HECATE ENERGY COLUMBIA COUNTY 1 LLC

SHEPHERD'S RUN SOLAR PROJECT

Matter No. 24-00103

§ 900.2-22 Exhibit 21

Electric System Effects and Interconnection

Contents

Appendices

Acronym List

CTOAF	Connecting Transmission Owner's Attachment Facilities
DC	Direct current
EPC	engineering, procurement, and construction
IEEE	Institute of Electrical and Electronics Engineers
KCMIL	kilo-circular mils
kV	kilovolts
LGIA	Large Generator Interconnection Agreement
MIS	NYISO Minimum Interconnection Standard
MVA	mega volt-amp
NEC	National Electric Code
NESC	National Electric Safety Code
NYCRR	New York Codes, Rules, and Regulations
NYISO	New York Independent Service Operator
NYPP	New York Power Pool Task Force
NYSEG	New York State Electric and Gas
NYSTS	New York State Transmission System
OATT	Open Access Transmission Tariff
O&M	Operation and Maintenance
POI	point of interconnection
PV	Photovoltaic
SRIS	System Reliability Impact Study
SUF	System Upgrade Facility

Glossary of Terms

Applicant	Refers to Hecate Energy Columbia County 1 LLC, the entity seeking a siting permit for the Project from the Office of Renewable Energy Siting (ORES) under Article VIII of the New York State Public Service Law.[1]
Point of Interconnection	Refers to the Craryville 115 kilovolt (kV) substation owned by New York State Electric and Gas (NYSEG) on the Craryville-Klinekill and Churchtown-Craryville 115 kV transmission lines.
Project	Refers to the proposed Shepherd's Run Solar Project, a utility scale solar project that will be comprised of solar arrays, inverters, access driveways, electrical collection lines, collection substation, construction staging areas, fencing and plantings, located on private land in the Town of Copake, Columbia County, New York.
Project Area	Refers to those privately-owned parcels under option to lease, purchase, easement or other real property interests with the Applicant in which all Project components will be sited.
Project Footprint or Limit of Disturbance	Refers to the limit of temporary and permanent disturbance caused by the construction and operation of all components of the Project. This includes all areas to be used for project components, maintained areas and areas outside of the Project fence to be used as landscaping.
Study Area	Refers to the area evaluated for specific resource identification and/or resource impact assessment. The size of this area is appropriate for the target resource and takes into account the project setting, the significance of resource or impact being identified or evaluated, and the specific survey distances included in Title 19 of NYCRR Part 900. As appropriate, the Study Area for each type of survey or resource impact assessment is provided in the respective sections within the Application.

[1] Any references to Executive Law Section 94-c in this Application refer to former New York State Executive Law Section 94-c, now New York State Public Service Law Article VIII.

Exhibit 21: Electric System Effects and Interconnection

This exhibit addresses the requirements specified in 19 New York Codes, Rules and Regulations (NYCRR) § 900-2.22.

21(a) Electric Interconnection

The Project will interconnect with the existing Craryville substation that is owned and operated by New York State Electric and Gas (NYSEG). The electrical interconnection within the Project Area will consist of a project substation on an adjacent parcel to the Craryville substation. The Project electrical design drawings are illustrated in Appendix 5-2: *Electrical Design Drawings* and the Project collector substation conceptual design is depicted in Appendix 5-4.

(1) Voltage

The electric interconnection proposed for the Project will convey the power generated by the Project's solar photovoltaic modules operated at a voltage of up to approximately 1500 volts-direct current (DC). The DC power from the photovoltaic modules will be collected by the inverters, which will then convert the DC power to alternating current (AC) power at a low voltage, approximately 630 volts, contingent upon the final inverter design. The AC power produced by the inverters will be directed to several medium voltage transformers that will increase the voltage to approximately 34.5 kilovolts (kV) for the collection system. The Project's collection system will tie into each medium voltage transformer to collect the power that was produced by the Project and deliver it to the proposed on-site collection substation.

The power transformers within the collection substation will increase the medium voltage to the utility transmission line voltage of 115 kV, for interconnection to the existing Craryville substation.

(2) Conductors

The proposed transmission line that will be installed to convey the Project's energy to New York State's electricity grid will have a voltage of 115 kV. The conductors associated with the transmission line are proposed to be 795 kilo-circular mils (KCMIL) "Drake," aluminum steel reinforced, bare overhead transmission cable.

(3) Insulator Design

Typical utility-grade ceramic/porcelain or composite/polymer insulators, designed and constructed in accordance with American National Standards Institute C29, will be used.

(4) Length of Transmission Line

The proposed Project substation will be located within the Project Area, on a parcel that is immediately adjacent to the existing NYSEG Craryville substation. The length of the transmission line connecting the two substations is approximately 250 feet.

(5) Tower Dimensions & Construction Materials

The current preliminary design is anticipating a single pole structure to support the transmission line that is connecting the two substations. The pole will be 61-feet in height, from the ground level, with approximately 9-feet embedded in the ground. The pole will be made up of light duty, weathering steel. For specific details regarding the construction materials of the pole structure, see the conceptual substation design drawings in Exhibit 5, Appendix 5-4.

(6) Tower Design Standards

The following standards are anticipated for the design of the towers and foundations:

- Institute of Electrical and Electronics Engineers C2 - National Electric Safety Code;
- American Society of Civil Engineers Manual 72, “Design of Steel Transmission Pole Structures”, and Standard 48, “Design of Steel Transmission Pole Structures”;
- Rural Utilities Service Bulletin 1724E-200 “Design Manual for High Voltage Transmission Lines”;
- American National Standards Institute;
- American Society of Testing of Materials;
- Occupational Safety and Health Administration;
- National Fire Protection Association 70, National Electric Code.

(7) Underground Cable System & Design Standards

No underground cable system is required as part of the 115-kV interconnection. The 34.5-kV collection systems will consist of primarily underground cross-linked polyethylene cables. The list of codes and standards with which the Applicant has conformed, and will conform with during the planning, design, construction, operation, and maintenance of the Project, is in Exhibit 5: *Design Drawings* of this Application.

(8) Underground Lines Profile /Manhole Locations

No underground cabling for the 115-kV interconnection is anticipated. The underground 34.5-kV collection line cross section details are presented in Appendix 5-2: *Electrical Design Drawings* of Exhibit 5 of this Application. The underground collection system will be installed

at varying depths dependent upon the natural environmental factors. In general, the depth of the underground collection system will be no less than 48 inches below ground surface within agricultural lands and 36 inches below ground surface in non-agricultural lands. The Design Drawings in Appendices 5-1 and 5-2 illustrate the underground collection system in detail.

The Project's 34.5 kV underground collection system will not require oil pumping stations or manholes. The locations of planned splice boxes are illustrated in Appendix 5-2.

(9) Equipment to be Installed

The major equipment that is necessary to be installed for the proposed substation includes a 36/52.8/66 MVA transformer, 115 kV HV breaker, 34.5 kV MV breaker, 115 kV disconnect switch, 34.5 kV disconnect switch, SSVT and relays for protection & control.

Additional equipment within the substation may include air break switches, instrument transformers, combined or separate current transformers and voltage transformers, and outdoor type overhead bus or cable connecting the devices, steel support structures, lightning masts, surge arrestors, and shield wires. The selection of this equipment for inclusion in the Project design will be determined during the final design process. The substation will include a grounding grid designed in accordance with IEEE 80, Guide for Safety in AC Substation Grounding.

Work will also be done within the NYSEG's existing Craryville substation, adjacent to the proposed Project substation, in order to facilitate the electrical interconnection. Work will be performed under the Large Generator Interconnection Agreement (LGIA) negotiated with NYSEG and NYISO and will not require any activities outside the Project Area. Work includes installing 115kV circuit breakers, disconnect switches, instrument transformers, CCVTs, Wave Traps, Surge Arrestors, Line Tuning Unit and the associated structures, conductors, and controls.

Work will also be done within NYSEG's existing Klinekill substation at the remote end of the transmission line. This System Upgrade Facility (SUF) was required as NYSEG standards do not allow generation to connect to multi-terminal lines. Work will be performed under the LGIA negotiated with NYSEG and NYISO and will be contained entirely within the existing substation footprint. Work includes installing 115kV circuit breakers, disconnect switches, instrument transformers, CCVTs, Wave Traps, Surge Arrestors, Line Tuning Unit and the associated structures, conductors, and controls.

Work will also be done within the new NY Transco Churchtown substation at the remote end

of the transmission line. This System Upgrade Facility (SUF) was required as NYSEG standards do not allow generation to connect to multi-terminal lines. Work will be performed under the EPC agreement negotiated with NYISO and NY Transco and will be contained entirely within the existing substation footprint. Work includes installation of one (1) 115kV three phase combined current transformer/voltage transformer ("CT/VT") metering unit on the 115kV line to the new Churchtown Substation.,.

(10) Any Terminal Facility

The collection substation and upgrades to the Craryville Substation are the only terminal facilities that will be constructed or updated for the Project, which are described in detail throughout this Exhibit. See Appendix 5-3: *Collection Substation Conceptual Drawings* of Exhibit 5 of this Application for detail.

(11) Cathodic Protection Measures

The Project does not anticipate cathodic protection measures to be necessary for the underground collection system or for the overhead 115 kV transmission line and steel pole. Therefore, this section is not applicable.

21(b) System Reliability Impact Study

A System Reliability Impact Study (SRIS) was conducted and finalized in December 2019 for the Project, in accordance with the Federal Energy Regulatory Commission - approved Open Access Transmission Tariff (OATT) of the New York Independent System Operator, Inc. (NYISO). The purpose of the SRIS was to evaluate the effect of the Project, and the Project's proposed Point of Interconnection (POI), on the New York State Transmission System (NYSTS). The Project impact on the 115 kV transmission line and its interconnection to NYSEG's Craryville substation were analyzed. A copy of the SRIS report can be found in Appendix 21-1.

The SRIS analyzed the expected flows on the NYSTS under normal, peak, and emergency conditions to fully understand the stability of the transmission system. The technical analyses performed to conduct this study included steady state voltage and thermal (N-0, N-1), short circuit and stability analysis. NYISO concluded that the project had no unfavorable impacts on the transmission system. System Upgrade Facilities (SUFs) were required at the remote end substations to comply with NYSEG transmission planning standards for relaying and generation connected to multi-terminal lines.

Steady State Analysis (N-0, N-1)

BEGIN CONFIDENTIAL INFORMATION < [redacted]

[redacted]

> END CONFIDENTIAL INFORMATION

Short Circuit Analysis

BEGIN CONFIDENTIAL INFORMATION < [redacted]

> END CONFIDENTIAL INFORMATION

Stability Analysis

BEGIN CONFIDENTIAL INFORMATION < [redacted]

[redacted]

[redacted] > END

CONFIDENTIAL INFORMATION

21(c) Impact on Transmission System Reliability

The SRIS analysis and results summary can be found in Section 21(B). The results from the SRIS report conclude that the Project will not have a significant, adverse impact on the NYSTS. Therefore, the Project will operate in accordance with the NYISO operational procedures.

21(d) Impact on Ancillary Services

The SRIS did not identify significant adverse impacts from the Project's operation or the POI on ancillary services.

21(e) Impact on Total Transfer Capacity

The SRIS analysis did not identify significant adverse impacts from the Project's operation or the POI on the total transfer capacity across any interfaces.

21(f) Criteria, Plans, and Protocols

For the design, build, and commission of the Project, the Applicant will contract with an engineering, procurement, and construction (EPC) contractor(s). The Applicant will ensure that the contractor(s) engineer, construct, commission, and operate the Project in compliance with applicable federal, state, and local building codes. The contractor(s) will follow all requirements set forth and adopted by agencies that have jurisdiction within the Project Area. The engineering drawings provided for the construction of the Project will be stamped by a New York State Professional Engineer.

(1) Engineering Codes, Standards, Guidelines and Practices

The Applicant will require that the Project be designed, constructed, tested, operated and maintained to meet the requirements of Project agreements, including the LGIA with the NYISO and NYSEG, as well as applicable requirements and standards of American Society for Testing and Materials International, the American Society of Mechanical Engineers, the American Society of Civil Engineers, the Institute of Electrical and Electronics Engineers, the Occupational Safety and Health Administration, and the New York State Uniform Building Code. Upon completion of Project construction and commissioning, the Applicant's EPC contractor(s) will provide to the Applicant a certificate that documents that the work was completed in compliance with Project agreements and all applicable codes and standards.

The LGIA will require that the Project comply with the following standards:

- 2020 National Electric Code (NEC);
- 2017 National Electric Safety Code (NESC), C2-2017;
- NYISO, “Control Center Requirements,” Version 3.0, March 28, 2014;
- NYISO, “Direct Communications Manual,” Version 3.0.1, August 17, 2017;
- New York State Electric Meter Engineers’ Committee. “Guide for Uniform Practice in Revenue Quality Metering,” Rev. 4, August 20, 2003;
- New York State Public Service Commission, “Approved Meter List,” Latest Revision;
- NYISO, “Revenue Metering Requirements Manual,” Version 2.0, March 11, 2019;
- NYISO, “Emergency Operations Manual,” Version 7.5. April 1, 2019;
- NYPP Tie-Line Ratings Task Force, Final Report on Tie-Line Ratings 1995, November 1995;
- NYISO, “Outage Scheduling Manual,” Version 4.9, May 3, 2019;
- NYISO, “Transmission and Dispatching Operations Manual,” Version 4.1; and
- NYISO, “System Restoration Manual,” Version 4.3, April 12, 2017.

(2) Facility Type Certification

Type certification is commonly provided for wind turbines, but it is not applicable for photovoltaic (PV) solar power equipment; however, some equipment, such as the PV modules or the inverters, may be listed per the requirements of the National Electric Code.

(3) Inspection, Testing, and Commissioning Procedures and Controls

The purpose of completing the inspection, testing, and commissioning process is to validate electrical connections, validate panel operation, and perform appropriate field tests to ensure the integrity of the Project’s components. Visual and test-based confirmation of components and wiring during Project construction, as well as prior to the Project going online, will be performed to create a benchmark for the future system checks during Project operation.

The system inspection, testing, and commissioning of the Project will comply with the applicable NYISO and NYSEG utility requirements. A commissioning team will manage and supervise the Project commissioning and document the results of the tests. Irregularities found in these tests may be investigated and corrected as necessary. Where required, the tests will be performed using certified calibrated equipment. The test reports will be compiled and saved for the owner's review and archived for reference during Project operation. Overall, Project performance testing will be conducted, including applicable measurements, field observations, weather conditions, calculations, and correction factors to demonstrate that the Project meets

the owner's performance requirements and is ready for reliable operation. The checkout and commissioning tasks conducted for the Project and the collection substation may include:

- Visual and mechanical inspections of all equipment, structures, and systems;
- As-built verifications;
- Checkout and commissioning of the power inverter skids according to the manufacturer requirements;
- Electrical cabling testing (continuity, megger, phase rotation, etc.);
- Direct current string testing, open circuit voltage testing, and operating current testing;
- Verification of latest firmware on inverters, trackers, and data acquisition system;
- Checkout and commissioning of trackers according to manufacturer's requirements;
- Infrared scans of key equipment and combiner boxes according to owner's requirements;
- Checkout and commissioning of medium and high voltage transformers including dissolved gas analysis oil sample testing;
- High-potential testing of major high voltage equipment;
- Substation Supervisory Control and Data Acquisition and relay protection checks;
- Substation grounding checks;
- Commissioning of Facility's data acquisition system remote communication system; and
- Facility reliability and performance testing.

(4) Maintenance and Management

The Applicant intends to hire experienced Operation and Maintenance (O&M) personnel, or hire qualified contractors to operate and maintain the Project, which includes all solar power systems; PV modules; trackers; inverters; control and monitoring systems; collection substation and Substation Supervisory Control and Data Acquisition; direct current and alternating current cable systems; on-site access pathways; fencing; grounds and vegetation management; security; substation lighting equipment; safety; stormwater and erosion control management features; and general site conditions.

The Applicant will maintain overall responsibility for the Project's compliance with the Project's agreements and permits, including any final siting permit. O&M personnel may hire subcontractors and labor to perform various required O&M tasks, such as landscaping, vegetation management, security, inspection services, environmental inspections, operations control, monitoring, communications, and other tasks.

21(g) Transfer of Transmission Ownership

Per the terms of the LGIA negotiated with NYISO and NYSEG, the Project may construct the SUFs and Connecting Transmission Owner's Attachment Facilities (CTOAFs) at the Craryville and Klinekill substations. The constructed facilities would be transferred to NYSEG as per the terms of the LGIA. Per the terms of the EPC Agreement with NYISO and NY Transco, the SUFs at Churchtown substation may be constructed by the Project and would be transferred to NY Transco as per the terms of the agreement.

(1) Facilities to be Transferred

A description of the SUFs and CTOAFs at Craryville, Klinekill, and Churchtown substations is included in the SRIS found in Appendix 21-1: *System Reliability Impact Study*. Per the terms of the governing agreements, control of these facilities will be transferred once the facilities are energized.

(2) Transmission Owner Design Requirements

All facilities will be designed in accordance with the respective owner's requirements; NYSEG and NY Transco respectively.

(3) Operational and Maintenance Responsibilities and Standards

The Applicant will be responsible for operation and maintenance of the SUFs until the ownership is transferred to NYSEG and NY Transco. Once NYSEG and NY Transco obtain ownership of the facilities, they will be the responsible party. The Applicant, NYSEG, and NY Transco will meet the transmission owner's standards and any of the relevant codes and standards discussed in Section 21(F)(1).

21(h) Multi-use Options for Utilities

The Applicant does not propose to share any above-ground infrastructure with other utilities.

21(i) Equipment Availability and Delivery Schedule

The Applicant will have more information on the construction equipment and expected delivery dates for major project components (i.e. solar panels, inverters, and transformers) closer to the anticipated construction date. If the Project receives all required approvals, it is expected that construction equipment and major project components would be delivered on site within the second quarter of 2026, based on an anticipated commercial operation date at the end of 2026. Anticipated equipment deliveries and schedules are subject to change related to global supply chain delays.