Hecate Energy
Cider Solar Farm

Exhibit 21: Electric System Effects and Interconnection

Cider Solar Farm
Towns of Oakfield and Elba
Genesee County, New York

Matter No. 21-01108

EXHIBIT 21: ELECTRIC SYSTEM EFFECTS AND INTERCONNECTION

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Abbreviations

AC	alternating current
BPS	Bulk Power System
DC	direct current
EPC	engineering, procurement, and construction
kV	kilovolt
MV	medium voltage
MW	megawatt
NESC	National Electric Safety Code
NPCC	Northeast Power Coordinating Council
NYCRR	New York Codes, Rules and Regulations
NYISO	New York Independent System Operator
NYPA	New York Power Authority
O&M	operation and maintenance
OATT	Open Access Transmission Tariff
ON-NY	Ontario-New York
OSP	Operations and Management Service Provider
PAR	Phase Angle Regulators
POI	point of interconnection
PV	photovoltaic
ROW	right-of-way
SRIS	System Reliability Impact Study

Glossary of Terms

Applicant	Hecate Energy Cider Solar LLC
Project	Refers to the proposed Cider Solar Farm, an up to 500-megawatt utility scale solar project that will be comprised of photovoltaic panels, inverters, access driveways, electrical collection lines, point of interconnection/substation, construction staging areas, fencing and plantings, located on private land in the towns of Elba and Oakfield, Genesee County, New York.
Project Area	Refers to the Project Site and surrounding/adjacent land totaling approximately 7,518 acres.
Project Footprint	Refers to the limit of temporary disturbance within the Project Site caused by the construction and operation of all components of the Project totaling approximately 2,452 acres.
Project Site	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 totaling approximately 4,650 acres.
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 Chapter XVIII, 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.

EXHIBIT 21: ELECTRIC SYSTEM EFFECTS AND INTERCONNECTION

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The content of Exhibit 21 is provided in conformance with Chapter XVIII, Title 19 of the New York Codes, Rules, and Regulations (NYCRR) § 900-2.22, as follows.

a) Proposed Electric Interconnection

1) Design Voltage and Voltage of Initial Operation

The electric system proposed for the Cider Solar Farm (the Project) will carry the power generated by the Project's solar photovoltaic modules at a voltage of up to approximately 1500 volts-direct current (DC). The DC power from the photovoltaic modules will be collected by inverters packages, which convert power from DC to alternating current (AC) power at a low voltage between approximately 915 and 1300 volts depending on the final inverter design. The AC power produced by the inverters will be directed to multiple medium voltage transformers that will increase the voltage to a medium voltage of approximately 34.5 kilovolts (kV) for the collection system. The Project's collection system will connect to each medium voltage (MV) transformer to the proposed substation. Main power transformers within the substation will raise the medium voltage to the utility transmission voltage of 345 kV, for interconnection to a new switchyard to be constructed, owned, and operated by New York Power Authority (NYPA). The substation and the switchyard will be located adjacent to the existing NYPA 345-kV transmission line. As the Project will interconnect with the existing NYPA transmission lines located within the Project Site, no new off-site transmission lines will be required. Upgrades along the existing NYPA 345-kV line are anticipated within the existing right-of-way (ROW) adjacent to Project Site.

2) Type, Size, Number and Materials of Conductors

The substation (500-megawatt [MW] output) would be located in the northern section located north of Lockport road between Fischer road and Graham road near the center of the Project Site, adjacent to the existing 345-kV transmission line that runs between NYPA Dysinger to New Rochester. A transmission line (approximately 424 feet in length) would connect the proposed substation to the proposed switchyard. The proposed switchyard will connect into the NYPA transmission line via a line side tap consisting of two sets of 795 KCMIL cables.

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. Insulators in the substation will generally be porcelain and insulators on the 345-kV poles will be polymer.

4) Length of Transmission Line

The proposed switchyard connecting to the NYPA 345-kV transmission line will be located directly adjacent to the substation. The line length between the NYPA 345-kV line and the switchyard will be approximately 223 feet. The lines connecting cables between the switchyard and substation are expected to be approximately 424 feet in length.

5) Typical Dimensions and Construction Materials of Towers

The new structure connecting the switchyard and the substation will be a steel single pole structure installed on a drilled shaft foundation with above ground height of approximately 100 to 120 feet and will have a total span length of approximately 424 feet between the terminal structures located in the switchyard and the substation.

The Applicant proposes to install two sets of 3-pole dead-end steel pole structures to support the transmission line to connect the switchyard to the NYPA 345-kV line. The poles will be installed on drilled shaft foundations with an above ground height of approximately 70 to 90 feet and are expected to be supported by poles similar to the existing NYPA poles.

The proposed routes and structures for lines associated with the Project are depicted in Appendix 5-A, Civil Design Drawings of this Application.

6) Design Standards for Each Type of Tower and Tower Foundation

The towers and foundations were designed in accordance with the following standards:

- Institute of Electrical and Electronics Engineers C2 and 691-2001 - 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.

The foundation for each wooden pole, consistent with similar designs in the area, will be granular fill that is installed into the voids around the pole in the hole drilled for embedment. The fill will be compacted in small lifts to ensure a solid, compacted base for each pole.

7) Type of Cable System and Design Standards for Underground Construction

No underground cabling for the 345-kV connection is anticipated. 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*.

8) Profile of Underground Lines

No underground cabling for the 345-kV connection is anticipated. The underground 34.5-kV collection line cross section details are presented in Appendix 5-A. Collection lines will be buried at a depth of 4 feet. No oil pumping stations or manholes are proposed.

9) Equipment to be Installed in Substation or Switchyard

To accommodate the 500 MW anticipated output from the Project, the substation will include a medium voltage (34.5-kV) underground feeder riser connected to the 34.5-kV feeder breaker, which will feed to a 345-kV step-up transformer via a 34.5-kV disconnect switch. The step-up transformer will raise the voltage to 345-kV utility voltage level.

Additional equipment within the substation may include a 345-kV breaker, 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.

Additional details regarding the substation and switchgear (switchyard equipment) are provided in Exhibit 5.

10) Terminal Facilities

As discussed in Part 21(a)(5), the substation will include a dead-end structure or pole to receive the tie lines from the utility switchyard. These are further detailed in Exhibit 5.

11) Cathodic Protection

No metallic pipelines will be installed as part of the Project, and no Project cables are planned in parallel with existing underground pipelines. Therefore, no cathodic protection measures are required.

b) System Reliability Impact Study

The Project will be interconnected to the New York State transmission system. The point of interconnection for the Project will be on the NYPA Dysinger to New Rochester 345-kV transmission line that extends between the existing Dysinger and Rochester substations. The Project will connect to the NYPA line via substation located in the center of the northern portion of the project site located north of Lockport road between Fischer road and Graham road. where the existing NYPA 345-kV line is located. The New York Independent System Operator (NYISO) evaluated the 500-MW Project through its interconnection queue process. The Project was identified as queue #811.

A System Reliability Impact Study (SRIS) (Appendix 21-A, Interconnection System Impact Study[1]) was conducted for the Project in accordance with the NYISO Applicable Reliability Standards set forth under Attachment X of the NYISO Open Access Transmission Tariff (OATT). Results of this study are summarized below.

- Steady-State Analysis (N-0, N-1 & N-1-1): For the studied summer and winter system conditions, the steady-state analysis did not identify any thermal or voltage violations caused or worsened by the Project.
- Transfer Limit Analysis: Transfer limit analysis was performed for summer peak cases for both pre-project and post-project cases. The Project reduces the Ontario-New York (ON-NY) thermal transfer limit by 39 MW and increases the NY-ON thermal transfer limit by 50 MW. The ON-NY thermal transfer reduction can be reduced to less than 25 MW by adjusting the Dysinger Phase Angle Regulators (PAR). Based on the SRIS study, the Project will not adversely impact the Dysinger-East and West – Central interfaces.
- Stability Analysis: Stability simulations showed that the system remained stable and positively damped for all contingencies tested following the addition of the Project.
- Northeast Power Coordinating Council (NPCC) A-10 BPS Testing: Testing of the NPCC Bulk Power System (BPS) classification of the Q811 POI 345-kV bus was performed according to the NPCC A-10 criteria and requirements. Results indicate that the Q811 POI 345-kV station does not need to be classified as NPCC BPS based on transient stability and steady state tests.
- Short-Circuit Analysis: Short circuit analysis was performed to assess the impact of the Project on the adequacy of existing circuit breakers and related equipment in the SRIS study area (Study Area). The results indicate that the Project increases fault duties in the Study Area by 100 A or more but does not cause any fault interrupting device to exceed its interrupting capability.

The Q811 Cider Solar Project System Reliability Impact Study revealed that the Project has no significant adverse impact on the reliability of the New York State transmission system. Steady state voltage and thermal (N-0, N-1, N-1-1) analysis, extreme contingency analysis, NPCC A-10 testing, transfer limit analysis, short circuit, and stability analyses were evaluated with the addition of Project in making this determination.

c) Evaluation of Potential Significant Impacts of the Project and Interconnection

The results of the SRIS assessment (Appendix 21-A) conducted for the Project show that the Project will have no significant or adverse impact on the State transmission system's reliability. This conclusion assumes that the Project will be operated in accordance with all applicable requirements, including, but not limited to, 19 NYCRR Subpart 900-6, Uniform Standards and Conditions and NYISO operational procedures. The Project will be operated in a manner that does not negatively impact the State

[1] Appendix 21-A, System Reliability Impact Study, analyzed the NYPA Kintigh to New Rochester 345-kV transmission line as the points of interconnection for the Project.

transmission system, which may include dispatching patterns that eliminate potential reliability issues that may exist during certain system contingency conditions.

d) Effects of the Project on Ancillary Services and the Electric Transmission System

The SRIS indicated the Project will not have any significant adverse impact to the State transmission system. For the studied summer and winter system conditions, the steady-state (N-0) did not identify any voltage violations caused or worsened by the Project. The SRIS also performed a post-contingency analysis of the system performance with and without the Project for the summer peak and winter peak cases (N-1). Results for the summer peak analysis indicated the Project worsened the pre-existing low voltages at Sawyer 230-kV bus #1 and bus #2 and improved the voltages at other 115-kV buses. Results of the winter peak analysis indicated the Project worsened the pre-existing low voltages at Wilet 115-kV bus. Results indicated the Project does not cause any new voltage violations for the summer peak and winter peak cases.

e) Estimate of Increase in Total Transfer Capacity

As part of the SRIS, transfer limit analysis was performed for summer peak cases for both pre-project and post-project cases. The SRIS indicates the Project reduces the ON-NY thermal transfer limit by 39 MW, which can be reduced to less than 25 MW by adjusting the Dysinger PAR. The Project increases the NY-ON thermal transfer limit by 50 MW. The SRIS concluded that the Project will not adversely impact the Dysinger-East and West – Central interfaces.

f) Description of Criteria, Plans, and Protocols for Generation and Ancillary Facilities Design

The Applicant intend to contract with an engineering, procurement, and construction (EPC) contractor(s) to design, build, and commission the Project. The Applicant shall require their consultants and contractors to engineer, construct, and commission the Project in compliance with all applicable federal, state, and local building codes and requirements adopted by the applicable agencies having jurisdiction. The Project will be constructed based on New York State Professional Engineer-stamped drawings.

1) Engineering Codes, Standards, Guidelines, and Practices

The Applicant will require that the Project to be designed, constructed, tested, operated and maintained to meet the requirements of Project agreements, including the planned electrical Interconnection Agreement with the utility, 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.

It is anticipated that Interconnection Agreements will require that the Project comply with the following standards:

- 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) Certification for Representative Technology Type being Considered

The materials and equipment used in the final Project design will be new and will meet applicable requirements. The equipment will be investment-grade to facilitate the long-term, reliable operation of the Project. Type certification, as commonly provided for wind turbines, 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. Several PV module and inverter suppliers will be considered. Final selection of the major solar equipment will be completed prior to construction and will depend on a variety of factors including market conditions All selected equipment will comply with the applicable standards and requirements, including any applicable conditions as outlined in 19 NYCRR Subpart 900-6, Uniform Standards and Conditions.

3) Procedures and Controls for Project Inspection, Testing, and Commissioning

Successful Project operation starts with a thorough and comprehensive Project commissioning effort. Visual and test-based verification of components and wiring during Project construction, as well as prior to Project energization, will be performed. These data sets will serve as benchmarks for the future system checks during Project operation.

The system checkout, testing, and commissioning of the Project will comply with the applicable NYISO and NYPA utility requirements. The commissioning team will manage and oversee the Project commissioning and document the results of the tests. Anomalies uncovered 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 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 performance requirements and is ready for reliable operation. The checkout and commissioning tasks conducted for the Project and the 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 Project’s data acquisition system remote communication system; and
- Project reliability and performance testing.

4) Maintenance and Management Plans, Procedures, and Criteria

Project maintenance and management plans, procedures, and criteria are 19 NYCRR § 900-10.2(e)(3). Management of the Project involves various aspects, including:

- Operating and maintaining the Project;
- Compliance with Project contracts;
- Compliance with the any permit issued by Office of Renewable Energy Siting in accordance with 19 NYCRR Part 900 and all applicable laws, regulations, and Project permits and approvals;
- Project dispatch and energy market participation;

- Accounting and budget control; and
- Regulatory and public stakeholder engagement.

The Applicant will have overall responsibility for managing the Project. The Applicant may engage contractors, consultants, and other third parties to manage different aspects of overall Project management; however, the Applicant will oversee contractual and regulatory compliance.

The Project will normally be unstaffed except for routine inspections; planned and unplanned maintenance; and other on-site work. The Project will be designed with industry standard protections and fail-safe shutdown features. The Project will be remotely monitored and controlled by the Operations and Management Service Provider (OSP) staff located at the OSP's control center (the location of the OSP control center will be determined upon selection of the OSP, prior to operation). The OSP will actively monitor and control the Project during daytime hours and be on-call for emergency responses during nighttime hours.

The Project Construction Operational Plan and Facility Maintenance and Management Plan activities will be supported by a network of local support staff and subcontractors. The OSP will ensure all operation and maintenance (O&M) is conducted in compliance with the equipment warranties and, when necessary, may pursue the equipment suppliers to satisfy warranty claims. The Construction Operations Plan and Facilities Maintenance and Management Plan will be submitted as part of the Applicant's pre-construction compliance filings in accordance with 19 NYCRR § 10.2(e)(2) and (3).

Project O&M activities will be limited to within the Project Site. The Project O&M activities will not include any work on or near any off-site high-voltage transmission facilities. No O&M work is proposed within public ROWs.

g) Substation

1) Solar Substation and Switchyard

The Applicant will design and construct the substation and switchyard. Upon completion of construction, it is anticipated that the Applicant will own the substation and will transfer ownership of the switchyard to NYPA. The terms of the transfer will be negotiated by the Applicant and NYPA prior to completion of construction, with the intent that ownership of the switchyard would pass upon completion of construction.

2) Substation, Switchyard, and Interconnection Design for Transmission Requirements

The design of the substation and associated facilities will be closely coordinated between the Project engineer and the utility's engineering team. The Project engineer will ensure all applicable utility requirements are addressed in the design. Prior to startup, the Project engineer and utility engineers will coordinate the protection relay settings at the Project substation to ensure the settings and logic meet the utility requirements and are coordinated to properly work in conjunction. Upon completion of the installation, the Project engineer will ensure the final as-built drawings of the substation are provided to the utility in accordance with the interconnection agreements.

3) Operational and Maintenance Responsibilities

NYPA will be responsible for the O&M of the regional electric system upgrades and the new interconnect facilities required for the Project. The Applicant will be responsible for the O&M of the substation. The NYPA interconnection facility will consist of two sets of 3-pole structures for the interconnection line and one mono pole for the proposed substation to switchyard connection located within the existing utility ROW. An access easement may be required across the Project Site in order to allow NYPA access to the substation and the utility interconnect facilities. The final arrangement will be determined during the final design process by NYPA.

h) Sharing of Aboveground Facilities

The Applicant is not proposing that the Project share any aboveground infrastructure with other utilities.

i) Equipment Availability

Availability and delivery times for key equipment may vary slightly depending on desired equipment features, manufacturer activity, inventory, infrastructure activity, and market conditions. The Applicant will continue to monitor equipment availability and market conditions that will guide final equipment selection. The Applicant will maintain contact with suppliers and explore early discussions in preparation for purchase orders to support the implementation schedule. The delivery of key major equipment may be in the range identified in Table 21-1: *Equipment Deliveries*.

Table 21-1: Equipment Deliveries

Equipment	Timing of Delivery (following receipt of order)
PV Modules	6–16 weeks
Trackers	12–16 weeks
Inverters and Medium Voltage Transformers	14–20 weeks
Electrical Switchgear	14–22 weeks
High Voltage Transformers	16–25 weeks

Long-lead equipment includes the main step-up transformers, which typically can be ordered early and be delivered in the late stages of construction. The equipment procurement strategy will be finalized during the final engineering and planning stage of the Project, prior to construction. Some adjustments to equipment procurement may be made after starting Project construction.