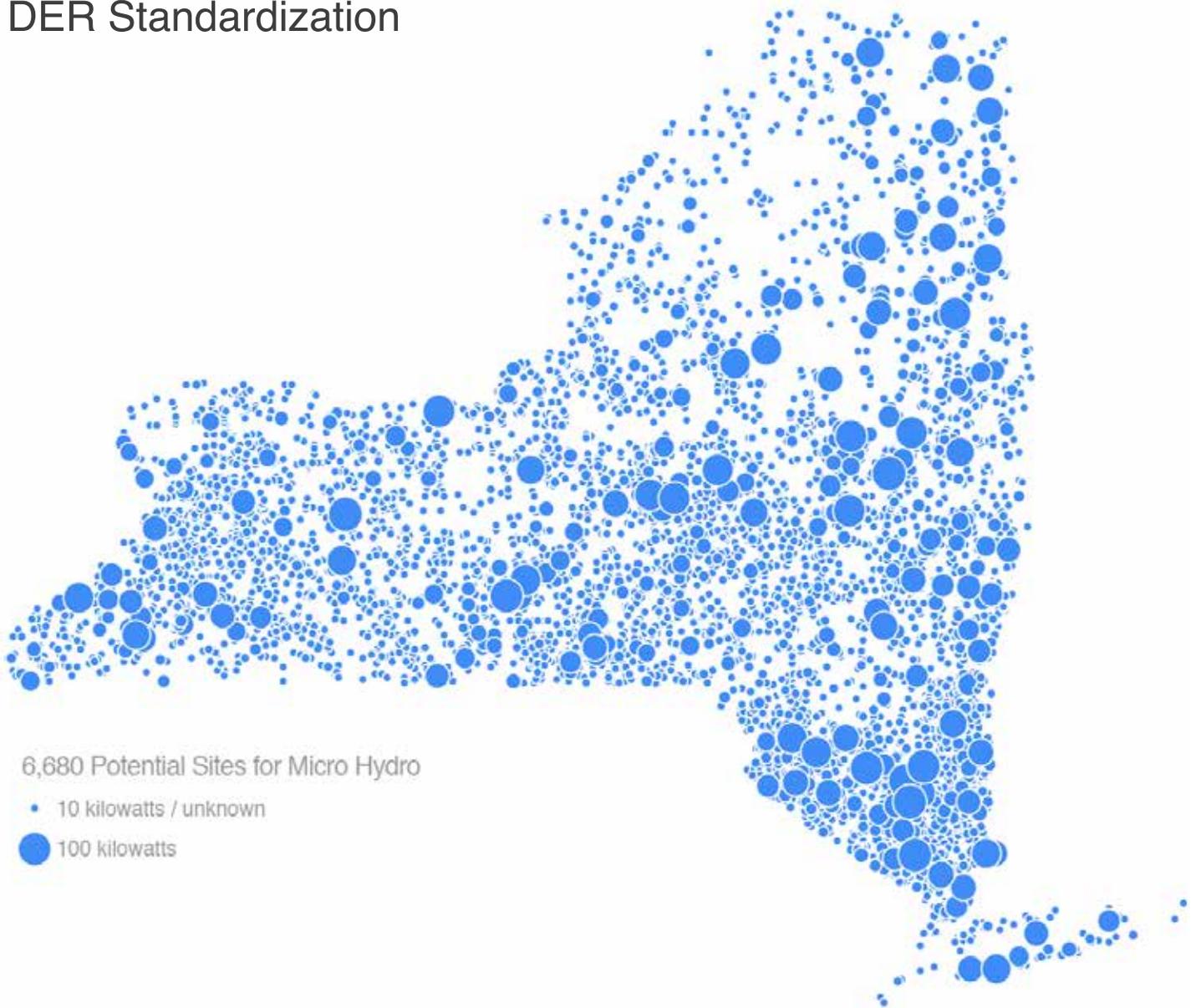


Micro Hydro Macro Impact

Bard Hydropower

A Pathway to Micro Hydro

DER Standardization



NYSERDA REV Campus Challenge: Energy to Lead Competition

RFP: 3214

Bard College is pleased to submit our response to RFP 3214, REV Campus Challenge. We feel confident that we have a unique proposal that addresses all of the requirements of Energy to Lead competition.

Synopsis

Bard was the first college to sign onto the REV Campus Challenge and is delighted to present its Bard Hydropower plan for the Energy to Lead competition. The goal of the project is to turn New York State on to hydroelectric energy as a viable potential option for the 6,600+ non-powered dams spread across the state. Our objectives will be carried out by our private and not-for-profit team members, and our community connections, all with student involvement and faculty support. We will develop this ultra low carbon energy resource on our campus where we have two dams, representing three potential sites, demonstrating and documenting each step to create an easily replicable model for others to follow. In the process of evaluating Bard's micro hydro potential, we will build an informative archive covering all of the ecological, technical, and logistical aspects of the process. To share our knowledge, we will launch New York Micro Hydro (NYMH), a project which will host a public, online repository of all relevant research. NYMH will also offer regular events with on-site hydro facility tours. At the conclusion of the grant period, we will host a statewide Micro Hydro conference to share lessons learned.

NYMH will provide a dynamic platform to advance a statewide conversation on developing these widely distributed, unused energy assets. NYMH will be an objective source of information to landowners, regulators, educators, municipalities, and communities to make informed decisions about existing dams. No new dams are proposed. Dam removal will remain the preferred option if the underlying scientific analysis of a specific site recommends a return to the river's former state. Content will range from site assessment, technology choice, financing, vetted micro hydro developers, fish passage devices, and maintenance protocols of the built environment as well as those of the ecosystem. Dam owners in New York can identify and assess dam locations in their own areas for replicating environmentally positive, economically viable hydro energy resources.

Our key innovations include **project design** by standardizing a replicable approach to an underutilized renewable energy category that needs thoughtful consideration, **business model** innovation with the development of a power purchase agreement tailored to micro hydro, **innovative partnerships** through a consortium of nonprofits with an international joint venture and **curricular integration** as our academic team engages faculty and students in the natural and social sciences while leveraging existing watershed work with community stakeholders. These multiple strategies are being synchronized to allow us to successfully modernize a long-standing technology that is ripe for reconsideration given the field tested advances in hydro turbine technology and the pressing need for low-carbon energy sources. We believe our project is an excellent solution for creating an innovative clean energy resource that will be efficient, replicable, and significantly reduce greenhouse gas emissions.

Innovation

Bard Hydropower is unique in that it will make positive impact micro hydro power a realistic and attractive alternative. The project re-imagines the process for working with the watershed community to identify appropriate project locations and then re-envision the method for how power is generated by falling water. Bard Hydropower will convince the myriad stakeholders who are unaware they have the ability to create a sustainable process. At this time there are more than 6,600 dam structures spread across NYS whose structural and environmental problems have gone unattended. Bard Hydropower will accomplish this through all four areas of innovation mentioned in the RFP: project design, business model, innovative partnerships, and curriculum integration.

Project Design

Bard Hydropower is creating a new product with an established technology by bundling the two using a new process. Then it will widely share and promote the project throughout New York State.

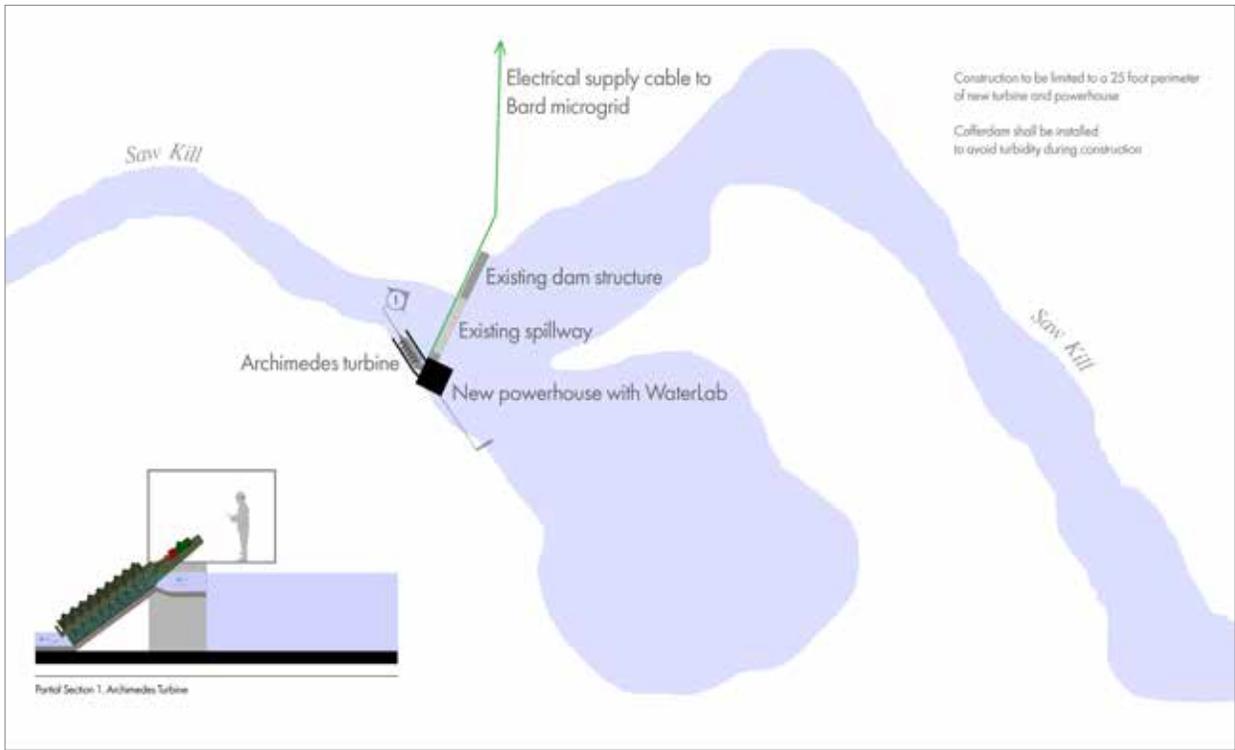
Product	We are modernizing micro hydroelectric power generation (10-100kw) by determining the feasibility of three types of installations on the Bard campus. We will leverage technology including open source application programming interface (API) for distributed energy resources (DER) control, alongside ecological and water quality and quantity monitoring.
Process	We are making a roadmap that others can follow easily and inexpensively. We will accomplish this by refining the process through our on-site trials, and through helping other dam owners in the region with pre-feasibility studies at their sites (using interns, professionals, GIS technology) and through the creation of model micro hydro power purchase agreement (MHPPA) language.
Enhanced communications	The New York Micro Hydro Project (NYMH) allows information to be shared with other campuses, dam owners regulators and other stakeholders.

We will take a nature-first, power-neutral approach to site assessments as not all sites are appropriate for hydro. The NYMH project will help landowners categorize which sites have power possibilities that are ecologically friendly. This will streamline the installation process at the sites where power make sense. On the technology side, we are bringing turbines and installation expertise from Europe to the US. The Archimedes screw and gravitational vortex turbines (both viable candidates for Bard) are considered fish friendly and we will do studies on the Bard site to verify this if installed. The gravitational vortex turbine is essentially a large concrete bathtub that must be built from field-proven engineering plans on site. The cross flow turbine is projected for use if we are able to restore the historic system at the Lower Dam and will be updated with new, proven technology to enable fish passage.

Project Detail: Facility Construction



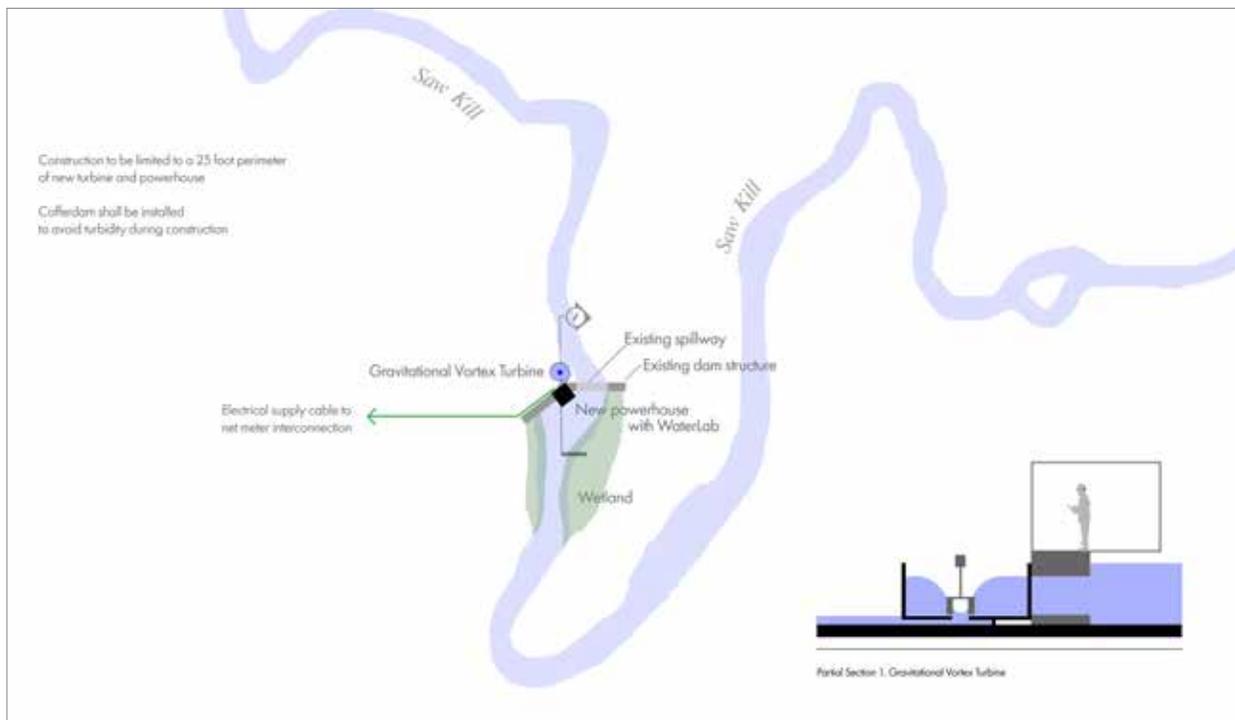
F1.1 Facility 1: Existing powerhouse ruin **Micro Hydroelectric Project** **Bard**
Bard College
Annandale-on-Hudson, NY



F2.1

Facility 2: Archimedes Feasibility Sketch

Micro Hydroelectric Project
Bard College
Annandale-on-Hudson, NY



F3.1

Facility 3: Gravitational Vortex Feasibility Sketch

Micro Hydroelectric Project
Bard College
Annandale-on-Hudson, NY

The model pricing for the three facilities is included as Appendix C and includes an estimate for design, permit acquisition assistance, equipment purchase, civil construction, equipment installation, grid connections, system testing and final commissioning. This represents both anticipated costs for the actual projects, were they to be implemented, and a projection for pricing under standardized system. The pricing includes an open source application programming interface for Distributed Energy Resources control and grid interconnect. Access to systems will use OAuth 2.0 with two-step authentication.

For Bard Hydropower, we are proposing a more detailed ecological analysis than is usual under a standardized model. Ecological analysis would be performed during the feasibility stage, to determine potential effects of turbine installation. If turbine installation is deemed appropriate for the site, additional analyses will be performed post installation. The exploratory work is necessary 1) to understand impacts to biological resources (such as the American eel population) and 2) to test our predictions that at appropriate sites turbines can enhance stream water quality. A “Rationale for Studying the Biological Impacts of Microhydropower Installation” prepared by Dr. Erik Kiviat is attached as Appendix D.

A more detailed analysis is through the scope of work proposed by Hudsonia, in collaboration with the Bard Water Lab will include a focus on these scientific concerns:

- American eel sampling below lowest dam, second waterfall (between the two dams) and below the upper dam
- Quantifying and evaluating presence and vulnerability of herptofauna in the stream and riparian areas
- Documenting plants in the stream and riparian areas
- Bird survey (performed if water levels are expected to change at Mill ponds)
- Creating a baseline understanding of the overall quality of Saw Kill surface waters (including temperature, conductivity, pH, dissolved oxygen, water level, turbidity, and bacterial loading)
- Water quantity and flow study

Project Detail: New York Micro Hydro Project (NYMH)

Web site development

- Based on team design process to meet outreach needs and goals
- Open source software application
- Functionality: Feasibility, Permitting, Construction, Detail Analysis, Monitoring, Maintenance, Security
- Includes interactive infographic and responsive design

Content creation

- Stream habitat analysis
- Property boundary analysis
- Terrain analysis
- Environmental monitoring database development
- Project visualization and map development
- Web-based assessment tool design

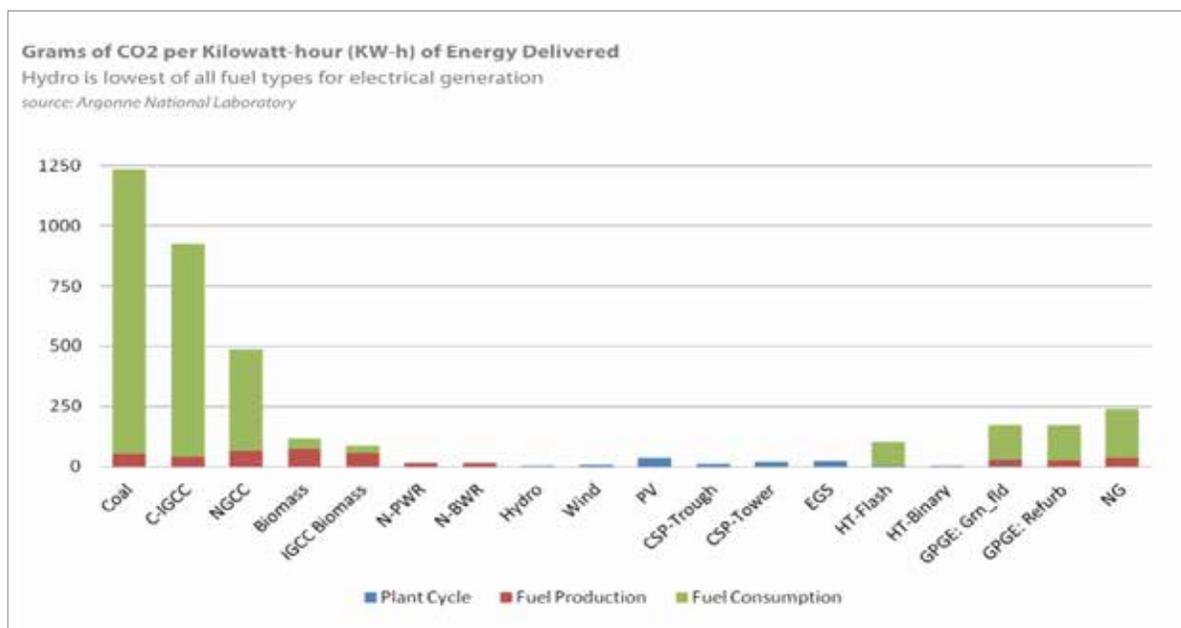
- Drone mapping implementation
- Continuous water quality data from installed hydro projects
- Ecosystem service analysis: Provisioning Services (material or energy outputs from ecosystems, including food, water and other resources); Regulating Services (eg., regulating the quality of air and soil or by providing flood and disease control); Habitat services; Cultural services (recreation, physical and mental health, tourism)
- Stakeholder engagement model and resources
- Micro hydro technology resources
- Micro hydro economic and financial analysis
- Dam removal resources

Outreach

- Stakeholder engagement via Bard Center for Environment Policy (CEP)
- Four meetings at colleges that have a dam in their community
- Launch campaign
- New York Micro Hydro Conference at the conclusion of the grant period (funded through registration fees)

Project Detail: Benefits of Bard Hydropower

- Long lived – for power, fish passage and water quality monitoring data for 50 years, and can be re-powered at the end of 50 years
- Continuous power – unlike the sun, the power is generated around the clock, though subject to seasonal variation
- Uses existing dams and ecological systems that have been created around them
- Low grams of carbon dioxide KWh delivered



- Low impact design – fish friendly, can improve water quality through aeration
- New source of environmental data collection – continuous monitoring of fish passage and water quality and quantity at new sites
- On grid (interconnected) or off grid, based on site conditions
- Money stays in the local economy
- Grid is stabilized
- Power created close to where it is used
- Jobs are created now and in the future
- An innovative use of hydropower, which is the one of the most efficient renewable energy sources

Project Detail: Enhances Resiliency of System

- Decrease likelihood of dam failures and destruction during storms, increase aquatic connectivity for endangered organisms (in line with goals of DEC/HREP), enhance our understanding of the health of understudied waterways.
- Potential to supply microgrids – Bard’s sewer treatment and water treatment plants are adjacent to the Lower Saw Kill dam and can utilize this source of power 24/7.
- Micro hydro facilities are unlikely targets of terrorism and attacks. In noting the 2013 terrorist attack on the Bowman dam, micro power sites are so small that damage is very limited. To bring down the whole network of micro hydro facilities, each one would have to be made unusable.

Business Model

Bard Hydropower will develop two model financing options: an Ownership Model and a Power Purchase Agreement Model. A PPA creates the possibility of attracting large scale investment by allowing for risk diversification.

Ownership Model

Owning a system may be preferred, since when a system is purchased directly by an owner, and once debt service is done, they have free power and a revenue stream for life. Property owners with non-productive dams are often faced with the vexing, expensive task of complying with NYSDEC dam safety requirements. The micro hydro protocol we develop will help establish whether an owner can turn a liability into a 50-year positive cash flow asset, raise the property value, and provide an operating budget to support ongoing maintenance.

The challenge for owners is to attract private financing for a technology that is unfamiliar. One of the key goals to Bard Hydropower is to verify two or three technology options in order to help reduce perceived technology risk.

New York State has institutions like the NY Green Bank, “a state-sponsored, specialized financial entity working in partnership with the private sector to increase investments into New York’s clean energy

markets” that could facilitate private ownership. With its widespread opportunities, micro hydro could become an attractive outlet for Green Bank investment. Bard Hydropower will build trust with the Green Bank and other potential investors by demonstrating over a two-year period that the technology can be installed and operated cost-effectively, generating a potentially long-lived income stream. In the years that follow the grant, we will continue to report publicly on the performance of the technology, creating a track record to encourage public and private finance. At the same time our NYMH project will establish a research repository evaluating the economic performance of micro hydro in other regions of New York to help inform investor decisions.

If Bard Hydropower, and the research of NYMH can demonstrate sustained positive cash flow from micro hydro in our region, then installed micro hydro assets should also increase the value of the landowner’s property, helping to offset default risk.

Power Purchase Agreement

Beyond technology risk, additional unexpected costs for hydropower development could arise from the need to protect ecological or cultural resources. For example, should second phase studies or additional mitigation measures be needed, project costs will increase beyond initial expectations. A PPA is a potential vehicle to attract large scale investment into micro hydro, by allowing investors to develop a portfolio of projects, and diversify risk. Investors holding a portfolio of projects might also be in a position to increase revenue as well as value to the grid by discharging the power at peak times.

To evaluate this opportunity, we will create model language for Microhydro Power Purchase Agreement (MPPA), or a financial arrangement in which a third-party developer owns, operates, and maintains the micro hydropower system and a host customer agrees to site the system on its property and purchases the system’s electric output from the hydro developer.

Solar entrepreneur Jigar Shah changed the status quo when as CEO of SunEdison in the early 2000s he created the PPA for the solar industry. Now, PPA language exists for large hydropower projects and small hydro power in a developing world: (ppp.worldbank.org/public-private-partnership/hydropower-0) but we have not found standardized language for micro hydropower in the United States.

Innovative Partnerships

Bard, whose motto is “a private institution in the public interest”, celebrated its 150th anniversary in 2010, and marked the occasion with a new program to enhance a connection based in science with the greater community through its Citizen Science program. On April 2, 2016, Bard celebrated its January 2016 purchase of the 380-acre historic Montgomery Place Estate, along with the two dams that came with the acquisition, with a Celebration of the Saw Kill grand opening event. In the six years between those two events, the College has founded the Center for Civic Engagement, which connects Bard undergraduates on projects and in partnerships with thousands of public school students in local, regional, and New York City school districts, and has founded the Saw Kill Watershed Community, which unites stakeholders in

the watershed over the common stewardship of this resource.

Bard is pleased to partner with our students, two businesses, a not-for-profit, community group and other colleges to advance clean energy on campus, in the surrounding community and across New York State:

New Businesses We will partner with the NY startup Current Hydro in their joint venture with the UK firm, Renewables First. This relationship makes it possible to leverage the entrepreneurial vision necessary to work in the renewable energy space, with a firm that has proven experience installing the systems abroad. Our other partners are Terrapin Bright Green, who will use an integrative process to develop the NYMH solution in partnership with the Bard Center for Environmental Policy and GroundPoint Technologies, a GIS firm.

Community Through their ability to analyze water samples and manage water quality data, the Bard Water Lab offers more than a physical space. The Saw Kill Watershed Community allows us to communicate effectively with local stakeholders and regulatory agencies. Hudsonia will ensure we are properly valuing our impact on the ecosystem. The ongoing development of the The Hudson River Subwatershed & Tributary (THurST) Research Network (repl) allows us to connect with other college campuses to aid dissemination of NYMH project.

With the NYMH, Bard will leverage this established record of working with the community for the public good. The Bard Water Lab, which has initiated and supports laboratory processing for community drawn water samples from the Saw Kill and Roeliff-Jansen watersheds, will serve as a community-centered site for management of NYMH-generated data. Bard Hydropower's proposal will bring enhanced and continuous water monitoring to newly powered dams, and the Bard Water Lab is uniquely positioned to monitor and analyze these data. Furthermore, the Bard Water Lab's participation in founding the THurST network (a partnership of Colleges and Universities working in their respective, local watersheds, but using common methodologies, to answer a set of unifying research questions with answers of both scientific and community significance) will aid in the NYMH's goal to bring the Bard Hydropower model to regional campus communities.

Problems to be solved

Bard Hydropower modernizes a historic power source that has fallen out of favor. Historic estates, like the one upon which Bard and its addition of Montgomery Place were built, have used hydro power for the last two hundred years for electricity, flood control, recreation, irrigation or water storage. Hydroelectric power generation at Bard's newly acquired dam, the "Lower Saw Kill Dam," was first installed in the 1920s and went out of service in the 1970s. One reason for closure was that the 30kw generator was regularly clogged by the American Eel, the very species whose migration we will be assisting with our project. This type of power uses "run of river" technology. Unlike impoundment dams which store the water and

controls its release, run of river is considered more environmentally-friendly and offers a lower flood risk than impoundment dams. The lower power potential of such dams creates this niche opportunity - it has not been economical for traditional developers. The upper or Annandale Dam was rebuilt in the 1930s and is the second artificial barrier on the Saw Kill. A water wheel used water to pump water for irrigation of the nearby farm. These types of power projects have been largely abandoned with the advent of cheap electricity; often useful infrastructure and valuable equipment are left behind.

There are vast numbers of NY dams and they are broadly distributed and information about them is incomplete. They will require categorization, multi-stakeholder and multi-discipline attention. We need to review these dams with a sustainability lens because siloed stakeholders have competing priorities for dams (stakeholders include owners, regulatory agencies, not for profits, and the community members and municipalities in their watersheds).

DEC classifies dams “A-C” with “C” considered the most hazardous to others in the event of failure (its classification is not an expression of condition). There are dams that aren’t inventoried: Bard’s Lower Saw Kill Dam does not appear on the regulatory database (the Dam Safety office opined because it is considered an extremely low hazard dam). DEC has also said that we may be able to re-categorize Annandale Dam from B to A.

Hazard Class	Count	Percent of total
O - Other	515	8%
A - Low	4,074	61%
B - Intermediate	548	8%
C - High	259	4%
D - Extremely low hazard, removed, not installed	1,256	19%
	<u>6,652</u>	

Source: NYS Inventory of Dams <http://www.dec.ny/lands/4991.html>

According to the NYS Inventory of Dams, 33% of dams are in private hands, 47% are described as N/A or “not found”, with 20% owned by local, state or federal government. The “dam owners’ lament” that we have heard throughout the discovery process, is that dams, and the possibility for breaching, represent a growing cause for concern, fear and expense from storms, especially with increasing climate change. Owners would like to understand the power potential of their dams but don’t have a source to go to for answers. Some non-owners express concern about removal or alteration of historic dams – for historical reasons the loss of the historic dam structures and associated mill ponds is a concern. They feel the dams also provide recreation and habitat.

Other departments in DEC currently tasked with enhancing the ecology of NY are proposing dams be

removed or altered to enhance their ecological objectives, including fish passage. The DEC Dam Safety office recently requested that Bard remove vegetation and trees from around the Annandale Dam. Power potential is not part of those departments' decision-making criteria. Our approach avoids precipitous, single agency decision-making.

The federal government has tried to apply basin level analysis to the dam issue with an Integrated Basin Scale Opportunity Assessment Initiative – the Department of Energy's approach offers useful lessons for hydropower, which we will access and use in our more in-depth analysis of micro hydro power at the tributary level.

Curriculum Integration

Bard Hydropower will integrate project construction, implementation and operations into student coursework, research projects, and off-campus internships. Faculty members from the undergraduate program and the graduate Center for Environmental Policy and the MBA in Sustainability programs will incorporate aspects of the micro hydro project into existing and planned courses, and as a research platform for undergraduate senior projects and graduate theses and Capstone projects. In addition, we have identified several new internship and outreach opportunities at other local colleges and community groups.

While the Bard College campus has been part of the Saw Kill Watershed for 150 years, the Saw Kill's place in the curriculum of the college has recently undergone swift evolution. The watershed has become Bard's living laboratory, where a science-based process that includes community engagement aims to safeguard the health of the ecosystem while maximizing the ways in which the community can benefit from the Saw Kill's many ecosystem services. The College and local stakeholders are working together to ensure this ecological and recreational resource is understood, maintained and integrated into our educational mission.

Bard Hydropower will fit well into this ongoing program because our proposed approach stands in stark contrast to a standard hydropower project, in which an outside developer would implement a plan that maximizes energy production per dollar spent, with the only community interaction being the filing of an environmental impact statement that espouses a 'least harm' approach. Bard Hydropower puts forth an alternative paradigm by pioneering a comprehensive ecosystem-based approach: a water power resource that is already present is identified, the overall health of the waterway is evaluated and held paramount, and consensus decisions are made on how best to move forward.

In the execution of the project, we will confront the questions that any group considering the options for their own dams will have to answer.

- Is the dam appropriate for micro hydro? Can it physically sustain turbine installation?
- Is there a steady local use for the power that would be generated?
- Would the power generated justify the cost of the micro hydro installation?

- What stakeholders need to be involved?
- How can fish migration be enhanced?
- How will water quality be affected, and can it be improved?
- What other ecological considerations must be taken into account?
- What social and cultural impacts will the project entail?
- Would a better alternative be a plan to remove the dam?

There are nearly 6,700 dams in New York State that are currently not used for power generation. The communities around these dams need answers to these questions, and only an integrated approach will provide a balanced consideration of all the pros and cons of the decisions that have to be made as a group figures out how to spend its limited funding and time. By basing this research in an academic setting, the emphasis will be on developing data-based solutions, not on advocating a particular option because of any financial self-interest.

In the process of developing Bard's micro hydro system from conception to completion, we will build up information resources on all of the ecological, technical and logistical aspects of the process. This information will feed into our proposed New York Micro Hydro Project (NYMH) designed to support landowners and communities as they make informed decisions about existing dams. The NYMH will focus on: site assessment, technology choices, financing and project implementation for micro hydro, fish passage and the maintenance of other ecosystem services, and the evaluation of other land-use alternatives such as dam removal.

Specifically, the NYMH will establish an online information center, convene stakeholder meetings, promote research, and highlight lessons learned from ongoing projects, at Bard and other sites. These services will support other groups in New York State to identify and assess dam locations in their own area for the possibility of producing environmentally positive, economically viable, reliable local energy. The NYMH will provide a dynamic platform to foster statewide conversation on all aspects of how best to develop this widely distributed energy resource. Bard College is ideally suited to integrate the development, construction, and utilization of the micro hydro facility into its curriculum at many levels.

Bard Undergraduate Curriculum

The existing Environmental and Urban Studies Program (EUS) already uses an interdisciplinary model that combines the social and scientific aspects in studying any environmental system. Faculty in EUS span the natural sciences (Biology, Ecology, Environmental Science, Physics), and social sciences (Anthropology, Archaeology, Economics, Sociology).

Courses currently offered or about to be offered in 2016-17 that incorporate field work on the Saw Kill are shown on the next page.

Courses 2016-17

EUS 102	Intro to Environmental and Urban Science
EUS 221	Water
EUS 222	Air
EUS 214	Water Quality on the Saw Kill
EUS 2**	Land
EUS 3**	Biogeochemistry
BIO 145	Environmental Microbiology
BIO 330	Freshwater Biology

As part of Bard Hydropower, these and other existing and new courses would incorporate case studies and field work on the Saw Kill as part of their curriculum. This would include such courses as PHYS 120 Global Energy and ECON 242 Ecological Economics. Bard Hydropower would also expand the research field work that EUS and Ecology students do on the Saw Kill, both in Bard Summer Research Institute projects and for their senior research projects, and enhance a robust community engagement program that involves the Bard Water Lab, the Saw Kill Watershed Community, the Saw Kill Water Quality Monitoring Program, and the Hudson River Subwatershed & Tributary Research Network.

An example of the unique curricular initiatives possible at a college that values curricular innovation and community engagement is the recent proposal to the Bard Experimental Humanities Program for Drone Imagery as a Watershed Community Builder. This project is a joint EUS, Experimental Humanities Program, and Saw Kill Watershed Community (SKWC: Bard, Red Hook, Milan, Rhinebeck community partnership) project that will use science and technology to build community cohesion around the sustainable management of water. This project will produce seasonal and accessible imagery of the Saw Kill waterway on Bard College campus while critically examining the social politics of mapping the landscape with a drone. In addition to mapping, this project will conduct ethnographic research about the relationship between the watershed community and the Bard researchers. This will be integrated into a current SKWC initiative, the Saw Kill Streamwalk.

Bard Graduate Curriculum

Given the focus of the Bard Center for Environmental Policy (CEP) on interdisciplinary analysis of environmental problems and policy, the Center will play a key role in developing curricula around the complex issue of decision making by individuals and communities regarding options for managing existing small dams. The trade off that exists between ecological connectivity achieved by dam removal and enhanced renewable energy supply achieved by “upfitting” small dams for micro hydro poses a rich problem space for interdisciplinary learning for our graduate students. Bracken, Bulkeley, and Maynard (2014) argue that the discussion around renewable energy at the community level is dominated by technical options and financial implications, with less exploration of social and environmental values. The involvement of faculty and graduate students from the Bard CEP will ensure that social and ecological systems elements are included in the decision process for this particular project, and are represented in

the guidance we generate for others to follow.

Bard CEP faculty will incorporate the various aspects of the development and maintenance of the NYMH into the CEP course on Energy Policy and the cross-disciplinary Energy Module conducted across the science, economics, and politics courses. In addition, as part of the Politics sequence, Bard CEP will develop and field-test a stakeholder engagement model and decision-making framework that can be used by others across New York State on how to assess aging dams and take advantage of hydro potential in an environmentally, economically and socially acceptable way. Graduate students under the supervision of CEP faculty will facilitate stakeholder involvement through activities such as community meetings, focus groups, and scenario exercises. In particular, in the first year of the grant, a stakeholder engagement model will be developed, tested on the Saw Kill and documented on the NYMH. In the second year, the model will be refined by engaging two additional colleges with potential energy dams and their associated stakeholders. In this way, a document and additional resources outlining a “Stakeholder Engagement Process” will be developed.

Beyond incorporation into classwork, the micro hydro installation process has the potential to serve as the focal subject for a series of Master’s theses. Bard CEP Graduate students will help staff the NYMH, and take the lead in constructing, developing materials for, and maintaining the on-line information portal.

The Bard MBA in Sustainability

Bard’s MBA program brings to the project faculty and graduate student interest in clean energy finance, entrepreneurship, project management, and business strategy. In particular, program expertise in finance will be critical to develop replicable models for communities beyond Bard. In addition:

- An MBA student will develop model Ownership and PPA Contracts.
- As with Bard CEP, the micro hydro case study will be incorporated into MBA classes,
- MBA Capstone projects can focus on making the business case for expansion of the model to other suitable sites in NY State.

Off-Campus Learning and Internships

While Bard College has a broad curriculum, we have begun discussions with other colleges and universities, community groups, and technology companies to draw on their complementary expertise as we develop the Bard Hydropower project. This will provide additional learning and internship opportunities for Bard students both in EUS and the Bard CEP, as well as consulting resources for all stages of the Bard Hydropower project. A broad knowledge base will be crucial as we develop the NYMH as a state-wide resource that can provide information, consultation, and educational materials to interested groups.

Two faculty members from the SUNY New Paltz School of Science & Engineering will serve as advisors in areas of their expertise, fluid mechanical engineering and electric power engineering, throughout the project. The United States Military Academy, with which Bard has an on-going collaboration, has an

extensive Engineering program, and has recently submitted a proposal for a 50 kW micro hydro project on its campus. This will provide opportunities for students at all the schools, following the existing model of the Bard-West Point Exchange.

Other colleges will become involved through the Hudson River Subwatershed & Tributary Research Network (THurST). Begun as a partnership between Siena College and Bard College in November 2015, this is a quickly-growing consortium of academic institutions conducting scientific research specifically on Hudson River tributaries.

Hudsonia, a non-profit environmental research institute, will work with Bard students on field work necessary to determine the ecological constraints and opportunities associated with the project. Students will benefit from working under the direction of experienced scientists Drs. Erik Kiviat and Bob Schmidt, leaders in their respective fields and intimately knowledgeable about the Hudson River and its tributaries.

Current Hydro LLC will hire two Bard undergraduates as interns, with the work integrated into their curriculum under the academic guidance of Physics Professor Dr. Matthew Deady.

Local jobs will be generated by all three micro hydro facilities. The gravitational vortex will require significant civil construction, the Archimedes turbine will be manufactured at a nearby computerized numerical control equipped (CNC) fabricator, and the 1920's turbine and generator from the original Montgomery Place hydro facility will be refurbished by a specialist in Albany. Finally, as overseen by the Bard Center for Civic Engagement, Hudson Valley Science Outreach is a program that coordinates free science mentoring, tutoring, and after-school activities to 3000 students a year in six local school districts. In visits to the Bard campus for science activities, students have performed data collection on the Saw Kill. As part of the BMHP, this program would be expanded to explicitly include more projects connected to the stream's ecology as well as a new focus on clean energy generation possibilities.

Project Team

The best projects are ones that bring together stakeholders at the earliest stage to collaborate on a vision for development – we initiated our innovative curricular integration structure by literally standing at the project site together with students, faculty, entrepreneurs and community members. This approach has brought diverse viewpoints that informed the creation of our Bard Hydropower Steering Committee and that identified places to integrate this rich, multi-dimensional project into existing classes, new classes and internships.

A three-member steering committee brings together undergraduate and graduate programs at Bard College, the College's Facilities Community, and local Stakeholder Engagement through the Bard Water Lab at the on-campus Ecology Field Station. An existing staff member, Laurie Husted, Sustainability Manager (Facilities), will be moved to full time for this project, and reporting to the Steering Committee, and in consultation with the Steering Committee, would manage the project implementation.

Steering Committee

Laurie Husted, Buildings & Grounds, Office of Sustainability, Program Director

Undergraduate:	Matthew Deady, Physics Program
Graduate	Eban Goodstein, Director: Bard CEP and Bard MBA
Community	Eli Dueker, Biology Program, Environmental & Urban Studies Program, Bard Water Lab

Steering Committee members will liaison with the following lead representatives

Bard administration:	Taun Toay, VP for Strategic Initiatives and Chief of Staff
Undergraduate students:	Jason Chang, Class of 2018
Graduate students:	Jason West, Bard CEP Class of 2017
Graduate faculty:	Dr. Monique Segarra, Bard CEP faculty
Off Campus:	Dr. Aubryn Cooperman

Proposal partner	Lead contact
Current Hydro	Joel Herm
Bard Water Lab, Saw Kill Watershed Community, THurST	Eli Dueker
Hudsonia	Erik Kiviat
GroundPoint Technologies	Ben Houston
Terrapin Bright Green	Bob Fox

Bard Hydropower Project Director

A Project Director will be hired to head up a program to develop micro hydro power at existing on-campus dams on the Saw Kill. The Director will work with the graduate and undergraduate faculty and students as well as the college administration. The Director will coordinate, monitor, and archive research activities connected to the dam project, including GIS mapping, ecological, cultural, and water quality and quantity studies, as well as the assessment of technological aspects of the project. The hire will oversee the creation of the New York Micro Hydro Project, an open-access information center that will serve as a resource for potential dam site owners to consult as they assess their own dams for the feasibility of obtaining useful power from installing micro hydro equipment. The Director will coordinate classroom integration of the Bard Hydropower project.

Resumes - Bard Team

Laurie Husted

MSIA (MBA) Sustainability Manager, Bard Office of Sustainability, Bard College

Proposal Role & Responsibility: Bard lead on overall coordination of proposal preparation

Project Role & Responsibility: Bard Hydropower Project Director

Laurie has 12 years of experience managing sustainability projects for the College including a recent \$800,000 Environmental Facilities Corporation (EFC) grant for a Regional Demonstration Project for Green Infrastructure project that was completed on time and under budget. She has successfully managed NYSERDA-funded projects including an ARRA renewable energy project and an ARRA Clean Cities Program implementation. As a community member, she was recently awarded a Solarize Campaign for Northern Dutchess under a NYSERDA grant to Solarize Hudson Valley, and is currently running a four month campaign in seven communities to accelerate the adoption of solar energy on homes and businesses. She is representing small towns in NYS on the Permitting team for the Unified Solar Permit Process under the CUNY SunShot Initiative. Prior to her work with the College, she was Project Scientist with an environmental engineering firm in New York where she managed environmental projects.

Matthew Deady

Professor of Physics, Physics Program Director

Proposal Role & Responsibility: Curricular Coordinator

Project Role & Responsibility: Steering Committee (Curriculum Coordinator, Student Research Supervisor)

Matthew Deady received B.S. and M.S. degrees in Physics and in Mathematics at the University of Illinois and a Ph.D. in Experimental Nuclear Physics at the Massachusetts Institute of Technology. He has been at Bard College since 1987, teaching courses at all levels of the Physics Program, as well as in other disciplines. He has taught courses and supervised student research projects in alternative energy technologies, including a student project performing a feasibility study of micro hydro power on the Saw Kill.

Dr. Eban Goodstein

Director, Bard CEP and Director, Bard MBA

Proposal Role & Responsibility: Bard CEP/MBA Proposal Lead

Project Role & Responsibility: Steering Committee, NYMH and graduate program integration

Eban Goodstein is Director of Bard's Graduate Programs in Sustainability, including Bard CEP and Bard's MBA in Sustainability. Goodstein is the author of a college textbook, *Economics and the Environment*, (John Wiley and Sons: 2014) now in its seventh edition; *Fighting for Love in the Century of Extinction: How Passion and Politics Can Stop Global Warming* (University Press of New England: 2007); and *The Trade-off Myth: Fact and Fiction about Jobs and the Environment*. (Island Press: 1999). His research has been featured in *The New York Times*, *Scientific American*, *Time*, *Chemical and Engineering News*,

The Economist, USA Today, and The Chronicle of Higher Education. He serves on the editorial board of Sustainability: The Journal of Record, is on the advisory committee for Chevrolet's Clean Energy Initiative.

Eli Dueker

Assistant Professor of Biology and Environmental and Urban Studies, Bard Water Lab

Director, Saw Kill Watershed Community Leadership Team Member

Proposal Role & Responsibility: Reviewer

Project Role & Responsibility: Steering Committee, Bard Water Lab Director, SKWC, THruST liaison)

Eli Dueker joined Bard in 2014 as an environmental scientist focusing on water quality issues. With a B.A. from Rhodes College, and Ph.D. from Columbia University, he completed his postdoctoral research at Queens College, City University of New York, and Lamont-Doherty Earth Observatory of Columbia University through studying microbial aspects of water quality in the Lower Hudson River Estuary. Before entering academia, he worked for 14 years in the nonprofit world, primarily in environmental and human rights organizations. He is the founder and Interim Leadership Team member of the Saw Kill Watershed Community, which protects the Saw Kill Watershed and its ecological, recreational, and historic resources through hands-on science, education, and advocacy. He is also the founder and director of the Bard Water Lab. His current research is focused on bacterial water quality, watershed-level processes including atmosphere-land interactions, and connections between water and air quality.

Taun N. Toay

M.Phil., Vice President for Strategic Initiatives and Chief of Staff, Bard College

Proposal Role & Responsibility: Senior Administrative reviewer

Project Role & Responsibility: Financial review and due diligence

Taun Toay has been involved in green initiatives at the College for nearly a decade, where he has worked on both energy procurement, contracting and alternative energy installations. He chairs the Planning and Administration Committee of Bard's Sustainability Council. He has also served as an administrative member of Bard's Socially Responsible Investment Committee since its inception and was a Technical Advisor to the Investment group for the Sustainability Tracking, Assessment and Rating System (STARS) from the Association for the Advancement of Sustainability in Higher Education (AASHE). He is also managing director of the Levy Economics Institute where he holds a research analyst position. He was a Fulbright research grantee to Greece for 2005–06 and an affiliate of the University of Piraeus and has served as a visiting lecturer in the economics department at Bard College. He holds an M.Phil. in economics from the New School for Social Research.

Jason Chang

Computer Science Undergraduate Student, Bard College

Proposal Role & Responsibility: Computer Systems and Architecture

Project Role & Responsibility: candidate for Current internship

Jason Chang is currently in his sophomore year of Bard College studying Computer Science. During

his two years at Bard College he has taken courses in Physics, Data Structures, Discrete Math, Object Oriented Programming, and Robotic Systems. He has interned with the New York Republican State Committee. During his time there he helped manage large databases using MySQL. He also worked on Bard's Spring Fling Committee to design, create, and maintain their website. The website is viewable at blogs.bard.edu/springfling15. In his free time he enjoys working with Arduino micro controllers.

Jason West

Bard College, graduate student

Project Role & Responsibility: Liaison to Graduate Students, GIS Class Project Team member Candidate for graduate internship

Jason West is a first year student at the Center for Environmental Policy, earning an MS in Climate Science and Policy. Previously Jason served eight years as Mayor of New Paltz, NY, overseeing multiple public works and urban planning projects. He is currently Executive Director of the Walkkill River Watershed Alliance.

Dr. Monique Segarra

Bard CEP

Proposal Role & Responsibility: Reviewer

Project Role & Responsibility: Lead on Developing a Model for Stakeholder Engagement

With an M.I.A. from the School of International and Public Affairs and a Ph.D from Columbia University, in Comparative Politics and Latin America, Segarra's research focuses on the politics of water reform and comparative analysis of human and environmental rights movements challenging mineral and oil policies of states and multinational corporations in Ecuador, Mexico and Chile. She has published articles in journals such as Latin American Politics and Society, The Journal of Contemporary Sociology, and edited and contributed to The New Politics of Inequality in Latin America. Segarra brings experience in stakeholder management through her work with a range of international development institutions including the World Bank, the United Nations Development Program, and the Council on Foreign Relations.

Dr. Aubryn Cooperman

Project Role & Responsibility: Liaison to Off Campus Consultants, site analysis

Aubryn received her Ph.D. in mechanical and aeronautical engineering from the University of California, Davis. Her primary research interests are in sustainable energy, including wind and water power. She has investigated micro hydro systems for the California Energy Commission, and conducted environmental monitoring at Williams College. She previously worked at the Delft University of Technology, where her research was focused on sensors for use on wind turbines.

Resumes - Proposal Partner Team Leads

Joel Herm

Managing Director, Current Hydro LLC

Proposal Role and Responsibility: Micro hydro consultant

Project Role and Responsibility: Design/build team member for micro hydro facilities

Joel is a veteran technology entrepreneur with clients ranging from world-class biotech companies like Sanofi Genzyme to financial powerhouses like JP Morgan. He has developed and actualized innovations in capital markets, consumer finance, and FDA-cleared medical devices - all with the theme of revealing insights from seemingly opaque data. Those successes came from combining his University of Illinois industrial design degree, expertise in system architecture, leadership in banking and healthcare deployments, and perhaps most important, his Midwestern farm upbringing. He brings a can-do/must-do agricultural pragmatism to this NYSERDA project that will ensure the generation of ultra-clean, fish-friendly electricity. Of note, he has been living and breathing micro hydro for the last three years since he purchased a 10-acre parcel near the Bard campus where he is thoughtfully restoring a 130-year-old hydroelectric facility.

Dr. Erik Kiviat

Executive Director, Hudsonia

Proposal Role & Responsibility: Biological Proposal

Project Role & Responsibility: Biological impact assessment and reporting

Erik Kiviat PhD is a wetland and terrestrial ecologist who has studied the Saw Kill and its environs, as well as riparian and estuarine biota throughout the Hudson River system, since 1971. Erik's interests lie in applied ecological research and interpreting research for environmental practitioners. He has studied higher plants, cryptogams, amphibians, reptiles, birds, mammals, and their habitats, and is especially interested in rare species of conservation concern as well as overabundant (invasive) species. Erik has written or edited several hundred technical assistance reports, and published 60 scientific papers and book chapters, and four books, as well as many articles for the general public. He taught natural history to undergraduates as a part time faculty member for 8 years in the 1970s, as well as co-designing, teaching in, advising thesis research in, and serving on the administrative committee for a Bard master's of environmental studies program for 15 years beginning in 1988. Erik is executive director of Hudsonia which he co-founded in 1981.

Benjamin H. Houston

P.E., PMP, GISP, Visiting Professor, Bard Center for Environmental Policy, Bard College

Proposal Role & Responsibility: Curriculum integration, Academic/Private partnerships, geospatial technology integration

Project Role & Responsibility: Bard GIS Program integration (Academic), Geospatial data development and analytics (Private)

Ben has over 25 years of experience in a wide range of engineering and mapping technologies. As the lead GIS professor at Bard College, Ben will be responsible for integrating project elements into course materials such as lectures, laboratory exercises and student capstone projects. His longtime active role in the NYS GIS Association will enhance the project's outreach to other academic programs throughout the State, leveraging the Association's network of geospatial educators in sharing both developed curriculum and in fostering collaboration in replicating the work done at Bard. A licensed professional engineer in the State of New York, Ben is also a principle with GroundPoint Technologies, LLC, a certified Woman Owned GIS consulting business in NYS. He brings to this project a wealth of expertise in topographic mapping, digital photogrammetric and airborne laser scanning, and the development of spatial analytics to support a range of environmental management and modeling objectives. A certified GIS Professional (GISP) and Project Management Professional (PMP), Ben has successfully managed portions of NYSERDA-funded projects including the mapping support to a Sea Level Rise Affecting Marshes Model (SLAMM) project on coastal Long Island and topographic, hydro-enforcement and change detection modeling for the West Valley Nuclear Service Center in Western NY. Most recently he has become a subject matter expert on the application of small unmanned aerial systems (sUAS) for mapping applications that will enhance this project with high resolution mapping updates to support a number of the overall program objectives.

Robert F. Fox, Jr., AIA

Partner, COOKFOX; Co-founder, Terrapin Bright Green LLC

Proposal Role & Responsibility: Proposal preparation

Project Role & Responsibility: Project Manager, NYMH

Bob Fox is a highly respected leader in the green building movement, whose work has advanced ideas of urban sustainability and design excellence. His projects have set new precedents in scale and strategic impact, establishing him as an influential voice in the architectural profession, the business community, and in service to the public sector. First LEED Platinum skyscraper, Bank of America Tower, NY Founding Chairman, GSA Green Building Advisory Committee US Green Building Council Leadership Award

Allison Bennett

Terrapin Bright Green LLC, Research Analyst and Graphic Designer

Project Role & Responsibility: Content Research and Development, NYMH

Allison Bennett currently works as a research analyst and public relations coordinator for Terrapin Bright Green. She graduated summa cum laude from Washington University in St. Louis with a double major in architecture and biology. Allison's interests focus specifically on architecture, sustainability and bio-inspired innovation. She received the Fitzgibbon Scholarship, a full-tuition, merit scholarship awarded to one incoming freshman architecture student from Washington University. She also is the co-author of Tapping into Nature, a paper by Terrapin which highlights current examples of bio-inspired products and illustrates the market potential of a biologically-inspired approach to innovation.

Resumes - Bard Graduate Faculty and Students

Dr. Gautam Sethi

Project Role & Responsibility: Supervision of Graduate Student Research

Environmental and Natural Resource Economics, econometrics. Currently lead project evaluation scientist for a NYSERDA-funded program assessment through ENERGIZE NY. Dr. Robyn Phillips: Biophysical aquatic processes and lake management. Dr. Jennifer Phillips: land-based processes, biogeochemical cycling and climate change. Victor Tafur, JD: Environmental Law. Ben Houston, MS: Geographic Information Systems.

Katherine Hipple

MBA. Bard MBA

Proposal Role & Responsibility: Reviewer

Project Role & Responsibility: Lead on micro hydro Project Finance

Katherine Hipple is a founding partner of Noosphere Marketing, where she works with mission-driven organizations, financial services and tech firms to communicate – and advance -- their ESG initiatives. While teaching Finance at Bard's Sustainable MBA, Kathy infuses sustainability and regenerative capitalism into a traditional finance curriculum. Prior to launching Noosphere, Kathy had an extensive background on Wall Street, working with international institutional clients at Merrill Lynch, and in local search, where she ran a NYC-based media company with nearly 200 employees and \$35 million in revenues and served on the national board of the Local Search Association. Kathy is a founding member of the Generative Council, a group of women leaders in the for-profit and not-for-profit sector.

Jennifer Shelbo

Candidate, MBA in Sustainability, Bard College, May 2017

Proposal Role & Responsibility: market research

Jennifer Shelbo is a first year student in the Bard MBA in Sustainability program. She earned her undergraduate degree at Northeastern University - BS in Business Administration, with a concentration in Finance. She has worked in finance as a research analyst and in hospitality as an Executive Pastry Chef in multiple fine dining establishments in New York City.

Resumes - Off Campus Support

Dr. Kevin T. Shanley

Assistant Professor of Engineering, School of Science & Engineering, SUNY New Paltz

Project Role & Responsibility: consultation, course integration, expert liaison for NYMH

Dr. Kevin T. Shanley earned a B.A. in Engineering from Saint Michael's College, B.S. in Mechanical Engineering from Clarkson University, M.S. in Applied Physics from UMass Boston, and a Ph.D. in

Mechanical Engineering from Clarkson University. He has worked as a Manufacturing Engineer at IBM, and Design Engineer at Rolls-Royce. Dr. Shanley's work has earned him a Graduate Fellowship from the EPA and promotion to the Aerothermal Professional Leadership Scheme at Rolls-Royce. A longtime member of the ASME, Dr. Shanley was selected for the Early Career Leadership Internship to Serve Engineering (ECLIPSE) in 2013. He currently holds the position of Assistant Professor of Mechanical Engineering at SUNY New Paltz and a Faculty Research Fellowship with the U.S. Department of Energy.

Dr. Jerry Selvaggi

Professor of Engineering, School of Science & Engineering, SUNY New Paltz

Project Role & Responsibility: consultation, course integration, expert liaison for NYMH

Dr. Jerry Selvaggi is a visiting associate professor at SUNY New Paltz and a consulting electric Power Engineer. He previously worked as a research professor for about 7 years at Rensselaer Polytechnic Institute where he received his PhD in Electric Power Engineering in 2006. He has over 27 years of experience as a consulting engineer in electric power. His current consulting work includes industrial power design, mechanical system design, and magnetic design. His current research interests include electromagnetic modeling of electromechanical devices such rotating machines and transformers. He also develops mathematical models of large electric power systems specifically related to power system stability, analysis and control as well as comprehensive fault study analysis.

Gretchen Stevens

BS, Hudsonia

Proposal Role & Responsibility: Proposal development

Project Role & Responsibility: Plant Surveys

Gretchen Stevens has 35 years of experience in Hudson Valley and northeastern botany, habitat analysis, wetland science, environmental planning, project management, GIS habitat mapping and analysis, and training environmental decision makers in the public and private sectors. She worked for an environmental consulting firm for 9 years prior to her 26 years with Hudsonia. Gretchen is director of Hudsonia's Biodiversity Resources Center which promotes the protection of species, habitats, and ecosystems by placing good biological information in the hands of agencies and individuals most involved with decisions pertaining to resource development and conservation. She curates the Bard College Field Station Herbarium, and manages the Hudsonia GIS laboratory. Gretchen coauthored (with E. Kiviat) the Biodiversity Assessment Manual for the Hudson River Estuary Corridor (NYSDEC 2001)—a standard reference for land use and conservation analysis in the Hudson Valley. She has also authored or coauthored numerous articles, scientific papers, and technical assistance reports on conservation biology topics. Gretchen and Erik directed a stream bank restoration project on the Saw Kill in Annandale for Montgomery Place

Robert E. Schmidt

PhD, Faculty, Bard at Simon's Rock (retired)

Proposal Role & Responsibility: proposal development

Project Role & Responsibility: Fish Surveys, emphasis on American Eels

Bob Schmidt has conducted research on stream, lake, and estuarine fishes since the 1970s and has worked on Hudson River tributaries and their biota for more than 35 years. He has had a particular research interest in American eel and other fishes in the Saw Kill and Tivoli South Bay (into which the Saw Kill flows). He also taught undergraduates at Bard College at Simon's Rock for 30 years, as well as teaching graduate courses at Fordham University and Bard. Bob served on graduate committees for MS and PhD students at Fordham, Bard, Queens College, and SUNY ESF. He is currently Adjunct Curator at the New York State Museum (Fishes) and Associate Director of Hudsonia Ltd. as well as a director of the Berkshire Environmental Research Center. Bob has been studying and publishing papers on Hudson River fishes for many years, concentrating on migratory species and invasive species.

About the Partners

Saw Kill Watershed Community

sawkillwatershed.wordpress.com

The Saw Kill Watershed Community was formed to unite people who reside and work in Milan, Red Hook, Rhinebeck, and Annandale-on-Hudson and are interested in the protection and management of the Saw Kill and its watershed. The group is made up of farmers, scientists, students, educators, sportsmen, historians, conservationists, municipal leaders and other interested parties.

Current Hydro

www.currenthydro.net

Current Hydro, a green technology startup in New York, develops ultra-low impact, hydropower projects. These projects consider the biotic environment first and foremost. The company's commercial mission is the installation of micro hydro distributed energy resources that will produce near carbon-free electricity safely for the next fifty years.

GroundPoint Technologies LLC

www.groundpointllc.com

GroundPoint offers topographic mapping, digital photogrammetric and airborne laser scanning, to the development of spatial analytics. In that way it supports a range of environmental management and modeling objectives and the application of small unmanned aerial systems (sUAS) for mapping applications. These programs will enhance this project with high resolution mapping updates to support a number of the overall program objectives.

Renewables First

www.renewablesfirst.co.uk

Working in the UK, the Republic of Ireland and overseas, Renewables First are engineering consultants and project delivery experts. The company specializes in hydro and wind power. Their whole-project capability enables them to take projects from initial feasibility, through design and permitting and on to construction and commissioning. Their focus is on quality and performance, ensuring a completed project will operate reliably and efficiently into the future. They have a 10-year successful track design/build/operate micro hydro record throughout the UK.

Bard Water Lab

www.bard.edu

The BW Lab provides standard and cutting-edge water quality analyses on citizen-based sampling. Beginning in May 2016 the BWL will be serving the Saw Kill Watershed Community (18 sites, once a month) and the Roe-Jan Community (10 sites, once a month). Analyses are provided at cost, are processed by student interns, and are faculty monitored.

Bard Center for Environmental Policy - Bard CEP

www.bard.edu/cep

Bard CEP is a graduate program in which students gain MS degrees in Environmental Policy or in Climate Science and Policy. Bard students can also pursue an undergraduate/graduate program leading to both BS and MS degrees in five years. The core faculty at the Bard CEP represents strengths in environmental economics, political science, aquatic science, and land surface processes. Bard also offers an MBA in Sustainability, one of a select few programs worldwide that fully integrates a social and environmental mission into a graduate business curriculum. Faculty in the MBA program offer expertise in project finance, business strategy, entrepreneurship, and the integration of sustainability into business decision-making .

Bard CEP courses delve simultaneously into curricular themes (science, economics, policy, law) so that students gain a deep understanding of the issues from multiple perspectives. This multi-disciplinary approach also highlights linkages and divisions across disciplines. This holistic approach illuminates integral connections between the social world and the physical sciences.

Environmental and Urban Studies Program (EUS)

eus.bard.edu

Both biogeophysical systems and human societies (cultures, economies, political regimes) are nested complex systems involving numerous interactions. Environmental and Urban Studies (EUS) is a transdisciplinary program that examines the interdependence of human societies and the physical environment. The program strives to ensure that majors have a solid background in the physical sciences,

the humanities, and economics and policy. They should understand what sustainability means in the real world. We aim to enhance students' understanding of the complexities of environmental and urban issues and their awareness of interrelationships between built and "natural" environments.

Project Impact

GHG emissions

The project will generate an estimated usable 544,480 kWh per year from the Lower Saw Kill site and the Annandale (upper) site generators. We have assumed a system/turbine efficiency of 75%, a generator efficiency of 90%, a local line loss of 3% and equipment downtime of 7%. The annual average generation rate of both locations combined is estimated to be approximately 62 kW. The Bard campus will consume 100% of the electricity generated by the project's three sites, offsetting an equal amount of utility delivered power. Peak output is expected in the month of March and will reach up to 350 kW of continuous electricity generation.

The annual GHG emissions offset by the project were calculated using EPA methodology for metric tons of equivalent carbon dioxide (CO₂e). The Bard electric power supply emission rate (as avoided) was assumed to be equal to the non-baseload emissions rate for the EPA eGRID 2012 Northeast Power Coordinating Council (NPCC) Upstate New York (NYUP) Subregion. Grid line losses were also calculated using the eGRID 2012 average gross loss percentage of 9.17% for Eastern United States. Application of this factor to our generation estimate results in an avoidance of 599,450 kWh generated from utility sources.

CO₂e values were calculated using Global Warming Potential (GWP) values published by the IPCC for CO₂, CH₄ and N₂O. Based on these assumptions, we are estimating that the electric power that Bard College consumes from the utility grid (as delivered) has resulted in emissions of greenhouse gases at the rate of 0.00056 metric tons CO₂e/kWh. It is worth noting that this value calculated for upstate NY is lower than the nationwide average for non-baseload emissions published by the EPA of 0.00069 metric tons/kWh.

Once the three hydro sites on the Bard campus pass ecological safety standards, the new facilities would have a CO₂e emission avoidance of 335 metric tons (739,000 pounds CO₂e) on an annual basis.

Of note, the kilowatt hour production from the two sites will represent 2.5% of Bard's current electricity consumption of 20,000 MWh. By replicating the above generation performance to a wider New York state cadre of approximately 4000 micro hydro sites through the NYMH project, NY could avoid emitting approximately 1,341,000 metric tons of CO₂e annually.

The 2015 State Energy Plan sets a goal to obtain 50% of the state's electricity from clean sources by

2030, reducing emissions by 40% from 1990 levels. Governor Cuomo’s Reforming the Energy Vision (REV) strategy and the Clean Energy Standard (CES) have committed state resources and efforts to meet these goals through market-based initiatives to build industry and capacity for the generation of clean, locally sourced, distributed power. The Bard hydroelectric project and NYMH project is a viable way to take steps toward this goal using proven technology and existing natural landscape features.

As the recently-approved Clean Energy Fund (CEF) framework is implemented, NYMH can be a trusted partner for coordinating and tracking micro hydro projects and power generation projects. It will function as a tool and resource for businesses and consumers within the market development portfolio of the CEF.

Replicability

The New York Micro Hydro Project will be Bard College’s primary means of communicating lessons learned, research and best practices relating to small scale hydropower in an institutional setting. All project materials would be available in an open source format through NYMH. NYMH will provide the resource for industry stakeholders, NYSERDA and landowners. It will create a network for the sharing of contacts at engineering firms, financing entities, ecological assessment services and equipment suppliers.

A key part of the Saw Kill project will be an in-depth Hudsonia study of the ecological impact of the installation. This result will provide a detailed case study for use in justifying other projects statewide. Additionally, the project team from the Lower Saw Kill project will be available to engage with other institutions desiring to use their own watershed hydro resources.

The THurST Research Network has indicated the “work has proposed is especially suited to our growing network of academic institutions who are involved in watershed-level research and management on waterways along the Hudson River Estuary. Our current members represent waterways with many dams that could benefit from the nature-first, community-centered approach of Bard’s proposed NYMH program.

Metrics

The project team will track achievement toward project goals in three broad metric categories: economic, environmental and social.

Economic

- Annual savings to Bard college (avoided purchase of kwh)
- Overall annual savings attributable to other NY Hydro Project sites (\$)
- Return on investment for Bard College (\$)
- Volume of private sector investment (\$)

Environmental

- Total clean, renewable electricity generated (kwh)
- Total GHG emissions reduction (annual tons)
- Water quality on Saw Kill at two monitoring sites (temperature, conductivity, pH, dissolved oxygen, water level, turbidity, and bacterial loading)
- Water quantity and flow study
- Water quality data availability at other NY sites
- Count of American eels passed, and other biological indicators as determined by Hudsonia

Social

- Number of Colleges who receive direct BardCEP stakeholder engagement
- Number of new projects in NY state attributable to NY Hydro Project
- Reduction of peak grid usage by Bard College
- Number of stakeholder contacts available on NYMH website

Resiliency

The proposed microgrid distribution design will supply power to select Bard facilities in the event of a utility grid power loss. At peak capacity, the hydroelectric system will generate approximately 3% of Bard College's peak electricity demand. One potential candidate to receive consistent microgrid power from the Lower Saw Kill project is the campus Wastewater Treatment Plant (WWTP). This facility that demands up to 24kW could remain in an operating condition through most parts of the year, even during a power loss. This would decrease reliance on backup forms of distributed generation such as diesel generators. Keeping the Bard College WWTP operational during storm events will decrease the amount of overflow and runoff into nearby waterways.

Additionally, the Stevenson Athletic Center is designated as a disaster relief shelter for local community. Ensuring a consistent supply of electric power to these facilities is a priority both to Bard College and local municipal governments.

The Lower Saw Kill project would be an "anti-fragile" system, one that increases in capacity during a period of stress or disorder. Power loss events are commonly associated with storms and other extreme weather events with resultant rainfall. Increased rainfall in the Saw Kill watershed will increase the project's power generation capability up to its peak output level. With a properly designed microgrid, the Lower Saw Kill project would have the capability provide portions of the Bard campus with electricity in event of a power loss. Additionally, it would reduce the draw on the local utility grid, reducing grid stress and increasing resilience during extreme events.

Economic Development

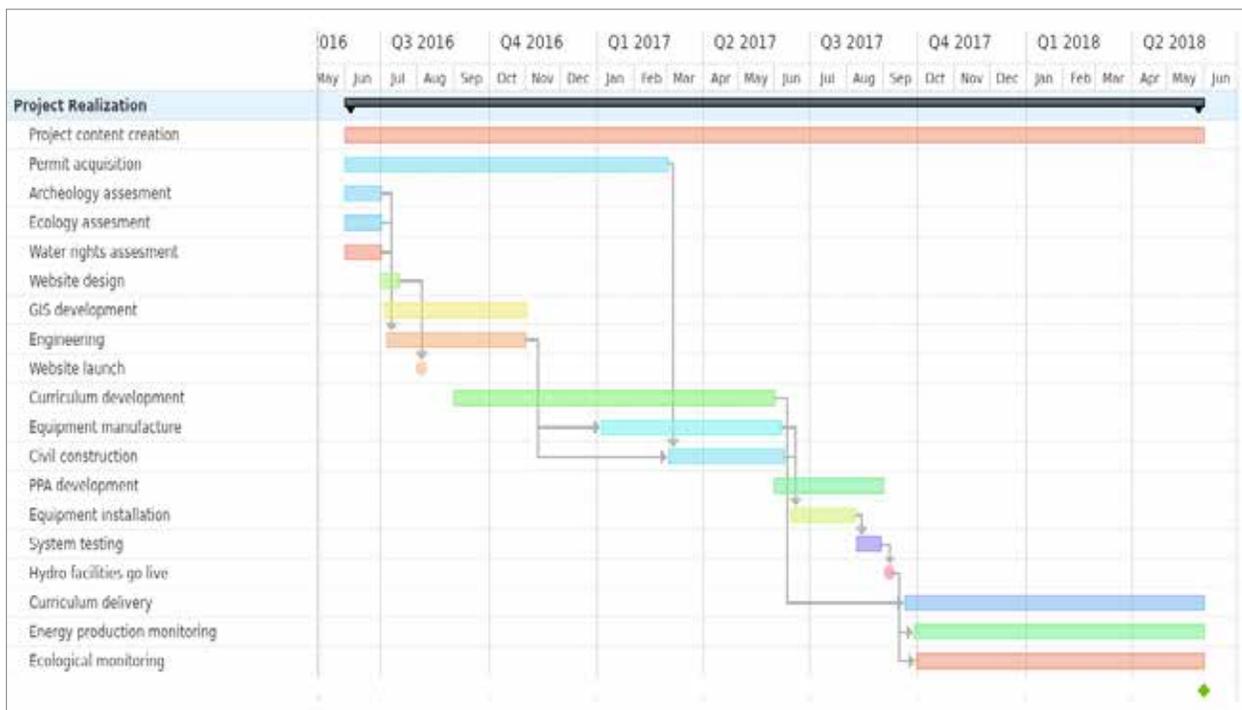
The economic development effects of the Saw Kill project will be limited due to its size and nature. It is inherently a system that should require only limited maintenance and basic operations control. However, there will be business opportunities for engineering firms, contractors and equipment suppliers involved directly in the installation.

On a larger scale, the NY Hydro Project is intended to multiply the economic effects of the Saw Kill project by fostering its replication throughout the state of New York. Thus our micro project should have macro implications.

Project Viability

Timeline

We have a two year timeline. We are challenging ourselves with an aggressive goal of obtaining federal, state, and local permits and licenses (or exemptions from licensing) within nine months from project launch. Indeed, one of the content products of our work under the grant will be documenting inefficiencies in the permitting process as well as how the process can be streamlined on subsequent micro hydro projects. The first version of the NYMH will launch within one month of project initi



Work to date

As part of developing this project, we have had stakeholder conversations with the FERC Manager in charge of licensing in our region, staff from NYS Dam Safety Office and the NYSDEC Hudson River Estuary Program, State Historic Preservation Office (SHPO), dam owners including three private dam owners, two historic dam property owners, and faculty members from Siena College, West Point, and New Paltz.

The College took ownership of the two dams on January 16, 2016. As preparation for dam ownership, the College submitted a grant to the NYSDEC Hudson River Estuary Program in December 2015 entitled “Feasibility Study for the Alteration or Removal of the Saw Kill Dam to Restore Connectivity on the Saw Kill Creek” This is mostly an engineering study, and includes stakeholder outreach. It would enhance our ability to analyze the corridor for a better understanding of options.

We have reserved the NYMH site: newyorkmicrohydro.org

We have secured commitment from Bard College as well as civic and community stakeholders

- Leon Botstein, President, Bard College
- Bard Center for Environmental Policy & Bard MBA in Sustainability
- Bard Water Lab, SKWC, THurST
- Renewables First LLC
- Hudsonia
- State Senator Sue Serino
- State Assemblyman Kevin Cahill
- County Executive Marcus Molinaro
- County Legislator Micki Strawinski
- Historic Red Hook
- SUNY New Paltz

NYSERDA Award Enablement

On March 30, we received a notification from the NYSDEC Dam Safety Office about outstanding issues necessary to bring Annandale Dam into compliance. In the absence of this project award, we will proceed to make the safety changes required by the Dam Safety office (which includes a request for the removal of trees and stream-side vegetation that currently provides habitat).

However, the award allows us to apply a sustainability lens to the Saw Kill watershed to answer critical questions that will go unanswered: “What are the best solutions that address the needs of all stakeholders involved?” and “How can we efficiently and effectively teach others based on our scientific and commercial experience?” Bard is experiencing first hand what thousands of private dam owners are faced with. Only with the help of NYSERDA can we be equipped to help solve this problem for others.

Barriers and Challenges

According to the International Energy Agency “In order to achieve its considerable potential for increasing energy security while reducing reliance on electricity from fossil fuels, hydropower must overcome barriers relative to policy, environment, public acceptance, market design and financial challenges.”

Dams can have a negative connotation as concerns over the use of hydropower have grown in past decades . What is the impact on fish and stream life? Will water flow be reliable? Will rivers become silt-filled? It is time to change the conversation to one that is more measured and factual, which this project aims to achieve. While removal is relevant at some dam sites, there will be many for which power generation is a more appropriate approach.

A major barrier to installation of hydro power is the Federal Energy Regulatory Commission (FERC) process: micro hydro projects are subject to federal regulations. That means the owners get less energy for each dollar they invest in getting the federal exemption and dealing with other regulations. This federal permit can take years and includes multiple agency approvals. Even with President Obama’s 2015 easing of restrictions on hydropower, and the exemption process, developers are leery of moving forward on smaller power production possibilities due to the investment of time to get permits and the associated cost of studies. Our project design with enhanced monitoring overcomes this barrier. Our partners are crucial in creating trust and expediting the permit acquisition. We are intentional inefficiency with our project proposal and the thoroughness of our ecological review. If we are setting up a model process, we would rather ‘over study’ the Saw Kill to identify issues that have not been evaluated to date for lack of funding. As we learned from a FERC workshop on expediting their process – if you do your homework, you can get it done in nine months. We have factored into our plan thoroughly doing our homework.

According to the Nature Conservancy and the DEC, dam removal is a policy priority. When we first approached these stakeholders, their reaction was that there was a conflict between our project and their goals. In several off the record conversations, we were able to reach that “aha” moment when they saw that our larger goals are aligned. Of the more than 6,600+ dams, not all can or should be removed. We are contributing to their ability to prioritize which dams should be removed, which should be powered, and in general, how to enhance fish passage and water quality monitoring at the sites where power is preferred to removal. By creating a mechanism for open information sharing, we will be able to overcome perceived conflicts.

A recent conversation with a member of the DEC reminded us that power is sometimes needed for fish passage. Our source said: “Recently, the NYSDEC has been experimenting with low-cost ‘eel-ladders’ to capture then pass eels at derelict dams in tributaries to the Hudson. These devices siphon water from the upstream head pond to the ladder downstream of the dam. The siphon system relies on gravity and requires no energy to supply water to the ladder. However this requires a minimum elevation difference between the ladder and the surface of the head pond. Many dams do not have enough ‘head differential’ to provide sufficient siphon to supply an eel ladder. In these situations, external power would be required to pump water to the eel ladders. Placement of micro-hydro power devices at derelict dams could provide the power necessary to pump water to the eel ladder. The pump could be set on a timer to run only when

eels are migrating.

Multi-year droughts in the western United States have caused problems for hydro power. But in New York climate change is predicted to increase the intensity and frequency of precipitation. In fact, a study of a nearby watershed by Bard geophysicist Gidon Eshel confirmed this regional assessment in a paper entitled "Recent Southern NY Climate Change: Observations, Mechanisms and Spatial Context" 2016.

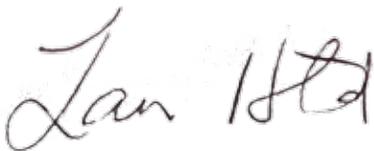
In the unlikely event that hydropower is not a viable alternative for either Bard dam, there are many candidates waiting for the technology, including the third dam site on the Saw Kill, which has a potential of 30 kw. Additional feasibility study work can be performed at the 326 sites within a 22-mile radius of Bard or dams within the watershed of our colleagues at SUNY New Paltz or THruST members.

Conclusion

The 6,680 dams in New York State have an uncertain future, but the current trajectory is clear: many will be ignored, removed, fail in storms and slowly fall apart. For the dams that can stand for another 100 years, our project turns these liabilities into assets and allows the deployment of ultra clean energy in a dispersed pattern across New York State. A member of the DEC recently expressed his feelings - that he would like to see more happening at these dams sites than DEC can accomplish alone. Our team has the entrepreneurial vision, the community ties, regulatory relationships and the work ethic to identify the opportunities and to dive in to this energy source.

We believe our project offers an exciting solution for implementing an innovative clean energy project that provides **energy efficiency, a source of renewable energy, and a significant reduction in greenhouse gas emissions.**

Respectfully submitted.



Laurie Husted
Bard Office of Sustainability
Bard College
husted@bard.edu

Appendix

Letters of support



March 25, 2016

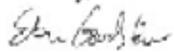
Roseanne Viscusi
RFP 3214, NYS Energy Research and Development Authority
17 Columbia Circle
Albany, NY 12203-6399

Dear Ms. Viscusi:

It is my pleasure to provide this letter in strong support of the **Bard Micro Hydro Power Project: *Identifying the Pathway to Distributed Energy Resources Standardization***. I direct Bard's Graduate Programs in Sustainability, including MS degree programs in Environmental Policy and Climate Science and Policy, and an MBA in Sustainability. Our graduate faculty and students stand ready to take advantage of the research and practical opportunities arising from the grant implementation.

In particular, our policy program will contribute by developing a model for community and stakeholder engagement in micro-hydro development decisions, in a way that can effectively balance ecological, community and power needs. At the same time, our MBA program will use data from the project to explore the business case for micro-hydro implementation beyond Bard, including private financing options. Lessons learned through these and other research activities will be shared across the state via the New York Dam Project—to be staffed in part by our graduate students-- that is an integral part of the overall Bard proposal.

With thousands of small dams in New York state alone, and through modeling an integrated approach to development, the Bard Micro Hydro Power Project has the potential to catalyze a significant shift to distributed hydro-powered electricity generation.

Sincerely,


Director, Bard Graduate Programs in Sustainability

BARD COLLEGE, P.O. Box 5000, Ellettsburgh Road, Annandale-on-Hudson, New York 12598-5000
tel 845.754.7601 fax 845.754.7454 email reg@bard.edu web www.bard.edu

Appendix: Letters of support



Hydro and Wind Consultancy, Design & Installation
Securing a clean energy future, profitably

To whom it may concern,

I am pleased to offer this letter of support for the NYSERDA Energy to Lead Competition proposal presented by Bard College. Renewables First Ltd is happy to collaborate with Bard College and Current Hydro LLC on what promises to be an innovative project with wide-reaching positive impacts across New York State.

Renewables First has been providing technical consultancy, design, consenting and installation expertise to hydro and wind projects since 2002 and holds a market-leading position, providing engineering advice across the UK and internationally.

One of the founding principles of Renewables First is that we offer a whole-project capability from initial feasibility, through the consenting and design stages, onto installation and commissioning and the ongoing operational support. This means that our staff need to have a wide range of skills to cover the breadth of services we offer. Our team of 20 full-time staff is primarily based at our head office in Gloucestershire, UK, and includes experienced Chartered Engineers, younger engineers working towards chartership, graduate engineers and apprentices, plus consenting specialists integrated with the engineering team.

Our hydro project experience includes detailed design and project management of more than 40 run-of-river projects from initial conception through to installation and operation. Our focus was initially on smaller projects with a power output of 5 – 20 kW and has gradually expanded to deliver projects up to 500 kW. In total we have provided consultancy on hundreds of schemes across a wide range of scales, including technical due diligence services for MW-scale systems.

Hydropower rests firmly in trusted, reliable designs and engineering principles which have been used for hundreds of years, but innovation is also essential to maximise the benefits of these systems in the present day. Our aptitude for performance and innovation has been recognised by the prestigious Institute of Civil Engineers (ICE) which recently awarded Renewables First various regional awards including Sustainability Award 2015, Project of the Year 2015, Community Project Award 2015 and Project of the Year 2014.

Please see below and attached for full details of our project experience and key staff profiles.

Yours faithfully,

Philip Davis
Managing Director



Renewables First Ltd
The Mill, Brimscombe Hill
Brimscombe
Stroud, Glos. GL5 2QG
Phone: +44 (0)1453 88 77 44
Fax: +44 (0)1453 88 77 84
Email: info@renewablesfirst.co.uk
Web: renewablesfirst.co.uk

© Renewables First Ltd 2015 Company Registration Number: 6975396 VAT Number: GB 975 8598 37

Appendix: Letters of support



COUNTY OF DUTCHESS

MARCUS J. MOLINARO
COUNTY EXECUTIVE

March 23, 2016

Roseanne Viscusi
RFP 3214
NYS Energy Research and Development Authority
17 Columbia Circle Albany
NY 12203-6399

Re: Bard College and the REV Campus Challenge Energy to Lead Competition

We are pleased to support Bard College's application to the NYSEDA Reforming the Energy Vision competition to improve New York's distributed renewable energy generation capacities through the implementation of micro hydropower on their existing dams on the Saw Kill. This project will reduce greenhouse gas emissions and enhance resiliency, while protecting and enhancing the ecology and history of the area. We feel their project and the replication model they will create have positive implications for the local community, New York State, and beyond.

The project aligns with the core values of the REV Campus Challenge "to encourage the sharing of ideas, best practices, and lessons learned amongst institutions of higher education, identify gaps and barriers to clean energy implementation, and provide the targeted resources and professional connections institutions need to succeed." They will create a blueprint for a model process that will enable the replication of this project at other existing New York dam sites. There are more than 6700 of these dams across New York State. The initial pre-qualification and categorization of possible sites is already taking place through a student-led GIS initiative.

The College recently purchased the historic 380-acre Montgomery Place Estate, which brought the dam and Saw Kill within their borders. This hydropower restoration project represents an effort that is both respectful of the past while bringing New York into a more carbon friendly future.

Sincerely,

Marcus J. Molinaro
Dutchess County Executive

22 Market Street, Poughkeepsie, New York 12501 • (845) 486-2000 • Fax (845) 486-2021
www.dutchessny.gov

Appendix: Letters of support



THE ASSEMBLY
STATE OF NEW YORK
ALBANY

KEVIN A. CAHILL
Assemblymember 103rd District

CHAIR
Assembly Insurance Committee

COMMITTEES
Ways and Means
Economic Development, Job Creation,
Commerce & Industry
Ethics and Guidance
Health
Higher Education

March 24, 2016

Roseanne Viscusi
NYS Energy Research and Development Authority
17 Columbia Circle
Albany, New York 12203-6399

Re: RFP 3214

Dear Ms. Viscusi:

I am writing to express my support for Bard College's application to the NYSERDA REV competition to improve New York's distributed renewable energy generation capacities through the implementation of micro hydropower on their existing dams on the Saw Kill. The College recently purchased the historic 380-acre Montgomery Place Estate, which brought the dam and Saw Kill within their borders. This project will reduce greenhouse gas emissions and enhance resiliency while protecting and enhancing the ecology and history of the area.

As former Chair of the Energy Committee and a strong supporter of renewable energy, I recognize that their project and the replication model they create will have positive implications for the community, New York State and beyond. The project aligns with the core values of the REV Campus Challenge "to encourage the sharing of ideas, best practices, and lessons learned amongst institutions of higher education, identify gaps and barriers to clean energy implementation, and provide the targeted resources and professional connections institutions need to succeed." They will create a blueprint for a model process that will enable the replication of this project at other existing New York dam sites. There are more than 6,700 dams across New York State. The initial pre-qualification and categorization of possible sites is already taking place through a student-led GIS initiative.

This hydropower restoration project represents an effort that is both respectful of the past in that it will use the neglected dams rather than destroying them, while bringing New York into a more carbon friendly future. I urge your strong support and consideration of this timely and worthy endeavor.

Sincerely

Kevin A. Cahill

Appendix: Letters of support



March 9, 2016

Roseanne Viscusi
RFP 3214
NYS Energy Research and Development Authority
17 Columbia Circle
Albany, NY 12203-6399

Re: Bard College and the REV Campus Challenge **Energy to Lead Competition**

On behalf of the 250-plus members of Historic Red Hook, we are pleased to support Bard College's application to the NYSERDA REV competition to improve New York's distributed renewable energy generation capacities through their proposed micro hydropower project on their dam on the Saw Kill.

In our opinion, the Bard project is a thoughtful, inclusive model for Red Hook that can demonstrate to other dam owners throughout the state what can be done to move to a practical, affordable and clean energy future with existing technology and dam infrastructure.

We look forward to working with Bard College, our members, neighbors and friends throughout Red Hook and Northern Dutchess County to protect the ecology and history of our area, while reducing greenhouse gas emissions.

Respectfully,

A handwritten signature in black ink, appearing to read "Claudine Klose".

Claudine Klose
President, Historic Red Hook

PO BOX 397 RED HOOK | NEW YORK 12571-0397 | TELEPHONE: 845 758 1920 | HISTORICREDHOOK.ORG

Appendix: Letters of support



Hudsonia

PO Box 5000, Annandale, NY 12504
Phone: (845) 758-7053
Fax: (845) 758-7033
www.hudsonia.org

a nonprofit institute

Roseanne Viscusi

April 1, 2016

RFP 3214
NYS Energy Research and Development Authority
17 Columbia Circle
Albany, NY 12203-6399

Dear Laurie,

This letter expresses Hudsonia's commitment to working as a subcontractor on the Bard College Saw Kill micro-hydropower project. (It should be noted that this is the Dutchess County – Town of Red Hook Saw Kill; there are other Saw Kills in other counties that are not directly addressed in the Bard proposal.)

The hydropower project is important because new turbine technologies, and the push for development of renewable energy sources, will combine to stimulate small scale hydropower development on many tributaries to the Hudson River estuary and other New York State streams. It is critical to analyze the impacts of micro-hydropower on fish and other biological resources, and devise design and implementation approaches to minimize those impacts while efficiently capturing energy from streams.

The location of Bard College and Hudsonia on the Saw Kill afford us with some background and baseline information, as well as a wealth of talent that can appropriately be applied to the questions at hand: is this a good stream for micro-hydropower using existing dams (or their modifications), what types of turbine installations are cost effective and ecologically sensitive, what biodiversity does the stream support and how can this be fostered while generating electricity efficiently? Now that Bard has acquired the Montgomery Place property across the Saw Kill, the entire lower Saw Kill from Route 9G to the Hudson River is bordered by college property and the use of the stream for monitoring and hydropower is institutionally more straightforward.

Hudsonia has long experience and strong skills in biological studies of streams and estuaries. We enthusiastically participate in the Bard proposal to NYSERDA, and we look forward to working with you on this project.

Sincerely,

Erik Kiviat PhD
Executive Director

Appendix: Letters of support

Dutchess County Legislature
22 Market Street, Poughkeepsie, NY 12601
845-486-2100 Fax 845-486-2113

March 3, 2016

Roseanne Viscusi
RFP 3214
NYS Energy Research and Development Authority
17 Columbia Circle Albany
NY 12203-6399

Re: Bard College and the REV Campus Challenge **Energy to Lead Competition**

I am pleased to support Bard College's application to the NYSERDA REV competition to improve New York's distributed renewable energy generation capacities through the implementation of micro hydropower on their existing dams on the Saw Kill. This project will reduce greenhouse gas emissions and enhance resiliency, while protecting and enhancing the ecology and history of the area. I feel their project and the replication model they will create have positive implications for the local community, New York State, and beyond.

The project aligns with the core values of the REV Campus Challenge "to encourage the sharing of ideas, best practices, and lessons learned amongst institutions of higher education, identify gaps and barriers to clean energy implementation, and provide the targeted resources and professional connections institutions need to succeed." They will create a blueprint for a model process that will enable the replication of this project at other existing New York dam sites. There are more than 6700 of these dams across New York State. The initial pre-qualification and categorization of possible sites is already taking place through a student-led GIS initiative.

The College recently purchased the historic 380-acre Montgomery Place Estate, which brought the dam and Saw Kill within their borders. This hydropower restoration project represents an effort that is both respectful of the past while bringing New York into a more carbon friendly future.

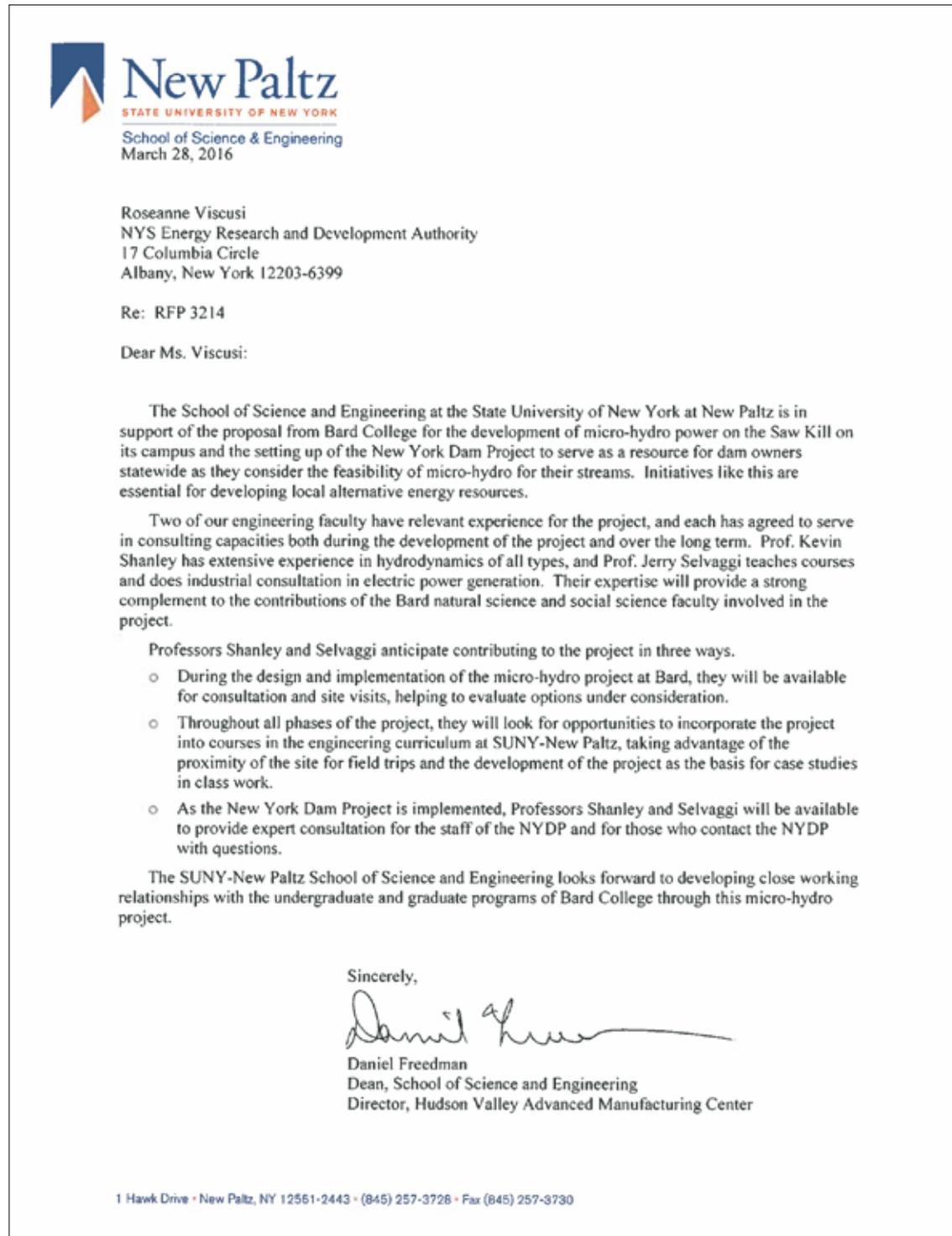
Sincerely



Micki Strawinski, Dutchess County Legislator
District 20 – Red Hook

countylegislature@dutchessny.gov
www.dutchessny.gov

Appendix: Letters of support



Appendix: Letters of support

<p><u>CHAIR</u> AGING <u>COMMITTEE MEMBER</u> CHILDREN & FAMILIES CULTURAL AFFAIRS, TOURISM, PARKS RECREATION EDUCATION HIGHER EDUCATION INSURANCE JUDICIARY MENTAL HEALTH & DEVELOPMENTAL DISABILITIES</p>	<p>THE SENATE STATE OF NEW YORK</p>  <p>SUSAN SERINO 41ST District</p>	<p><u>ALBANY OFFICE</u> ROOM 812 LEGISLATIVE OFFICE BUILDING ALBANY, NEW YORK 12247 (518) 455-2945 FAX: (518) 426-6770</p> <p><u>DISTRICT OFFICE</u> 4254 ALBANY POST ROAD HYDE PARK, NEW YORK 12538</p> <p><u>SATELLITE OFFICE</u> PUTNAM CO. SENIOR CITIZEN CENTER 1ST FLOOR PUTNAM VALLEY, NEW YORK 10579</p>
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March 31, 2016

Ms. Roseanne Viscusi
RFP 3214
NYS Energy Research and Development Authority
17 Columbia Circle
Albany, NY 12203-6399

Re: Bard College and the REV Campus Challenge *Energy to Lead Competition*

Dear Ms. Viscusi:

I am writing to you to express my absolute support for Bard College's application to the NYSERDA REV competition to improve New York's distributed renewable energy generation capacities through the implementation of micro hydropower on their existing dams on the Saw Kill. As a representative of a district that depends heavily on its natural resources, I am always looking for innovative ways to encourage our young people to get involved in identifying solutions for providing clean energy.

This project will reduce greenhouse gas emissions and enhance resiliency, while protecting and enhancing the ecology and history of the area. I believe the project is a win-win for all involved. It will not only challenge students to develop creative ideas to identify gaps and barriers to clean energy implementation, but it will provide the targeted resources and professional connections institutions need to succeed.

This project will help our future leaders to embrace their role in building a healthier environment and a stronger economy. They will create a blueprint for a model process that will enable the replication of this project at other existing New York dam sites. With over 6,700 of these dams across New York State, there is real potential to capitalize and build on this important project.

The College recently purchased the historic 380-acre Montgomery Place Estate, which brought the dam and Saw Kill within their borders. This hydropower restoration project represents an effort that is both respectful of the past, while bringing New York into a more carbon friendly future.

With Bard's long history of success in our community and beyond, I am confident in their ability to deliver results. I hope that you will look favorably upon their application, and I thank you for your time and consideration.

Sincerely,


Sue Serino
New York State Senator
41st District

SS/nj

Appendix: Letters of support

Bard College

Office of the President

March 29, 2016

Roseanne Viscusi
RFP 3214
NYS Energy Research and Development Authority
17 Columbia Circle Albany
NY 12203-6399

Re: Bard College and the Reforming the Energy Vision (REV) Campus Challenge:
Energy to Lead Competition

As the first college to sign on to the REV Campus Challenge, and as a Charter signatory to the Second Nature Carbon Commitment, Bard College has demonstrated its commitment to reducing the emissions of harmful greenhouse gases to zero and to mitigating our impact on climate change. I am therefore pleased to support our submission to the NYSEDA REV competition to improve New York's distributed renewable energy generation capacities through the implementation of "run of river" micro hydropower on one or both of our existing dams on the Saw Kill River which can serve as a model for replication at some of the 6,600 other non-powered dams that exist across New York State.

The project allows the College to innovate in four areas: project design, business model, innovative partnerships, and curricular integration. Bard faculty have invested heavily in understanding the Saw Kill watershed and are in a unique position to identify and to overcome barriers to the implementation of this type of renewable energy. Faculty members in the graduate and undergraduate programs, including the Environmental & Urban Studies Program, Physics, Biology, and the Arts are committed to this project. Bard continues to embrace the challenges of the 21st century: to develop and implement plans that advance clean energy in innovative ways while respecting the embedded history, culture, and ecology of our landscape.

Cordially,



Leon Botstein
President

PO Box 5000, Annandale-on-Hudson, NY 12504-5000
Phone 845-758-7423 Fax 845-758-0815 E-mail president@bard.edu

Appendix: Letters of support

BARD*A College of the Liberal Arts and Sciences**Division of Science, Mathematics, and Computing*

March 23, 2016

Roseanne Viscusi
 RFP 3214
 NYS Energy Research and Development Authority
 17 Columbia Circle
 Albany, NY 12203-6399

Re: Bard College and the REV Campus Challenge **Energy to Lead Competition**

Dear Ms. Viscusi:

I am pleased to provide this letter that describes my interest in and support for the **Bard Micro Hydro Power Project: Identifying the Pathway to Distributed Energy Resources (DER) Standardization (Bard Hydropower)** proposed by Bard College. In my role as Interim Leadership Team Member of the Saw Kill Watershed Community (SKWC) and Director of the Bard Water Lab (BWL), I am confident that this proposed project will strengthen community efforts to sustainably manage important water resources and has the potential to greatly expand our knowledge of understudied waterways in the Hudson Valley and beyond.

The goal of the SKWC is the protection of our precious water resource, and an important part of that process is creating long-term stewardship plans for existing dams on the Saw Kill. Bard's proposed approach to micro-hydropower will provide important and holistic understanding of our watershed and the current role that existing dams play. The option of micro-hydropower (and accompanying aquatic connectivity and water quality monitoring features) for those dams where removal is not feasible is unique and potentially transformative. We appreciate being formally included in the study process as stakeholders and being included in stakeholder communications. We will continue to include the topic of dam stewardship in our planning sessions, and will gladly participate in stakeholder meetings conducted by Bard Hydropower.

The Bard Water Lab, which is currently serving the Saw Kill and **Rocloff Jansen** watershed communities in monitoring water quality and watershed health, will be a strong site for managing and analyzing water quality data generated through micro-hydro projects installed through this proposal. Studies generated to evaluate micro-hydro projects can expand our understanding of water quality and quantity in understudied waterways feeding the Hudson River. Participation in the New York Hydropower Project will help us to advance in our mission to connect watershed communities through science-based stewardship.

Sincerely,



M. Elias Dueker
 Saw Kill Watershed Community Interim Leadership Team Member
 Bard Water Lab Director
 Assistant Professor
 Environmental and Urban Studies & Biology Programs

PO Box 5000, Annandale-on-Hudson, NY 12504-5000

Telephone: 845-758-6822

Appendix: Letters of support



April 3, 2016

Dear NYSERDA's REV Campus Challenge Energy to Lead Competition Selection Committee,

As Director of the Hudson River Subwatershed and Tributary (THurST) Research Network, I am happy to support Bard College's proposal, "Micro Hydro, Macro Impact", submitted to NYSERDA's REV Campus Challenge Energy to Lead Competition. This innovative approach to the aging dams issue across New York State has the potential to move the issue of climate change and aquatic connectivity along our waterways to the forefront.

The THurST Research Network is a partnership of Colleges and Universities working in their respective, local watersheds, but using common methodologies, to answer a set of unifying research questions with answers of both scientific and community significance. The work that Bard has proposed is especially suited to our growing network of academic institutions who are involved in watershed-level research and management on waterways along the Hudson River Estuary. Our current members represent waterways with many dams that could benefit from the nature-first, community-centered approach of Bard's proposed New York Micro Hydro (NYMH) program. We are excited to work with Bard to take this approach Hudson River-wide.

Sincerely,

Katherine L. Meierdiercks, Ph.D.
Director, Hudson River Subwatershed and Tributary (THurST) Research Network
Associate Professor, Department of Environmental Studies and Sciences, Siena College
Phone: 518-782-6936
Email: kmeierdiercks@siena.edu