

## **EXHIBIT A STATEMENT OF WORK**

Contract Title: **New York State Wide Area Protection Study**  
Contractor: **Quanta Technology Inc.**  
Project Number: **118219**

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### **DEFINITIONS**

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**1. *The Project*** is defined as:

The feasibility of implementing a controlled system separation method in New York State to counter transient angular instability under certain major disturbance scenarios had been investigated in two previous studies. They are the Major Disturbance Mitigation Study (MDMS), and the Feasibility Study of Controlled System Separation Methods. With the amount of inverter-based renewable resources in the New York State and New England area projected to reach 15% or higher in the next few years and with a much higher level by 2030, and the impact that these resources could have during major system disturbances, there is an urgent need to reexamine the previous study results in order to take the changing New York State power system conditions into consideration. Major disturbance scenarios from the mentioned studies shall be expanded to include additional credible extreme disturbances that could be the result of terrorist acts, gas pipeline rupture, and so on. Finally, major disturbances usually lead not only to transient angular instability, but also to frequency and voltage instability, for which mitigation measures should also be developed and implemented.

**2. *The Project Objectives*** are defined as:

In this research study, Quanta Technology, along with its partners the New York State Reliability Council (NYSRC), New York Independent System Operator (NYISO) and participating New York State Transmission Owners (TOs), plans to expand on the work of previous studies to develop new and improved mitigation measures that are also feasible for near term field implementations. This project will assess the feasibility of implementing the major disturbance mitigation measures in a New York State Wide-Area Protection and Control System (WAPCS) that will leverage the Phasor Measurement Unit (PMU) systems already deployed in New York State to enhance the reliability and resiliency of the New York electric power system during major disturbances. This project will focus on improving current dynamic power system models to include inverter-based renewable resources, developing dynamic simulation cases to represent expanded wider ranges of disturbance scenarios, investigating the New York State power system's responses to such disturbances, developing instability detection algorithms based primarily on PMU measurement data, developing mitigation measures for containing the impact of the disturbances, and verifying the effectiveness and feasibility of the candidate mitigation measures through power system dynamic simulations.

**3. *Contractor*** is defined as:

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4. **Subcontractors** are defined as:

Additions and/or Substitutes – Upon written approval of Project Manager and formal modification to this Agreement.

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**PROJECT MANAGEMENT AND PROGRESS REPORTING**

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**Task 0 – Project Management and Progress Reporting**

**0.0** Responsibility

The Contractor shall provide all project management activities necessary for the performance of this Statement of Work, which shall include the following activities:

- a. Coordinate the work of the contractor's employees and those of sub-contractors and equipment vendors that are undertaking tasks described in this Statement of Work;
- b. Ensure control over the project budget and adherence to the project schedule; and
- c. Provide all project reporting to NYSERDA as specified in this Statement of Work.

**0.1** Progress Reporting

The Contractor shall submit **periodic** progress reports, no less frequently than **quarterly**, to NYSERDA's Project Manager no later than the 15th of the month following each reporting period. The Progress Reports shall include information on the following subjects, in the order indicated, with appropriate explanation and discussion:

- a. Name of contractor;
- b. Title of the project;
- c. Agreement number;
- d. Reporting period;
- e. Project progress including a summary of progress, findings, data, analyses, results and field-test results from all tasks carried out in the covered period;
- f. Planned work for the next reporting period;
- g. Identification of problems;
- h. Planned or proposed solutions to identify problems described in (f) above;
- i. Ability to meet schedule, reasons for slippage in schedule;
- j. Schedule-percentage completed and projected percentage of completion of performance by calendar quarter-may be presented as a bar chart or milestone chart; and
- k. Budget- analysis of actual costs incurred in relation to the budget.

**Deliverable(s):** Written Periodic Progress Reports.

**0.2** Project Kick-off Meeting

The Contractor shall hold a project kick-off meeting **within thirty days** from the contract execution date. The Contractor shall coordinate with NYSERDA's Project Manager to arrange the meeting at a mutually convenient time and place. The Contractor is encouraged to invite representatives of sub-contractors and equipment vendors, if applicable. The purpose of this meeting shall be to finalize the strategies for accomplishing the objectives of this work. In a timely manner, the Contractor shall submit to NYSERDA's Project Manager a brief report summarizing the issues discussed and decisions made, if any, during this meeting.

**Deliverable(s):** A brief report regarding the project kickoff meeting.

### **0.3 Project Completion Meeting**

The Contractor shall conduct a project completion meeting, which shall occur within a time period covering **15 days prior to and 15 days following** the submission of the draft Final Written Document. The Contractor shall coordinate with NYSERDA's Project Manager to arrange the meeting at a mutually convenient time and place.

**Deliverable(s):** A brief report regarding the project completion meeting.

### **0.4 Project Metrics Reporting**

On an annual basis, the Contractor shall submit, to NYSERDA's Project Manager, a prepared analysis and summary of metrics addressing the anticipated energy, environmental and economic benefits that are realized by the project. All estimates shall reference credible sources and estimating procedures, and all assumptions shall be documented. Reporting shall commence the first calendar year after the contract was executed. Reports shall be submitted by January 31st for the previous calendar years activities (i.e. reporting period). Reports shall continue to be submitted for **two** consecutive calendar years after the project is completed. The Contractor shall make every effort to quantify and document benefits and incorporate them into the Final Report and technology transfer activities as required in this agreement.

**Deliverable(s):** Written Annual Metrics Report

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## **PROJECT TASKS**

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### **Task 1 – Develop Technology Transfer Plan**

The Contractor shall develop a technology transfer plan that is designed to communicate project results to interested parties in New York and throughout the United States.

**Task 1 Deliverable(s):** Report detailing technology transfer plan.

### **TASK 2 – Review Previous Work and Develop Simulation Cases**

#### **Task 2.1: Review and Summarize Previous Work**

The Contractor shall review prior work and summarize the state-of-the-art analytical approaches for assessing short and long- term stability of bulk power systems subjected to major disturbances. The Contractor shall include identification of approaches for rotor angle stability, frequency stability, and voltage stability assessment, with a focus on methods suitable for real time applications. The Contractor shall review prior work, including, but not be limited to, the Major Disturbance Mitigation Study (MDMS) report, the NYISO's Controlled System Separation Method Feasibility Study report, the 2003 Northeast Blackout Study reports, the New York Control Area's defensive strategies study reports, the NYSRC working group meeting materials, and the Northeastern Power Coordinating Council's oscillation study reports. The Contractor shall identify pros and cons of the existing methodologies.

The Contractor shall prepare a Task 2.1 report to summarize the results of Task 2.1 work. The Contractor shall distribute the draft Task 2.1 summary report to all project partners and NYSERDA's Project Manager for review and comments, and organize either an in person or web meetings to review and discuss the results in the draft Task 2.1 report. The Contractor shall finalize the Task 2.1 summary report taking into consideration the comments and suggestions received from project partners and NYSERDA's Project Manager.

**Task 2.1 Deliverable(s):** Report summarizing the prior work results reviewed of the state-of-the-art analytical approaches for assessing short- and long-term stability of bulk power systems subjected to major disturbances.

### **Task 2.2 Base Case Development and Testing**

**Task 2.2.1:** The Contractor shall review the 2020 and 2030 New York State planning study cases with detailed modeling of Transmission Owners (TOs) relay systems and under-frequency load shedding (UFLS) methods as the initial base cases. The Contractor shall develop dynamic simulation cases for an expanded range of major disturbance scenarios. The Contractor shall modify initial base cases to incorporate dynamic response models of renewable resources for investigating their impacts under major disturbances. The Contractor, with participation from the NYSRC and New York's TOs, shall define the major disturbance scenarios that are representative of the types of major disturbances to be investigated in this study, run simulation studies of the defined scenarios using the developed cases, and summarize the findings of the simulation studies.

**Task 2.2.2:** The Contractor shall also evaluate the system dynamic response under the simulated major disturbances in an alternative system topology wherein the Northeast is separated from the rest of the Eastern Interconnection by establishing a new, smaller synchronous interconnection, referred to herein as the Northeast Interconnection (NEI). The alternative topology would consist of New York, New England, the Canadian Maritimes and Ontario. This NEI configuration will include simplified models (power flow only) at each asynchronous interconnection point with the remaining portion of the Eastern Interconnection and with Quebec. The renewable resource models will be included.

The Contractor shall prepare a Task 2.2 draft report to summarize the results of Task 2.2 work. The Contractor shall distribute the draft Task 2.2 summary report to all project partners and NYSERDA's Project Manager for review and comments, and organize either an in person or web meetings to review and discuss the results in the draft Task 2.2 summary report. The Contractor shall finalize the Task 2.2 summary report taking into consideration the comments and suggestions received from project partners and NYSERDA's Project Manager.

**Task 2.2 Deliverable(s):** Report describing the simulation cases developed, the disturbance scenarios to be investigated, and the initial dynamic simulation results of the simulated disturbance scenarios.

### **TASK 3 – Develop Instability Detection Algorithm and Mitigation Measures**

The Contractor shall develop new algorithms or improve existing ones, utilizing the PMU measurements, for timely detection of the rotor angle, frequency, and voltage instability resulting from major disturbances as modeled in Task 2. The Contractor shall also develop adequate

mitigation measures, triggered by the instability detection, to minimize the impacts of major disturbances to the New York State bulk electric power system.

**Task 3.1:** The Contractor shall assess the algorithms for angular instability detection developed in the MDMS study to determine whether any improvements should be made. If improvements are required, the Contractor shall either improve on or develop new algorithms for detecting angular instabilities. The Contractor shall select, improve and develop algorithms for real-time and online detection of frequency and voltage instability. The Contractor shall develop detection algorithms according to the findings of Tasks 2.2. The Contractor shall include an analysis of the latency delays that will be required in the performance testing of Task 4.1. The Contractor shall utilize the capabilities of new measurement devices including but not limited to, PMUs to design detection algorithms that can predict impending angular, frequency, and voltage instabilities in the New York power system under the studied major disturbance scenarios.

The Contractor shall prepare a Task 3.1 draft report to summarize the results of Task 3.1 work. The Contractor shall distribute the draft Task 3.1 summary report to all project partners and NYSERDA's Project Manager for review and comments, and shall organize either an in person or web meetings to review and discuss the results in the draft Task 3.1 report. The Contractor shall finalize the Task 3.1 summary report taking into consideration the comments and suggestions received from project partners and NYSERDA's Project Manager

**Task 3.1 Deliverable(s):** Report documenting the developed detection algorithms. The report shall include a description of the desired performance of the detection algorithm.

### **Task 3.2 Mitigation Measure Development**

**Task 3.2.1:** The Contractor shall assess the controlled system separation mitigation measures developed in the MDMS study to determine if any improvements can be made. The Contractor shall investigate mitigation measures in addition to controlled separation of the New York transmission system. Using modified base case, the Contractor shall explore using the Wide Area Protection and Control Systems (WAPCS) to communicate with the controller of inverters located at individual wind and solar farms to prevent uncoordinated tripping off and automatic returning to the grid and explore using the WAPCS to communicate with the controllers of Flexible Alternating Current Transmission System (FACTS) devices and High Voltage Direct Current (HVDC) terminals to provide emergency support for stabilizing the post-disturbance system or to increase synchronous torque and stability margins when the neighboring systems are experiencing disturbances. The Contractor shall consider whether any modifications to TOs relay systems and under frequency load-shedding (UFLS) methods may offer required reliability improvements as part of the mitigation measure investigation.

**Task 3.2.2:** The contractor will also assess performance of the NEI topology modeled in Task 2.2 with particular focus on those contingencies which result in instability. Consideration will only be given to converter power order modulation to determine if this could be a stabilizing influence. None of the MDMS based WAPCS measures will be applied to this topology as this concept is based on "separation before the event".

The Contractor shall prepare a Task 3.2 draft report to summarize the results of Task 3.2 work. The Contractor shall distribute the draft Task 3.2 summary report to all project partners and NYSERDA's Project Manager for review and comments, and shall organize either an in person

or web meetings to review and discuss the results in the draft Task 3.2 report. The Contractor shall finalize the Task 3.2 summary report taking into consideration the comments and suggestions received from project partners and NYSERDA's Project Manager.

**Task 3.2 Deliverable(s):** Report describing the contemplated mitigation measures. The report shall include a description of the effectiveness of the mitigation measures.

#### **TASK 4 – Testing of Mitigation Measures**

The Contractor shall verify the effectiveness and feasibility of the developed detection algorithms and the mitigation measures developed in Task 3 using the dynamic simulation cases developed in Task 2.

The Contractor shall perform tests on the detection algorithms and the mitigation measures developed in Task 3 to assess their effectiveness and feasibility for implementation in the WAPCS using PMU measurements. The Contractor shall consider practical implementation factors against the disturbance scenarios developed in Task 2, which shall include, but not be limited to, the expected latencies and delays of all devices in the chain of sensing and control including PMUs, data concentrators, computation delays, tele-protection delays, communication delays, relay delays and breaker operation delays in the simulations to test the proposed mitigation options. The Contractor shall evaluate the actions of TOs relay systems and UFLS and the WAPCS system architecture with redundant design concepts that would satisfy Northeast Power Coordinating Council (NPCC) and North American Electric Reliability Corporation (NERC) standards for wide area protection systems.

The Contractor shall prepare a Task 4 draft report to summarize the results of Task 4.1 work. The Contractor shall distribute the draft Task 4 summary report to all project partners and NYSERDA's Project Manager for review and comments, and organize either an in person or web meetings to review and discuss the results in the draft Task 4 summary report. The Contractor shall finalize the Task 4 summary report taking into consideration the comments and suggestions received from project partners and NYSERDA's Project Manager.

**Task 4 Deliverable(s):** Report documenting the test results of the developed mitigation measures and the analysis of these results along with findings, recommendations and conclusions.

#### **Task 5 - Technology Transfer**

The Contractor shall conduct all technology transfer tasks to the Project Manager's satisfaction. Should the project's results differ from the expected outcome, the Contractor shall be allowed to modify the technology transfer plan, with the Project Manager's approval, to facilitate appropriate technology transfer activities.

**Task 5 Deliverable(s):** Completion of all technology transfer activities approved by NYSERDA's Project Manager. The Contractor shall hold a workshop to present the results and findings.

### Task 6 - Final Written Documentation

The Contractor shall prepare a detailed Final Written Document in the form of a report covering all aspects of the work performed under this Agreement.

- a. The report shall include information on the following subjects and synthesize all information into understandable and actionable findings:
  1. Discussions of the observations and findings and recommendations, if any, from all tasks, and avenues for further improvements, as appropriate;
  2. Discussions of the project results and lessons learned regarding configuration, capabilities, and benefits of the Project; and
  3. Environmental, and economic benefits, and implementation scenarios associated with such.
- b. The report shall be provided in Draft and Final form as follows:
  1. A Draft Version of the Final Written Document in the form of a report shall be submitted to NYSERDA's Project Manager no later than the date specified in the Milestone Schedule of the NYSERDA Agreement for this task. NYSERDA will comment on the draft version within 60 working days after receipt of such draft.
  2. A Final Version of the Final Written Document in the form of a report shall be submitted **within 30 working days** after receipt of NYSERDA's comments. The Contractor shall:
    - i. prepare the final version of the Final Written Document to reflect careful consideration of NYSERDA's comments to the satisfaction of NYSERDA;
    - ii. submit electronic copy of the final version of the Final Written Document; and
    - iii. include in the final version of the Final Written Document the *appropriate version* of the following disclaimer notice:

#### Task 6 Deliverable(s):

A draft version of the Final Written Document.