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**The Empire District Electric Company d/b/a Liberty**

**EA-2025-0299**

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1898 & CO
PART OF BURNS & McDONNELL

# TECHNOLOGY ASSESSMENT STUDY

## LIBERTY UTILITIES

## PROJECT NO. 178566

## REVISION 0

September 4, 2025

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# FIGURES

**No table of figures entries found.**

# TABLES

# LIST OF ABBREVIATIONS

| Abbreviation | Term/Phrase/Name |
|---|---|
| $/GT-start | Dollar per Gas Turbine start |
| % | Percent |
| °F | Degrees Fahrenheit |
| 1898 & Co. | 1898 & Co., a part of Burns & McDonnell, Inc. |
| AF | Availability Factor |
| ASHRAE | American Society of Heating, Refrigerating, and Air-Conditioning Engineers |
| BACT | Best Available Control Technology |
| BESS | Battery Energy Storage System |
| BOP | Balance of Plant |
| Btu/kWh | British Thermal Units per Kilowatt-hour |
| CEMS | Continuous Emissions Monitoring System |
| CO | Carbon Monoxide |
| COD | Commercial Operations Date |
| DLN | Dry-Low NOx |
| EPC | Engineer, Procure, Construct |
| FOF | Forced Outage Factor |
| ft | Feet |
| FTE | Full-time Equivalent |
| GADS | Generating Availability Data System |
| GE | General Electric |
| GSU | Generator Step-up Unit |
| GT | Gas Turbine |
| GTG | Gas Turbine Generator |
| kV | Kilovolts |

| Abbreviation | Term/Phrase/Name |
|---|---|
| Liberty | Liberty Utilities |
| LTSA | Long-term Service Agreement |
| MECL | Minimum Emissions Compliant Load |
| MMBtu/hr | Million British Thermal Units per Hour |
| MW | Megawatt |
| NERC | North American Electric Reliability Corporation |
| NOx | Oxides of Nitrogen |
| NSPS | New Source Performance Standard |
| O&M | Operations and Maintenance |
| O2 | Oxygen |
| OEM | Original Equipment Manufacturer |
| PM | Particulate Matter |
| ppm | Parts per Million |
| R&D | Research and Development |
| RH | Relative Humidity |
| RICE | Reciprocating Internal Combustion Engine |
| SCGT | Simple Cycle Gas Turbine |
| SCR | Selective Catalytic Reduction |
| SOF | Scheduled Outage Factor |
| SPP | Southwest Power Pool |
| Study | Technology Assessment |
| Summary Table | Appendix A |
| USD | 2025 US Dollars |

# 1.0 Executive Summary

**1898 & Co., a part of Burns & McDonnell, ("1898 & Co."), conducted a study for Liberty Utilities ("Liberty") to evaluate potential technology options for the development of a new gas-fired power generation facility.**

## 1.1 Overview

Liberty has identified the potential need for approximately 250 megawatts ("MW") of new gas-fired generation to support load growth in their "Empire District" service territory near Southwestern Missouri. Liberty Utilities retained 1898 & Co. to develop cost and performance information to support evaluating generation technologies to meet the 250 MW need. The objective of 1898 & Co.'s scope of services is to assist Liberty with technology comparison and selection.

1898 & Co. conducted a technology assessment ("Study") to compare the following four peaking generation technologies:

- 5x 50 MW Aeroderivative Simple Cycle Gas Turbine ("SCGT")
- 1x F-Class frame SCGT
- 1x J-Class frame SCGT
- 12x 18 MW Reciprocating Internal Combustion Engine ("RICE")

The Aeroderivative SCGTs, F-Class frame, J-Class frame, and RICE are common peaking generation technologies with fast start-up times and high ramp rates which can quickly dispatch to the grid.

The Study is screening-level in nature and includes a comparison of technical features, cost, performance, and emissions characteristics of the generation technologies listed below. Any technologies of interest to Liberty should be followed by additional detailed studies to further investigate each technology and its direct application within or around Liberty's service area.

## 1.2 Results

1898 & Co. evaluated four technologies for Liberty to address capacity requirements. Table 1 shows the selected representative technologies and the total project capital cost per installed kW for each generation technology considered in this report.

Table 1: Evaluated Generation Technologies

| Assumption | SCGT | | | RICE |
|---|---|---|---|---|
| Technology | 50 MW Aeroderivative | J-Class | F-Class | 18 MW RICE |
| Total Capital Cost 2025$/kW | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |

## 1.3 Conclusions

This Study provides information to support Liberty in assessing potential dispatchable generation technologies within its service area. The information provided in this Study is preliminary in nature and is intended to highlight indicative, differential costs between each technology.

All technologies evaluated in the Study are proven and are widely utilized in power generation. Each technology demonstrated several strengths and weaknesses and could be feasible for further development depending on Liberty's priorities. Large frame units provide lower $/kW installed capacity. Aeroderivatives and RICE provide better heat rate and faster startup time and ramp rates. RICE also provide greater shaft diversity by having twelve engine shafts at the 250 MW plant. However, RICE units have higher ongoing major maintenance costs on a per MWh basis.

After identifying the preferred technology(s) within the Study, Liberty should pursue additional engineering studies to further define the project scope for the preferred technologies of interest.

# 2.0 Introduction

Liberty has identified the potential need for approximately 250 MW of new gas-fired power generation to support load growth in their service territory. With current equipment lead times and construction timelines, 1898 & Co. expects that the process from development and procurement of major equipment to COD would take approximately 52 months (about 4 and a half years) at a minimum. Given this timeline, Liberty will need to evaluate and quickly begin feasibility studies and procurement/development if a 2030 COD is to be met.

Liberty retained 1898 & Co. to provide project development consulting services in the potential development of a dispatchable capacity resource. 1898 & Co. was retained to support technology evaluation as well as initial site selection activities. This report details the methodology and findings of the technology assessment. The other tasks within 1898 & Co.'s scope of services will be presented in separate deliverables. As part of this Study, 1898 & Co. developed cost and performance summary information for representative technologies. The Study is screening-level in nature and includes a comparison of technical features, cost, performance, and emissions characteristics of the generation technologies listed below. Any technologies of interest to Liberty should be followed by additional detailed studies to further investigate each technology and its direct application within or around their service area.

## 2.1 Evaluated Technologies

1898 & Co. considered multiple technology types and models for this Study. An outline of each technology and key project-specific assumptions are included below in Table 2.

Table 2: Evaluated Generation Technologies & Key Project Assumptions

| Assumption | SCGT | | | RICE |
|---|---|---|---|---|
| Technology | 50 MW Aeroderivative | J-Class | F-Class | 18 MW RICE |
| Number of Units | 5 | 1 | 1 | 12 |
| Heat Rejection | Fin-Fan Heat Exchanger | | | |
| Fuel Type | Dual Fuel | | | |
| NOx Control | Dry Low Nox Nominal 25ppm NOx | SCR Included | Dry Low Nox Nominal 9ppm NOx | SCR Included |
| Inlet Conditioning | Evaporative Cooling | Evaporative Cooling | Evaporative Cooling | Not Applicable |

## 2.2 Study Approach

This report compiles the assumptions and methodologies used by 1898 & Co. during the Study. Its purpose is to articulate that the delivered information aligns with Liberty's intent to assess potential generation technologies for the quad-state service area of Missouri, Kansas, Oklahoma, and Arkansas. A detailed summary of the cost, performance, and emissions information developed for each technology is included in Appendix A ("Summary Table"). A scope assumptions matrix is provided in Appendix B to document the basis for the information provided in the Summary Table.

## 2.3 Statement of Limitations

Estimates and projections prepared by 1898 & Co. relating to performance, construction costs, and operating and maintenance costs are based on experience, qualifications, and judgment as a professional consultant. 1898 & Co. has no control over weather, cost, and availability of labor, material and equipment, labor productivity, construction contractor's procedures and methods, unavoidable delays, construction contractor's method of determining prices, economic conditions, government regulations and laws (including interpretation thereof), competitive bidding, and market conditions or other factors affecting such estimates or projections. Actual rates, costs, performance ratings, schedules, etc., may vary from the data provided.

# 3.0 Study Basis and Assumptions

## 3.1 Scope Basis and Assumptions Matrix

Scope and economic assumptions used in developing the Study are presented below. A spreadsheet-based scope assumptions matrix is included in Appendix B.

## 3.2 General Assumptions

The assumptions below govern the overall approach of the Study:

- All estimates are screening-level in nature, do not reflect guaranteed costs, and are not intended for budgetary purposes. Estimates concentrate on differential values between options.
- All information is preliminary and should not be used for construction purposes.
- All capital cost and operations and maintenance ("O&M") estimates are stated in 2025 US dollars ("USD"). Escalation is excluded.
- Estimates assume an Engineer, Procure, Construct ("EPC") contract for project execution.
- Unless stated otherwise, all options are based on a generic site near Joplin, MO to represent the Quad-State border area along Missouri, Kansas, Oklahoma, and Arkansas.
- Ambient conditions are based on winter, summer, and ISO weather data acquired from the American Society of Heating, Refrigerating, and Air-Conditioning Engineers ("ASHRAE"):
  - Elevation: 1,000 feet ("ft") above sea level
  - Winter Conditions: 12.2 degrees Fahrenheit ("°F") and 62.9 percent ("%") relative humidity ("RH")
  - Summer Conditions: 92.5 °F and 45.7% RH
  - Average Conditions: 59 °F and 60.0% RH
- The primary fuel for each technology option is pipeline quality natural gas. All technologies will also have an option to add fuel oil as a back-up fuel.
- All performance estimates assume new and clean equipment. Operating degradation is excluded.
- Fuel and power consumed during construction, startup, and/or testing are included and are broken out in the Owners' Costs.
- Piling is included under heavily loaded foundations.
- Water is assumed to be sourced from wells or surface water and available at the site boundary. Pipeline costs and intake structure costs are excluded.
- Wastewater is assumed to be delivered to the site boundary. Treatment facilities are excluded.
- Electrical scope is assumed to end at the high side of the generator step-up unit ("GSU"). Unless otherwise stated, GSU costs assume 138 kilovolts ("kV") transmission voltage.
- Demolition or removal of hazardous materials is not included.
- Emissions estimates are based on a preliminary review of Best Available Control Technology ("BACT") requirements and provide a basis for the assumed air pollution control equipment included in the capital and O&M costs.
  - Emissions are estimated at base load operation at ISO conditions.

## 3.3 EPC Project Indirect Costs

The following project indirect costs are included in capital cost estimates:

- Performance testing and continuous emissions monitoring system ("CEMS")/stack emissions testing (where applicable)
- Construction/Startup Technical Service
- Engineering and Construction Management
- EPC Fees & Contingency

## 3.4 Owner Costs

Allowances for the following Owner's Costs are included in the pricing estimates:

- Owner's Project Development
- Owner's Operational Personnel Prior to COD
- Owner's Engineer
- Owner's Project Management
- Owner's Legal Costs
- Owner's Startup Engineering and Commissioning
- Temporary Utilities During Construction
- Permitting and Licensing Fees
- Land
- Transmission Line
- Political Concessions & Area Development Fees
- Permitting and Licensing Fees
- Switchyard
- Natural Gas Interconnection
- Startup/Testing (Fuel and Consumables)
- Initial Fuel Inventory (Fuel Oil)
- Site Security
- Operating Spare Parts
- Builder's Risk Insurance
- Permanent Plant Equipment and Furnishings

## 3.5 Cost Estimate Exclusions

The following costs are excluded from all estimates:

- Financing Fees
- Escalation
- Interest During Construction
- Performance and Payment Bonds
- Property Insurance
- Water Rights

- Off-Site Infrastructure
- Utility Demand Costs
- Decommissioning Costs
- Salvage Values
- Property Tax
- Transmission Interconnection Cost
- Sales Tax

## 3.6 Operating and Maintenance Assumptions

O&M estimates are based on the following assumptions:

- O&M costs are based on new clean equipment.
- O&M costs are in 2025 USD.
- O&M estimates exclude emissions credit costs and property insurance.
- Where applicable, fixed O&M cost estimates include labor, office and administration, training, contract labor, safety, building and ground maintenance, communication, and laboratory expenses.
- Personnel counts for each technology are included in the scope matrix in Appendix B.
- Where applicable, variable O&M costs include routine maintenance, makeup water, water treatment, water disposal, ammonia, SCR replacements, and other consumables not including fuel.
- Fuel costs are excluded from O&M estimates.
- Where applicable, major maintenance costs are shown separately from variable O&M costs.
- Gas turbine (“GT”) major maintenance assumes third party maintenance based on the recommended maintenance schedule set forth by the original equipment manufacturer (“OEM”).
    - Base O&M costs are based on performance estimates in average ambient conditions unless otherwise stated.

# 4.0 Simple Cycle Gas Turbine Technology

This Study includes three SCGT options, including an F-Class frame unit, J-Class frame unit, and aeroderivative unit.

## 4.1 Simple Cycle Gas Turbine Technology Description

A SCGT plant utilizes natural gas to produce power in a gas turbine generator ("GTG"). The GT (Brayton) cycle is one of the most efficient cycles for the conversion of gaseous fuels to mechanical power or electricity. Simple cycle GTs are typically used for peaking power due to their fast load ramp rates and relatively low capital costs. However, the units have high heat rates compared to combined cycle technologies. Heat rate is a measure of the efficiency of power generation, with a lower value indicating a more efficient power generation process. Combined cycle technologies are more efficient than an equivalent simple cycle alternative. Simple cycle GT generation is a widely used, mature technology.

Evaporative coolers or inlet foggers are often used to cool the air entering the GT by evaporating additional water vapor into the air, which increases the mass flow through the turbine and thereby increasing the output. Evaporative coolers are included in all SCGT technologies in this Study.

While this is a mature technology category, it is also a highly competitive marketplace. Manufacturers are continuously seeking incremental gains in output and efficiency while reducing emissions and onsite construction time. Frame unit manufacturers are striving to implement faster starts and improved efficiency. Combustor design updates allow improved ramp rates, turndown, fuel variation, efficiency, and emissions characteristics. Aeroderivative turbines also benefit from the research and development ("R&D") efforts of the aviation industry, including advances in metallurgy and other materials.

Low load or part load capability may be an important characteristic depending on the plant's expected operational profile. Low load operation allows the SCGT's to remain online and generate a small amount of power while having the ability to quickly ramp to full load without going through the full start sequence. Most turbines can sustain stable operation at synchronous idle when the SCGT generator is synced with the grid but there is virtually no load on the turbine. At synchronous idle, a turbine runs on minimal fuel input and generates minimal power.

### 4.1.1 Aeroderivative Gas Turbines

Aeroderivative GT technology is based on aircraft jet engine design, built with high quality materials that allow for increased turbine cycling. The output of commercially available aeroderivative turbines ranges from less than 20 MW to approximately 100 MW in generation capacity. In simple cycle configurations, these machines typically operate more efficiently than larger frame units and exhibit shorter ramp up and turndown times, making them ideal for peaking and load-following applications. Aeroderivative units typically require fuel gas to be supplied at higher pressures (i.e., 675 psig to 960 psig for many models) than traditional frame units.

A desirable attribute of aeroderivative turbines is the ability to start and ramp quickly. Most manufacturers will guarantee ten-minute starts, measured from the time the start sequence is initiated to when the unit is at 100 percent load. Simple cycle starts are generally not affected by cold, warm, or hot conditions. However, all GTs start times in this Study assume that all start permissives are met, which can include purge credits, lube oil temperature checks, fuel pressure, etc. Available aeroderivative GT models include both DLN and water injection methods to control emissions during natural gas operation. For this study, a DLN technology was utilized.

Aeroderivative turbines are considered mature technology and have been used in power generation applications for decades. These machines are commercially available from several vendors, including General Electric ("GE"), Siemens , and Mitsubishi-owned Pratt & Whitney Power Systems.

### 4.1.2 Frame Gas Turbines

Frame style turbines are industrial engines, more conventional in design, that are typically used in intermediate to baseload applications. In simple cycle configurations, these engines typically have higher heat rates when compared to aeroderivative engines. The smaller frame units have simple cycle heat rates around 11,000 British thermal units per kilowatt-hour ("Btu/kWh") (HHV) or higher while the largest units exhibit heat rates approaching 9,000 Btu/kWh (HHV). However, frame units have higher exhaust temperatures (≈1,100°F) compared to aeroderivative units (≈850°F), making them more efficient in combined cycle operation because exhaust energy is further utilized. Frame units typically require fuel gas at lower pressures than aeroderivative units (~500 psig). Most available frame GT models utilize DLN to control emissions during natural gas operation. This can result in decreased water usage in comparison to some aeroderivative GTs, which reduces variable O&M costs.

Traditionally, frame turbines exhibit slower startup times and ramp rates than aeroderivative models, but manufacturers are consistently improving these characteristics. Conventional start times are commonly 30 minutes for frame turbines, but fast start options allow 10-to-15-minute starts. Fast start times and fuel consumption estimates are also shown in the Summary Table.

Frame engines are offered in a large range of sizes by multiple suppliers, including GE, Siemens, and Mitsubishi. Commercially available frame units range in size from approximately 50 MW to 400 MW and advancements in turbine control systems and further testing has led equipment manufacturers to tout capacities greater than 420 MW. Continued development by GT manufacturers has resulted in the separation of GTs into several classes, grouped by output and firing temperature: E-Class turbines (nominal 85 to 100 MW); F-Class turbines (nominal 200 to 240 MW); G/H-Class turbines (nominal 270 to 300 MW); and J-Class turbines (nominal 325 to 400 MW). This Study includes both F-Class and J-Class turbine technologies.

## 4.2 Simple Cycle Gas Turbine Emissions Controls

Emissions levels and required oxides of nitrogen ("NOx") and CO controls vary by technology and site constraints. Historically, natural gas SCGT peaking plants have not required post-combustion emissions control systems because they normally operate at low capacity factors. However, permitting trends suggest post-combustion controls may be required depending on annual number of GT operating hours, proximity of the site to a non-attainment area, and current state regulations.

In addition, there is a current New Source Performance Standard ("NSPS") limit for NOx emissions measured in parts per million ("ppm"), independent of operating hours. Per NSPS, units with heat inputs below 850 million British thermal units per hour ("MMBtu/hr") have a NOx limit of 25 ppm, but units with heat inputs greater than 850 MMBtu/hr have a NOx limit of 15 ppm. Furthermore, in the event the overall facility has the potential to emit greater than 250 tons per year of NOx emissions, SCR may be required or the number of operating hours available for the facility may be limited.

Most turbine manufacturers will guarantee emissions down to a specified minimum load, commonly 40 to 50 percent load. Below this load, turbine emissions may spike. As such, emissions on a ppm basis may be significantly higher at low loads.

For both the aeroderivative and frame options 1898 & Co. has evaluated add-on costs for including an SCR for the SCGTs.

Oxidation catalysts can be used to control CO emissions to 2-2.5 ppm at 15 percent $O_2$ while operating on natural gas fuel. If an SCR is installed, it is typical practice to install a CO catalyst as well. It is assumed that CO controls are included in the add-on costs for all technologies alongside the SCR systems.

Outside of good combustion practices, it is assumed that emissions control equipment is not required for $CO_2$ and particulate matter ("PM"). Sulfur dioxide emissions are not controlled and are therefore a function of the sulfur content of the fuel burned in the GTs.

Emissions estimates are shown in the Summary Table for full load operation at ISO conditions. Emissions are shown for the bare turbine operating on natural gas fuel and are also shown for units equipped with SCR and CO catalyst systems.

## 4.3 Simple Cycle Gas Turbine Performance

Performance results are shown in the Summary Table. Estimated performance results are based on data requested within OEM's Gas Turbine Performance Tool with estimates for plant auxiliary loads at the winter, summer, and ISO average ambient conditions derived from the weather analysis. Full load and minimum load performance estimates are shown for winter, summer, and ISO ambient conditions.

Minimum load is defined as the minimum emissions compliant load ("MECL"), as reflected in the OEM ratings. 1898 & Co. provided 50% load as the standard MECL.

The general assumptions in the Study Basis and Assumptions Section apply to the evaluation of all SCGT options, and additional assumptions are listed in the scope matrix.

- All performance ratings are based on natural gas fuel.
- Base load ratings include installed evaporative coolers where evaporative coolers are assumed to be operating when temperatures are above 59 °F.

The Summary Table includes startup time and ramp rate estimates for SCGT options. SCGT start times assume that purge credits and other permissives are accounted for.

Outage and availability statistics, collected using the North American Electric Reliability Corporation ("NERC") Generating Availability Data System ("GADS"), are also shown in the Summary Table. Simple cycle GADS data are based on 2014 to 2023 operating statistics for applicable North American units that are no more than 10 years old. The outage statistics included in the analysis are now Scheduled Outage Factor ("SOF"), Forced Outage Factor ("FOF"), and Availability Factor ("AF") which are additive to 100% of the potential uptime for the generating facility.

## 4.4 Simple Cycle Gas Turbine Capital Cost Estimates

The simple cycle cost estimate results are included in the Summary Table. The EPC cost includes all equipment procurement, construction, and indirect costs for a greenfield simple cycle project.

Additional cost clarifications and assumptions are shown below:

- The EPC capital cost estimate includes, but is not limited to, the following considerations:
    - Engineering
    - Procurement
        - GT
        - GSU
        - Balance of Plant ("BOP") Equipment (Including SCR & CO systems if applicable)

        - Mechanical equipment, electrical equipment, instrumentation and controls, chemical storage, fire protection equipment, and other miscellaneous items are required.
        - Includes supplemental fuel gas metering equipment for verification of billing/consumption information provided by gas supplier.
        - Fuel gas metering and conditioning equipment owned by the gas supplier is excluded.
        - Onsite water treatment systems are not included. SCGT plants assume that demineralized water trailers are used to treat raw water.
        - Demineralized water tank and related pumps are included for onsite storage.
    - Construction
        - Accounts for labor adjustments for the service area.
        - Includes major equipment erection, civil/structural construction, mechanical construction, and electrical construction.
    - Indirect Costs and Fees
    - EPC Contingency
- Base unit estimates assume natural gas operation with evaporative coolers.
- It is assumed that natural gas is available at sufficient pressures for operation. Fuel compression is excluded.
- The estimate assumes the turbines are installed outdoors with enclosures.
- Cost estimates include a building with administrative/control spaces and a warehouse.

## 4.5 Simple Cycle Operations & Maintenance Cost Estimate

The results of the simple cycle O&M evaluations are shown in the Summary Table. Additional assumptions are detailed below.

Major Maintenance costs for the aeroderivative GT are estimated on a dollar per run-hour basis. Major Maintenance costs for the frame engines are estimated on a dollar per GT start (“$/GT-start”) and dollar per run-hour basis. In general, if there are more than 27 operating hours per start, the maintenance will be hours based. If there are less than 27 hours per start, maintenance will be start-based. Note that the $/GT-hr and $/start costs are *not* meant to be additive or combined in any way. The operational profile determines which value to use to determine annual major maintenance costs. The major maintenance $/MWh cost shown in the summary is calculated using the $/hr major maintenance cost (it is intended as another way to show the same cost, so it is also not intended to be added to $/start or $/hr). If a start-based maintenance scheme is desired, it should be noted that the applicable $/MWh will need to be calculated based on the start-based annual cost expectations.

Aeroderivative SCGTs are designed for frequent startups and major maintenance is exclusively performed on a per-equivalent operating hour basis.

# 5.0 Reciprocating Engine Technology

This Study includes one simple cycle reciprocating engine plant for comparison among the peaker options, which is a 12x Wärtsilä 18V50DF configuration.

## 5.1 Reciprocating Engine Technology Description

The internal combustion, reciprocating engine operates on a four-stroke cycle for the conversion of pressure into rotational energy. Utility scale engines are commonly compression-ignition models, but some are spark-ignition engines. By design, cooling systems are typically closed-loop radiators, minimizing water consumption.

Reciprocating engines are generally less impacted by altitude and ambient temperature differences than GTs. With site conditions below 3,000 ft and 95˚F, altitude and ambient temperature have minimal impact on the electrical output of reciprocating engines, though the efficiency may be slightly affected. In the case of Liberty, an elevation of 1,000 ft was assumed and therefore the engines would not experience a derate in output and efficiency. Performance information is provided in the Summary Table.

Reciprocating engines can start up and ramp load more quickly than most GTs, but it should be noted that the engine jacket temperature must be kept warm to accommodate start times under 10 minutes. However, it is common to keep water jacket heaters energized during all hours that the engines may be expected to run (associated costs have been included within the fixed O&M costs).

Many different vendors, such as Wärtsilä, Fairbanks Morse (MAN Engines), Hyundai, GE (Jenbacher), Rolls Royce, etc. offer reciprocating engines. They are a popular option to pair with intermittent renewable generation with their quick start times and operational flexibility. There are slight differences between manufacturers in engine sizes and other characteristics, but all largely share the common characteristics of quick ramp rates and quick start up when compared to GTs.

Utility scale applications most commonly rely on medium speed engines in the 9-11 MW and 18-20 MW classes. All OEMs indicated above offer a spark ignition engine in the 9-11 MW class, but only Wärtsilä and MAN have commercially available 18-20 MW class engines in the US.

This Study includes the dual fuel Wärtsilä 18V50DF technology with a nominal plant size of 216 MW. These heavy duty, medium speed engines are easily adaptable to grid-load variations.

## 5.2 Reciprocating Engine Emissions Controls

Emissions estimates are shown for full load at ISO conditions on natural gas fuel. It is assumed that SCR and CO catalyst technologies are installed and operating. In addition to good combustion practices, it is expected that reciprocating engines will require SCR and CO catalysts to control NOx and CO emissions. Operation on natural gas fuel with an SCR yields a reduction of NOx emissions to 4.5 ppm at 15 percent excess $O_2$, while a CO catalyst results in anticipated CO emissions of 15 ppm. It is assumed that emissions control equipment is not required for $CO_2$ and PM. Sulfur dioxide emissions are not controlled and are therefore a function of the sulfur content of the fuel. It is assumed that CEMS monitoring systems are also not required.

## 5.3 Reciprocating Engine Performance

Performance results are shown in the Summary Table. Estimated performance results are based on data from OEM ratings. Full load and minimum load performance estimates are shown for winter and summer conditions. Minimum load assumes 50% load for the spark-ignited engines. The general assumptions in the Study Basis and Assumptions Section apply to the evaluation of reciprocating engine options, and additional assumptions are listed in the scope matrix.

The Summary Table includes startup times for engine options. Start times of 5-10 minutes require that the engine jacket temperatures be kept warm for standby operation (this is addressed in the O&M costs). Outage and availability statistics, collected using the NERC GADS, are also shown in the Summary Table. The GADS data delivered was changed from weighted rates which correct for derating or dependable plant capacity impacts by weighting each term in the calculation by the Net Maximum Capacity, to unweighted time-based calculation methods. The outage statistics included in the analysis are now SOF, FOF, and AF which are additive to 100% of the potential uptime for the generating facility. It should be noted that EFOR data from GADS may not accurately represent the benefits of a reciprocating engine plant, depending on how outage events are recorded. Typically, a maintenance event will not impact all engines simultaneously, so only a portion of the plant would be unavailable.

Reciprocating engines consume minimal water (approximately 5 gallons per engine, per week for cooling loop makeup, plus a gallon per day for turbo rinses). Depending on site conditions and access to water, the low water consumption rate can be advantageous for comparison to other simple cycle plants.

## 5.4 Reciprocating Engine Capital Cost Estimates

The cost estimate results are included in the Summary Table. The EPC costs include all equipment procurement, construction, and indirect costs for a greenfield reciprocating engine project.

Additional cost clarifications and assumptions are shown below:

- SCR and CO catalysts are included for reciprocating engines. It is assumed that CEMS equipment is not required.
- It is assumed that natural gas is available at approximately 125 psig. Fuel compression is not required.
- The reciprocating engine plant includes an indoor engine hall with associated administrative/ control/warehouse facilities.
- The 12x RICE technology option assumes the engines are divided into 3 groups of 4 engines per GSU, for a total of 3 GSUs.

## 5.5 Reciprocating Engine O&M Cost Estimate

The results of the O&M evaluations are shown in the Summary Table. Additional assumptions are listed in the scope matrix.

Fixed O&M costs include six (6) full-time equivalent ("FTE") personnel. Fixed O&M also includes an estimate for standby electricity costs to keep the engines warm and accommodate start times of less than ten minutes. Additional fixed O&M costs include allowances for administrative, communications, and other routine maintenance items.

Major maintenance costs are shown per engine, regardless of configuration. It is assumed that a long-term service agreement ("LTSA") with the OEM or other third party would include parts and labor for major overhauls and catalyst replacements.

Variable costs account for lube oil, SCR reagent, routine BOP maintenance, and scheduled minor engine maintenance. It is expected that the LTSA would include supervision and parts for these minor intervals (i.e. ~2,000 hour intervals), but that these may not be considered capital maintenance intervals, so they are included in the variable O&M.

# 6.0 Conclusions

This Study provides information to support Liberty in assessing potential dispatchable generation technologies within its service area. The information provided in this Study is preliminary in nature and is intended to highlight indicative, differential costs between each technology.

1898 & Co. evaluated four technologies for Liberty to address capacity requirements. Table 3 details the selected representative technologies as well as the total capital cost (including Owner's cost) information for the development of each generation technology considered in this report.

Table 3: Evaluated Generation Technologies

| Assumption | SCGT | | RICE | |
|---|---|---|---|---|
| Technology | 50 MW Aeroderivative | J-Class | F-Class | 18 MW RICE |
| Total Capital Cost 2025$/kW | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |

All technologies evaluated in the Study are proven and are widely utilized in power generation. Each technology demonstrated several strengths and weaknesses and could be feasible for further development depending on Liberty's priorities. Frame units provide the lowest dollar per installed kW of capacity compared to the aeroderivative and RICE units. Reciprocating engines provide the best heat rate and operational flexibility. They also have shaft diversity by having twelve engine shafts at the 216 MW plant. However, reciprocating engines have higher ongoing major maintenance costs on a per MWh basis. The aeroderivative options provide high amounts of flexibility which provides significant value as renewable generation continues to be built out in SPP but require the highest upfront capital costs in the Study.

After identifying the preferred technology(s) within the Study, Liberty should pursue additional engineering studies to further define the project scope for the preferred technologies of interest.

## APPENDIX A – SUMMARY TABLE

## LIBERTY UTILITIES 2025 TECHNOLOGY ASSESSMENT SUMMARY TABLE
## PRELIMINARY AND CONFIDENTIAL - NOT FOR CONSTRUCTION
## MISSOURI

Simple Cycle Gas Turbine & Reciprocating Engine Project Options
June 2025 - Revision 0

| Project Type | Simple Cycle - 50 MW Aeroderivative | Simple Cycle - J-Class Frame | Simple Cycle - F-Class Frame | Reciprocating Engine (18MW Engines) |
|---|---|---|---|---|
| **BASE PLANT DESCRIPTION** | First Block | First Unit | First Unit | First Block |
| Number of Gas Turbines/Engines | 5 | 1 | 1 | 12 |
| Representative Class Gas Turbine | GE LM6000 PF+ | GE 7HA.03 | GE 7FA.05 | Wartsila 18V50DF |
| Capacity Factor, % | 10% | 10% | 10% | 10% |
| Startup Time to Base Load, min (Note 1) | 5 | 10 | 11 | 5 |
| Startup Time to MECL, min (Note 2) | 4 | 8 | 8 | 4 |
| Cold Startup Time to SCR Compliance, min (Note 2) | N/A | 45 | N/A | 45 |
| Maximum Ramp Rate, MW/min (Online, All Units) | 250 | 75 | 40 | 100 |
| Book Life, Years | 35 | 35 | 35 | 35 |
| Scheduled Outage Factors (SOF), % (Note 3) | 5.8% | 8.4% | 6.8% | 3.7% |
| Forced Outage Factor (FOF), % (Note 3) | 2.9% | 2.8% | 2.0% | 3.9% |
| Availability Factor (AF), % (Note 3) | 91.3% | 88.8% | 91.2% | 92.4% |
| Assumed Land Use, Acres | 30 | 20 | 20 | 40 |
| Fuel Design | Dual Fuel (Natural Gas and Fuel Oil) | Dual Fuel (Natural Gas and Fuel Oil) | Dual Fuel (Natural Gas and Fuel Oil) | Dual Fuel (Natural Gas and Fuel Oil) |
| Heat Rejection | Fin Fan Heat Exchanger | Fin Fan Heat Exchanger | Fin Fan Heat Exchanger | Fin Fan Heat Exchanger |
| $NO_x$ Control | Dry Low Nox<br>Nominal 25ppm NOx | Dry Low Nox<br>Nominal 25ppm Nox<br>SCR Included | Dry Low Nox<br>Nominal 9ppm Nox | SCR Included |
| CO Control | Good Combustion Practice | CO Catalyst Included | Good Combustion Practice | CO Catalyst Included |
| Particulate Control | Good Combustion Practice | Good Combustion Practice | Good Combustion Practice | Good Combustion Practice |
| Technology Rating | Mature | Mature | Mature | Mature |
| **ESTIMATED PERFORMANCE (NATURAL GAS OPERATION) (Note 4)** | | | | |
| **WINTER PEAK** | | | | |
| Base Load Performance @ 12.2˚F / 62.9% RH | | | | |
| Inlet Air Conditioning | Evap Off | Evap Off | Evap Off | None |
| Net Plant Output, kW | 279,500 | 420,600 | 240,000.0 | 212,144 |
| Net Plant Heat Rate, Btu/kWh (HHV) | 9,250 | 8,810 | 9,820 | 8,405 |
| Heat Input, MMBtu/h (HHV) | 2,600 | 3,710 | 2,360 | 1,783 |
| Minimum Load (Single Turbine/Engine at MECL) @ 12.2˚F / 62.9% RH | | | | |
| Inlet Air Conditioning | Evap Off | Evap Off | Evap Off | None |
| Net Plant Output, kW | 28,000 | 210,300 | 120,000 | 8,839 |
| Net Plant Heat Rate, Btu/kWh (HHV) | 12,440 | 10,860 | 11,910 | 9,230 |
| Heat Input, MMBtu/h (HHV) | 350 | 2,280 | 1,430 | 82 |
| **ISO** | | | | |
| Base Load Performance @ 59˚F / 60% RH | | | | |
| Inlet Air Conditioning | Evap Off | Evap Off | Evap Off | None |
| Net Plant Output, kW | 249,500 | 412,700 | 227,000 | 212,144 |
| Net Plant Heat Rate, Btu/kWh (HHV) | 9,370 | 8,920 | 9,980 | 8,455 |
| Heat Input, MMBtu/h (HHV) | 2,350 | 3,680 | 2,270 | 1,794 |
| Minimum Load (Single Turbine/Engine at MECL) @ 59˚F / 60% RH | | | | |
| Inlet Air Conditioning | Evap Off | Evap Off | Evap Off | None |
| Net Plant Output, kW | 24,900 | 206,300 | 113,500 | 8,839 |
| Net Plant Heat Rate, Btu/kWh (HHV) | 13,050 | 10,780 | 12,040 | 9,285 |
| Heat Input, MMBtu/h (HHV) | 330 | 2,220 | 1,370 | 82 |
| **SUMMER PEAK** | | | | |
| Base Load Performance @ 92.5˚F / 45.7% RH | | | | |
| Inlet Air Conditioning | Evap On | Evap On | Evap On | None |
| Net Plant Output, kW | 221,000 | 395,400 | 220,100 | 212,144 |
| Net Plant Heat Rate, Btu/kWh (HHV) | 9,710 | 9,030 | 10,150 | 8,491 |
| Heat Input, MMBtu/h (HHV) | 2,150 | 3,570 | 2,230.00 | 1,801 |
| Minimum Load (Single Turbine/Engine at MECL) @ 92.5˚F / 45.7% RH | | | | |
| Inlet Air Conditioning | Evap On | Evap On | Evap On | None |
| Net Plant Output, kW | 22,100 | 197,700 | 110,100 | 8,839 |
| Net Plant Heat Rate, Btu/kWh (HHV) | 13,670 | 10,930 | 12,300 | 9,325 |
| Heat Input, MMBtu/h (HHV) | 300 | 2,160 | 1,350.00 | 82 |
| **ESTIMATED CAPITAL AND O&M COSTS (Note 5)** | | | | |
| **EPC Project Capital Costs, MM$ (w/o Owner's Costs)** | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |
| Engineering | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Gas Turbines/Engines | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| GSU | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| BOP Equipment and Materials | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Construction | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Indirects and Fees | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| EPC Contingency | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| **Owner's Costs, MM$** | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |
| Owner's Project Development | *[redacted]** | *[redacted]** | $*[redacted]** | *[redacted]** |
| Owner's Operational Personnel Prior to COD | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Owner's Engineer | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Owner's Project Management | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Owner's Legal Costs | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Owner's Start-up Engineering and Commissioning | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Temporary Utilities During Construction | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Permitting and Licensing Fees | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Land | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Natural Gas Interconnect | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Switchyard | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Transmission Line | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Political Concessions & Area Development Fees | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Startup/Testing (Fuel & Consumables) | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Initial Fuel Inventory (Fuel Oil) | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Site Security | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Operating Spare Parts | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Permanent Plant Equipment and Furnishings | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| Builders Risk Insurance (0.45% of Construction Costs) | *[redacted]** | *[redacted]** | *[redacted]** | *[redacted]** |
| **Total Project Costs, MM$** | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |

| | | | | |
|---|---|---|---|---|
| | **[redacted]** | **[redacted]** | **[redacted]** | |
| **Project Cost Per kW, $/kW (excl. Owner's Costs)** | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |
| **Total Cost Per kW, $/kW** | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |
| **FIXED O&M COSTS (Note 6)** | | | | |
| Fixed O&M Cost - LABOR, 2024$MM/Yr | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |
| Fixed O&M Cost - OTHER, 2024$MM/Yr | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |
| **LEVELIZED CAPITAL MAINTENANCE COSTS (Note 7)** | | | | |
| Major Maintenance Cost, $/GT-hr or $/engine-hr | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |
| Major Maintenance Cost, $/GT-start | No starts-based maintenance | **[redacted]** | **[redacted]** | No starts-based mainteneance |
| Major Maintenance Cost, $/MWh | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |
| Catalyst Replacement Cost, $/MWh | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |
| **NON-FUEL VARIABLE O&M COSTS (EXCLUDES LEVELIZED CAP. MAINT. COST)** | | | | |
| Total Variable O&M Cost, $/MWh - ISO | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |
| Water Related O&M, $/MWh | **[redacted]** | **[redacted]** | **[redacted]** | **[redacted]** |
| Water Usage, gpm @ ISO | 1.9 | 2.1 | 1.4 | 0.0 |
| SCR Reagent, $/MWh | **[redacted]** | **[redacted]** | **[redacted]** | $[redacted] |
| Ammonia or Urea Consumption (with SCR), tons/yr (Note 8) | - | 503 | - | 524 |
| Other Consumables and Variable O&M, $/MWh | **[redacted]** | **[redacted]** | **[redacted]** | $[redacted] |
| **DUAL FUEL CAPABILITY ADD-ON COSTS** | | | | |
| Project Capital Cost, MM$ (w/o Owner's Costs) | **[redacted]** | **[redacted]** | **[redacted]** | Inc. In Base |
| **ESTIMATED BASE LOAD OPERATING EMISSIONS: NATURAL GAS, ppm @15% $O_2$ (Note 9)** | | | | |
| $NO_X$ (without SCR/CO Catalyst) | 25 | N/A | 9 | N/A |
| CO (without SCR/CO Catalyst) | 89 | N/A | 9 | N/A |
| NOX (with SCR/CO Catalyst) | N/A | 2.5 | N/A | 5 |
| CO (with SCR/CO Catalyst) | N/A | 2 | N/A | 15 |
| **ESTIMATED BASE LOAD OPERATING EMISSIONS: NATURAL GAS, lb/MMBtu (ISO) (Note 9)** | | | | |
| **Turbine Only** | | | | |
| $NO_X$ | 0.010 | 0.1 | 0.04 | N/A |
| $SO_2$ | <0.002 | 0.002 | <0.002 | N/A |
| CO | 0.220 | 0.02 | 0.02 | N/A |
| $CO_2$ | 120 | 120 | 120 | N/A |
| $PM/PM_{10}$ | 0.514 | N/A | 0.622 | N/A |
| **Turbine/Engine with SCR and CO Catalyst** | | | | |
| $NO_X$ | N/A | 0.01 | N/A | 0.021 |
| $SO_2$ | N/A | 0.002 | N/A | < 0.002 |
| CO | N/A | 0.002 | N/A | 0.032 |
| $CO_2$ | N/A | 120 | N/A | 120 |
| $PM/PM_{10}$ | N/A | 0.004 | N/A | 3.116 |
| **ESTIMATED BASE LOAD OPERATING EMISSIONS: ULTRA-LOW SULFUR FUEL OIL (Note 10)** | | | | |
| **Turbine Only (lb/MMBtu, HHV) (Note 11)** | | | | |
| $NO_X$ | 0.16 | 0.11 | 0.16 | 2.45 |
| $SO_2$ | 0.001 | 0.002 | 0.001 | 0.032 |
| CO | 0.04 | 0.02 | 0.03 | 3.72 |
| $CO_2$ | 160 | 160 | 160 | 160 |

**NOTES**

Note 1: Simple cycle GT starts are not affected by hot, warm or cold conditions. Simple cycle starts assume purge credits are available.
Note 2: MECL start time assumes the min load at which the GT achieves the steady state NOx emissions ppm rate. The SCR compliance start time assumes a cold start, ending at the time when the catalysts are heated and the NOx levels meet the desired SCR emissi
Note 3: Outage and availability statistics are collected using the NERC Generating Availability Data System. Combined cycle data is based on North American units that came online in 2014 or later. Reporting period is 2014-2023.
Note 4: New and clean performance assumed for all scenarios. All performance ratings based on NATURAL GAS operation. Minimum loads are based on one unit running at 50% for all technologies at 1000 ft. elevation and ambient conditions.
Note 5: Capital and fixed O&M costs are presented in 2025 USD $MM. Estimated costs exclude decommisioning costs and salvage values.
Note 6: All FOM costs assume 6 full time personnel for first block/unit. FOM costs do not include engine lease fees that may be available with LTSA, depending on OEM.
Note 7: Major maintenance $/GT-hr and $/GT-start values are the same information shown in different units. The values are NOT additive.
Note 8: 19% Aqueous ammonia for turbines; 40% Aqueous urea for reciprocating engine plants.
Note 9: Emissions estimates are shown for steady state operation at annual average conditions for natural gas, unless otherwise stated. Emissions estimates should not be used for permitting.
Note 10: Fuel oil emissions based on ultra low sulfur diesel. Per the US EPA, this fuel must meet 15 ppm sulfur.
Note 11: Emissions estimates shown for steady state operation at ISO. Estimates account for the impacts of SCR and CO catalysts for reciprocating engine plants. Emissions are for reference only.

# APPENDIX B – SCOPE ASSUMPTIONS MATRIX

| LIBERTY UTILITIES TECHNOLOGY ASSESSMENT ASSUMPTIONS<br>PRELIMINARY AND CONFIDENTIAL - NOT FOR CONSTRUCTION | | | | |
|---|---|---|---|---|
| | Simple Cycle - Aeroderivative | Simple Cycle -Frame | Simple Cycle - Frame | Reciprocating Engines |
| June 2025 - Revision 0 | | | | |
| **Project Description** | | | | |
| Plant Configuration(s): | 5x Aeroderivative SCGT | 1x F-Class SCGT | 1x J-Class SCGT | 12x Reciprocating Engine (18 MW) |
| Plant Size(s) (Nominal): | 262 MW | 230 MW | 430 MW | 216 MW |
| Manufacturer & Model | GE LM6000 PF+ | GE 7FA.05 | GE 7HA.03 | Wartsila 18V50SG |
| Fuel: | Dual Fuel (Natural Gas & Fuel Oil) | | | |
| Project Location: | Quad-State Area (MO, KS, AR, OK) | | | |
| Contract Philosophy: | Engineer, Procure, Construct (EPC) Methodology | | | |
| Project COD: | Costs shown in 2025 USD (i.e. no escalation) | | | |
| Labor Type: | Union Labor | | | |
| **Scope Basis / Assumptions** | | | | |
| Redundancy: | Reflective of typical utility service.<br>Redundant installed components (2 x 100%, 3 x 50%) where component failure could cause outage of the plant. No spare GSU. | | | |
| Site Condition: | Flat, minimal rock, soils stable for spread footings for all foundations except turbines. | | | |
| Initial Site Conditions: | Assumed generic greenfield site. No estimates related to the decommissioning/potential remediation associated with existing assets is included. | | | |
| Site Elevation: | 1,000 ft | | | |
| ISO Ambient Conditions: | 59°F / 60% RH | | | |
| Site Summer Ambient Conditions: | 92.5 °F / 45.7% RH | | | |
| Site Winter Ambient Conditions: | 12.2 °F / 62.9% RH | | | |
| Water Supply: | Fresh Water supply from wells, surface water, or existing plant infrastructure; pipeline/intake excluded from cost. | | | |
| Waste Water Disposal: | Discharge offsite, piping beyond site boundary excluded. | | | |
| **Performance Basis** | | | | |
| Inlet Cooling | Evap cooler included | | | N/A |
| Heat Rejection Design: | Fin Fan Heat Exchanger | | | |
| Availability Metrics | NERC GADS data for SOF, FOF, AF. | | | |
| **Fuel and Reagent Storage & Disposal** | | | | |
| Design Fuel: | Dual Fuel (Natural Gas & Fuel Oil) | | | |
| Design Fuel Supply: | Assumed fuel oil trucked to site and stored in existing tanks. Assumed pipeline quality of natural gas at sufficient operating pressures. | | | |
| Distillate Fuel: | 72 Hours at Base Load | | | |
| Ammonia: | N/A | | Aqueous Ammonia delivered by truck. | Urea |
| **Enclosures** | | | | |
| Gas Turbine or Engine: | Outdoor - OEM Enclosure Only | | | Indoor - Engine Hall |
| Steam Turbine | N/A | | | |
| HRSG | N/A | | | |
| Buildings: | | | | |
| Administration Building | Included | | | Included in Engine Hall |
| Warehouse | Included | | | Included in Engine Hall |
| Maintenance | Included | | | Included in Engine Hall |
| Misc. Equipment Enclosures | Minimal Included.<br>Limited to Electrical Equipment, CEMS enclosure, etc. | | | |
| **Emissions and Emissions Controls** | | | | |
| NOx Control: | N/A | | SCR | |
| CO Control: | N/A | | CO Catalyst | |

LIBERTY UTILITIES TECHNOLOGY ASSESSMENT ASSUMPTIONS
PRELIMINARY AND CONFIDENTIAL - NOT FOR CONSTRUCTION

| | Simple Cycle - Aeroderivative | Simple Cycle -Frame | Simple Cycle - Frame | Reciprocating Engines |
|---|---|---|---|---|
| $SO_2$ Control: | Fuel Oil: Ultra Low Sulfur Fuel | | | |
| $SO_3$ Control: | N/A | | | |
| PM10 Control (filterable & condensable particulate): | N/A | | | |
| Mercury Control: | N/A | | | |
| VOC Control: | Good combustion practice. | | | |
| CO2 Capture / Compression | N/A | | | |
| **Transmission/Interconnection:** | | | | |
| Switchyard: | Included | | | |
| Transmission Network Upgrade Costs: | Excluded - See Injection Study | | | |
| Transmission Interconnect: | Allowance to be included from high side of the GSU to the switchyard/substation located on-site. | | | |
| Interconnection Voltage: | Site Specific | | | |
| **Miscellaneous Equipment:** | | | | |
| Fire protection: | New Fire Pump and Emergency Diesel Backup for dedicated onsite storage | | | |
| Emergency Generator: | New Diesel Generator | | | |
| Auxiliary Boiler: | N/A | | | |
| Black Start: | N/A | | | |
| Bypass Dampers | N/A | | | |
| **Miscellaneous Contract Costs:** | | | | |
| Startup Spare Parts: | Allowance Included | | | |
| Construction Indirects: | Construction Mgmt, Engineering, Performance testing and start-up, initial fills and consumables, startup, surveys, and site security included. | | | |
| Performance Bonds: | Included. Allowance is 1% of project cost. | | | |
| **Indirect / Owner's Indirect Costs:** | | | | |
| Project Development | Allowance Included | | | |
| Owner's Operations Personnel Prior to COD | Allowance Included | | | |
| Owner's Project Management | Allowance Included | | | |
| Owner's Engineering | Allowance Included (Assuming full OE support) | | | |
| Owner's Legal Costs | Allowance Included | | | |
| Commissioning Costs | Allowance Included | | | |
| Operator Training | Allowance Included | | | |
| Permitting & License Fees | Allowance Included | | | |
| Land | Allowance Included | | | |
| Construction Power | Allowance Included | | | |
| Fuel Consumed during Commissioning | Allowance Included | | | |
| Power generated & sold during commissioning | Allowance Included | | | |
| Initial Fuel Inventory | Allowance Included | | | |
| Builder's Risk Insurance | Allowance Included | | | |
| Operating Spare Parts | Allowance Included for critical equipment only & minor parts. No spare GSU included. | | | |
| Workshop Tools & Test Equipment | Allowance Included | | | |
| Mobile Equipment, Vehicles | Allowance Included | | | |
| Permanent Plant Equipment and Furnishings | Allowance Included | | | |
| Owner's Contingency: | Included to reflect anticipated spent contingency for screening purposes. Additional contingency is recommended for budgetary estimate. | | | |
| Financing Fees | Excluded | | | |
| Interest During Construction | Excluded | | | |
| Sales Tax: | Excluded from EPC and Owners Costs | | | |

| MIDWEST ENERGY TECHNOLOGY ASSESSMENT ASSUMPTIONS<br>PRELIMINARY AND CONFIDENTIAL - NOT FOR CONSTRUCTION | | | | |
|---|---|---|---|---|
| Operating & Maintenance Assumptions<br>February 2025 - Revision 1 | | | | |
| | **Simple Cycle - Aeroderivative** | **Simple Cycle -Frame** | **Simple Cycle - Frame** | **Reciprocating Engines** |
| GENERAL | | | | |
| Technology Configuration: | GE LM6000 PF+ | GE 7FA.05 | GE 7HA.03 | Wartsila 18V50SG |
| Number of Full-Time Personnel: | 6 | 6 | 6 | 6 |
| Labor Cost: | $150,000 Burdened Labor per FTE<br>(Salary, Bonus, Benefits) | | | |
| Capacity Factor / Use Case: | 10% (876 hours/year) | | | |
| Standby Power: | Included | | | |
| Standby Power Cost ($/MWh) | $30 | | | |
| MAINTENANCE CONSIDERATIONS | | | | |
| Major Maintenance Basis: | Long Term Service Agreement through OEM | | | |
| Service Director Included: | Included | | | |
| Engine Lease Agreement: | Excluded | | | |
| SCR & CO Catalyst Replacements | N/A | | Every 6 Years | |
| SCOPE BASIS/ASSUMPTIONS | | | | |
| Water Supply Cost: | Raw water assumes $0.35 per 1,000 gallons. | | | |
| Water Quality Assumptions: | Suitable for use in evaporative coolers / cooling towers with 4 cycles of concentration and without any pretreatment. Standard chemical treatment for corrosion / biological growth only. | | | |
| Demineralizer System: | On-site storage with demin trucked to site | | | |
| Water Discharge Treatment: | Minimal water discharge; no discharge treatment. | | | |
| Water Discharge Cost: | N/A | | | |
| EMISSIONS & EMISISONS CONTROLS | | | | |
| NOx Emissions Allowance Costs: | Excluded | | | |
| SOx Emissions Allowance Costs: | | | | |
| Mercury Emissions Allowance Costs: | | | | |
| Carbon Dioxide Emissions Allowance Costs: | | | | |

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