Climate Neutral Campus Energy Alternatives Report

Appendix F: Wind, Water, and Solar (WWS) Summary

CNCEAR Appendix F: Cornell University Wind, Water, and Solar (WWS): Renewable Electricity Progress, Strategies, and Execution

The pursuit of both large scale and building integrated renewable energy is an important step in implementing the Cornell Climate Action Plan, and contributes to the President's goal of carbon neutrality by 2035. The 2009 Climate Action Plan Fuel Mix and Renewables wedge was targeted to reduce campus GHG emissions by 42% by replacing the use of fossil fuels with clean, renewable energy. Progress to date has taken shape in several forms including direct ownership and installation and power-purchase agreements with third party developers. The most recent CAP (2016) update no longer uses the "wedges" description but continues to highlight the importance of WWS integration:

https://es.fs.cornell.edu:8448/Sustain/cap/Shared%20Documents/Internal%20CAP%20Report%202016.docx

The decision-making process to select and move projects forward under various business models is comprised of a complex web of factors including funding sources, land use planning, community engagement, teaching and research opportunities, accounting and budgetary impacts, technology, project size, regulatory environment, current and projected energy prices, and the impacts of labor requirements, taxation and tax credits.

In order to preserve capital and prevent expenditure of debt financed funds on large renewable projects, a blended model of investment and power purchase agreements has emerged.

Smaller scale building scale projects have been directly purchased and installed on campus buildings. Individually, these systems may not require the same level of capital, but still need significant leveraging due to the relatively high unit cost of smaller installations. However, in these cases, the renewable system may be attractive to donors and may be funded through the donor project.

Large scale projects and larger building scale projects have been pursued on campus lands/rooftops using a power-purchase agreement model. This model minimizes direct investment risks and impacts. Further, this type of investment provides a stable cost of energy supply for the duration of the project contract. Upon completion of the project term (typically 20-30 years) the University has several options including purchasing the system, requiring removal of the system, or renewing the contract. This type of model is attractive as the developer brings tax equity investors eligible to monetize state and federal tax credits, and may then offer a lower energy rate due to lowered capital construction costs.

Details regarding each of these project ownership and execution models are included on the E&S website (https://energyandsustainability.fs.cornell.edu/sustain/sustenergy/default.cfm); some summary descriptions are also included in the sections that follow.

1. Direct ownership and operation – building integrated

Current Progress – Rooftop Solar

University green building initiatives have encouraged the installation of renewable energy systems to meet our building energy requirements. Campus owned building integrated renewable energy systems installed at the central campus include the following:

- Solar thermal hot water (building-scale thermal) – Nevin Plantations Welcome Center
- Solar thermal hot water (building-scale thermal) – Central Energy Plant Offices
- Solar PV 15 kW (electrical) – Day Hall
- Solar PV (test scale - electrical) – Snee Hall
- Solar PV 2.2 kW (electrical) – Campus Store
- Fernow Hall

Strategy

The impact of these renewable installations extends beyond the energy use reduction realized at each location. Each installation provides a highly visual example of the University commitment to climate action and environmental responsibility.

Rooftop solar installations have challenging economics due to scale and complexity. Funding for the construction of directly owned building-scale renewables may be gleaned from a variety of sources including targeted gift funds, unit funding targeted at sustainability, mission, or public relations goals, or capital project funding. Central utility funds may be utilized, but these funds are likely better focused on larger scale utility scale projects.

Opportunities

During new construction and significant renovation of existing building stock, opportunities to integrate renewable energy (typically in the form of solar PV or thermal) can be integrated into the project design and construction. These smaller building scale systems provide an opportunity to create distributed generation nodes and directly exploit otherwise underutilized real estate (typically rooftops).

A 2014 study of campus rooftops was completed by the Cornell University Sustainable Design student organization. This study assessed building orientation, rooftop condition, and size across campus looking for opportunities for solar rooftop generation. This study found sufficient rooftop space to accommodate approximately 1 MW of solar PV generation.

Coupling renewable energy projects with scheduled rooftop replacements or new installations minimizes long term maintenance issues and would not interfere with roofing product warranties.

2. Direct ownership and operation – commercial scale

Current Progress – Hydroelectric

Cornell has a long history of hydroelectric generation with the first electrical generation facility in Fall Creek gorge built in the early 1880's. On an annual basis, this plant produces approximately 6,000,000 kWh of electricity representing 2% of total campus usage. From 2008 through 2015, new automation and turbine rebuilds have improved operations and reliability and have increased output by over 20%.

Strategy

Due to the environmental impacts and large outlay of funds required to construct and operate new utility scale renewable energy projects, the University has not elected to independently pursue utility scale renewable generation at this time. In the event that the economic or incentive landscape changes in the future, this strategy will be re-evaluated.

Opportunities

The Climate Action Plan (CAP) is a "living document" that is routinely revised. WWS opportunities are updated as they are developed. Details of the CAP are available on the (public) E&S website (including a link to a pdf version of the 2009 web-based CAP):

http://www.sustainablecampus.cornell.edu/initiatives/climate-action-plan

The original 2009 CAP outlined four steps that could be utilized to upgrade the capacity of the existing hydroelectric plant within the Fall Creek gorge which includes the turbine rebuilds executed in 2014. Additional potential upgrades included restructuring the intake, relining the penstock, and optimizing the draft tubes. Combined these actions could produce an additional 900 MWh annually resulting in a CO2 reduction of about 360 metric tons annually in electrical offsets.

Funds for the hydropower intake have been allotted in the 2016-17 budget with construction anticipated in the summer of 2017. Funding for the additional work on the facility penstock and draft tubes will be allotted in the future after high maintenance priority items are completed.

3. Power purchase agreements – building integrated

Current Progress – Rooftop PV

In December 2015, the University's first building-scale renewable energy installations were completed with the placement of solar PV on the rooftops of Klarman Hall and the Human Ecology Building.

- Solar PV 20 kW (electrical) – Klarman Hall
- Solar PV 70 kW (electrical) – Human Ecology Building

The Klarman Hall project, as part of its pursuit of sustainability goals including a LEED Platinum certification was designed with solar PV panels on its rooftop. This installation was originally envisioned to be a direct purchase and ownership model. After the construction bid was awarded, CU then realized that the funds associated with installing panels could be better leveraged by using a third party ownership model to monetize the federal tax incentives. Project funds were contributed to reduce the power purchase rate to be on par with the campus billed utility rate. Additional funds were contributed by the College of Human Ecology in order to promote their unit sustainability goals. The economics of building scale solar PV are challenging due to scale, complexity, and low regional energy prices.

Cornell issued an RFP and eventually partnered with Distributed Sun and Building Energy to undertake a 20-year power purchase agreement. Cornell pays an electrical rate competitive with grid purchased electricity, while actually tripling the amount of PV that could otherwise have been installed. This electrical rate is locked-in for the duration of the term thus insulating the University from electrical price volatility. Some solar project information is summarized below; the same information is also provided (and routinely updated) on the web:

https://es.fs.cornell.edu:8448/Sustain/sims/energy/Solar%20PV/SolarProjectSummaries.docx

Rooftop Solar Project Fast Facts	
Nature of Transaction	• Developer agrees to construct, finance, own and maintain solar PV arrays • Cornell agrees to purchase all of the electricity generated by the arrays at a fixed price per kilowatt hour (final rate will depend on actual interconnection costs as determined by the local utility)
Contract Term	• Up to 20 years (commencing on the commissioning date) ○ 20-year initial term
Description of Facilities	• Various small solar PV arrays totaling 0.09 MW located on Ithaca Campus buildings • Estimated aggregate energy production of ~126 MWh in first year
Hedge	• Serves as a hedge against volatile electricity prices
Cost Comparison	• Transactions are expected to be cost neutral in the early years, savings over time given projected energy prices. • Starting price of $0.08/kWh.
Project Timeline	• December 2015 – Project Completed
Greenhouse Gas Reduction	• 0.01% reduction in Cornell's GHG footprint

Present Value of Purchase Commitment	• *(Redacted due to Non-Disclosure concerns)*
REC Value	• Estimated REC value of $140 in first year.
Estimated Economic Life	• 35 Years

Strategy

Leveraging existing project capital funds to reduce the power purchase price in a PPA contract has the potential to multiply planned renewable energy system sizes on campus projects. Furthermore, the university may acquire the asset after the initial five years of the term have been completed and the full tax advantages have been absorbed by the provider, thereby lowering the asset value for the third party owner.

Finally, at the completion of the term, the University may seek to renegotiate the power purchase agreement, or seek to acquire the system at a competitive price.

Opportunities

Future new construction and significant renovation projects should consider including renewable energy systems as an add/alternate during the bidding process. This would allow managers to consult with energy and sustainability staff who can assist in weighing the costs vs. benefits of a PPA for a particular action.

4. Power purchase agreements – commercial Scale

Current Progress – Solar PV at outlying facilities

The first large ground-mount solar photovoltaic PPA installation was completed in September 2014 on university owned property on Snyder Road in the Town of Lansing. The project was initiated as a result of a competitive 2013 RFP process where solar developers competed to install arrays at outlying campus facilities using the State's monetary remote net-metering rules in place at the time, which limit the size of the solar farms to 2MWac. The net metering program in NYS is slated to be replaced by a new tariff structure per proceedings currently underway in the NY Public Service Commission. Cornell has five solar facilities that have been grandfathered under the monetary remote net metering rules. Currently, the Snyder Road and Geneva installations are complete and generating power while the Musgrave Farm East and West, and Harford Farm PV facilities should be completed by December 2016.

Snyder Road PV Facility Fast Facts	
Nature of Transaction	• Developer agrees to construct, finance, own and maintain solar PV arrays • Cornell agrees to purchase all of the electricity generated by the arrays at a fixed price per kilowatt hour (final rate will depend on actual interconnection costs as determined by the local utility)
Contract Term	• Up to 30 years (commencing on the commissioning date) o 20-year initial term o Developer has two five-year extension options
Description of Facilities	• One 1.76 MW solar PV arrays located in Lansing, New York • Estimated energy production of ~2,500 MWh in first year
Hedge	• Serves as a hedge against volatile electricity prices
Cost Comparison	• Transactions are expected to be cost neutral in the early years, savings over time given projected energy prices. • Starting price of $0.0760/kWh.
Project Timeline	• September 2014 – Project Completed
Greenhouse Gas Reduction	• 0.21% reduction in Cornell's GHG footprint
Present Value of Purchase Commitment	• *(This information redacted to abide by non-disclosure terms)*
REC Value	• Estimated REC value of $2700 in first year.
Estimated Economic Life	• 35 Years

Geneva PV Farm Fast Facts	
Nature of Transaction	• Developer agrees to construct, finance, own and maintain solar PV arrays • Cornell agrees to purchase all of the electricity generated by the arrays at a fixed price per kilowatt hour (final rate will depend on actual interconnection costs as determined by the local utility)
Contract Term	• Up to 30 years (commencing on the commissioning date) o 20-year initial term o Developer has two five-year extension options
Description of Facilities	• One 2 MW solar PV arrays located in Geneva, New York • Estimated aggregate energy production of ~3,200 MWh in first year
Hedge	• Serves as a hedge against volatile electricity prices
Cost Comparison	• Transactions are expected to be cost neutral in the early years, savings over time given projected energy prices. • Starting price of $0.1032-0.1048/kWh pending final NYSEG interconnection cost.
Project Timeline	• December 2015 – Project Completed
Greenhouse Gas Reduction	• 0.27% reduction in Cornell's GHG footprint
Present Value of Purchase Commitment	• *(This information redacted to abide by non-disclosure terms)*
REC Value	• Estimated REC value of $3400 in first year.
Estimated Total Project Costs	• Total Cost: $6.8 million • Tax Credit: $2.4 million • NYSERDA Incentive: estimated $1.3 million, paid over first 2 years of operation
Estimated Economic Life	• 35 Years

Harford PV Farm Fast Facts	
Nature of Transaction	• Developer agrees to construct, finance, own and maintain solar PV arrays • Cornell agrees to purchase all of the electricity generated by the arrays at a fixed price per kilowatt hour (final rate will depend on actual interconnection costs as determined by the local utility)

Contract Term	• Up to 30 years (commencing on the commissioning date)
	  ○ 20-year initial term
	  ○ Developer has two five-year extension options

Description of Facilities	• One 2 MW solar PV array located in Harford, New York • Estimated aggregate energy production of ~3,300 MWh in first year
Hedge	• Serves as a hedge against volatile electricity prices
Cost Comparison	• Transactions are expected to be cost neutral in the early years, savings over time given projected energy prices. • Starting price of $0.1027-0.1050/kWh pending final NYSEG interconnection cost.
Project Timeline	• June 2015 – PPAs approved • Summer 2015 – Finalize interconnection with NYSEG • Spring/Summer 2016 – Construction • November 2016 – Begin commercial operation
Greenhouse Gas Reduction	• 0.28% reduction in Cornell's GHG footprint
Present Value of Purchase Commitment	• *(This information redacted to abide by non-disclosure terms)*
REC Value	• Estimated REC value of $3500 in first year.
Estimated Economic Life	• 35 Years

Musgrave West PV Farm Fast Facts	
Nature of Transaction	• Developer agrees to construct, finance, own and maintain solar PV arrays • Cornell agrees to purchase all of the electricity generated by the arrays at a fixed price per kilowatt hour (final rate will depend on actual interconnection costs as determined by the local utility)

Contract Term	• Up to 30 years (commencing on the commissioning date)
	  ○ 20-year initial term
	  ○ Developer has two five-year extension options

Description of Facilities	• Two 2 MW solar PV arrays located in Ledyard, New York • Estimated aggregate energy production of ~3300 MWh in first year
Hedge	• Serves as a hedge against volatile electricity prices
Cost Comparison	• Transactions are expected to be cost neutral in the early years, savings over time given projected energy prices. • Starting price of $0.1027-0.1050/kWh pending final NYSEG interconnection cost.
Project Timeline	• June 2015 – PPAs approved • Summer 2015 – Finalize interconnection with NYSEG • Spring/Summer 2016 – Construction • December 2016 – Begin commercial operation
Greenhouse Gas Reduction	• 0.28% reduction in Cornell's GHG footprint
Present Value of Purchase Commitment	• *(This information redacted to abide by non-disclosure terms)*
REC Value	• Estimated REC value of $3500 in first year.
Estimated Economic Life	• 35 Years

Musgrave East PV Farm Fast Facts	
Nature of Transaction	• Developer agrees to construct, finance, own and maintain solar PV arrays • Cornell agrees to purchase all of the electricity generated by the arrays at a fixed price per kilowatt hour (final rate will depend on actual interconnection costs as determined by the local utility)

Contract Term	• Up to 30 years (commencing on the commissioning date)
	  ○ 20-year initial term
	  ○ Developer has two five-year extension options

Description of Facilities	• Two 2 MW solar PV arrays located in Ledyard, New York • Estimated aggregate energy production of ~3,300 MWh in first year
Hedge	• Serves as a hedge against volatile electricity prices
Cost Comparison	• Transactions are expected to be cost neutral in the early years, savings over time given projected energy prices. • Starting price of $0.1027-0.1050/kWh pending final NYSEG interconnection cost.
Project Timeline	• June 2015 – PPAs approved • Summer 2015 – Finalize interconnection with NYSEG • Spring/Summer 2016 – Construction • December 2016 – Begin commercial operation
Greenhouse Gas Reduction	• 0.28% reduction in Cornell's GHG footprint
Present Value of Purchase Commitment	• *(This information redacted to abide by non-disclosure terms)*
REC Value	• Estimated REC value of $3500 in first year.
Estimated Economic Life	• 35 Years

Strategy

The University holds an impressive land asset base located both in the vicinity of the central campus and throughout the State. At this time, the University has utilized nearly all of the regulatory allotment of net metered capacity for the central campus, and has done so by taking advantage of favorable grandfathered regulatory status obtained by being an early adopter and advocate for regulatory change with the NYS Public Service Commission.

By remaining active in the regulatory environment and receptive to new opportunities and business models, the University can continue to expand renewable plant installations using strategic industry and governmental partnerships.

Opportunities

The University will continue to explore opportunities for the installation of additional solar photovoltaics on campus owned land assets using the community solar model. Developers under this model pay rental fees for the control of these land assets for the duration of the installation agreement. Under the terms of these proposals, the University could require that the Developer provide all of the associated Renewable Energy Credits (RECs) for the energy generated at the facilities in addition to the rental fees, while making the power available to community members.