PRB) coal.

Mitsui & Co. Ltd – Thailand

- 2003 | Developed technical and EPC contract information for the client to submit an offer for a 3x100-MW project using coal and biomass with CFB technology in Thailand. Sargent & Lundy’s scope included development of general arrangements, performance calculations, emission evaluations, site environmental parameters, single-line diagrams, costs estimates, scheduling, and functional plant and system descriptions, such as water supply and treatment.

Southern Illinois Power Cooperative – Marion Station Units 1-3

- 2000-2003 | Engineering and design to support the repowering of units that were originally commissioned in 1963. Existing steam turbines remained intact while the existing steam generators were retired and replaced with a single 120-MW circulating fluidized steam generator capable of burning coal refuse, petroleum coke, wood refuse, and tire-derived fuel.

Minnesota Power – Laskin Station

- 2001 | Studied the addition of a new boiler to an existing site and the repowering of existing steam turbines, including 70% PRB and 30% wood chips, and integration of a new material handling system with the existing coal yard.

Minnesota Power – Rainy Station

- 1997 | Condition and cost evaluation of the Blandin Paper Mill cogeneration and hydroelectric facility. Evaluated the existing facility condition (four wood waste/coal boilers, two turbines, 27-MW total; two hydroelectric turbines, 1-MW total) and performed a valuation in terms of potential sale value (capital value vs. revenue for an assumed rate of return) and remaining life value. Also evaluated potential partial replacement/expansion of the facility by integrating a variety of technology options: CFB, CT/HRSG, gas-fired boilers, and/or wood waste/coal stoker boilers.

Indiana Inland Steel Company – East Chicago

- 1989 | Assessed condition of powerhouse system and components, and identified and evaluated alternatives for upgrading powerhouse. Alternatives included burning process waste, paper, and wood currently being recycled.
Minnesota Power – Hibbard Station

- 1985-1987 | Conceptual design, feasibility study, and detailed design for converting Units 3 and 4 to burn wood and coal on a traveling grate stoker spreader. Scope encompassed engineering, procurement, and onsite engineering. Liaison during construction to convert oil-fired boilers, originally designed to burn coal, to fire on wood and coal and to provide a steam supply to a paper mill half a mile away. Early studies established the feasibility of converting two of the units, but dictated an ambitious 24-month schedule from authorization to completion. The boilers required extensive modifications to convert to traveling grate spreader stokers for efficiently firing the new fuel and meeting the paper mill’s steam requirements.

Sargent & Lundy has been actively involved in numerous landfill gas (LFG) projects, including the following explored below.

Dallas Clean Energy – McCommas Bluff LFG Facility

- 2010-2011 | Sargent & Lundy performed a due diligence review for the purposes of bond financing of the proposed project to improve existing wellfield infrastructure and to expand processing capacity from 9.8 million standard cubic feet per day (mmscfd) to 14.8 mmscfd. Our analysis included a wellfield and processing facility technology assessment, economic analysis of the project pro forma, validation of LFG recovery projections, forward renewable gas pricing analysis, and impact assessment of environmental regulations.

Electric Power Research Institute LFG Industry Report

- 2007 | Sargent & Lundy was retained by EPRI to prepare an assessment of the LFG industry in 2009. As part of EPRI’s Technical Assessment Guide (TAG’s) program, Sargent & Lundy prepared the LFG section in the renewable energy module entitled “Renewable Power Generation Technologies – Current Status, Cost & Performance and Future Trends.”

Exelon Fairless Hills LFG Generating Station Project

- 2003-2008 | Fairless Hills was purchased by Exelon from U.S. Steel in 1997. The boiler plant was being used to support the steel production at the site. The boilers burned off-gas product with a heat content ranging from 100–200 Btu. Fairless Hills was converted to burn LFG in 1997 when it was purchased by Exelon Corporation. At that point, Exelon converted Boilers 4 and 5 from burning off-gas to burning LFG with a heat content of approximately 500–600 Btu. Exelon has a long-term contract with Waste Management Corp. to supply LFG to the facility. Boiler 6 still burns natural gas as a peaking boiler.

There are two turbines and three boilers with each turbine producing roughly 30 MW. One boiler usually supports one turbine, but the LFG flow will increase such that two turbines and two boilers will need to be online at all times.

Since 2003, Exelon has invested approximately $8–$12 million each year to support this facility. Sargent & Lundy was involved with and supported turbine inspections/overhauls, boiler studies, and outages to support the dual unit operation. In addition to the boiler and turbine work, Sargent & Lundy has also been involved with all of their BOP improvement services. The following summarizes some of the projects Sargent & Lundy has performed at Fairless:

- Boiler 4 and 5 outages: scope of work specifications, contractor evaluations, and recommendations
- Turbine 2: scope of work specifications, contractor evaluations, and recommendations
- Boiler 6 study on the scope and cost to convert to LFG
- Installation of a revenue LFG flow meter interfaced with Waste Management Corp.
- Replacement of the low-temperature and high-temperature air heaters on Boiler 4.
- Conceptual design, detailed design, and follow-on work associated with adding a new water treatment plant; downsized from the old facility.
- Modified BOP systems
E/S Energy Solutions – McCommas Bluff Landfill Gas Projects

2006 | Performed due diligence reviews for E/S Energy Solutions on two alternatives for the McCommas Bluff LFG facility in Texas.

LFG to High-Btu Gas Conversion Project (4.0 Million Cubic Feet/Day)

2005 | The previous LFG to high-Btu gas conversion project had been underperforming in capacity factor and availability. Sargent & Lundy performed a due diligence review of E/S Solutions’ plans to improve the performance and availability of the facility. Areas of potential improvement or upgrades included reliability of the LFG flow from the landfill, LFG purification, maintenance program, and selected equipment replacement or upgrading.

LFG Engine Project (14 x 1.75-MW Reciprocating Engines)

2005 | Sargent & Lundy reviewed an alternate plan to install LFG engines to utilize the McCommas Bluff LFG. Proposals were reviewed for the engine supply and installation work, and engine maintenance. Sargent & Lundy reviewed the LFG flow capability from the landfill to support a multiple engine project over the long term and the proposed LFG purification strategy.

Richland & Anderson County LFG Projects

2004-2006 | Sargent & Lundy was the owner’s engineer for the design and installation of two power generation LFG facilities located in South Carolina. The client negotiated the rights to take LFG currently being flared from existing landfills and installed Solar Taurus 60 combustion-turbine-based power generation facilities at both sites. The solar equipment and the LFG conditioning skids were reviewed by Sargent & Lundy and purchased by the client.

Sargent & Lundy’s scope included the review of client-prepared specifications for various LFG system components and associated prefabricated buildings, and review of the vendor design drawings and direct vendor interface. In addition, we provided engineering support for all BOP systems and structures, including assisting with the final site general arrangement, development of an installation package for all of the plant equipment, integration of the fuel system components, and reviews of vendor data.

Dairyland Power LFG Project

2004 | Sargent & Lundy was retained by Dairyland to evaluate the costs associated with potential LFG to energy projects to be constructed at two different landfill sites within the Dairyland service territory. The scope of the study included: (a) estimates of LFG production and evaluation of generation technology options, sizing and performance; (b) range estimates for capital costs and for O&M costs; and (c) development of a project pro forma that estimated the annual revenue requirements derived from electric energy sales needed to provide a reasonable rate of return. The pro forma calculated annual income based on fixed and variable operating costs, debt service, taxes, insurance and general administrative costs.

Johnston, Rhode Island – Florida Power & Light LFG Project

2004 | Sargent & Lundy was retained by SCS Engineers to investigate the utilization of LFG at Florida Power & Light’s Johnston, Rhode Island, combined-cycle plant, which is located adjacent to the Rhode Island Resource Recovery Corporation landfill. The Johnston combined-cycle plant consisted of two Westinghouse W501FD combustion turbines, including supplemental burners in the heat recovery steam generators. The facility did not possess an auxiliary boiler or any other gas burning components. Sargent & Lundy, in conjunction with Earth Tech Solid Waste Services, evaluated the impact of both treated as well as untreated LFG in terms of performance issues (e.g., power output, heat rate, and emissions), maintenance issues (e.g., wash frequencies, maintenance cycles, and warranty issues), HRSG performance issues (e.g., duct burners and SCR catalyst), and the feasibility and economics associated with various LFG cleaning technologies.
Arrow Canyon LFG Project

2003 | Sargent & Lundy was retained by Reliant Resources, Inc., to investigate the use of LFG at its proposed Arrow Canyon combined-cycle facility in Nevada. The following production options were evaluated:

- Compression and treatment of LFG for use as a supplemental fuel in the Siemens-Westinghouse combustion turbines.
- Compression and treatment of LFG for use in the combined-cycle burners.
- An independent steam boiler/steam turbine facility for electrical generation.
- Steam boilers fueled by LFG integrated with the combined-cycle boilers and steam turbines.
- Internal combustion engines with and without heat recovery.
- Gas turbines with and without heat recovery.

The above options were evaluated in terms of plant performance, maintenance, reliability, and cost.

Jacksonville Electric LFG Project

2003 | Sargent & Lundy was retained by Jacksonville Electric Authority to evaluate and solve a significant corrosion problem associated with the BOP piping on the reciprocating engine skids firing LFG. The problem was caused by inadequate treatment of the LFG.
Geothermal

Examples of Sargent & Lundy’s active involvement in geothermal energy projects are summarized below.

**Enel Green Power North America, Inc.**

- 2013 | Independent engineering assessment of the Cove Fort Geothermal Project in southern Utah to provide a completion certification report in accordance with application requirements of the *United States Treasury American Recovery and Reinvestment Act of 2009 (ARRA) Payments for Specified Energy Property in Lieu of Tax Credits Section 1603*. Sargent & Lundy performed a site visit and reviewed project design documents and agreements. The project was completed by Enel Green Power North America, Inc., a branch of the Italian utility Enel SpA, with Ormat Technologies, Inc., as the EPC contractor and major equipment provider.

**Inversiones Energeticas S.A. DE C.V.**

- 2007-2010 | Berlin Unit 3 is a 44-MW geothermal power plant in the Usulutan province in eastern El Salvador. The plant is a direct-injection geothermal plant, and the steam turbine is designed for steam conditions of 160°C and 8 bar at the inlet. During inspections of the steam turbine, cracks were discovered by the owner in the last stage blades. Sargent & Lundy provided engineering services to identify the root cause of the cracks and to evaluate potential solutions. We worked with the owner and the steam turbine manufacturer to identify and implement modifications. We also participated in steam turbine inspections to verify the success of the modifications.

**Electric Research Power Institute**

- 2010 | Updates to the geothermal sections of the EPRI *Technology Assessment Guide*.

**Confidential Clients**

- 2008 | Environmental reviews for 10 geothermal generating plants in the Southwestern United States.

- 2008 | Study for additional generation adjacent to an existing facility. This included non-combustible renewable energy and geothermal.

- 2007 | Technical support on two geothermal projects in Central America. This included evaluation of failure modes on new and operating turbines, reviewing manufacturer’s root cause analysis results, and formulating independent recommendations on addressing reliability issues.
Renewable Energy Project Experience

Geothermal

Pacificorp
- 2005 | Services associated with well bearing cooling water issues, BR-6 brine pump repairs, derating, and a controls system upgrade for the Blundell Geothermal Plant.

Southern California Edison
- 2005 | Study of alternative/complementary generation resources for the Mohave power plant. Our study included a feasibility analysis of renewable energy, including geothermal.

CMS Generation
- 2001 | Technology survey and analysis investigation of commercially available renewable energy technologies for CMS Generation (Michigan) to incorporate into their long-term power generation strategic plan. The renewable energy technologies surveyed included geothermal power.

For more information:
Matthew Thibodeau | Vice President
+1-312-269-6864 | matthew.r.thibodeau@sargentlundy.com
Sargent & Lundy has provided extensive engineering and consulting services for hydroelectric power projects worldwide. Recent hydroelectric power consulting and engineering service engagements are summarized below.

**International Finance Corporation, West LB, Akbank, and European Investment Bank**
- 2007-2017 | Nine Enerjisa hydroelectric projects in Turkey totaling over 1,000 MW. Lender's engineering, including preconstruction due diligence and environmental review; construction and performance test monitoring; monitoring during startup; and operations monitoring. Sargent & Lundy has performed more than 70 construction monitoring and operations monitoring site visits.

**Kaukauna Utilities**
- 2017 | Owner's engineer bid reviews to support relicensing of two existing small hydroelectric power plants in Wisconsin.
- 2015 | Owner’s engineer bid review to support relicensing of an existing small hydroelectric power plant in Wisconsin.

**Confidential Clients**
- 2016 | Asset acquisition due diligence services for two hydroelectric projects in Peru.
- 2016 | Technical consulting services for arbitration support for three hydroelectric projects in Canada.
- 2016 | Technical support and prepared EPC specification for the upgrade (from 3 MW to 12 MW) of a small hydroelectric project in the Midwestern U.S.

**Enerjisa Enerji Uretim A.S.**
- 2017 | Performed a technical review of the Dogançay hydroelectric power plant (HEPP) project in cooperation with its partner, Fichtner GmbH & Co. KG (Fichtner). Also prepared a review of the environmental and social aspects of the projects. This review was designed to verify the project’s compliance with the Equator Principles and the IFC’s Performance Standards. The installed capacity of the powerhouse is 64 MW, which results in a power generation of about 168.98 gigawatt hours (GWh) per year. The project is located in the Seyhan River Basin in the southern part of Turkey,
ContourGlobal

- 2017 | Independent technical and environmental due diligence for the Vorotan Cascade project consisting of three HEPPs across four reservoirs situated on and adjacent to the Vorotan River in the southeastern part of Armenia. The three power plants have a total installed electrical capacity of 404 MW. Additional annual monitoring was requested as well.

- 2016 | Asset acquisition due diligence of three hydroelectric power plants, two in Peru and one in Central America, to support client.

American Electric Power

- 2015 | Independent engineering review of a small hydroelectric project in Ohio.

Overseas Private Investment Corporation and International Finance Corporation

- 2013-2014, 2016-2017 | Independent engineering review as lender’s technical advisor to support financing of acquisition and refurbishment of a hydroelectric project in Armenia. Sargent & Lundy performed a technical review of the project, including project financial statement, hydrological studies, refurbishment plan, interconnection, and key project contracts.

Comisión Ejecutiva del Río Lempa (CEL)

- 2005-2007 | 180-MW hydroelectric plant in El Salvador. Sargent & Lundy performed owner’s engineering services for a generator re-wind and other changes in order to increase two generators’ power output by approximately 20%.

West LB

- 2004-2007 | El Cajon 750-MW hydroelectric project in Mexico. Sargent & Lundy performed lender’s engineering services, including preconstruction due diligence and environmental review; construction and performance test monitoring; and monitoring during startup.

Inter-American Development Bank (IDB)

- 2006 | Abanico 15-MW run-of-river hydroelectric project in Ecuador. Provided lender’s engineering services, including preconstruction due diligence.

Total Fina Elf

- 2000 | Piedra del Aguila 1,400-MW hydroelectric project in Argentina. Provided a due diligence review for potential acquisition.

For more information:
Matthew Thibodeau | Vice President
+1-312-269-6864 | matthew.r.thibodeau@sargentlundy.com
Sargent & Lundy has been actively involved in numerous energy storage projects that have used a variety of technologies, including batteries, compressed air, and pumped hydropower. Energy storage is a major issue with renewable generation: intermittent fuel availability creates challenges aligning generation with demand. Sargent & Lundy has assessed and designed systems for energy supply, grid stability, and other applications. Below is a summary of our experience.

**Confidential Clients**

- **2017-2018** | Performed technical study and conceptual design for integration of battery energy storage into six existing power generation projects in the U.S., including one solar PV project and five gas plants.
- **2016** | Performed due diligence for a private equity client seeking to invest in a battery manufacturing company. Sargent & Lundy evaluated the technical performance of the battery company’s novel metal-air battery technology and reviewed the company’s financial projections. Sargent & Lundy also performed a valuation of the company.
- **2016** | Performed market study and financial evaluation of adding a battery energy system to an existing wind project in the PJM region. Sargent & Lundy assessed the new PJM capacity performance market to evaluate the battery system economics.
- **2016** | Performed a technical feasibility study and conceptual design for integrating battery energy storage into the San Francisco Bay Area Rapid Transit (BART) electrical system.
- **2015-2017** | Owner's engineering bid evaluation services for six energy storage projects in the Northeastern U.S. Sargent & Lundy supported technical Q&A and negotiations with bidders. In addition, Sargent & Lundy supported the offtaker to negotiate the power supply contract.
- **2013, 2015** | Provided cost and performance estimates to a Midwestern U.S. utility for battery storage and pumped storage systems to support client’s resource planning activities.
- **2013-2014** | Bid reviews of more than a dozen energy storage proposals on behalf of a utility client in the Northeastern U.S.
2009-2011 | Engineering services for several energy storage projects totaling in excess of 60 MW, including conceptual studies, conceptual design, detailed design, construction oversight, and interconnection studies. The objectives of the projects were to provide services, such as grid stability and power plant ancillary services, and enhance wind facilities’ operation.

2009 | Study and development of a plan, including conceptual design, to integrate 10 MW of battery storage with the client’s utility-scale solar PV project in the Southwestern U.S.

NextEra Energy Resources

2016 | Engineering services and equipment procurement support for Casco Bay 16-MW Battery Energy Project in Maine.

2016 | Engineering services and equipment procurement support for Pima 10-MW Battery Energy Project in Arizona.

2016 | Engineering services and equipment procurement support for Southwest 1.5-MW Battery Energy Project in Florida.

2016 | Engineering services and equipment procurement support for Florida Bay 1.5-MW Battery Energy Project in Florida.

2015 | Independent engineering services for two energy storage projects in the Northeastern U.S.

2015 | Engineering services and equipment procurement support for Meyersdale 18MW Battery Energy Project in Pennsylvania. The project is co-located with a wind power project.

2015 | Engineering services and equipment procurement support for Green Mountain 10MW Battery Energy Project in Pennsylvania.

PacifiCorp

2005 | Owner’s engineering services, including development of compressed air energy storage (CAES) conceptual design.

CAES – Norton

2004 | Owner’s engineering services, including development of CAES conceptual design.

Electric Power Research Institute

1998 | Study and preparation of a technical report (EPRI Report TR-111691, “Compressed Air Energy Storage with Humidification – An Economic Evaluation”) on compressed air energy storage with humidification (CASH). This project encompassed technology evaluation and financial modeling; preliminary system design, including layout drawings and conceptual equipment arrangements; capital cost estimates for this technology and competing technologies; market price study for electricity; fuel cost estimates; and development of pro formas for each technology.

U.S. DOE, EPRI, Public Service Company of Indiana, Westinghouse Electric Company

1982 | Three-year study of CAES and preparation of a report (EPRI Report EM 2351, “Compressed Air Energy Storage Preliminary Design and Site Development Program in an Aquifer”), including project coordination, power system studies, geotechnical review and design, site study and selection, turbine design, BOP design, cost estimating, schedule preparation, licensing assessment, and environmental impact study.

For more information:
Matthew Thibodeau | Vice President
+1-312-269-6864 | matthew.r.thibodeau@sargentlundy.com
Sargent & Lundy has extensive experience with hybrid power plants, including the planning and design of these complex projects.

**Confidential Clients**
- 2016 | Provided development support, conceptual design, and owner’s engineering services for planned 120 MW hybrid power plant in California using solar PV and thermal generation.
- 2013, 2015 | Managed power supply planning process for a utility client in the Northeastern U.S. Reviewed and evaluated more than 50 power supply and load reduction bids. The bids included technologies such as combustion turbines, reciprocating engines, energy storage, microgrids, and demand-side projects.

**Value Recovery Holding**
- 2017 | Developed modeling tool for integration and optimization of backup generators for microgrids.
- 2015-2016 | Reviewed sizing and conceptual design of microgrid planned for installation at a U.S. Army base. The project included solar PV, liquid fuel engines, and battery energy storage.

**NIPSCO**
- 2013, 2015 | Provided cost and performance estimates for various power generation and energy storage systems to support client’s resource planning activities.

**American Capital Energy & Infrastructure**
- 2014 | Performed a renewable energy integration assessment for the Senegal (country-wide) electric grid to assist the client with their evaluation of a wind power project acquisition. As part of the study, Sargent & Lundy assessed the existing generators on the system and their reserve capabilities.

**Maui Electric Company**
- 2013 | Performed a renewable energy integration assessment to assist the client with their efforts to expand the use of wind and solar power while maintaining reliability requirements.
Agrifos Fertilizer
- 2009-2010 | Prepared a study of onsite renewable energy alternatives for an industrial company located in the Houston, Texas area. The evaluation included solar PV, solar thermal, and wind power.

Unilever
- 2008-2009 | Performed a study of energy usage, boiler replacement options, and onsite renewable energy alternatives for Unilever’s industrial facility in Southern California. The evaluation included combined heat and power, solar PV, and energy efficiency.

InterGen: Integrated Solar Combined Cycle
- 2008 | A feasibility study of a solar retrofit for a 501F 1x1 combined-cycle unit. The CSP technologies addressed were parabolic trough, power tower, and compact linear Fresnel receiver (CLFR). The relevant advantages and disadvantages of each type of system were identified. Evaluation areas included steam conditions achievable, technology maturity, comparative capital and O&M costs, and equipment availability.

Southern California Edison
- 2005 | Prepared a study of alternatives for replacement or to complement the share of electrical capacity generation of Southern California Edison’s ownership share of the 1,580-MW Mohave generating station, in response to a California Public Utilities Commission (CPUC) order. The evaluation included solar, wind, other renewables, demand side management and energy efficiency, integrated solar combined-cycle, and combined-cycle natural gas.

City of Ames, Iowa
- 2004 | Developed a recommended resource plan that identified the generation resources required to meet the forecast electricity needs of Ames Electric Services’ customers through 2025. The resource options included renewable energy resources that would be appropriate for the Green Choice program, primarily biomass and wind along with efficient, low-emission generating technologies like natural gas or other fuels.

San Diego Gas & Electric
- 2003 | Consulting support and services to San Diego Gas & Electric (SDG&E) for new power supply resources, including renewable generation, fossil generation, and demand-side resources; provided consulting support through the evaluation of options, contract negotiation, and utility commission filings for PPAs and turnkey plant purchases.

CMS Generation
- 2000 | Performed a technology survey and analysis investigation of commercially available renewable energy technologies for CMS Generation (Michigan) to incorporate into their long term power generation strategic plan. The renewable energy technologies surveyed included wind power, biomass, geothermal, solar thermal, and solar PV.

For more information:
Matthew Thibodeau | Vice President
+1-312-269-6864 | matthew.r.thibodeau@sargentlundy.com
Selected Sargent & Lundy Renewable Energy Publications and Presentations


These and other papers are available upon request.