EXHIBIT A: STATEMENT OF WORK
MDMS2 - Wide-Area Protection Study (WAPS)
NYSERDA Agreement No. PON 3397

BACKGROUND/OBJECTIVES

The feasibility of implementing a controlled system separation scheme in New York State to counter transient angular instability under certain major disturbance scenarios had been investigated in two previous studies: Major Disturbance Mitigation Study (MDMS), and the Feasibility Study of Controlled System Separation Scheme. 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 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.

In this Wide-Area Protection Study (WAPS), which could also be considered the second phase of the MDMS (i.e., MDMS2), 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[a] (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. The MDMS2 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) system already deployed in New York State to enhance the reliability and resiliency of the New York electric power system during major disturbances. In the course of these activities, MDMS2 will focus on improving current dynamic power system models to include inverter-based renewable resources, developing dynamic simulation cases to represent expanded wider range 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, development of 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.

DEFINITIONS

CenHud: Central Hudson Gas & Electric Corporation
ConEd: Consolidated Edison Company of New York
FACTS: Flexible Alternating Current Transmission System
HVDC: High-Voltage, Direct Current
MDMS: Major Disturbance Mitigation Study
MDMS2: Major Disturbance Mitigation Study, phase 2
NEI: Northeast Interconnection

[a] Participating New York State TOs include: Central Hudson Gas & Electric (CenHud), Consolidated Edison (ConEd), National Grid (NGrid), New York Power Authority (NYPA), Public Service Enterprise Group (PSEG), and New York State Electric & Gas Corporation (NYSEG) / Rochester Gas and Electric Corporation (RGE).

NERC: North American Electric Reliability Corporation
NGrid: National Grid
NPCC: Northeast Power Coordinating Council, Inc.
NYISO: New York Independent System Operator
NYPA: New York Power Authority
NYSRC: New York State Reliability Council
PMU: Phasor Measurement Unit
PSEG: Public Service Enterprise Group
NYSEG/RGE: New York State Electric & Gas Corporation / Rochester Gas and Electric Corporation
SOW: Statement of Work
TO: Transmission Owner
UFLS: Under frequency Load-Shedding
WAPCS: Wide-Area Protection and Control System
WAPS: Wide-Area Protection Study

Contractor is defined as:

Quanta Technology LLC
4020 Westchase Blvd., Suite 300
Raleigh, NC 27607
Contact: Yi Hu
Phone: (919) 334-3042
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Subcontractors/Partners are defined as:

Partner	**Address**	**Contact**
New York State Reliability Council (NYSRC)	1907 Evva Drive Schenectady, NY 12303	George Smith
New York Independent System Operator (NYISO)	10 Krey Blvd., Rensselaer, NY 12144	Kevin DePugh
Consolidated Edison Company of New York (ConEd)	4 Irving Place New York, NY 10003	Daniel F. Taft
New York Power Authority (NYPA)	123 Main Street White Plains, NY 10601-3170	Sunil Kumar Palla
National Grid (NGrid)	300 Erie Blvd. W. Syracuse, NY 13202	Bart D. Franey
Public Service Enterprise Group (PSEG)	125 East Old Country Road Hicksville, NY 11801	Curt J. Dahl
Central Hudson Gas & Electric Corporation (CenHud)	284 South Avenue Poughkeepsie, NY 12601	Frank S. Pace
New York State Electric & Gas Corporation (NYSEG) / Rochester Gas &Electric Corporation (RG&E)	18 Link Drive Binghamton, NY 13902-5224	Ray Kinney

TASK 0 – PROJECT MANAGEMENT AND PROGRESS REPORTING

Responsibility

Regardless of subcontracting/partnership arrangements, the Contractor shall be responsible for the timely completion of all the tasks in the Statement of Work (SOW) per the Project Schedule included herein. The Contractor shall provide all project management activities necessary for the performance of this SOW, as per attached *milestone schedule/budget*, which shall include the following activities:

- Coordinate the work of the Contractor's employees and those of subcontractors that are undertaking tasks described in this SOW;
- Ensure control over the Project Budget and adherence to the Project Schedule; and
- Provide all project reporting to NYSERDA as specified in this SOW.

Subcontract(s)/Agreement(s)

The Contractor shall enter into an agreement with NYSRC to perform work in the area of overseeing the project and providing technical support of the project. Since the NYSRC's mission relates to reliability of the New York State Electric System, this agreement will address the desire of the NYSRC, on behalf of its members including the TO's, to provide direction to the study so as to insure that it meets the needs of New York State.

The Contractor shall enter into an agreement with NYISO to perform work in the area of providing dynamic stability simulation base case for 2020 and 2030 and the related information corresponding to future renewable resources integration. In addition, this agreement will also address advisory comments from the NYISO relating to reliability of New York State.

At NYSERDA's request, the Contractor shall submit a copy of the above agreement(s) to NYSERDA's Project Manager.

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 (g) 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.
k. Budget- analysis of actual costs incurred in relation to the budget.

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 project partners. 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.

Project Monthly Status Review Meeting

The Contractor shall hold a project monthly status review web meeting within seven days after the end of each previous month excluding the first month from the contract execution date when the project kickoff meeting and the last month from the contract execution date when the project completion meeting will be held. The Contractor shall coordinate with representatives of all project partners to arrange the meeting at a mutually convenient time and invite NYSERDA's Project Manager to the scheduled meeting. The purpose of the monthly status review meetings shall be to review progress being made in the previous month, discuss any issues identified and the action plan, and the work plan for the current month. In a timely manner, the Contractor shall prepare a brief report summarizing the issues discussed and decisions made, if any, during a monthly status review meeting, and distribute it to all project partners and NYSERDA's Project Manager.

Project Completion Meeting

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

Annual Metrics Reports

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 year's activities (i.e. reporting period). The Contractor shall provide metrics in accordance with the attached Metrics Reporting Guide for Information Dissemination.

Task 0 Deliverables:

(1) Written periodic Progress Reports.
(2) Brief report summarizing the Kick-off Meeting and Minutes.
(3) Brief report summarizing the Completion Meeting and Minutes.
(4) Annual Metrics Reports.

TASK 1 – DEVELOP TECHNOLOGY TRANSFER PLAN

Task 1.1: 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 Deliverables:

(1) Detailed technology transfer plan.

Task 1 Schedule:

(1) Complete the draft technology transfer plan within thirty (30) days from the contract execution date.
(2) Finalize the technology transfer plan within sixty (60) days from the contract execution date.

TASK 2 – REVIEW PRIOR WORK AND SIMULATION CASES DEVELOPMENT

Task 2.1: The Contractor shall review prior work and summarize state-of-the-art analytical approaches for assessing short and long term stability of bulk power systems subjected to major disturbances. The summary shall include identification of approaches for rotor angle stability, frequency stability, and voltage stability assessment, with a particular focus on methods suitable for real time application. Prior work results to be reviewed should include: EnerNex's MDMS final report, NYISO's Controlled System Separation Scheme Feasibility Study report and 2003 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.

Task 2.2: Using 2020 and 2030 New York State planning study cases with detailed modeling of TO transmission relay systems and under-frequency load shedding (UFLS) schemes 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 impact under major disturbances. The Contractor, with advice 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 defined scenarios using the developed cases, and summarize the findings of the simulation studies.

Task 2.3: The Contractor shall prepare a Task 2 summary report to summarize the results of Task 2.1 and Task 2.2. The Contractor shall distribute the draft Task 2 summary report to all project partners and NYSERDA's Project Manager for review and comments, and organize face-to-face and/or web meetings to review and discuss the results in the draft Task 2 summary report. The Contractor shall finalize the Task 2 summary report taking into careful consideration the comments and suggestions received from project partners and NYSERDA's Project Manager.

Task 2 Deliverables:

(1) Task 2 Summary Report summarizing state-of-the-art analytical approaches for assessing short- and long-term stability of bulk power systems subjected to major disturbances, prior work results review, the simulation cases developed, the disturbance scenarios to be

investigated, and the initial dynamic simulation results of the simulated disturbance scenarios.

Task 2 Schedule:

(1) Draft Task 2 summary report complete 120 days from contract execution date
(2) Final Task 2 summary report complete 150 days from contract execution date

TASK 3 – INSTABILITY DETECTION ALGORITHM AND MITIGATION MEASURES DEVELOPMENT

A timely detection of an instability condition is a prerequisite for a successful application of mitigation measures. Appropriate mitigation measures should be applied to contain a major disturbance and minimize the impact to the overall New York electric power system. The Contractor shall develop new algorithms (or improve existing ones) for timely detection of the rotor angle, frequency, and voltage instability resulting from major disturbances as modeled in Task 2. The PMU measurements will be used as the main real-time input source. 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 make an assessment of the algorithms for angular instability detection developed in MDMS to determine whether any improvements should be made. If a need for improvement is identified, the Contractor shall either improve on or develop new algorithms for detecting angular instabilities. The Contractor shall develop new algorithms for real-time and online detection of frequency and voltage instability. As part of this task, the Contractor should include an analysis of the latency delays that will be included in the performance testing of Task 4.1 (see below). The Contractor shall develop detection algorithms according to the findings of Tasks 2.2. In particular, the Contractor shall utilize the capabilities of new measurement devices such as 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.

Task 3.2: The Contractor shall make an assessment of the controlled system separation mitigation measures developed in MDMS to determine whether any improvement could be made. The Contractor shall investigate mitigation measures in addition to controlled separation of the New York transmission system. Two distinct topologies will be studied in the analysis:

- The existing Eastern Interconnection topology, and
- A new 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); this new topology would consist of New York, New England, and the Canadian Maritimes and Ontario. This regional synchronous NEI interconnection could be connected to the remaining Eastern Interconnection by means of asynchronous high-voltage, direct current (HVDC) ties.

For these two topologies:

- Explore using the 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.

- Explore using the WAPCS to communicate with the controllers of Flexible Alternating Current Transmission System (FACTS) devices and HVDC terminals to provide emergency support for stabilizing the post-disturbance system or to increase synchronous torque and stability margin when the neighboring systems are experiencing disturbances.

The Contractor shall consider whether any modifications to TO relay systems and under frequency load-shedding (UFLS) schemes may offer required reliability improvements as part of the mitigation measure investigation.

Task 3.3: The Contractor shall prepare a Task 3 summary report to summarize the results of Task 3.1 and Task 3.2. The Contractor shall distribute the draft Task 3 summary report to all project partners and NYSERDA's Project Manager for review and comments, and shall organize face-to-face and/or web meetings to review and discuss the results in the draft Task 3 report. The Contractor shall finalize the Task 3 summary report taking into careful consideration the comments and suggestions received from project partners and NYSERDA's Project Manager.

Task 3 Deliverables:

(1) Task 3 Summary Report describing the improved/developed detection algorithms. The report shall also include a description of the performance and effectiveness evaluation process and the verification results of the algorithms under the simulated disturbance conditions.

Task 3 Schedule:

(1) Draft Task 3 summary report complete 210 days from contract execution date
(2) Final Task 3 summary report complete 270 days from contract execution date

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.

Task 4.1: 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 WAPCS using PMU measurement, taking the practical implementation factors into consideration against the disturbance scenarios developed in Task 2, which include the following:

- Expected latencies and delays of all devices in the chain of sensing and control including PMUs, data concentrators, computation delays, teleprotection delays, communication delays, relay delays and breaker operation delays in the simulations to test the proposed mitigation schemes.
- Actions of TO transmission relay systems and UFLS.
- WAPCS system architecture with redundant design concepts that would satisfy Northeast Power Coordinating Council, Inc. (NPCC) and North American Electric Reliability Corporation (NERC) standards (e.g., NPCC Directory #7, NERC PRC-012-2) for wide-area protection systems.

Task 4.2: The Contractor shall prepare a Task 4 summary report to summarize the results of Task 4.1. 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 face-to-face and/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 careful consideration the comments and suggestions received from project partners and NYSERDA's Project Manager.

Task 4 Deliverables:

(1) Task 4 Summary Report describing the test results of the developed mitigation measures and the analysis of these results along with findings, and conclusions.

Task 4 Schedule:

(1) Draft Task 4 summary report complete 300 days from contract execution date
(2) Final Task 4 summary report complete 330 days from contract execution date

TASK 5 - TECHNOLOGY TRANSFER

Task 5.1: The Contractor shall conduct all technology transfer tasks according to the technology transfer plan as developed in Task 1 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 Deliverables:

(1) 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 5 Schedule:

(1) The schedule of Task 5 deliverables will follow the agreed-upon schedule developed with NYSERDA's Project Manager as part of the technology transfer plan.

TASK 6 - FINAL REPORT

Upon completion of the contract period, the Contractor shall prepare a non-proprietary/non-confidential Final Report covering all aspects of the work performed under this Agreement; the report shall include information on the following subjects:

- Discussions of the observations and findings and recommendations, if any, from all tasks, and avenues for further improvements, as appropriate;
- Discussions of the project results and lessons learned regarding configuration, capabilities, and benefits of the project; and
- Environmental, and economic benefits, and implementation scenarios associated with such.

Draft Version and Final Version of Final Report: A draft version of the Final 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 30 working days after receipt of such draft. Within 30 working days after receipt of NYSERDA's comments, the Contractor shall prepare a final version of the report reflecting therein careful consideration of NYSERDA's comments to the satisfaction of NYSERDA, and submit two (2) bound, color hard copies and one (1) electronic copy of the final version of the Final Report.

Task 6 Deliverables:

(1) A draft version of the Final Report.
(2) A final version of the Final Report.