SAND2012-4221P

# System Integration Study for Long Island

Proposal to NYSERDA for PON 2474

Submitted by:

Sandia National Laboratories
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## Proposal Checklist

*Attached*

## Disclosure of Prior Funding

*Attached*



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# Executive Summary

Sandia National Laboratories is a multi-disciplinary laboratory with leading expertise in a broad range of science and engineering disciplines. Energy security, complex energy systems and renewable energy and enabling technologies (such as energy storage) are core competency areas. Focus on grid integration has increased significantly over the last decade. Sandia's approach to grid integration of renewable energy is multi-disciplinary, recognizing that future evolution of the grid is influenced by multiple factors and technologies.

The members of this team include a diverse range of capabilities. Verne Loose, PhD is a distinguished economist having an extensive career in energy economics, research management and finance spanning more than three decades. Jim Ellison is a research engineer experienced with valuing energy storage and other grid projects using production cost models. Cesar Augusto Silva Monroy is a power systems engineer with expertise in power grid analysis and modeling. Dhruv Bhatnagar is a technology and policy analyst experienced with systems analysis in the integration of energy storage and renewable resources.

Higher wholesale electric power rates in Long Island and New York City as compared to other areas of New York State persist due mainly to less generation than is needed to meet demand coupled with transmission congestion.[1] Not only does this transmission congestion increase wholesale power costs, it also poses a threat to the reliability of the grid. LIPA's (Long Island Power Authority) 2010 – 2020 Electric Resource Plan) indicates that Long Island will need additional resources by 2016 for the continued reliable operation of the LIPA grid.[2] This considers the fact that LIPA is working to integrate renewables into its grid to meet the state's RPS standard of 30% renewable generation by 2013 and reduce its electric power generation's negative environmental impact. As a result of this renewable generation integration, resources will be needed to manage the increased variability they present to a power system.

In August 2010, LIPA issued a Request for Proposals (RFP) for up to 1000 MW of additional capacity, which could be either new generation based on Long Island, or elsewhere and delivered by a new transmission line.[3] Of the 16 companies that submitted proposals, only one proposed something other than new generation or transmission. That company, AES Energy Storage, proposed a large battery storage system comprised of 400MW and 1600MWh of Li-Ion batteries.[4]

Thus, we propose to evaluate the benefits to the grid of a 400MW / 1600MWh battery storage facility based on Long Island. Using a nodal representation of the NYISO grid in a production cost model, the value of the system benefits provided by the proposed storage facility could be compared to those provided by a 400 MW simple-cycle combustion turbine and those provided by new transmission infrastructure.

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[1] "Long Island Power Authority Electric Resource Plan 2010-2020." Long Island Power Authority. February 2010. http://www.lipower.org/company/powering/energyplan10.html

[2] *Ibid.*

[3] Long Island Power Authority. http://www.lipower.org/newscenter/pr/2010/082010-rfp.html.

[4] "Can Batteries Replace Generators?" The New York Times Green Blog. May 18, 2011. http://green.blogs.nytimes.com/2011/05/18/can-batteries-replace-power-generators/

Such an assessment would be of value to LIPA, NYISO, NYSERDA, and to the New York State Public Service Commission, in comparing an energy storage system with the other alternatives for additional generation and transmission capacity. Not only would the value apply to this specific RFP, but to other sites around the state of New York requiring similar services where a better understanding of all options enables the selection of the best choice.

Energy storage technologies can provide significant benefits that include allowing additional renewable energy resources to be installed on the NY state grid, to achieve and exceed the state's 30% RPS. Additionally, system operation efficiency and resource utilization should improve, specifically in the Long Island region. There are also likely to be significant reliability improvements for the power system that include transmission capacity increases, to allow the replacement of aging infrastructure. With energy storage transmission and distribution system usage could be reduced, especially during peak load periods. These changes should result in a reduction in system congestion and the reduction of reliability issues with the overall effect of reducing electricity costs for NY state consumers.

There may also be significant environmental benefits involved. The use of energy storage technologies will replace the installation of an emissions-producing thermal generation power plant. While it is true that the storage unit will need to be charged with what is likely thermal generation, a new installation will not be required, and thus there will be a reduction in emissions. Most of these benefits will be in the form of carbon dioxide emissions reduction, but there will also be a reduction of nitrogen oxides. In addition to the direct reduction of emissions, the use of this option will increase the potential for the deployment of non-pollution emitting renewable energy resources, further reducing statewide power emissions. The environmental hazards resulting from natural gas production may also be reduced, especially if the natural gas being used is that from the underground fracking process, which the Environmental Protection Agency (EPA) has determined may create water pollution issues.[5]

There is also the potential for tangible economic benefits. Since there will be less peak demand from Long Island, not only should there be less transmission congestion and lower prices on Long Island, but also less demand of off-island generation. This should also reduce the cost of power in other parts of New York State. The reduction in the cycling of thermal generation plants on Long Island should reduce wear on equipment, decreasing maintenance costs. There is likely to be a reduction in overall system operational costs resulting from the reduction in generation resources required. There are also likely to be job opportunities created for the NY state public. These would be a large number of near-term jobs during construction phases, and a smaller number of short-term jobs during the operational phases of the selected resource. This benefit may vary over the various technology options being considered, but would likely be an increase over the status quo. There will be additional economic benefits resulting from the reduction in the cycling of thermal generation plants in terms of long-term equipment wear,

[5] http://www.pnas.org/content/early/2011/05/02/1100682108.abstract?sid=46d031e7-a1f8-4e52-b0e8-76e966599dd6.
http://planetsave.com/2011/05/12/in-first-scientific-study-links-fracking-to-flammable-water/
http://www.propublica.org/article/feds-link-water-contamination-to-fracking-for-first-time

leading to increased operational and maintenance costs. Improvement in air quality in the NYC area should reduce health care cost particularly with respect to the incidence of respiratory illness.

This work will also provide value to the state's research organizations and to its companies. Particularly the NY-BEST (New York Battery and Energy Storage Technology Consortium) organization and its members would benefit. The consortium was established with seed money from NYSERDA and its members may see an increased demand for their technologies, both inside and outside the state of New York. This would of course lead to economic development in the state and jobs.



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## Problem Statement and Proposed Solution

We propose to evaluate the benefits of a proposed 400MW / 1600MWh electric energy storage facility based on Long Island, NY. For this engineering study (category B), we will use a nodal representation of the New York state power grid in a production cost model, and compare the total costs of meeting load with the proposed energy storage facility in place to the total costs with a 400 MW simple-cycle combustion turbine and to the total costs with new transmission infrastructure with a minimum 400 MW capacity. The proposed storage facility will be evaluated at specific nodes on the LIPA system.

Higher wholesale electric power rates in Long Island and New York City as compared to other areas of New York State persist due mainly to less generation than is needed to meet demand coupled with transmission congestion.[6] Not only does this transmission congestion increase wholesale power costs, it also poses a threat to the reliability of the grid. LIPA's (Long Island Power Authority) 2010 – 2020 Electric Resource Plan) indicates that Long Island will need additional resources by 2016 for the continued reliable operation of the LIPA grid.[7] This considers the fact that LIPA is working to integrate renewables into its grid to meet the state's RPS standard of 30% renewable generation by 2013 and reduce its electric power generation's negative environmental impact. As a result of this renewable generation integration, resources will be needed to manage the increased variability they present to a power system.

In August 2010, LIPA issued a Request for Proposals (RFP) for up to 1000 MW of additional capacity, which could be either new generation based on Long Island, or elsewhere and delivered by a new transmission line.[8] Of the 16 companies that submitted proposals, only one proposed something other than new generation or transmission. That company, AES Energy Storage, proposed a large battery storage system comprised of 400MW and 1600MWh of Li-Ion batteries.[9]

While a battery storage facility would almost certainly be more costly per MW of installed capacity than a simple-cycle combustion turbine plant, it would have the potential to provide grid services that the combustion turbine does not. A battery storage system, unlike a combustion turbine, could provide spinning reserve without having to be dispatched at a minimum level. This would allow less expensive plants to be dispatched at higher levels, and reduce generation from more expensive plants. Additionally, the electric energy storage system would excel at providing regulation reserve, which is the matching of generation to load every few seconds based on an AGC (automatic generation control) signal. It could ramp much faster and follow this signal much more accurately than could a combustion turbine. This speed and accuracy means that it would be possible to have less conventional generation capacity reserved for regulation service, potentially freeing up capacity in generation resources that could then operate at optimal levels, producing energy more efficiently. The storage system could also

[6] "Long Island Power Authority Electric Resource Plan 2010-2020." Long Island Power Authority. February 2010. http://www.lipower.org/company/powering/energyplan10.html
[7] *Ibid.*
[8] Long Island Power Authority. http://www.lipower.org/newscenter/pr/2010/082010-rfp.html.
[9] "Can Batteries Replace Generators?" The New York Times Green Blog. May 18, 2011. http://green.blogs.nytimes.com/2011/05/18/can-batteries-replace-power-generators/

offer primary frequency response reserves that would more quickly react to changes in frequency than thermal generation, reducing the total requirement for primary frequency response.

On the other hand, a battery storage system may be cheaper than a new transmission connection. Comparing the proposed battery storage system to additional transmission capacity is reasonable, since additional transmission capacity could provide grid services that are analogous to that provided by grid-scale storage. The additional transmission capacity would be useful only to the extent that off-island generation is available to make use of the capacity. In addition, the extra capacity might be useful in helping to deal with integrating renewable resources.

These issues will be more important especially as renewable energy sources penetrate the LIPA grid and the NY state grid. As the NY State Energy Plan of 2002 indicated, the state is reliant on fossil fuel generation and aims to get away from such generation due to security, economic, and environmental concerns. By intending to build a new gas combustion turbine, LIPA will not reduce their reliance on fossil fuels.

The proposed electric energy storage facility would charge with off-peak power when excess generation and transmission capacity is available and thus prices are low. It would then discharge or provide power on-peak. This would effectively time-shift energy from the off-peak to the on-peak, reduce the need for generation sources to provide that power on-peak and thus ease transmission congestion during the on-peak. Since a large fraction of LIPA generation at night is from efficient combined-cycle plants, storing this power and releasing it at peak times would be more efficient than generating power at peak times with either a single-cycle combustion turbine facility or with other thermal resources and then transmitting it via new infrastructure.

As mentioned above, LIPA is likely to have increased wind and solar generation in the future due to the states 30% RPS and further expected renewables penetration targets. An energy storage resource would provide significant benefits in facilitating the integration of this variable generation. The storage resource would have a greater ability to counteract minute-to-minute changes in wind or solar generation as compared to a combustion turbine either on location or at a distance and transmitted over new infrastructure. In the case of excess wind generation at night, when load is low, the storage resource could absorb this power.

Such a storage resource could provide multiple benefits to the LIPA grid and perhaps to the overall NYISO grid as well. Some assert that the additional benefits justify the added cost of the storage system. However, to our knowledge, there has not been an assessment of this claim in a rigorous, quantitative way.

Thus, we propose to evaluate the benefits to the grid of a 400MW / 1600MWh battery storage facility based on Long Island. Using a nodal representation of the NYISO grid in a production cost model, the value of the system benefits provided by the proposed storage facility could be compared to those provided by a 400 MW simple-cycle combustion turbine and those provided by new transmission infrastructure.

Such an assessment would be of value to LIPA, NYISO, NYSERDA, and to the New York State Public Service Commission, in comparing an energy storage system with the other alternatives for additional generation and transmission capacity. Not only would the value apply to this specific RFP, but to other sites around the state of New York requiring similar services where a better understanding of all options enables the selection of the best choice.

The major tasks to be accomplished through this proposal are as follows:

1) Develop a production cost model for the NY power grid.
2) Establish several scenarios for evaluation: energy storage facilities, simple-cycle combustion power plants, and transmission infrastructure installations.
3) Investigate the feasibility of installing each of the options at the identified sites.
4) Use the model to evaluate the various scenario options.
5) Based on this modeling, determine the energy, environmental, and economic benefits of each of the alternative options to the state of New York.

Project duration is planned as 1 fiscal year from the start date. Planned major milestones are as follows:

1) Working production cost model: 4 months from start date.
2) Determination of regulatory and site-specific installation and interconnection requirements: 6 months from start date.
3) Scenario development: 8 months from start date.
4) Modeling results: 10 months from start date
5) Final Report: 12 months from start date.

## Technology Transfer and Repeatability

Studies funded by state and federal research agencies have up to now been generally focused at the system level, and have not been specific to sites. While system level studies are necessary to determine the need for different resources from a general perspective, specific site analyses, such as that proposed here, can help to nail down the details and consider deployment issues, including site permitting; regulatory approvals; site and application specific economic analyses; site and application specific value streams' and site and application specific economic and environmental benefits.

The technology transfer involved with this study would be of the analysis methodology, the production-cost model, and the study results. Once developed for Long Island, the methodology and model could readily be applied to other parts of New York State. More broadly, the study may be useful in understanding how grid-scale electricity energy storage compares with a traditional resources in terms of benefits to the grid versus cost. The methodology will be clear from the project report and the production cost model and relevant scenarios will also be available to interested parties.

The target audience for the results of the work includes residents of the State of New York, particularly those in the New York Metropolitan Area and the electric utilities operating in this area, specifically the Long Island Power Authority (LIPA). The means by which the audience could benefit directly from the project include improvement in the reliability and quality of power delivered in the New York area as well as a possible reduction in cost. Nevertheless, if wholesale costs decline, then both the financial positions of LIPA and its customers have the potential to improve. Furthermore, net economic benefit could redound to New York State residents if there can be shown to be net employment effects of the proposed battery storage project as compared with relevant alternatives. The New York City Metropolitan Area would be able to repeat these results, if favorable, with further installations.

In other regions of New York and the country, the need for regulating reserves that can help reduce the overall cost of electric service will become more acute, particularly as renewable energy technologies increase penetration. Thus, a successful project that demonstrates the potential for cost reduction in the NYC area utilizing energy storage will provide incentive and demonstrable success to other areas. This sort of successful outcome will result in greater investment in and use of electrical energy storage technologies. The potential benefits to the NY state and national power systems could be significant. Such new installations could create short-term and long-term job opportunities. The potential environmental benefits could also be significant. Value to the customers in these alternatives could derive from lower energy costs.

In terms of transfer and repeatability of this work, the publishing of results, coupled with the potential operating success of the project will allow enough visibility for other organizations to consider similar projects. The NY state power system is a model system for the rest of the country, heavily investing in renewables and other alternatives to traditional resources. Thus, any proven installations are likely to be imitated not only within the state, but the nation as well.

## New York State Impact and Project Benefits

The purpose of this proposed study is to quantify the net benefits of specific strategies, or scenarios for integrating the various technology options discussed above, namely energy storage systems, transmission upgrades, and new generation infrastructure.

Energy storage technologies can provide significant benefits that include allowing additional renewable energy resources to be installed on the NY state grid, to achieve and exceed the state's 30% RPS. Additionally, system operation efficiency and resource utilization should improve, specifically in the Long Island region. There are also likely to be significant reliability improvements for the power system that include transmission capacity increases, to allow the replacement of aging infrastructure. With energy storage transmission and distribution system usage could be reduced, especially during peak load periods. These changes should result in a reduction in system congestion and the reduction of reliability issues with the overall effect of reducing electricity costs for NY state consumers.

There may also be significant environmental benefits involved. The use of energy storage technologies will replace the installation of an emissions-producing thermal generation power plant. While it is true that the storage unit will need to be charged with what is likely thermal generation, a new installation will not be required, and thus there will be a reduction in emissions. Most of these benefits will be in the form of carbon dioxide emissions reduction, but there will also be a reduction of nitrogen oxides. In addition to the direct reduction of emissions, the use of this option will increase the potential for the deployment of non-pollution emitting renewable energy resources, further reducing statewide power emissions. The environmental hazards resulting from natural gas production may also be reduced, especially if the natural gas being used is that from the underground fracking process, which the Environmental Protection Agency (EPA) has determined may create water pollution issues.[10]

There is also the potential for tangible economic benefits. Since there will be less peak demand from Long Island, not only should there be less transmission congestion and lower prices on Long Island, but also less demand of off-island generation. This should also reduce the cost of power in other parts of New York State. The reduction in the cycling of thermal generation plants on Long Island should reduce wear on equipment, decreasing maintenance costs. There is likely to be a reduction in overall system operational costs resulting from the reduction in generation resources required. There are also likely to be job opportunities created for the NY state public. These would be a large number of near-term jobs during construction phases, and a smaller number of short-term jobs during the operational phases of the selected resource. This benefit may vary over the various technology options being considered, but would likely be an increase over the status quo. There will be additional economic benefits resulting from the reduction in the cycling of thermal generation plants in terms of long-term equipment wear,

[10] http://www.pnas.org/content/early/2011/05/02/1100682108.abstract?sid=46d031e7-a1f8-4e52-b0e8-76e966599dd6.
http://planetsave.com/2011/05/12/in-first-scientific-study-links-fracking-to-flammable-water/
http://www.propublica.org/article/feds-link-water-contamination-to-fracking-for-first-time

leading to increased operational and maintenance costs. Improvement in air quality in the NYC area should reduce health care cost particularly with respect to the incidence of respiratory illness.

This work will also provide value to the state's research organizations and to its companies. Particularly the NY-BEST (New York Battery and Energy Storage Technology Consortium) organization and its members would benefit. The consortium was established with seed money from NYSERDA and its members may see an increased demand for their technologies, both inside and outside the state of New York. This would of course lead to economic development in the state and jobs.

Each of these impacts and project benefits will be quantitatively evaluated in this study. The use of production cost modeling can help to effectively evaluate the different resource options based on each of their potential benefits.

# Statement of Work and Schedule

## Statement of Work

**Project Goals**:

*Technical goals*

- Model development for the NY system
  - Determination of LIPA system requirements
  - Determination of technology and site characteristics for each option
- Scenario development and evaluation
- Analyze the performance of the different technology options: 1) electrical energy storage; 2) combustion turbine; 3) new transmission infrastructure
  - Quantification of energy benefits
  - Quantification of environmental benefits
  - Quantification of economic benefits
- Quantification of scenario costs
- Determination of optimal solution

*Business Goals*

- Partnership development with relevant stakeholders
  - Long Island Power Authority
  - New York Independent System Operator
  - NYSERDA

**Work Tasks:** In order to carry out the objectives of this project, the following tasks will be performed during this program by Sandia National Laboratories ("the Contractor"):

**Task 1: Project Management**

**Project Personnel:** Dhruv Bhatnagar will serve as Project Manager and as such will have the responsibility of the overall supervision and conduct of the project work on behalf of the Contractor. Any substantive change of project personnel by the Contractor will be subject to the prior written approval of NYSERDA. Such approval will not be unreasonably withheld.

**Internal Project Coordination and Coordination with Project Partners:** The Contractor will coordinate program-wide activities including internal and external communications, milestone and cost tracking, annual full team review meetings, and reports.

**Meetings:** The Contractor shall hold a Kickoff Meeting at the start of the project and a Wrap-Up Meeting at the end of the project. Additional meetings will be held as necessary to keep NYSERDA's Project Manager informed of project progress.

The Contractor will schedule meetings at a time and place agreeable to all participants, will provide a written agenda five days in advance of each meeting, and will document each meeting with minutes, which will be distributed within ten business days.

**Project Facilities:** A substantial portion of the project work will be conducted at the Contractor's facilities in Albuquerque, NM. Any change of project facilities by the Contractor will be subject to the prior written approval of NYSERDA. Such approval will not be unreasonably withheld.

**Project Funding:** NYSERDA and the Contractor are sharing the costs for the project work to be performed and that the cost share identified below will be readily available. The table below documents the cost sharing by tasks for this research effort. Any change of cost share by the Contractor will be subject to the prior written approval of NYSERDA. Such approval will not be unreasonably withheld.

***Cost Sharing Table***

| Task | NYSERDA Funding | Contractor Cost-Share | Total Task Funding |
|---|---|---|---|
| **Task 1: Project Management** | $37,500 | $12,500 | **$50,000** |
| **Task 2: Partnership Development** | $12,500 | $12,500 | **$25,000** |
| **Task 3: Determination of Requirements for LIPA** | $12,500 | $12,500 | **$25,000** |
| **Task 4: Model Development** | $56,000 | $18,750 | **$75,000** |
| **Task 5: Model Evaluation** | $75,000 | $25,000 | **$100,000** |
| **Task 6: Final Report** | $56,500 | $28,750 | **$75,000** |
| **TOTAL** | **$250,000** | **$100,000** | **$350,000** |

**Invoicing:** Pursuant to this Agreement, invoices will set forth total project costs incurred during the progress reporting period. Costs will be broken down into NYSERDA funding share and cost share provided by others, and they will be in a format consistent with the cost categories set forth in the Budget. The Contractor will be responsible to provide adequate cost documentation, including those incurred by the subcontractor, and the total costs per task should be in reasonable agreement with those listed above. NYSERDA reserves the right to limit the amount of progress payment made in any reporting interval to an amount commensurate to the documented cost share incurred.

**Metrics Reporting:** On an annual basis during when ~~and for a period of two years after~~ the project is being worked on, the Contractor will 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.[11] All estimates will reference credible sources and estimating procedures, and all assumptions will be documented.

**Project Dissemination:** The Contractor will prepare and present technical papers at appropriate conferences and symposia, exhibit displays at trade shows where economically viable, and write articles for publication in technical journals. At the appropriate time in the product development and in accordance with this Agreement, the Contractor will prepare media presentation packages and submit them to NYSERDA for review and approval.

During the performance period of this Agreement and upon 90-days notice, the Contractor will be prepared to attend an annual one-day workshop at a New York State venue and conduct a technical presentation of project results. Organized by NYSERDA, it is envisioned that numerous projects will be presented over the course of the day to relevant stakeholders and that each individual presentation will require approximately 30-minutes.

**Progress Reports:** The Contractor will prepare quarterly reports. The progress reports will be in a letter format and will include the following subjects in the order indicated, with appropriate explanation and discussion:

a. Title of project.
b. Agreement number.
c. Period of this report
d. Progress of this report.
e. Planned progress in the future.
f. Identification of problems.
g. Planned solutions.
h. Ability to meet schedule, reasons for slippage in schedule.
i. Schedule - percentage completed and projected percentage of completion of performance by months - could be a bar chart or milestone chart.
j. Analysis of actual cost incurred in relation to budget.

Copies of the progress reports will be submitted to NYSERDA's Project Manager by the 15th of each month following the period of work that was performed.

**Final Report:** The Contractor will prepare a Final Report in accordance with Exhibit C of this Agreement, detailing all of the work performed and task deliverables, but excluding proprietary information. The comprehensive Final Report will cover all aspects of the project and will merge together, and build further on, the previously generated Progress Reports. Hard copy of pertinent data taken during the various testing programs will be included. Conclusions and recommendations for further work will be provided.

Two copies of the draft Final Report will be submitted to the NYSERDA Project Manager, who will provide comments to the Contractor within 30 working days after receipt of the draft. The Contractor

[11] Sandia policy does not allow for such, reporting once the contract has expired.

will prepare the Final Report in final form, reflecting these comments. Within 30 working days after receipt of the comments, the Contractor will submit the Final Report to the NYSERDA Project Manager.

Deliverables: The following list of deliverables will be presented to NYSERDA from Task 1:

- Summary of meetings and meeting notes
- Appropriate metrics deliverables
- Annual Reports on product Metrics after all phases have been completed
- Regular Progress Reports to NYSERDA's Project Manager by the 15th of the month following completion of the Reporting Period
- Immediate written notification of any significant breakthroughs or problems
- Final Report on work completed and task deliverables

**Task 2: Partnership Development**

The Contractor will develop partnerships with the main actor involved in this study, namely the Long Island Power Authority. This process will involve obtaining their assistance in task 3, determining requirements, and task 4, model development.

Deliverables: The following list of deliverables will be presented to NYSERDA from Task 2:

- Summary of meetings and meeting notes
- Summary of information obtained

**Task 3: Model Development**

The contractor will develop a production cost model for the NY power grid. This process will be completed in Plexos, a production cost modeling tool. Data about the NY grid will need to be obtained. This includes each major node in the system, transmission connections between each major node, the load specific to each node, the generation available at each node, and the system's current ancillary service requirements.

Deliverables: The following list of deliverables will be presented to NYSERDA from Task 4:

- Summary of the production cost model.

**Task 4: Determination of Requirements for LIPA**

The Contractor will determine the specific requirements involved for LIPA to achieve its goals that motivated its RFP. This task will help to properly develop the scenario analysis to be used in the production cost model, and determine the technical specifications for each of the resource alternatives, as well as the status quo. Task 3 will involve the following subtasks.

*Task 4.1: Site Determination*

The contractor will determine the specific sites at which the alternative options may be installed. This will be accomplished with the assistance of LIPA as detailed in Task 2.

*Task 4.2: Regulatory and Site Analysis*

The contractor will determine the regulatory and site-specific issues that are involved with installation of the different alternative resources at the sites identified in Task 3.1. These include:

- Services that must be provided.
- Site and permitting issues that are involved.
- Regulatory and policy issues that may be involved.
- Installation and interconnection requirements.

<u>Deliverables:</u> The following list of deliverables will be presented to NYSERDA from Task 3:

- Summary of the site selections and the selection process.
- Summary of the regulatory and site analysis conducted for each site.

**Task 5: Model Evaluation**

The Contractor will evaluate each of the different alternatives using the production cost model developed in Task 4. Task 5 will involve the following subtasks:

*Task 5.1: Scenario Development*

The Contractor will, based on the requirements specified in Task 3, develop relevant scenarios incorporating each of the alternatives: the status quo, the energy storage option, the combustion turbine option, and the transmission infrastructure option. This work will require close scrutiny of the requirements specified, as well as an intimate understanding of the options and their capabilities. These scenarios will then be programmed into the production cost model.

*Task 5.2: Scenario Analysis*

The Contractor will evaluate the scenarios developed in Task 5.1 using the production cost model developed in Task 4. The simulated operational data from the model will be used to determine the value of the resource installation from each scenario. Specifically, parameters to be studied will include:

- Operation
  - Energy discharge
  - Ancillary service provision
  - Charging operation in the case of the energy storage system
- Total generation costs
- Total system operation costs E
- Emissions generation

*Task 5.3: Determination of Energy, Environmental, and Economic Benefits*

The Contractor will, based on the analysis in Task 5.2, quantify the energy and environmental benefits to the LIPA grid and the NYISO grid for each of the scenarios. This determination will use, and be based on, the data generated by the production cost model. The contractor will also quantify the economic benefits of the scenarios based on experience with system operation in different regions of the United States, an estimation of the job-creation potential of the scenarios, and an estimation of the benefits an installation will have to the State's electricity technology industry.

Deliverables: The following list of deliverables will be presented to NYSERDA from Task 5:

- Summary of the developed scenarios.
- Summary of the scenario analysis.
- Summary of the quantification of the energy, environmental, and economic benefits.

**Task 6: Final Report**

The Contractor will complete a final report based on the work laid out in the preceding tasks.

Deliverables: The following list of deliverables will be presented to NYSERDA from Task 6:

- Final report.

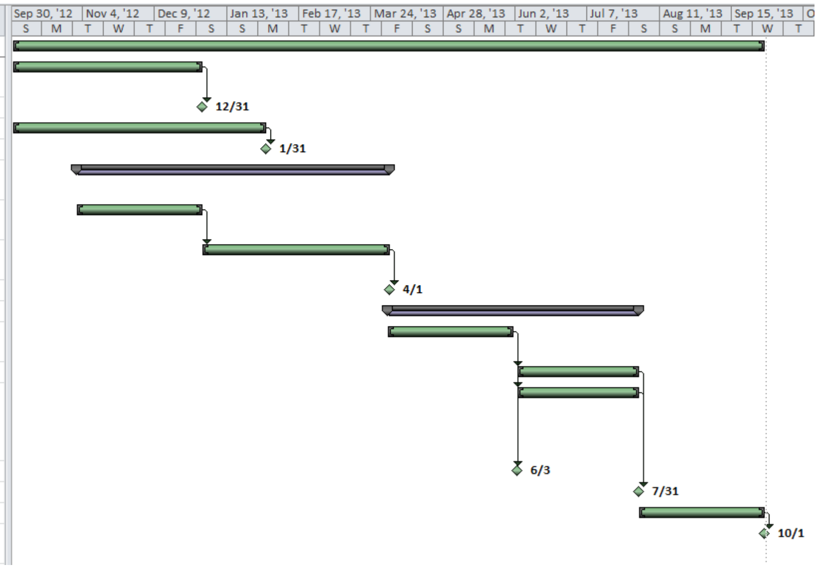
**Milestone Payments**

Due to the Contractor's internal legal requirements, it does not allow for milestone payments. All payments must be as reserve and advance funding, either in full or on a pay-plan

# Schedule

Project duration is planned as 1 fiscal year from the start date. The proposed schedule is attached on the next page.

| Task Name | Duration | Start | Finish |
|---|---|---|---|
| 1 Project Management | 261 days | Mon 10/1/12 | Mon 9/30/13 |
| 2 Partnership Development | 66 days | Mon 10/1/12 | Mon 12/31/12 |
| Task 2 Deliverables | 0 days | Mon 12/31/12 | Mon 12/31/12 |
| 3 Model Development | 89 days | Mon 10/1/12 | Thu 1/31/13 |
| Task 3 Deliverables | 0 days | Thu 1/31/13 | Thu 1/31/13 |
| **4 Determination of Requirements for LIPA** | **108 days** | **Thu 11/1/12** | **Mon 4/1/13** |
| 4.1 Site Determination | 43 days | Thu 11/1/12 | Mon 12/31/12 |
| 4.2 Regulatory and Site Analysis | 65 days | Tue 1/1/13 | **Mon 4/1/13** |
| Task 4 Deliverables | 0 days | Mon 4/1/13 | **Mon 4/1/13** |
| **5 Model Evaluation** | **88 days** | **Mon 4/1/13** | **Wed 7/31/13** |
| 5.1 Scenario Development | 45 days | **Mon 4/1/13** | Fri 5/31/13 |
| 5.2 Scenario Analysis | 43 days | **Mon 6/3/13** | **Wed 7/31/13** |
| 5.3 Determination of Energy, Environmental, and Economic Benefits | 43 days | **Mon 6/3/13** | **Wed 7/31/13** |
| Task 5 Deliverable 1 | 0 days | Mon 6/3/13 | Mon 6/3/13 |
| Task 5 Deliverable 2 | 0 days | Wed 7/31/13 | **Wed 7/31/13** |
| 6 Final Report | 43 days | Thu 8/1/13 | Mon 9/30/13 |
| Task 6 Deliverable: Final Report | 0 days | Tue 10/1/13 | Tue 10/1/13 |



# Proposer Qualifications

Since 1949, Sandia National Laboratories has developed science-based technologies that support our national security. Today, the 300+ million Americans depend on Sandia's technology solutions to solve national and global threats to peace and freedom.

Through science and technology, people, infrastructure, and partnerships, Sandia's mission is to meet national needs in five key areas:

- Nuclear Weapons: ensuring the stockpile is safe, secure, reliable, and can support the United States' deterrence policy
- Energy, Climate, & Infrastructure Security: enhancing the surety of energy and other critical resources
- Nonproliferation: reducing the proliferation of weapons of mass destruction, and enhancing the surety of critical infrastructures
- Defense Systems & Assessments: addressing new threats to national security
- Homeland Security & Defense: helping to protect our nation against terrorism

Sandia is a government-owned/contractor operated (GOCO) facility. Sandia Corporation, a Lockheed Martin company, manages Sandia for the U.S. Department of Energy's National Nuclear Security Administration. We seek collaborative partnerships on emerging technologies that support our mission.

To achieve the objectives of this proposal, Sandia will leverage core and leading competency in transmission systems analysis, energy storage technology expertise, advanced computation and optimization, renewable energy resource expertise, and systems modeling. Sandia will leverage on-going work that is helping shape the future evolution of electricity systems.

Sandia is a multi-disciplinary laboratory with leading expertise in a broad range of science and engineering disciplines. Energy security, complex energy systems and renewable energy and enabling technologies (such as energy storage) are core competency areas. Focus on grid integration has increased significantly over the last decade. Sandia's approach to grid integration of renewable energy is multi-disciplinary, recognizing that future evolution of the grid is influenced by multiple factors and technologies.

Sandia is well positioned to accomplish the proposed work based on its previous work and on its technical expertise. Sandia is a recognized leader in power system model development, transmission simulation, probabilistic optimization and multi-disciplinary grid reliability analysis.

The Sandia team has broad technical expertise in grid integration analysis that will be applied to this project. The Sandia team is engaged in several national level studies exploring current issues relevant to solar and other renewables integration, ranging from energy storage and demand response, to market and regulatory framework, to advanced computation and optimization, to Smart Grid applications. The proposed research pairs team members with an extensive background experience in transmission planning and operations, with researchers that have leading expertise in advanced analysis methods.



Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000

*Organizational Chart*

| Name | Roles and Responsibilities |
| --- | --- |
| **Dhruv Bhatnagar** | Project manager and production cost model developer and analyst. |
| **Jim Ellison** | Production cost model developer and analyst. |
| **Verne Loose** | Economics and regulatory analyst. |
| **Cesar Augusto Silva Monroy** | Power system specialist: grid technology and integration. |

**Verne W. Loose, PhD**

Verne has an extensive career in energy economics, research management and finance spanning more than three decades. Verne's research focus has been on the energy and natural resource industries, markets, and evaluation with emphasis on electric power, coal, and oil and gas. He has an extensive bibliography of refereed publications and conference papers and presentations in these fields. Among significant contributions is his early work on distributed generation in the electric power industry. He has managed professional staff exceeding 20 economists and analysts and managed technical projects exceeding $5 million annually (1985 dollars). He holds a B.Sc. degree in accounting, an M.A. and Ph.D. in economics.

**Jim Ellison**

Jim is a research engineer experienced with valuing storage and other grid projects using production cost models.  He has seven years of experience with an independent power producer, with responsibilities ranging from business development to power plant and distribution company operations.

**Cesar Augusto Silva Monroy, PhD**

Cesar is a power systems engineer with experience in grid analysis and modeling. He has worked on projects to classify grid reliability, he works on the application of advanced stochastic optimization techniques to the generation unit commitment problem, and is working on market design development for unbiased energy, capacity, and ancillary service markets.

**Dhruv Bhatnagar**

Dhruv is a technology and policy analyst experienced with systems analysis in the integration of energy storage and renewable resources using production cost modeling for unit commitment. He has experience in economic and regulatory analysis of the overall power system and individual projects. He is working on various system integration studies for energy storage resources, policy and regulatory analysis for energy storage and demand response, and project economic and performance analysis for energy storage demonstration projects.

## Budget

*Funding Source Table*

**Project Total:** $350,000

| Funding Source | Cash ($) | In-kind ($) | Total (cash + In-kind) ($) |
|---|---|---|---|
| **NYSERDA** | $250,000 | 0 | **$250,000** |
| **Department of Energy** | $100,000 | 0 | **$100,000** |
| **Total ($)** | **$350,000** | **0** | **$350,000** |

Category B: $250,000. The budget is attached on the following page.

# Appendices

Include any resumes, company qualifications, or ancillary information that is deemed necessary to support your proposal. If appropriate, also include:

**Exceptions to the Terms and Conditions**

Sandia is unable to accept any of the standard terms and conditions as contained in the sample agreement. This is based on standard operating practice as a Federally Funded Research and Development Center.

1) Sandia requires that an FIA (Funds-In-Agreement) guidance package be the only contractual mechanism between it and another party. Sandia will provide this if the proposal is awarded funding. The terms of conditions of the FIA are the only ones Sandia can accept, and Sandia will not comply with the Recoupment requirements.
2) Sandia cannot sign Attachment A due to standard operating practice in not signing other entities forms.
3) Sandia requires reserve and advance funding, either in full or on a pay-plan. The project cannot be invoiced as each section or milestone is complete. As a result, milestone payments are not allowed. Thus, they have not been included in the proposal.
4) Sandia cannot provide metrics reporting as requested, after the project is complete, 1 year in this case.

**Verne Loose, PhD**

*Selected Publications:*

V.W. Loose, “Quantifying the Value of Hydropower in the Electric Grid: Role of Hydropower in Existing Markets,” Sandia Report SAND2011-1009, January 2011

V.W. Loose, “Guidelines for Benefit Cost Analysis.” Environment and Land Use Committee Secretariat, Government of the Province of British Columbia, June 1977.

Loose, V.W. and T.A. Flaim, “Economies of Scale and Reliability: The Economics of Large Versus Small Generating Units,” Energy Systems and Policy, Vol. 4, Numbers 1 and 1, spring 1980.

V.W. Loose with A. Bopp C. Kolstad, and R. Pendley, “Air Quality Implications of a Nuclear Moratorium: An Alternative Analysis, The Energy Journal, Vol. 2, No. 3, 1981.