Hydrogen Experience
Owner's Engineering, Studies, Technical Oversight

Sargent & Lundy

Client	Location	Facility Type	Major Equipment	Schedule
Confidential	**Confidential, U.S.**	**Combined Cycle**	**Advanced-Class Gas Turbines**	**Q1 2022–Ongoing**
Feasibility study for cofiring of hydrogen in advanced-class gas turbines at new combined cycle facility. The study includes the preliminary engineering, design, and cost considerations of blending hydrogen with natural gas and cofiring in advanced-class gas turbines at concentrations of 30 vol% and 100 vol%.				
Confidential	**Confidential, U.S.**	**Combined Cycle**	**Proton Exchange Membrane (PEM) Electrolyzers, Storage, Compressor(s), Gas Turbine**	**Q1 2022–Ongoing**
Owner's engineering for hydrogen production facility. Sargent & Lundy is providing owner's engineering services to a utility client for the design of a hydrogen production facility co-located with an existing combined cycle power plant. Our scope includes conceptual design of a 20-MW hydrogen generation facility, encompassing gaseous hydrogen storage, compression, and blending systems.				
Confidential	**Various, U.S.**	**Solar PV**	**TBD**	**Q1 2022–Ongoing**
Owner's engineering for various solar PV facilities. Sargent & Lundy is providing owner's engineering services a solar PV developer with renewable energy facilities across the U.S. Our scope includes conceptual designs of hydrogen generation facilities, energy modeling and forecasting, and siting studies for hydrogen generation capacities from 25 MW to 200 MW, including liquefaction and trucking terminals.				
Confidential	**Confidential, U.S.**	**Wind Farm**	**Proton Exchange Membrane (PEM) Electrolyzers, Storage, Compressor(s), Tube Trailer Filling**	**Q1 2022–Ongoing**
Owner's engineering for virtual hydrogen pipeline. Sargent & Lundy is providing owner's engineering services for design and construction of a new virtual hydrogen pipeline facility at an existing renewable energy facility of greater than 300 MW. The facility design includes 12 MW to 15 MW of PEM electrolyzers with corresponding hydrogen compression and trailer offloading. Sargent & Lundy is leading the conceptual design, long-lead equipment procurement, EPC contract development, and overall project execution oversight.				
Confidential	**Confidential, U.S.**	**N/A**	**N/A**	**Q1 2022–Ongoing**
Hydrogen market forecasting Tool. Sargent & Lundy was contracted by a large investment firm to support the development of a supply and demand analysis of hydrogen and electricity based on future decarbonization initiatives in home heating and heavy industry sectors. The client requested Sargent & Lundy's assistance in developing a Microsoft Excel-based model and a data repository of industry data. The model will enable the client to forecast future hydrogen demand for electricity generation based on decarbonization sensitivities. Sargent & Lundy is also preparing a corresponding white paper that will provide supplemental qualitative discussion on various topics in hydrogen markets, home heating, and heavy-industry sectors.				

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Confidential	**Confidential, U.S.**	**Microgrid / Hydrogen Fueling**	**Proton Exchange Membrane (PEM) Electrolyzers, Storage, Compressor(s), H_2 Fueling, Fuel Cell**	**Q4 2021–Ongoing**
Resiliency study related to variable renewable energy sources coupled with grid electricity to provide resilient power and hydrogen fueling capabilities. The study focuses on both 100-kW and 1-MW electrolyzer systems with differently sized components incorporated within an existing microgrid to produce hydrogen for energy storage and hydrogen fueling stations. These components include electrolyzers, stationary fuel cells, hydrogen storage, hydrogen fueling stations, and all associated balance-of-plant (BOP) supporting systems. Activities include equipment sizing, systems design, and cost estimating for the systems.				
Confidential	**Confidential, U.S.**	**Power-to-Gas**	**PEM Electrolyzers, Storage, Compressor(s)**	**Q4 2021–Ongoing**
Front-end engineering and design (FEED) study related to a power-to-gas hydrogen demonstration plant for distributed energy storage around renewable assets. The study includes engineering, design, and cost estimating for a facility that will produce hydrogen via 5-MW of PEM electrolysis driven by renewable wind power and store the hydrogen on site to be sold to the hydrogen market. The study encompasses hydrogen compression and gaseous hydrogen storage in tube racks along with a filling station for mobile tube trailers. This first-of-a kind power-to-gas demonstration would produce carbon-free hydrogen for sale when the grid does not require all of the power produced at the site.				
Confidential	**Confidential, U.S.**	**Commercial Trucking Fleet**	**PEM Electrolyzers, Storage, Compressor(s)**	**Q4 2021–Ongoing**
Development of commercial Class 8 trucking fleet zero-emission/decarbonization transition utilizing multiple technologies, including battery electric and hydrogen fuel cell vehicles. Sargent & Lundy is providing energy assessments and conducting modeling for the fleet conversion to evaluate new energy needs to develop the corresponding infrastructure and facilitate power purchase agreements, as well as onsite renewable generation where feasible. The facilities are planned to include 95% of fleet fueling on site at regional distribution centers with onsite hydrogen production and storage.				

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Confidential	**Confidential, U.S.**	**Distributed Generation**	**SMR Based Hydrogen Generation**	**Q4 2021–Q1 2022**
Technology due diligence of novel SMR-based distributed hydrogen generation technology. Sargent & Lundy was contracted by a potential investor to perform a technology due diligence of a skid mounted distributed hydrogen generation system capable of generating 1,000 kg/day of hydrogen utilizing a proprietary SMR technology. Sargent & Lundy's review focused on process efficiency, output, and safety features to ensure that the skid was suitable for any site or environment. In addition to reviewing the technical aspects of the skid, Sargent & Lundy was tasked with reviewing the financial model prepared manufacturer. The manufacturer prepared a single representative financial model for the skid which included capital costs, O&M costs, and consumable costs. Sargent & Lundy was tasked with confirming that the financial model parameters were adequate for any site or environment the skid may operate in. Sargent & Lundy also prepared a technical and financial comparison of the skid against existing commercially available hydrogen technologies which included SMR, electrolysis, and fuel cell technologies.				
Confidential	**Confidential, U.S.**	**Simple Cycle**	**PEM Electrolyzer, Storage, Compressor(s), Gas Turbine**	**Q3 2021–Ongoing**
Engineering for commercial-scale hydrogen production and storage project collocated with existing simple cycle facility for hydrogen cofiring in a gas turbine. The project includes 2 MW of renewable solar photovoltaic (PV)-powered PEM electrolyzers, hydrogen compression, gaseous aboveground storage, and blending of hydrogen with natural gas for use in an existing gas turbine. Hydrogen will be stored on site in stationary tube bundles and be able to be blended into the gas turbine at varying concentrations. The project includes other aspects of the facility, such as integration with the plant's water treatment system, a cooling system, hydrogen detection and monitoring, and fire protection.				
Confidential	**Confidential, U.S.**	**Generation and Storage**	**Advanced-Class Gas Turbine, Alkaline Electrolyzers, Geologic Storage**	**Q3 2021–Ongoing**
Large-scale hydrogen production and storage. Sargent & Lundy is providing owner's engineering services for 200+MW of grid-connected alkaline electrolyzers with corresponding hydrogen compression and geologic storage.				
Confidential	**Confidential, U.S.**	**Liquid Hydrogen Terminal**	**Hydrogen Liquefaction, Hydrogen Filling Station/Terminal**	**Q2 2021–Ongoing**
Pre-front-end-engineering-design (FEED) study and conceptual design for large-scale hydrogen liquefaction and distribution terminal. The study encompasses the hydrogen liquefaction technology selection, process design, and storage, as well as the truck terminal. The study consists of conceptual engineering, design, and cost estimating related to the 30 tons per day (tpd) production facility. Hydrogen would be stored on site in cryogenic bullet tanks.				

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Confidential	**Confidential, U.S.**	**Combined Cycle**	**Advanced-Class Gas Turbines, PEM Electrolyzers**	**Q1 2021–Ongoing**

Pre-FEED study and conceptual design for production of green hydrogen powered by renewable solar photovoltaic (PV) power at advanced-class combined cycle facility. The study also includes the compression, storage, and blending of hydrogen with natural gas for use in an advanced-class combined cycle facility. The study consists of conceptual engineering, design, and cost estimating related to the 25-MW production facility. Hydrogen would be stored on site in stationary tube bundles and be able to be blended into the gas turbines at varying concentrations. The project encompasses other aspects of the facility, such as the electrolysis building design, hydrogen detection and monitoring, and fire protection.

Confidential	**Confidential, International**	**Power-to-Ammonia**	**Solar PV, Electrolyzers, Ammonia Production**	**Q1 2021–Ongoing**

Large-scale power-to-ammonia facility. We are providing lender's technical advisory (LTA) services for development of a facility that will use renewable solar PV resources to power the production of hydrogen via electrolysis. The hydrogen will then be synthesized into green ammonia using the Haber-Bosch process for distribution. We are also reviewing project documents on behalf of the client to ensure the safe and compliant design of the facility.

EPRI/ NYPA	**Long Island, New York**	**Simple Cycle**	**GE, LM6000**	**Q1 2021 - Ongoing, Q4 2021 (12 months)**

Hydrogen cofiring demonstration plant at simple cycle facility. Sargent & Lundy is providing owner's engineering services for this project being executed in conjunction with owner NYPA, research partner EPRI, and original equipment manufacturer (OEM) General Electric (GE). Our scope includes providing technical oversight on behalf of EPRI, to ensure the project design is executed properly, with specific focus on safety. We are performing a targeted review of all safety requirements, code requirements, OEM requirements, and utility procedural/safety requirements. Our scope also includes providing quality control inspections for all fabricated components.

Sargent & Lundy is also providing additional Engineer-of-Record services directly to NYPA for this project. These services include additional oversight of the project to enable Sargent & Lundy to provide certifying documentation that the project and the work of the engineering and design partners is being performed in accordance with applicable codes, standards, etc. We are further providing certifying documentation to the NYPA codes group in support of NYPA's internal certification process for obtaining building permits.

The intent of the project is to perform a short-duration hydrogen cofiring demonstration from 0-30 vol% hydrogen to gather technical data from real-world testing of the existing equipment's cofiring capabilities. The data are expected to be used by the OEM to improve technical knowledge of the impacts of hydrogen cofiring on the equipment. This project is first-of-its-kind for proving hydrogen cofiring capacity in an existing combustion turbine, which was not designed to accommodate hydrogen-blended fuels.

Confidential	**Confidential, U.S.**	**Combined Cycle**	**Advanced-Class Gas Turbines**	**Q4 2020–Ongoing**

Engineering study for mixing and cofiring of pipeline-supplied hydrogen in advanced-class gas turbines at new combined cycle facility. The study includes the preliminary engineering, design, and cost estimating of all upstream BOP infrastructure for hydrogen and natural gas conditioning, blending of hydrogen with natural gas, and more, before being sent to the gas turbines. The study also assesses the blending of hydrogen at an initial concentration of 30 vol% and eventual transition to 100 vol% with the focus on the impacts to the fuel delivery system.

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Confidential	**Confidential, U.S.**	**Nuclear Pressurized/Boiler Water Reactor (PWR)**	**High-Temperature Steam Electrolysis (HTSE)**	**2021–Ongoing**
High-temperature steam electrolysis (HTSE) equipment at nuclear facility. We are supporting the client's grant application to the DOE for the installation of an HTSE skid. Sargent & Lundy's work included conceptual plant interconnection designs and cost estimates for both a BWR and a PWR installation of a demonstration-sized HTSE skid (200-kW to 1-MW). The conceptual interconnect designs encompass both thermal and electrical interfaces, including the unique considerations needed for either a PWR or BWR. Also assisting the client with the development of a purchase specification related to the HTSE skid, now sized to be 150-360 kW in size.				
Confidential	**Confidential, U.S.**	**Nuclear PWR**	**PEM Electrolysis**	**2019–Ongoing**
Multiphase engineering study for coupling of nuclear power and carbon-free hydrogen production. The study focuses on conceptual engineering to couple a nuclear power plant with a PEM electrolyzer-driven green hydrogen production pilot as a proof-of-concept for nuclear-powered hydrogen production. Work covers the engineering change packages associated with the electrical interconnect, control room modifications, and the hydrogen island design. Hydrogen island includes 2 MW of PEM electrolysis, compression, and offtake to tube trailers. Project also investigating the scale-up of the system to larger sizes up to 65 MW.				
Confidential	**Confidential, U.S.**	**Power-to-Power**	**PEM Electrolyzer, Fuel Cell**	**Q1 2021–Q3 2021**
Pre-FEED study and conceptual design for power-to-power hydrogen demonstration plant for distributed energy storage around renewable assets. The study included engineering, design, and cost estimating for a facility that will produce hydrogen via 2.5 MW of PEM electrolysis driven by renewable wind power and be stored on site for dispatched use in a fuel cell. The study encompassed hydrogen compression and gaseous hydrogen storage in tube trailers. This first-of-a kind power-to-power demonstration would produce carbon-free hydrogen for energy storage to be converted back into power with the fuel cell when required by grid demands.				
Confidential	**Confidential, U.S.**	**Simple Cycle**	**GE, LM6000**	**Q4 2020–Q2 2021 (6 months)**
Engineering study for multiphase hydrogen cofiring project planning initiative. The study consisted of a two-phase execution plan for hydrogen cofiring at an existing simple cycle peaking plant. The study considered initial execution of the project for proof-of-concept testing utilizing truck/trailer-delivered hydrogen, onsite blending, and cofiring of hydrogen up to a specified percentage (as limited by the existing gas turbine technology). The study also considered long-term execution, including onsite generation of hydrogen via 12.5-MW of PEM electrolyzers, onsite storage of hydrogen, and cofiring at two percentages (again, as limited by the existing gas turbine technology). Both phases of the project required evaluation of technical impacts and cost implications. For cost control, demonstration-phase systems and infrastructure were designed for maximum reuse during long-term execution to support onsite generation, storage, blending, cofiring, etc.				

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Confidential	**Confidential, U.S.**	**Combined Cycle and Simple Cycle**	**GE, LM6000**	**Q4 2019–Q1 2020 (4 months)**
Multiphase study to evaluate hydrogen cofiring as compared to traditional carbon capture at two separate facilities (one combined cycle and one simple cycle). The intent of study was to determine the technical and economic feasibility of carbon reduction strategies after evaluating both hydrogen cofiring and traditional carbon capture. The initial study phase for hydrogen cofiring evaluated hydrogen generation technologies and storage methods (study also considered carbon capture). Consideration was given to onsite generation and onsite storage of hydrogen. Preliminary selections for hydrogen generation technology and hydrogen storage methods were set in this phase, based on high-level cost and technical feasibility considerations. The subsequent study phase for hydrogen cofiring developed the technical impacts and cost implications of onsite generation of green hydrogen (via renewable-powered electrolysis), onsite storage of hydrogen, and cofiring of hydrogen up to a specified percentage (limited by the existing gas turbine technology).				
Confidential	**Confidential, U.S.**	**Coal-Fired Power Plant**	**Coal-Fired Boiler**	**2019–2020**
Coal-to-gas repowering study for firing hydrogen-rich gas at ~120-MW coal power plant unit. The study included conceptual engineering, permitting and environmental investigations, and a cost estimate. The hydrogen source in this case was via pipeline from a neighboring facility; therefore, the study included both offsite and onsite transmission pipeline fuel delivery system infrastructure, such as a gas metering and regulation (M&R) stations, gas compression technology, flare technology and more, as well as BOP supporting systems. Several compressor OEMs were engaged related to the supply of large, multistage hydrogen compressors needed to meet the required pressure and flow at the boiler. The study also interfaced with the boiler OEM related to modifications needed to convert from coal to the hydrogen-rich gas as the primary fuel source, with natural gas as a secondary fuel source.				