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The Emerging Hydrokinetic Energy Market

An Industry Review of the Early Market Potential

Authors:

Joseph Sweet; (860) 942-4346, joseph.sweet@uconn.edu
Brian Wiessmeyer; bwiessmeyer@tecgraph.com
Lisa Stafford; lisa.stafford@uconn.edu
Katherine Ivey

Connecticut Center for Entrepreneurship & Innovation

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Executive Summary

Hydrokinetics is the term used to describe devices that utilize moving water to generate electricity. Similar to wind turbines and wind speed, a hydrokinetic device's ability to produce electricity is governed by the speed of the water in the waterway. The key differentiation between hydrokinetics and traditional hydro-power is that hydrokinetic technologies do not require dams or other man-made barriers to function properly. These units are often referred to as "in-stream" or "low-impact" solutions for water based power generation. Hydrokinetic technologies have been successfully deployed in rivers, tidal areas, and man-made structures such as pipes, aqueducts and canals. Additionally, many hydrokinetic devices have been designed to survive hostile environments including wastewater treatment facilities, waterways with high salinity, and waterways with debris, aquatic plant, and animal life. The hydrokinetics industry also employs antifouling agents that lower unit maintenance costs while enhancing operational life spans.

While large-scale, fully licensed hydrokinetic projects are few and far between, there have been major developments to accelerate the growth of hydrokinetic technology. Despite the somber economic climate of 2009, the CleanTech industry, which includes renewable energy technologies, has experienced continued growth: Clean-energy technologies grew from 11.4 percent in 2008 to 12.5 percent in 2009 of U.S.-based venture capital investments.[1] Capital infusions also come from government sources. For example, The American Recovery and Reinvestment Act (ARRA) of 2009 provides $787 billion in stimulus money—of which approximately $100 billion will go to CleanTech.[2] CleanTech has been described both as "the greatest economic opportunity of the 21st century" and "too early to invest in…because the economy is still not self-sustaining." [3]

Our report focuses on understanding hydrokinetics within the overlying CleanTech market. We evaluate the hydrokinetics industry based on its potential market segments as well as internal and external challenges. Market segments were identified based on size, customer needs, and technology application. In particular, we discuss nine hydrokinetics market segments key to the short and long-term success of the industry. Segment potential and value to the hydrokinetics industry were measured *via* a model developed around critical success factors (CSFs). CSFs were chosen based on our primary and secondary research including literature reviews, discussions with subject matter experts, and review of the similarly structured wind and solar industries. We continue with an in-depth analysis of three select market segments that highlight model attributes of the nine market segments. Our in-depth reviews utilize a mix of secondary research and primary research from surveying and discussion with industry experts. We also discuss the industry's revenue models; specifically the power purchase agreement (PPA), lease-based revenue model, and direct sales model. We conclude with a detailed discussion of industry specific risks and barriers and the hydrokinetic industry's value in the U.S.'s balanced renewable energy portfolio. In particular, we focus on the regulatory environment and the challenges and opportunities it provides for the hydrokinetic energy industry.

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[1] Bennett, Julie. Are We Headed Toward a Green Bubble? Entrepreneur, April 2010, p. 51-54.
[2] Pernick, Ron and Wilder, Clint. Five Emerging U.S. Public Finance Models: Powering Clean-Tech Economic Growth and Job Creation. Clean Edge, October 2009. p. 2. ©2009 Clean Edge Inc.
[3] Bennett, Julie. Are We Headed Toward a Green Bubble? Entrepreneur, April 2010, p. 51-54.

Under the Federal Power Act, hydrokinetic installations are subject to permitting and licensing procedures mandated by the Federal Energy Regulatory Commission (FERC) if they generate electricity from water that is released into navigable waterways and/or are tied to the national electrical grid. Regardless of the size of the hydrokinetic project, affected state, federal and local agencies may require proof that hydrokinetic devices will not inflict site-specific environmental damage. The potential involvement of sometimes hundreds of different agencies, including but not limited to the U.S. Army Corps of Engineers, U.S. Fish and Wildlife Service, federal land owner agencies, affected Native American tribes, state agency administering Clean Water Act section 401 water quality certification, state land managers, state fish and wildlife agencies, state water resources managers, state and tribal historic preservation offices, state energy facility sitting councils, county commissions, local governments, ports, fishing and crabbing commissions, non-governmental interest groups (environmental, fishing, recreational), public utility districts and investor-owned utilities, private landowners, and cable committees can cause some difficulty in preparing the needed application to FERC.[4]

However, two "exemptions" are available: A 5 MW exemption for sites that generate less than 5 MW of power and are associated with an existing dam site, natural water feature, or an existing utility generating less than 5 MW of power, and a conduit exemption for sites that use manmade structures for industry, agriculture, or municipal purposes. Hydrokinetic installations that fall under a FERC exemption are not free of regulation and contacting various federal, state, and local agencies may still be required, but there is an accelerated FERC licensing process. In terms of projects that fall under one of the two FERC exemptions, it can take FERC 4 to 6 months to review a completed application and a variable amount of time needed to complete the overall application. However, there is currently key legislation moving forward that offers the opportunity to fully exempt hydrokinetic projects less than 1.5 MW that are installed in conduits.[5]

Despite these regulatory hurdles, the hydrokinetics industry continues to grow due to the ability of the technology to provide low-cost, renewable, dependable electricity and a large unsaturated market. Traditional hydroelectric dams currently provide roughly 7% of power in the U.S. Meanwhile the free-flowing waters in U.S. rivers have the potential to create about two times the amount of energy currently generated by dams[6], or an estimated 3,400 MW.[7] Furthermore, this does not take into account the roughly 21,000 publicly wastewater treatment facilities,[8] 79,000 dam tailraces,[9] and 104,000 miles of man-made waterways,[10] that could benefit from the technology.

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[4] Oram, Cherise M., O'Connell, Michael P., and McKinsey, John A. *The Law of Ocean and Tidal Energy,* Chapter 3: Siting and Permitting Ocean and Tidal Energy Projects, Stoel Rives, LLP. p. 1.

[5] H.R. 5922, Small-Scale Hydropower Enhancement Act of 2010 *available at* http://www.govtrack.us/congress/billtext.xpd?bill=h111-5922; Accessed August 3, 2010.

[6] CNBC; http://www.cnbc.com/id/30194554/New_Technology_To_Drive_Hydro_Power_Comes_On_Stream; Accessed June 17, 2010.

[7] Cada, Glenn, et al. Potential Impacts of Hydrokinetic and Wave Energy Conversion Technologies on Aquatic Environments, April 2007, Fisheries, 32, 4: 174-181.

[8] Center for Sustainable Systems; http://css.snre.umich.edu/css_doc/CSS04-14.pdf; Accessed August 2, 2010.

[9] U.S. Army Corps of Engineers, National Inventory of Dams; http://www.agc.army.mil/fact_sheet/nid.pdf; Accessed July 30, 2010.

[10] Aqueduct opportunity estimated based upon web research of aqueducts in Washington, Oregon, California, Idaho, Florida, and New York and an estimated 100,000 miles of large irrigation canals; actual figure is likely to be higher with large aqueducts in Puerto Rico and Midwest locations, albeit it is questionable how much would be usable for a hydrokinetic project. *See* Hydrovolts for irrigation canal figure; http://www.hydrovolts.com/opportunity.htm; Accessed August 2, 2010.

In addition to regulatory issues, there is limited information available to potential customers. In a 2010 nationwide survey (N=528) of state utility, water resource, and environmental protection employees, 87% of respondents indicated that they little to no knowledge of hydrokinetics.[11] This lack of awareness has contributed to some public confusion with conventional hydropower in terms of impact and usage. Traditional hydropower has built a negative public image over the years as a result of high profile projects where damming had detrimental effects on the environment and recreational activities.[12] Thus, some groups have the same environmental concerns regarding hydrokinetic projects that they have for conventional hydropower projects, such as fish passage, changes in fish behavior, impact on water pressure, the blocking of sunlight to riverbeds, and sediment disturbance.[13] The same goes for concerns regarding recreation, including changes in aesthetics, changes in wave or water speeds, wreckage and salvage impacts, displacement to other recreation areas, and effects on recreation-relevant fish and wildlife.[14]

While the hydrokinetic industry faces its own distinctive challenges, the technology remains an important element in the U.S. renewable energy portfolio. Unlike wind and solar technologies, which are held hostage to daily weather conditions, water flow patterns are seasonal and predictable. In addition, water is eight times more energy dense than wind power. Water's energy density combined with its low material and engineering requirements relative to the solar and wind industry make hydrokinetic solutions inexpensive in terms of cost per watt produced. As well, hydrokinetic installations are both physically smaller than equivalent wind and solar installations and can be more easily integrated on a project site.

Federal and state governments have recognized the importance of hydrokinetics and provided backing through several important initiatives. The Energy Independence & Security Act of 2007 signed into law on December 19, 2007 requires, among other things, reduced use of fossil fuels and publicly-funded research of hydrokinetic renewable energy technologies. The American Clean Energy & Security Act passed in the House in 2009 and sets mandatory caps on greenhouse gas emissions. The Clean Energy Jobs & American Power Act was introduced to the Senate on September 30, 2009. It also calls for significant public investment in clean energy research, in addition to reducing carbon emissions and creating jobs centered on clean energy. In order for hydrokinetic companies to become economically viable, continued political support through grant and funding opportunities, streamlined regulations, and sustainability goals are crucial. The hydrokinetic industry must match state and federal efforts with a focus on building public awareness, highlighting the key benefits of the technology, and distancing themselves from conceptions of traditional hydropower. Public and private action together can ensure that water, like wind and solar technologies, will become a cornerstone of the CleanTech industry and the U.S.'s renewable energy portfolio.

[11] Connecticut Center for Entrepreneurship and Innovation, Nationwide Public Works Survey, July 2010.
[12] *See* Robert Righter, *The Battle Over Hetch Hetchy: America's Most Controversial Dam and the Birth of Modern Environmentalism*, Oxford University Press, March 2005.
[13] Manomet Center for Conservation Sciences; Hydrokinetic Energy, October, 2009.
[14] Hydrokinetics and Recreation Work Group. Hydrokinetic Energy Projects and Recreation: A Guide to Assessing Impacts. Public Review Draft, June 2010, 1-103.

Technology

Hydrokinetic technology relies on the flow of water to generate electricity. Unlike conventional hydropower, hydrokinetics does not require damming or diversion in order to tap into the energy stored in the water. Conventional hydropower relies on head to generate electricity, whereas, hydrokinetic technology relies on the velocity of the water to generate mechanical energy. However, this is not to say that some hydrokinetic systems do not deploy some form of diversion or utilize existing damming in order to optimize the power production of their units, or minimize the impact to the environment. In fact, companies like Hydro Green, LLC have used this as an early entry strategy; by using the tail race of existing hydroelectric dams, hydrokinetic units can generate several hundred kilowatts of power and reduce the permitting time by taking advantage of a FERC exemption.[15]

Primarily, the technology falls into three categories: horizontal axis turbines, vertical axis turbines, and an oscillating hydrofoil.[16] Both horizontal and vertical axis turbines have multiple blades on a shaft to form a rotor, and use the velocity of the water to drive a mechanical generator. Conceptually, these forms of turbines are similar to those deployed in wind power. An oscillating hydrofoil uses a hydrologic Bernoulli Effect to generate mechanical energy from lift. However, this is not to say there are not numerous approaches to these categories of power generation. According to the Electric Power Research Institute (EPRI), there have been thousands of concepts and patents filed for various marine, tidal and hydrokinetic technologies.[17] For any of these approaches, the industry has not yet settled on best practices or technology standards. Standardization will likely take years, and customers will have a variety of vendors and customization options to choose from.

Initially, the focus of hydrokinetic technology was for environments with significant water velocity to generate utility scale power. However, the market has broadened and the technology offering has evolved to supply small and micro grid power in low flow environments (i.e. 3 feet or less per second). The lowest recorded flow environments for which hydrokinetic units are capable of generating usable electricity are cut-in rates of 1 foot per second.[18] As a rule of thumb, the higher the velocity in a water system, the greater the amount of electricity generated. However, the overall length and diameter of the unit, as well as the number of turbines, will also play a significant role in the power generation. Overall, most technology offerings are fairly scalable and many can deployed as clusters in order to optimize the energy output according to the given environment.

The number of environments in which hydrokinetic systems can be used will be a function of their anti-fouling capabilities and robustness. While manmade aqueducts and other kinds of conduits provide environments mostly free of debris and with little to no salinity, environments such as desalination plants and the East River of New York have challenged the integrity of hydrokinetic devices. However, many of these obstacles have been overcome as developers have aggressively pursued the market.

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[15] Hydro Green Energy; http://www.hgenergy.com/hastings.html; Accessed August 2, 2010

[16] U.S. Department of Energy; http://www1.eere.energy.gov/windandhydro/hydrokinetic/techTutorial.aspx; Accessed August 2, 2010

[17] EPRI; http://oceanenergy.epri.com/attachments/ocean/reports/Final_MHK_Prioritized_RDD_Needs_Report_123108.pdf; Accessed August 2, 2010.

[18] eGen, LLC was a company identified as offering a hydrokinetic unit with a cut-in rate as low as 1 foot per second, a few other companies such as Hydro Green, LLC and Hydrovolts have materials stating a minimum cut-in rate of around 3 feet per second.

Companies such as Lucid, eGen, and Rentricity have developed products for fairly corrosive environments such as wastewater treatment pipes and feel confident simple annual maintenance will be enough to keep their equipment operational.[19] Mowat Technical Design and Verdant have even gone as far as trying to tame the unwieldy Amazon River with their technology.[20] Additionally, the further development of underwater transmission cables and anti-fouling coatings reduces the likelihood of environmentally-induced equipment failure. However, the lack of a pre-existing power grid may limit this versatility in some instances.

The hydrokinetic industry has seen less logistical concerns than wind power which has suffered from a mismatch between point of need and point of generation. As older communities such as mill towns have relied on steady water flows for decades, it is not difficult to find an adjacent city to a river or stream source. Nor is it hard to find man-made infrastructure such as aqueducts and irrigation canals to help transport water to areas of needs. Off-grid and micro-grid applications for hydrokinetic technologies are numerous; in fact, the technology can help solve the point of need and point of generation problem for many remote villages, such as those in Alaska that have relied on expensive diesel generators or that have simply gone without power. Off-grid usage can also help improve the U.S. water system infrastructure by powering equipment needed for the operation and maintenance of aqueducts, irrigation canals, and other conduits. The technology can even be crafted into a portable solution to allow for recreational usage in camping, fishing, and boating; commercial usage such as in civil engineering; and for the military.[21] Additionally, since many of these systems have twenty-four hour water flow, this makes hydrokinetic technology a more reliable solution than other forms of alternative energies. However, the future scope and size of hydrokinetic projects has conflicting estimates.

Many of the current units demonstrated or sold commercially will likely produce energy in the tens of kilowatts. According to the National Renewable Energy Laboratory (NREL), it will be between 2015 and 2020 when hydrokinetic technology will be commercially available for utility scale energy production of5 MW to 50 MW, while projects exceeding 100 MW will not be available until 2020.[22] On the other hand, some of the companies we interviewed have plans to fully install multi-unit projects exceeding 5 MW of capacity within the next one to two years.[23] There is a question as to whether the technology needs to be further developed to reach this scale, or whether this scale has not yet been achieved due to the regulatory environment.

As discussed in the regulatory section of this paper, many government officials and non-profit environmental groups feel that while the technology is promising, it has not yet been proven to have a negligible effect on the environment. While early environmental studies of Verdant's technology

[19] Company Interviews.
[20] Company Interviews.
[21] Bourne Energy is specifically working on a 500 watt back pack solution. *See* http://gadgets.softpedia.com/news/New-Portable-Backpack-Power-Plant-from-Bourne-Energy-8284-01.html.
[22] Thresher, R. "The United States Marine Hydrokinetic Renewable Technology Roadmap", 13 Apr., 2010. NREL Lab *available at* http://www.oceanrenewable.com/wp-content/uploads/2010/05/1st-draft-roadmap-rwt-8april10.pdf
[23] Confidential Interviews.

showed no evidence of any harm to local fish or wildlife[24] and some people within the industry have stated that the systems may even be beneficial by preserving areas to prevent overfishing, there has been an insufficient number of installations to demonstrate a lack of significant impact to varying ecosystems. However, theoretically speaking, the technology shows promise in being eco-friendly. Most developers have made their turbine blade tips move slower than 40 RPMs in order to minimize harm, and since the technology relies on the unabated flow of the water, it would be self-defeating to clog up the waterway. Additionally, EPRI, U.S. Fish & Wildlife, and other organizations have been doing extensive testing to determine whether various hydrokinetic systems will have a significant impact on fish life.[25]

Through the test of time and demonstrations, the technology will be further analyzed for its effects on sedimentation, attraction of wildlife, disruption of sea beds, and reduction of light to flora. Although it can be safely said that hydrokinetics will have a minimal impact on the ecosystem when compared to conventional hydropower. For manmade conduits without a natural ecosystem, some of the concerns are system clogging and the amount of energy removed from the water. Any point of failure in a wastewater treatment system could have serious repercussions; however, manufacturers have made sure to limit these concerns through the use of back-up pipes in the construction of their systems. In terms of energy removal, it is true that the flow of water will be reduced when a hydrokinetic system extracts energy. However, at this point, the energy removed is negligible enough to the overall energy contained within the water that this should not be a significant concern. In many of these installations, the amount of energy found within the water is in excess of what is needed at the point of extraction.

Regulatory

Subject matter experts from private consulting firms, the Department of Energy, the Department of Fish & Wildlife, private industry, and state agencies all cited regulatory hurdles as a primary barrier to entry into the hydrokinetic market.

The Federal Energy Regulatory Commission (FERC) issues hydrokinetic licenses under the Federal Power Act (FPA). FERC asserted jurisdiction in 2002 over "ocean, tidal, and other hydrokinetic projects pursuant to the FPA, which requires that a non-federal hydroelectric project be licensed if, among other things, it is located in navigable waters of the U.S. and is connected to an interstate electrical grid."[26] In this capacity FERC preempts all state and local laws concerning hydroelectric licensing. The exception is proprietary water rights and state approvals required by federal law. FERC may still, however, demand compliance with state and local requirements that do not make compliance with FERC regulations impossible or unduly difficult and they must still consider state and local concerns.[27] Despite having the right of preemption, we did not find any cases wherein FERC has asserted this right.

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[24] Grist; http://www.grist.org/article/regeneration-roadtrip-cant-fight-the-tides; Accessed August 2, 2010.
[25] Interview with Doug Dixon of EPRI.
[26] Oram, Cherise M., O'Connell, Michael P., and McKinsey, John A. *The Law of Ocean and Tidal Energy,* Chapter 3: Siting and Permitting Ocean and Tidal Energy Projects, Stoel Rives, LLP. p. 3.
[27] Oram, Cherise M., O'Connell, Michael P., and McKinsey, John A. *The Law of Ocean and Tidal Energy,* Chapter 3: Siting and Permitting Ocean and Tidal Energy Projects, Stoel Rives, LLP. p. 2.

FERC first grants a permit and then a license to generate energy from hydrokinetic power. Two exemptions are available: A 5 MW exemption for sites that generate less than 5 MW of power and utilize either an existing dam or natural water feature for head or increases the capacity for a facility generating less than 5 MW of power, and a conduit exemption for sites that use manmade structures for the purpose of industry, agriculture, or municipal purposes. An exemption, however, does not preclude the necessity for a great deal of leg work in obtaining a permit. While the review of an application by FERC may only take 4 to 6 months, Bob Bell of FERC explained that there could be a number of agencies to consult with in order for FERC to issue any permit or license and these agencies vary as a function of location.

The Law of Ocean and Tidal Energy, a Stoel Rives, LLP publication details the complex governmental permitting requirements and procedures that developers must navigate. Relevant agencies include

> …numerous federal, state, tribal, and non-governmental entities charged with or having substantial interest in laws, regulations, and programs regulating hydropower facilities, water quality and in-water discharges, state and federal lands located beneath the sea, coastal resources and marine sanctuaries, underwater and other cultural resources, shipping and navigation, crabbing and fishing, endangered and threatened species, marine mammals, migratory birds and seabirds, and recreation and public safety, among other things.[28]

FERC provides the framework within which all agency approvals must be obtained. "In addition to FERC, relative agencies and stakeholders include:

- U.S. Army Corps of Engineers
- U.S. Coast Guard
- National Marine Fisheries Service
- U.S. Fish and Wildlife Service
- Federal land owner agencies
- Affected tribes
- State agency administering Coastal Zone Management Act
- State agency administer Clean Water Act section 401 water quality certification
- State land managers
- State fish and wildlife agencies
- State water resources managers
- State and tribal historic preservation offices
- State energy facility siting councils
- County commissions
- Local governments
- Ports
- Fishing and crabbing commissions
- Non-governmental interest groups (environmental, fishing, recreational)

[28] Oram, Cherise M., O'Connell, Michael P., and McKinsey, John A. *The Law of Ocean and Tidal Energy,* Chapter 3: Siting and Permitting Ocean and Tidal Energy Projects, Stoel Rives, LLP. p. 1.

- Public utility districts and investor-owned utilities
- Private landowners
- Cable committee."[29]

In 2007 FERC, in an effort to streamline permitting and data collection, announced a Pilot Project Policy. Pilot project licenses reduce regulatory hurdles for technologies that are "(1) small (5 MW or less), (2) removable or able to be shut down on relatively short notice, (3) not located in waters with 'sensitive designations,' and (4) for the purpose of testing new technologies or determining appropriate project sites."[30]

While FERC's Pilot Project Policy has made hydrokinetic unit testing easier, a possible repercussion of FERC's policy is the "hoarding" of permits. A representative of a New England hydrokinetics company expressed frustration at the number of pilot permits that have been issued. His feeling was that there was a "gold rush" of permitting activity after EPRI put out a sustainable power report and that many of these permittees were hoarding permits with the intent of selling them. He also felt, however, that FERC has been diligent in investigating all permit holders and that roughly one-third of these original permits have been revoked due to lack of progress. EPRI was contacted to obtain an opinion on this point. The EPRI employee interviewed could not think of a relevant publication but did agree that many companies do obtain permits without the requisite technology to actually develop the site. He thought that the "gold rush" described was most likely due to a change in the FERC pilot project permitting process. He explained that permits allow for three years to develop a project, conferring exclusive rights to develop that site during that timeframe.

Despite the Pilot Project Policy, one consultant, a pioneer in the hydrokinetics consulting area, still expressed great frustration in appeasing the large number of state, federal, and local agencies in order to receive a permit as many do not wish to grant approval of a project without preliminary data. Her job is to help companies get through the FERC permitting and licensing process. She expressed the feeling that FERC is not difficult to deal with but rather that FERC takes a backseat approach to helping a hydrokinetics company navigate the various state and local authorities required to finalize a permit. She also explained that there is no set list of agencies that must be consulted. Furthermore, FERC does not recommend what studies must be done in order to appease agencies. For these reasons, companies often hire a consultant with both environmental and regulatory expertise. In addition, she stated that under some circumstances hydrokinetic companies might require millions of dollars over the course of many years in order to complete the FERC permitting process. She also indicated that a conduit exemption is not always an easy route. in that a large number of local, state, and federal agencies must be consulted, all of whom are likely to be dubious that the respective technology will not have an environmental impact.

[29] Oram, Cherise M., O'Connell, Michael P., and McKinsey, John A. *The Law of Ocean and Tidal Energy,* Chapter 3: Siting and Permitting Ocean and Tidal Energy Projects, Stoel Rives, LLP. p. 1.
[30] Oram, Cherise M., O'Connell, Michael P., and McKinsey, John A. *The Law of Ocean and Tidal Energy,* Chapter 3: Siting and Permitting Ocean and Tidal Energy Projects, Stoel Rives, LLP. p. 4.

A New England company employing this same consultant indicated that FERC itself does not make permitting an arduous process. Rather, the company spokesperson stated the difficulty lies in negotiating with the large number of federal, state, and local agencies. This representative felt that the agencies were using dams as a playbook because "when folks think of hydro, they think of dams." Due to the negative public image that the dam industry has acquired, this representative felt that the agencies are misjudging hydrokinetic technologies and making the process more difficult than it should be.

Conversely, a representative of a national environmental group has found that groups tend to distrust FERC, as the perception is that FERC is inclined to use their federal preemption to side with the applicant. Additionally, smaller government agencies tend to be wary of FERC, as some regulatory agents have stated that once the project is approved, FERC will not bear any liability for the impact caused by the project or help mediate any of the potential issues created by the permittee. These diverging opinions exemplify the ambivalence between the various stakeholders and highlight the need for companies seeking to permit and license hydrokinetic projects to be proactive in beginning the process.

While targeting conduits such as irrigation canals and water to cooling towers may save time and money in permit acquisition, there is no guarantee as each site is different and may be under the control of different federal, state, and local agencies. In addition, to obtain the conduit exemption, the conduits and the areas around it must be either owned or leased by the applicant.[31] This requirement could force start-up firms to sell their technology to the site owner with a maintenance plan or entering a licensing agreement, as opposed to directly selling the electricity, which has the potential to be more profitable.

An executive from a larger player in the hydrokinetics market voiced similar complaints regarding significant regulatory hurdles. His company started applying for permits in 2007 and hopes to have these permits approved by the end of 2012. Out of their twenty-five employees, they have five to ten working at least part-time on regulatory issues. He described the regulatory process as incredibly arduous and involving at least the following steps:

1) Preliminary approval documents
2) License pre-filing
3) Develop a study plan through diligence— took the company all of 2009
4) Get study plan determination
5) Disputes submitted
6) Resolve disputes with panel
7) Revise study plan.

A third consultant went into some detail regarding the number and types of environmental studies which may be necessary to survive the permitting and licensing process. He also confirmed that these will vary as a function of site and the agencies overseeing that site. Environmental studies to appease local, state, and federal agencies may include fishery surveys to identify fish behaviors including

[31] Interview with Bob Bell, Small Hydro Coordinator at FERC.

migratory, mating, feeding and how these behaviors might change due to the presence of hydrokinetic turbines. Fishery studies also identify the potential presence of any endangered species. Fish safety in the presence of turbines must also be investigated. One method is to attach balloons to fish and send them through the turbines. Following passage through the turbines, the balloons are inflated so the fish rise to the surface and can be analyzed. The Electric Power Research Institute (EPRI) is about to begin pilot-scale studies to evaluate fish safety and changes in behavior in the presence of low-blade-tip-speed turbines. Two flumes have been set up wherein the fish are released into the turbines, tracked *via* radio telemetry, and recaptured for evaluation. EPRI reached out to the entire hydrokinetic community and received responses from New Energy and Lucid. These tests will be done by the end of the year.

Fish are not the only endangered species that must be considered. For example, an application for ten turbines generating a total of 350 kW of power in Mason County, West Virginia and Gallia County, Ohio cites four federally threatened and endangered species, three of which are mussels and one bat species. The Office of Environmental Policy and Compliance under the U.S. Department of the Interior provided FERC with specifics including the habitat of the threatened and endangered species and a list of environmental consultants qualified to collect data related to any potential threats from the turbines.[32]

Recently Alaska Power & Telephone (AP&T) received a temporary permit to install a 25 kW hydrokinetic turbine in the Yukon River in Eagle, Alaska—population forty. While it is anticipated that this turbine will displace one-third of the diesel that currently powers the generators in Eagle, the representative from AP&T also indicated that the time and capital expense that went into the acquisition of the permit made this installation cost-prohibitive and thus solely for the benefit of improving the environment. This project also would not have been possible without a federal Department of Energy (DOE) grant. AP&T has also partnered with the University of Alaska at Fairbanks to complete the comprehensive list of environmental studies necessary for both permitting and licensing: fish studies—kills and changes in migration patterns, water temperature changes, and changes in water flow including pressure changes both in front of and behind the turbines. In addition, prior to installation, side scans and sonar studies were necessary to determine current fish activities and migration patterns in the area.

A National Renewable Energy Laboratory publication, "The United States Marine Hydrokinetic Renewable Energy Technology Roadmap," released on April 13, 2010, by Dr. Robert Thresher goes into more detail regarding the number and scope of environmental studies that may be necessary to complete the permitting and licensing processes. Dr. Thresher explains that environmental studies must include a baseline study prior to installation, a construction impact study, and post-construction impact studies. Studies may include observation of the following parameters:

1) Benthic Surveys
    a) Benthic organisms such as plants, algae, invertebrates, and fish
    b) Bottom geology such as sediment and rocks
    c) Scour protection

2) Water Column Surveys

[32] Robert C. Byrd Hydrokinetic Project, FERC No. 13442-000; Mason County, West Virginia and Gallia County, Ohio; http://edocket.access.gpo.gov/2009/E9-15897.htm; Accessed August 3, 2010.

a) Fish
b) Habitat
c) Mammals
d) Birds
e) Invertebrates
f) Turtles
g) Noise
h) EMF

3) Water Quality Surveys
a) Chemical

As stated by experts within the U.S. Department of Fish & Wildlife, these studies are to alleviate concerns with any untested technology that is going to be introduced into a marine environment. Typical concerns with hydrokinetics include:

- Mortality rates
- Altered migration and attraction of fish
- The impact to commercial and recreational fishing
- Alteration of river bottom habitats, including sediment deposits on muscle beds
- Sedimentation on navigation channels requiring an increased level of dredging by the U.S. Army Corps of Engineers
- Alteration of hydraulics and hydrologic regimes
- Diving birds and alterations to migratory birds habits
- Secondary electrical fields
- Toxicity of paints and other chemicals
- Noise pollution
- The compound rate of any unit when multiple units are deployed.

Figure 1 below explains these concerns in more detail.[33]

[33] Cada, Glenn, et al. Potential Impacts of Hydrokinetic and Wave Energy Conversion Technologies on Aquatic Environments, April 2007, Fisheries, 32, 4: 174-181.

Environmental issue	Brief description of the issue
Alteration of river/ocean bottom habitats	Bottom habitats will be altered by securing the device to the bottom and running power cables to the shoreline. Moving parts (rotors) and mooring systems could affect bottom habitat during operation. Device may create structural habitat in open waters. Structures may obstruct movements/migrations of aquatic animals.
Suspension of sediments and contaminants	Deployment and operation may disrupt sediments and buried contaminants and increase turbidity. Erosion and scour may occur around anchors, cables, and other structures.
Alteration of hydraulics and hydrologic regimes	Movement of the devices will cause localized shear stresses and turbulence that may be damaging to aquatic organisms. On larger scales, extraction of energy from the currents may reduce the ability of streams to transport sediment and debris, cause deposition of suspended sediments and thereby alter bottom habitats.
Strike	Fish and other aquatic organisms, diving birds, and mammals may be struck by moving parts of the devices (e.g., rotors). Large mobile animals may become entangled in submerged cables.
Impingement on screens	Screens used to protect the machine or to reduce strike could themselves injure aquatic animals.
Effects of electromagnetic fields	Electromagnetic fields associated with all of these devices may attract, deter, or injure aquatic animals.
Toxicity of paints and other chemicals	Paints, cleaners, hydraulic fluids and chemicals used to control biofouling may be toxic to aquatic plants and animals.
Noise	Noise during construction and operations may attract, deter, or injure aquatic animals.
Effects of multiple units	Effects on hydrologic regimes, sediment dynamics, and strike determined for single machines may be very different than a full deployment of dozens or hundreds of machines.

Figure 1. Environmental concerns relating to hydrokinetic power. [Fisheries, April 2007]

Another parameter that must be considered is the period of time over which testing must be completed. That is, studies should be completed during all seasons and at times of the year that correspond to migration and other behaviors of the aquatic life in a particular locale. Furthermore, a control site is often necessary to appease regulatory agencies. The industry refers to these studies as BACI studies: "before, after, control, impact." Environmental issues are discussed in more detail in the *Political & Social* section of this paper.

The challenge of fulfilling regulatory requirements in order to obtain the necessary permits and licenses to operate presents a significant barrier to entry into this market. The environmental studies in particular are cumbersome in that they take a great deal of time, are expensive, and have no set format or list of studies that must be completed—type and scope vary by site. As such, it is not surprising that one executive with a hydrokinetic power company confirmed that sites are chosen for ease in conducting environmental studies. For example, his company chose a series of river sites as all the sites fell into the same ecosystem so environmental studies could be bundled and there was only one endangered species within the region. Similarly, this logic also leads other companies to pursue options such as adding hydrokinetic turbines to existing dams and targeting manmade waterways to avoid extensive environmental studies that are both time consuming and expensive. It should be stressed, however, that a pioneering consultant in this field explained that even in the case of manmade waterways it is difficult to convince local, state, and federal agencies that there is no environmental impact so the consultation process with the relevant agencies in order to get a preliminary FERC permit can still be significant. While a primary area of concern is aquatic life, agencies are also concerned with issues such as temperature changes in the water and subsequent effects on the ecosystem.[34]

In particular, some companies such as Hydro Green Energy, LLC have looked into "piggy backing" off of an existing hydroelectric dam. The regulatory advantage is that instead of applying for a new permit,

[34] Confidential Interview, 2010.

the project can be included through the "under 5 MW off an existing dam" exemption (i.e. "the piggyback exemption") or an amendment to the existing permit held by the dam holder.[35] However, this would have to be agreed upon with the pre-existing permittee (in the case of a pre-existing project) or the owner of the land and the dam, and the exemption or the amendment process, while shorter than a new permit, follows similar procedural hurdles. The secondary advantage is that the hydroelectric dam owner is already experienced with the topography and ecosystem for his existing site and will have experience in the permitting process. Thus, while many hydrokinetic companies are focused on fully exploiting the conduit exemption, there seems to be a lack of appreciation that hydroelectric dam owners have already underwent the FERC process and would likely have to expend less resources and have a lesser need for outside know-how in applying for a "piggyback exemption" than say an irrigation district having to apply for a conduit exemption. What is not completely clear due to lack of historical data is whether the length of time between the application and the granting of a conduit exemption is any longer or shorter than a "piggyback exemption." One possibility is that many hydrokinetic companies believe that hydroelectric dam owners would simply not be interested in the lower-end power generation offered this early in the market, and that the demand of this particular brand of customer will come as the technology can increase its output capacity.

As the regulatory environment evolves, the "piggyback exemption" may further include offshore wind projects so that fully-submerged hydrokinetics may be coupled with a floating barge or standing pole of a wind turbine, to further augment the potential fast track market obtainable through an exemption. The primary driver in such an amendment to existing law would be in states like Rhode Island that are placing a large focus on offshore wind, and garnering large federal support in modifying federal laws (complemented by a cooperative change in state law) in order to promote the development of offshore wind.[36]

Regardless of the project type, complexity, and timeline, project proponents and stakeholders may choose to enter into settlement agreements with relevant agencies in order to alleviate concerns associated with the project. Terms and conditions may be included in the FERC project license. Examples of terms and conditions include specific minimization and mitigation measures, monitoring, and adaptive management. Terms and conditions may also fall outside the license and would therefore not be enforced by FERC.[37]

The race is on: technologies have been developed by many small firms and inventors and a few larger companies. Commercialization is currently underway; however, in addition to significant technical and regulatory hurdles, developers are also confronted with social, political, and economic challenges

[35] FERC Exemptions from Licensing; http://www.ferc.gov/industries/hydropower/gen-info/licensing/exemptions.asp; August 3, 2010.
[36] Ocean Tech Expo 2010, speech by Gov. Donald Carcieri
[37] Oram, Cherise M., O'Connell, Michael P., and McKinsey, John A. *The Law of Ocean and Tidal Energy,* Chapter 3: Siting and Permitting Ocean and Tidal Energy Projects, Stoel Rives, LLP. p. 2.

Social

Hydrokinetic technology is a relatively new sustainable energy source in comparison to wind and solar, and thus is not as firmly established in the public consciousness. During our survey of public water resource facilities, only 13% of respondents were familiar with hydrokinetic technology. Those who are looking to become more sustainable are typically looking to solar and wind because they have become more established in the market. For example, solar power panels have already been installed at twenty-eight Wal-Mart and Sam's Club stores.[38] Additionally, Sam's Club will be the first U.S. retailer to run a store with its own wind power from seventeen micro wind turbines mounted on light posts in a Palmdale, California, store's parking lot, according to TreeHugger.com.[39] In addition, a Wal-Mart store in Worcester, Massachusetts plans to install a wind turbine this month, May 2010.[40] Similarly, the Honorable Don Carcieri, governor of Rhode Island recently spoke about the search for sustainable energies in Rhode Island and indicated that a panel had found that off-shore wind made the most sense for Rhode Island.[41] The solidity that solar and wind have in the mindset of the public is an obstacle with which hydrokinetics must compete. However, this is not to say that solar and wind have been found to be a more practical solution than other renewable technologies, just better established in public awareness. For example in the waste water treatment industry, while solar and wind were more heavily considered by publicly owned waste water treatment plants (WWTPs), methane & biomass technology had a stronger adoption rate. This is primarily because WWTPs valued a renewable technology that could be more easily adopted into their existing infrastructure, as opposed to, being a bulky add-on within their limited space. We also observed a similar practice in the Maine pulp & paper industry where many facilities utilized their existing biomass. Of the roughly fifty paper companies contacted, all not only filled their own electricity needs through biomass conversion, but were also able to sell electricity back to the grid. Additionally, these two industries saw a real value in the reliability in the power production of methane & biomass technologies when compared to solar and wind technologies. This seems to suggest that the reliability and ease of integration of hydrokinetic technologies in rivers and streams, waste water treatment plants, irrigation systems, dams, water discharges, and other water resource facilities would deliver a strong value proposition when the public becomes better aware of the technology and its benefits. In particular, the running water in rivers nationwide has the potential to create an estimated 3,400 MW.[42] However, the communal nature of some natural water resources can create some tension with different organizations.

For river and stream installations, hydrokinetic technologies utilize a resource that is generally considered part of the "commons." Due to this feeling of shared ownership of water resources combined with the lack of knowledge regarding hydrokinetic technology and its impact, there are a number of groups that are highly suspicious of hydrokinetic power. This is exacerbated by the negative public image inherited by the hydropower industry—colloquially referred to as dams. Since hydroelectric dams currently provide roughly 7% of power in the U.S., they are the more well known

[38] Iconoculture, Comprehensive Consumer Insights; http://www.iconoculture.com/; Accessed May 25, 2010.
[39] Treehugger; http://www.treehugger.com/; Accessed May 1, 2010.
[40] Wal-Mart Stores; http://walmartstores.com/pressroom/news/; Accessed May 1, 2010.
[41] Speech by Rhode Island Governor, Don Carcieri, Ocean Tech Expo, Providence, R.I.; May 26, 2010.
[42] Cada, Glenn, et al. Potential Impacts of Hydrokinetic and Wave Energy Conversion Technologies on Aquatic Environments, April 2007, Fisheries, 32, 4: 174-181.

technology in the water power space. Dams have earned a bad reputation for harming the environment by disrupting the natural water flow leading to deleterious effects on birds and aquatic life and also for the flooding of human habitats. However, applying this negative image seems somewhat misguided as hydrokinetic technology does not require the damming, the diverting or flooding of water. The primary issue various groups have with hydrokinetic technologies are the unknowns surrounding potential impacts. Groups that question the impact of hydrokinetic power fall under two broad categories: environmental groups and recreational groups. Environmental groups include The Sierra Club, American Rivers, The Hydropower Reform Coalition, and The National Great Rivers Research & Education Center, while recreational groups tend to include less-organized locals with concerns regarding fishing, kayaking, swimming, canoeing, and general recreational use.

Environmental Impacts

Environmental concerns regarding hydrokinetic technologies include fish passage; change in fish behavior due to presence of the turbines, noise from the turbines, or electromagnetic waves emanating from the turbines; damage to aquatic life; and changes in the ecosystem due to changes in water pressure near turbines; blocking of sunlight to the floor; and sediment disturbance.[43] The primary concerns with fish include prevention of fish passage and fish kills and changes in food availability, competition, predation, reproduction, and recruitment. However, Hydro Green's recent testing of fish passage through their turbines has shown strong promise with a 99.998% fish survival rate.[44] The effects of eventual decommissioning of these units must also be considered. Recent reports by both the Department of Energy (DOE), in response to the Energy Independence and Security Act of 2007,[45] and the Manomet Center for Conservation Sciences[46] address environmental concerns relating to installation of hydrokinetic devices. Potential environmental effects are summarized by the DOE in Figures 2 and 3 below.[47]

[43] Manomet Center for Conservation Sciences; Hydrokinetic Energy, October, 2009.
[44] http://www.hgenergy.com/Final%20Fish%20Study%20Release.pdf
[45] U.S. Department of Energy, Energy Efficiency & Renewable Energy, Wind and Hydropower Technologies Program: Report to Congress on the Potential Environmental Effects of Marine and Hydrokinetic Energy Technologies, December 2009.
[46] Manomet Center for Conservation Sciences; Hydrokinetic Energy, October, 2009.
[47] U.S. Department of Energy, Energy Efficiency & Renewable Energy, Wind and Hydropower Technologies Program: Report to Congress on the Potential Environmental Effects of Marine and Hydrokinetic Energy Technologies, December 2009.

Possibility that the issue will require further investigation: ▲ = low | ▲▲ = medium | ▲▲▲ = high*

Issue	Potential effects on the physical and biological environment				
	Physical environment	Animal behavior	Individual injury & mortality	Population-level effects	Community- & ecosystem-level effects
Alteration of currents and waves	Current velocities or wave heights reduced in proportion to the size and number of units; possible changes to mixing, circulation, and water quality ▲▲	Changes in animal behavior resulting from alterations of currents, waves, circulation patterns, and water quality ▲	Likely not applicable ▲	Alterations of plant and animal populations from changes in hydrodynamics ▲▲	Alterations of plant and animal communities from changes in hydrodynamics ▲▲
Alteration of bottom substrates, sediment transport, and sediment deposition	Increased sediment deposition due to slower currents and smaller waves ▲▲	Behavioral responses to changed substrates and sediment dynamics ▲	Injuries or mortalities from gradual changes in substrate composition and dynamics ▲	Changes to plant and animal populations from changes in substrates ▲▲	Changes to plant and animal communities in vicinity of altered bottom substrates ▲▲
Alteration of benthic habitats	Habitat changes for bottom-dwelling plants and animals due to altered current velocities and sediment transport and deposition ▲▲	Avoidance of unsuitable habitats by some species and attraction by other species ▲▲	Mortality of sessile organisms during project installation ▲	Population declines in vicinity of the project for some species and population increases for other species ▲▲	Changes in plant and animal communities in response to altered substrates ▲▲
Noise	Additional noise in the environment from installation and operation ▲	Avoidance of areas with highest noise levels. Possible masking of animal communications and echolocation ▲▲	Hearing damage or mortality of marine animals near pile-driving activities and from operational noise ▲▲	Population level effects for marine mammals and sea turtles ▲▲	Changes to plant and animal communities from operational noise ▲▲
Electromagnetic fields (EMF)	New electrical and magnetic fields in the water and sediments near generating devices and electrical cables ▲	Altered feeding behavior, migration, reproduction, or susceptibility to predation of animals near the project ▲▲	Injuries and mortalities from the predicted electrical and magnetic field strengths ▲	Population-level impacts from effects on behavior and long-distance migrations ▲▲	Alterations of animal communities from effects on behavior and long distance migrations ▲▲

* The color code and triangles are intended to indicate the possible need for further investigation of an issue as part of siting and licensing a project. These are not recommendations that studies of a particular environmental issue should or should not be conducted for any given site or technology. Rather, they are intended to help the reader see general patterns across all technologies and locations.

Figure 2. Summary of potential impacts to the aquatic environment from installation and operation of marine and hydrokinetic renewable energy technologies. [Source: U.S. Department of Energy, 2009]

Possibility that the issue will require further investigation: ▲ = low | ▲▲ = medium | ▲▲▲ = high*

Issue	Effects on the physical and biological environment				
	Physical environment	Animal behavior	Individual injury & mortality	Population-level effects	Community- & ecosystem-level effects
Chemical toxicity	Releases of contaminants from oils and other operating fluids and anti-biofouling coatings ▲▲	Effects on behavior from released contaminants, except for avoidance of oil spills ▲▲	Toxicity to plants and animals exposed to contaminants; potential bioaccumulation of metals and other compounds ▲▲	Effects on local plant and animals populations from toxicity to individuals ▲▲	Effects on local communities and ecosystems from population-level changes ▲▲
Interference with animal movements and migrations	Creation of new structures and sensory stimuli on the bottom and in the water column ▲	Entanglement, obstruction, or avoidance by some organisms; attraction of some species to new habitat or sensory stimuli ▲▲▲	Injury and mortality associated with entanglement and increased predator activity; decreased injury and mortality if fishing is reduced ▲▲▲	Increases because of additional structures and reduced fishing; Declines from entanglement, predation, and interference with migrations ▲▲	Net effect of avoidance and attraction mechanisms and between population enhancements and declines ▲▲
Strike	Rigid, moving structure and possible cavitation near rapidly moving blades ▲	Ability of animals to sense and avoid strike may alter the potential for damage ▲▲	Injury and mortality from blade strike, impingement, and exposure to cavitation ▲▲▲	Changes to animal populations from strike mortality ▲▲	Effects on communities and ecosystems from strike mortality ▲▲
Ocean Thermal Energy Conversion (OTEC) operation	Transfer of large volumes of water between ocean depths; alteration of nutrients, water temperatures, dissolved solids, and dissolved gas concentrations; addition of biocides ▲▲▲	Effects on behavior; animals may avoid discharge plume and intakes ▲▲	Injury and mortality from entrainment, impingement, and temperature shock; toxicity of biocides ▲▲▲	Alteration of plant and animal populations from individual mortalities and avoidance of the project area ▲▲	Alteration of communities and ecosystems from mortalities, avoidance of the project area, and productivity changes ▲▲

* The color code and triangle are intended to indicate the possible need for further investigation of an issue as part of siting and licensing a project. These are not recommendations that studies of a particular environmental issue should or should not be conducted for any given site or technology. Rather, they are intended to help the reader see general patterns across all technologies and locations.

Figure 3. Summary of potential impacts to the aquatic environment from installation and operation of marine and hydrokinetic renewable energy technologies, continued. [Source: Department of Energy, 2009]

A representative from American Rivers who is familiar with hydrokinetic energy is reluctant to express approval of projects to FERC as he is wary of the environmental impact. Even though he says that hydrokinetic power seems to be more benign than dams in that the river is not diverted, there is still a lot of uncertainty. In addition, he finds the antagonistic relationship between FERC and various state and local agencies concerning. His experience has been that no one trusts FERC. American Rivers as a whole is concerned about the technology also; that is, do the turbines really work? The feeling is that there is the potential for better alternatives to fossil fuels and that just because you have a river does not mean you should use it for power. Also while smaller projects may seem to pose little risk, organizations are concerned as to what will happen when the technology is scaled up. These concerns are voiced by both other environmental groups and citizens alike. However, there are some within American Rivers that are open to the idea of testing pilot projects and developing the technology in conduits such as waste water treatment pipes and irrigation canals to determine how much of an impact will be made when a utility-scale project is installed.

Christine Favilla with the Sierra Club expressed similar concerns, indicating that each project has to be considered individually. The Sierra Club has many concerns regarding ecosystem impact including: (1) How will the turbines affect trophic relationships and specific substrates in the sediments; (2) The potential for erosion during construction; (3) The impact of oil or hydraulic fluids that are used as anti-fouling agents on ecosystems; (4) The disturbance of muscle beds; (5) The effect on threatened, endangered, and special status species; (6) Will the electronic stimulus or vibrations attract fish; (7) Is the distance between the rotors and the support structure long enough that large fish, such as sturgeon, can pass through; (8) Will wake effects and flow separation attract fish; and (9) Will hydrologic changes affect aquatic plant distribution and numbers. While the Sierra Club is opposed to new dams, hydrokinetic projects will be evaluated on an individual basis. However, the Sierra Club will oppose sites on federal and state scenic rivers, as well as, those in roadless areas. Christine stated that currently the Sierra Club is neutral on hydrokinetic power as there is not enough science available to make sweeping decisions.

Due to these concerns, the Hydropower Reform Coalition (HRC) is actively engaged in bringing together hydrokinetic companies that have permits on file with the Federal Energy Regulatory Commission (FERC) and environmental groups that have concerns regarding projects planned for their area. The HRC has a "wait and see" attitude as there is insufficient data on potential environmental effects. However, because the HRC seeks to increase public awareness of the deleterious effects of dams, they are impressed by the efforts the nascent hydrokinetic industry is making to perform comprehensive environmental studies. A representative of the HRC indicated that they are more receptive to hydrokinetic turbines being placed in conduits, or manmade waterways, such as canals, irrigation pipes, and wastewater effluent streams than they are to hydrokinetic turbines being placed in navigable waterways.

As of June 2010, there is only one licensed hydrokinetic project in the U.S. and there has been limited in-water testing. However, EPRI plans to conduct flume tests on hydrokinetic turbines for New Energy and Lucid Energy Technologies. The hydrokinetic devices will be tested on fish in order to evaluate fish injury and change in fish behavior. EPRI has two flumes in Massachusetts. The fish will be released, tracked by radio telemetry, and recaptured. Doug Dixon of EPRI expects that these tests will be done by the end of 2010. EPRI receives 95% of its funding from the power industry and the other 5% from proposals. EPRI strives to give the public the facts and nothing but the facts. In planning the flume tests, EPRI reached out to everyone in the industry. While the EPRI tests will help to elucidate some of the environmental impacts, another of the concerns regarding hydrokinetic power is the potential impact on recreational activities.

Recreational Impacts

A June 2010 report by the Hydropower Reform Coalition[48] addresses impacts on recreation specifically. The Hydropower Reform Coalition, a coalition of more than 150 national, state, and local conservation

[48]Hydrokinetics and Recreation Work Group. Hydrokinetic Energy Projects and Recreation: A Guide to Assessing Impacts. Public Review Draft, June 2010, 1-103.

and recreation groups that are concerned about the environmental impacts of hydropower dams on rivers, describes river hydrokinetics:

> In-river hydrokinetic electricity is generated by river currents that power turbines that are anchored to a river bottom or attached to existing infrastructure. Although hydrokinetic projects hold out the promise of generating power from moving water without the harmful impacts associated with dams, the technology has yet to be fully proven in a real-world setting. Since there has been little in-water testing, the actual environmental, recreational, and other impacts of hydrokinetic power are not yet well understood.[49]

While providing obvious quality of life benefits, outdoor recreation also contributes $730 billion to the U.S. economy and supports nearly 6.5 million jobs.[50] Recreational impacts as a function of installation of hydrokinetic technologies are evaluated both through descriptive information and through evaluative information. Descriptive information relates solely to how the recreation system works and explores specific changes to recreation as a result of development. Evaluative information seeks to identify recreation opportunities and seek middle ground between impacts emanating from installation of hydrokinetic turbines and actions to mitigate those impacts. In some areas, existing recreational opportunities will be both clear and well-developed whereas in other less-developed areas accessing recreational impacts will be more challenging. In this case, recreational opportunities may be assessed *via* aerial photographs, literature searches, interviews with key users and resource specialists, creation of maps using Geographic Information Systems (GIS), and public engagement. Utilization of Internet tools such as Google Earth allows analysis of a land mass for identification of potential recreation opportunities. This can be augmented with literature searches on existing recreation in the broader area. Key users and resource specialists can provide information regarding the type and magnitude of existing recreation. This information can be compiled spatially using (GIS). Public forums allow for diverse groups to participate in the planning process.[51]

Potential impacts on recreation from hydrokinetic projects include access restrictions, changes in aesthetics, changes in wave or hydraulic characteristics, wreckage and salvage impacts, displacement to other recreation areas, effects on recreation-relevant fish and wildlife, and cumulative impacts.[52]

Access Restrictions

Access restrictions include restrictions within a certain distance of a device, restrictions between devices, and exclusions where no activity is allowed whatsoever. These will vary as a function of the hydrokinetic device. Transmission lines may also lead to activity restrictions. Potential for more onerous restrictions is likely during times of installation or maintenance.

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[49] Hydropower Reform Coalition; http://www.hydroreform.org/news/2008/08/21/in-river-hydrokinetics-faq; Accessed June 17, 2010.
[50] Hydrokinetics and Recreation Work Group. Hydrokinetic Energy Projects and Recreation: A Guide to Assessing Impacts. Public Review Draft, June 2010, 1-103.
[51] Hydrokinetics and Recreation Work Group. Hydrokinetic Energy Projects and Recreation: A Guide to Assessing Impacts. Public Review Draft, June 2010, 1-103.
[52] Hydrokinetics and Recreation Work Group. Hydrokinetic Energy Projects and Recreation: A Guide to Assessing Impacts. Public Review Draft, June 2010, 1-103.

Aesthetics and Noise

As demonstrated by the tremendous opposition to Cape Wind, the proposal to install 130 wind turbines in Nantucket Sound, aesthetics is an issue of great concern to the general public. Additionally undesirable sounds may be produced as a result of installation and maintenance or just normal operations.

Impacts on Hydraulic Characteristics

Hydrokinetic devices transform mechanical energy into electrical energy by taking energy out of the water. This slows currents which may impact sediment transport, bathymetry, substrate type, or the ecological characteristics of plants and animals. Such changes have the potential to change recreational opportunities.[53]

Wreckage and Salvage Impacts

Hydrokinetics is a nascent technology and thus the long-term performance of these units is unknown. Devices may fail thus sinking and becoming debris on the water floor. Failure may also lead to pollution through, for example, leakage of anti-fouling fluids.

Displacement that Leads to Crowding at Substitute Areas

Recreation restrictions in some areas may lead to overcrowding in sites providing similar recreational opportunities.

Fish, Wildlife, and Related Ecological Impacts

Many recreational activities strive to take advantage of pristine environments with the opportunity to observe diverse wildlife. Hydrokinetic installations may alter ecosystems negatively impacting recreational activities such as kayaking and hiking that focus on Nature.

Adaptive Management

While many special interest groups are actively engaged in expanding the body of knowledge regarding potential environmental and recreational impacts emanating from the installation of hydrokinetic devices, there is still concern from local agencies regarding permitting and installation. For example, a leading national environmental group expressed the concern that once hydrokinetic devices are installed, should there be a problem such as changes in fish behavior or damage to aquatic life, that there will be limited opportunities or no opportunities to remove the devices. Thus groups are extremely reluctant to give approval for installations even after extensive environmental studies. The DOE white paper elucidates this concern further:[54]

> …[T]he severity of [environmental] impacts could be increased by the cumulative effects of multiple units within a project, multiple projects, or energy projects coupled with other stressors. Potential effects on bottom habitats, hydrographic conditions, or animal movements that are inconsequential for a few units could become significant if large, multiple-unit projects expand over large areas of a river, estuary, or the nearshore ocean. For some environmental

[53] Hydrokinetics and Recreation Work Group. Hydrokinetic Energy Projects and Recreation: A Guide to Assessing Impacts. Public Review Draft, June 2010, 1-103.
[54] U.S. Department of Energy, Energy Efficiency & Renewable Energy, Wind and Hydropower Technologies Program: Report to Congress on the Potential Environmental Effects of Marine and Hydrokinetic Energy Technologies, December 2009.

issues, it will be difficult to extrapolate predicted effects from small to large numbers of units because of complicated, non-linear interactions between the placement of the machines and the distribution and movements of aquatic organisms. Assessment of these cumulative effects will require careful environmental monitoring as the projects are deployed.

In order to mitigate social concerns regarding both impact on the environment and recreational activities, the ability to modify a project by operational monitoring based on the application of adaptive management principles through the project license conditions is an option. Adaptive management is promoted by FERC to resolve uncertainties related to environmental effects during both the construction and operational phases of hydrokinetic projects.[55]

Political & Economic

Like most renewable energy technologies, the political and economic factors are inextricably linked. A series of renewable energy grants and "green" legislation have made the technology more commercially practical for a variety of consumers, with some projects having 50% of their costs or more covered by funding opportunities.[56] There has also been significant legislation to spark further economic development and commercialization specifically in hydropower and in hydrokinetics. An analyst with the U.S. Energy Information Administration (EIA) started noticing a buzz regarding hydrokinetics about three years ago and began having the agency gather data. These data confirm that hydrokinetic power has a long way to go to catch up to both solar and wind power. However, the notorious instability in energy flow of wind and solar, coupled with recent legislative action at the national and state level necessitate the development of water-based technologies. Additionally, since the FERC permitting and licensing process plays an integral role in development of hydrokinetic power, politicians have sought ways to speed the process or circumvent it completely.[57] In order for hydrokinetic companies to become economically viable, continued political reform including provisions for grant money are necessary. Of the companies currently competing in the hydrokinetic market, we have not identified one that is generating a profit. Companies are mostly running on angel and venture capital funds. Grants, especially at the federal level, are highly competitive, rare, and require the expertise of an experienced grant writer.

CleanTech, or clean technology, includes renewable energies and other sustainable technologies that decrease energy cost, waste, and pollution. Hydrokinetic technologies have yet to become a prime player in this market; however, the progress of wind and solar power are good models for the economic future of hydrokinetic technologies. CleanTech has both been described as "the greatest economic opportunity of the 21st century" and "too early to invest in…because the economy is still not self-

[55] U.S. Department of Energy, Energy Efficiency & Renewable Energy, Wind and Hydropower Technologies Program: Report to Congress on the Potential Environmental Effects of Marine and Hydrokinetic Energy Technologies, December 2009.
[56] Confidential interviews with existing hydrokinetic customers.
[57] *See* H.R. 5922, Small-Scale Hydropower Enhancement Act of 2010 *available at* http://www.govtrack.us/congress/billtext.xpd?bill=h111-5922; Accessed August 3, 2010.

sustaining."[58] Economic growth of technology-based industries is built upon the alignment of three pillars: technology, capital, and policy.[59]

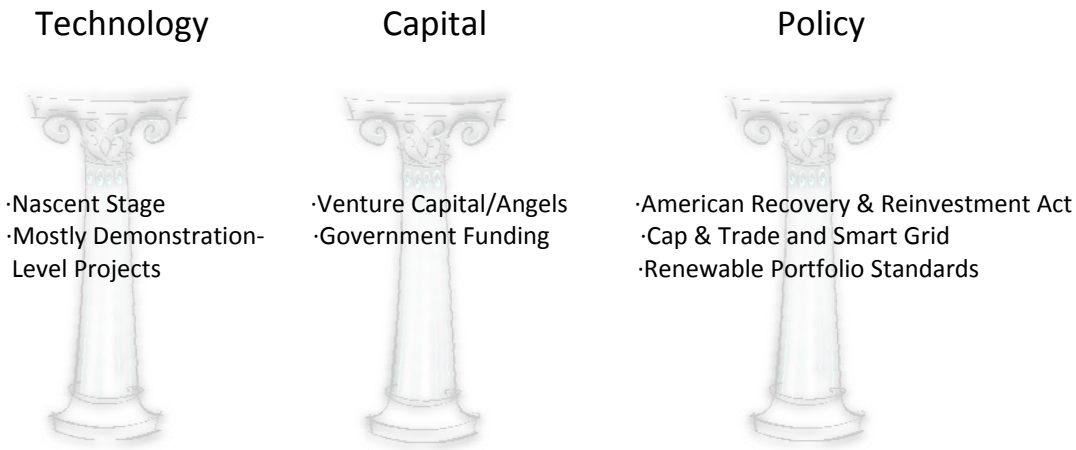

Figure 4. The Three Pillars of Technology-Based Industries

Early Hydrokinetic Projects

Of the multitude of hydrokinetic companies contacted, only one, Hydro Green, has a FERC-licensed project in the water and operating. In the scheme of research, development, demonstration, and deployment (RDD&D), the publicized projects, other than Hydro Green are in the demonstration phase while many others seek further development of hydrokinetic technologies. For example, Verdant Power has a demonstration-phase project in New York, the Roosevelt Island Tidal Energy Project (RITE), which has garnered a great deal of publicity from a performance standpoint. Verdant suffered a performance blow when, under a great deal of public scrutiny, their turbines could not withstand the currents and had to be removed. Negative press in the early stages of new technology deployment unfortunately colors public perception of evolving industries. Hindering technology deployment in particular is the uncertainty surrounding obtaining a FERC permit and license—a necessity to ultimately generate capital. While government grants are available to aid in technology development, demonstration, and deployment, these are out of reach for most due to the competition. Award of grants has gone to companies that employ or hire grant-writers. Thus technology RDD&D is ultimately tied to acquisition of capital. Until hydrokinetic technologies gain acceptance through the launching of successful projects, access to capital and thus further developments will be challenging.

[58] Bennett, Julie. Are We Headed Toward a Green Bubble? Entrepreneur, April 2010, p. 51-54.
[59] Five Emerging U.S. Public Finance Models: Powering Clean-Tech Economic Growth and Job Creation. CleanEdge, October 2009. p. 1-16. ©2009 Clean Edge, Inc.

Capital

Despite the somber economic climate of 2009, CleanTech has experienced continued growth: Cleanenergy technologies grew from 11.4 percent in 2008 to 12.5 percent in 2009 of U.S.-based venture capital investments. Investments in clean energy have exceeded those for conventional fossil fuels for the past two years in a row.[60] Publicly traded clean-energy stocks are tracked by several indexes. QWND which tracks global wind power companies is a good model for the future of hydrokinetics. QWND was up 67 percent in 2007, came down 54 percent in 2008, and rose again by 38 percent in 2009. Clean Edge predicts that clean-energy markets will continue to demonstrate such volatility.[61] Greener World Media reported the same trend: While 2009 venture capital investments in CleanTech dropped from 2008, they were still higher than 2007 investments. This is illustrated in Figure 5.[62]

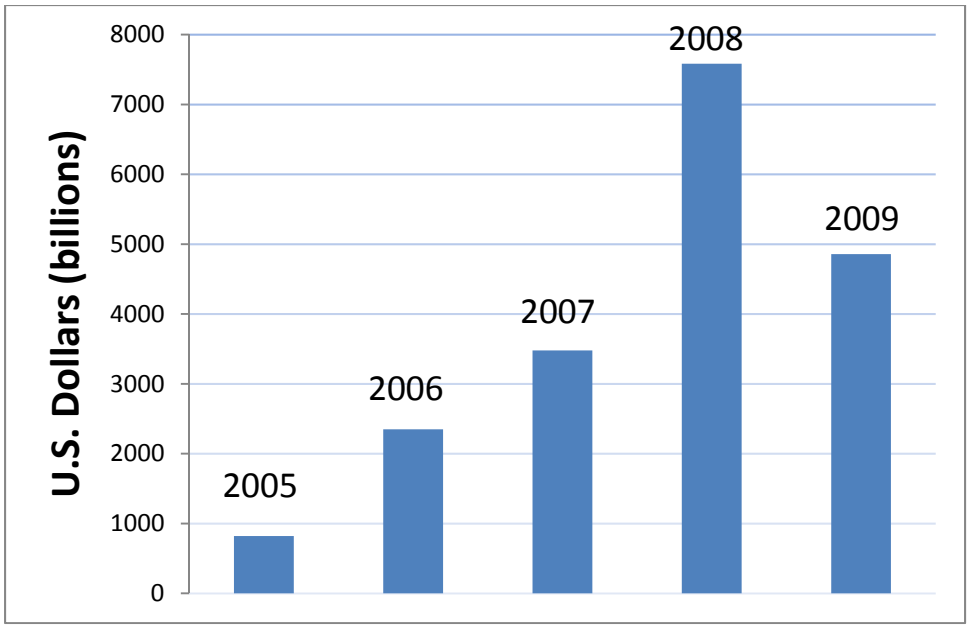

Figure 5. CleanTech venture capital investments in billions of dollars. [Source: State of Green Business 2010]

Capital infusions also come from government sources. The American Recovery and Reinvestment Act (ARRA) of 2009 provides $787 billion in stimulus money—of which approximately $100 billion will go to CleanTech.[63] Table 1 below highlights the significant aspects of recent legislation:

[60] Pernick Ron, Wilder, Clint, Gauntlett, Dexter, and Winnie, Trevor. Clean Energy Trends 2010, Clean Edge, April 2010 Update, p. 3. ©2010 Clean Edge Inc.
[61] Pernick Ron, Wilder, Clint, Gauntlett, Dexter, and Winnie, Trevor. Clean Energy Trends 2010, Clean Edge, April 2010 Update, p. 4. ©2010 Clean Edge Inc.
[62] Makower, Joel. State of Green Business 2010. ©2010 Greener World Media, Inc. (www.greenbiz.com) p. 65.
[63] Pernick, Ron and Wilder, Clint. Five Emerging U.S. Public Finance Models: Powering Clean-Tech Economic Growth and Job Creation. Clean Edge, October 2009. p. 2. ©2009 Clean Edge Inc.

Energy Independence & Security Act of 2007
Signed into law December 19, 2007[64]

Relevant Points:
· New standards and grants for promoting efficiency in government and public institutions. New and renovated federal buildings must reduce fossil fuel use by 55% (from 2003 levels) by 2010, and 80% by 2020. All new federal buildings must be carbon-neutral by 2030

· Taxpayer funding of research and development of marine and hydrokinetic renewable energy technologies

· Creation of Green Jobs: Creation of a training program for "Energy efficiency and renewable energy workers"

· Smart-Grid: Upgrading of the electrical grid to allow it to adjust to flow rates typical of sustainable energies. Smart-grids are more intuitive than existing grids and will be able to deal with varying inputs of energy from hybrid platforms containing wind, solar, hydrokinetic, and geothermal power, for example, without disrupting power supply to customers.

American Clean Energy & Security Act[65]
Passed in House of Representative on June 26, 2009

Relevant Points:

· Sets mandatory caps on 87 percent of U.S. greenhouse gas emissions. It would require 17 percent emission reductions below 2005 levels by 2020, and 83 percent below 2005 levels by 2050

Clean Energy Jobs & American Power Act[66]
Introduced to the Senate on September 30, 2009

· Reduce carbon emissions 20% by 2020 and 80% by 2050

· Creates new American jobs and the clean energy incentives that foster innovation

· Significant public investment in clean energy research

· Calls for a 20 percent emissions cut by 2020

[64] Richard Simon, "House okays energy bill; Bush to sign," *Chicago Tribune*, December 19, 2007
[65] U.S. Climate Action Network; http://www.usclimatenetwork.org/; Accessed May 25, 2010.
[66] U.S. Climate Action Network; http://www.usclimatenetwork.org/; Accessed May 25, 2010.

Table 1. National bills and legislation relevant to hydrokinetic power.

Additionally, California may be a very attractive state for hydrokinetic technology with their aggressive renewable energy legislation. The following timeline is a synopsis of these initiatives:[67]

Timeline for Electricity from Renewable Resources

- 2002: Senate Bill 1078 establishes the RPS program, requiring 20% renewable energy by 2017.
- 2003: Energy Action Plan I accelerated the 20% deadline to 2010.
- 2005: Energy Action Plan II recommends a further goal of 33% by 2020.
- 2006: Senate Bill 107 codified the accelerated 20% by 2010 deadline into law.
- 2008: Governor Schwarzenegger issues Executive Order requiring 33 % renewables by 2020.
- 2010: Electric utilities must generate 20% of their electricity from renewable resources.
- 2020: Electric utilities must generate 33% of their electricity from renewable resources.

However, the U.S. is not the only country investing heavily in clean technologies. South Korea has committed approximately $84 billion to CleanTech investments by 2013 in what is being called a "Green New Deal." In addition China has committed to spend almost 10 percent of its recent stimulus package on sustainable development[68] which some estimate will amount to $440 to $660 billion towards CleanTech.[69] In addition, China has established renewable energy goals of 15 percent by 2020.[70]

The U.S. Department of Energy's **Loan Guarantee Program** provides federal support of clean energy projects that use innovative technologies, and spurs further investment in these advanced technologies. "Established under Title XVII of the Energy Policy Act of 2005, the Secretary of Energy is authorized to make loan guarantees to qualified projects in the belief that accelerated commercial use of these new or improved technologies will help to sustain economic growth, yield environmental benefits, and produce a more stable and secure energy supply."[71]

Other governmental sources include Department of Energy grants (DOE)—some of which differentiate as a function of technology readiness level.[72] Thus less evolved technologies do not compete with those, for example, at the demonstration phase. These are competitive grants so proposals are often written by experienced grant writers. A representative from a hydroelectric company competing for a

[67] The California Energy Commission; http://www.energy.ca.gov/renewables/; Accessed May 25, 2010.

[68] Pernick, Ron and Wilder, Clint. Five Emerging U.S. Public Finance Models: Powering Clean-Tech Economic Growth and Job Creation. Clean Edge, October 2009. p. 2. ©2009 Clean Edge Inc.

[69] Pernick Ron, Wilder, Clint, Gauntlett, Dexter, and Winnie, Trevor. Clean Energy Trends 2010, Clean Edge, April 2010 Update, p. 2. ©2010 Clean Edge Inc.

[70] Pernick, Ron and Wilder, Clint. Five Emerging U.S. Public Finance Models: Powering Clean-Tech Economic Growth and Job Creation. Clean Edge, October 2009. p. 2. ©2009 Clean Edge Inc.

[71] U.S. Department of Energy; http://www.lgprogram.energy.gov/; Accessed June 3, 2010.

[72] Fed Connect; https://www.fedconnect.net/FedConnect/?doc=DE-FOA-0000293&agency=DOE; Accessed June 2, 2010.

DOE Water Power Program grant explained that the company had hired an experienced grant writer with a 25-30 percent success rate.

State governments also fund hydroelectric projects. The Connecticut Office of Policy and Management offers the New Energy Technology Program grant which is open to those developing sustainable in-state technologies.[73] A representative of the Connecticut Office of Policy and Management was not sure, however, if the grant would be available in 2010 due to the upcoming gubernatorial election. Another Connecticut opportunity, Project 150, is offered by the Connecticut Clean Energy Fund.[74] Project 150 provides both funding and an opportunity for clean energy technologies to partner with electric distributors in order to advance their technology. In general, state funding opportunities tend to be less competitive and to require far less paperwork—although the funding amounts are also less. Similar funding opportunities are available throughout the U.S.

In order for U.S. CleanTech to remain both viable and competitive worldwide, new financial models are necessary for capital generation. The five most promising financial models are Clean Energy Deployment Administration (CEDA) or The Green Bank, Clean Energy Victory Bonds, Tax Credit Bonds, Federal Loan Guarantees, and Clean Tech City Funds.[75]

Clean Energy Deployment Administration (CEDA)or The Green Bank

The quest for low-carbon energy has been described as the "space race" of our times. Many worry that the U.S. is falling behind. Competitors include China, South Korea, Japan, and the European Union. According to the Center for American Progress, "A Green Bank would allow the United States to ramp up investment in new renewable and efficient energy, using smart public policy to prime the pump for private investment into the growth of an entirely new industry."[76] The idea of a privately-run yet publicly-funded bank is not a new one. Similar policies in the past allowed for the funding of the railroads and, more recently, the precursor to the Internet. John Bohn, California public utilities commissioner explains, "[The Green Bank] is designed to help fund long-term investments to build the kinds of technologies and infrastructure that we need over the next decades."[77]

The Waxman-Markey Bill H.R. 2454, American Clean Energy and Security Act of 2009, is considered the most ambitious of the climate change legislation and has also been the most successful. It passed the house in June 2009. This bill will now to the Senate where it may be added to a companion bill, rather than have a separate vote.[78] Sections of H.R. 2454 that relate to The Green Bank fall under Subtitle I – Nuclear and Advanced Technologies and include:[79]

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[73] Connecticut Office of Policy and Management; http://www.ct.gov/opm/cwp/view.asp?a=2994&q=383312; Accessed June 2, 2010.
[74] Connecticut Clean Energy Fund; http://www.ctcleanenergy.com/YourBusinessorInstitution/Project150/tabid/97/Default.aspx; Accessed June 2, 2010.
[75] Pernick, Ron and Wilder, Clint. Five Emerging U.S. Public Finance Models: Powering Clean-Tech Economic Growth and Job Creation. Clean Edge, October 2009. p. 3. ©2009 Clean Edge Inc.
[76] Center for American Progress; http://www.americanprogress.org/issues/2009/05/green_bank.html; Accessed June 3, 2010.
[77] Pernick, Ron and Wilder, Clint. Five Emerging U.S. Public Finance Models: Powering Clean-Tech Economic Growth and Job Creation. Clean Edge, October 2009. p. 4. ©2009 Clean Edge Inc.
[78] GovTrack Insider; http://www.govtrackinsider.com/articles/2010-04-27/climate-change; Accessed June 3, 2010.
[79] Gov Track Insider: H.R. 2454: American Clean Energy and Security Act of 2009; http://www.govtrack.us/congress/bill.xpd?bill=h111-2454&tab=summary; Accessed June 3, 2010.

Section 184

·Establishes the Clean Energy Investment Fund for CEDA
·Requires the Secretary of the Treasury to issue Green Bonds to acquire capital stock of CEDA

Section 185

·Requires the Secretary to develop recommended goals for the deployment of clean energy technologies through the credit support programs

Section 186

·Established CEDA as an independent corporation wholly owned by the U.S.
·Requires CEDA's Administrator to be appointed by the President with the advice and consent of the Senate
·Requires CEDA to have an Energy Technology Advisory Council to develop and publish a methodology for assessment of clean energy technologies for potential CEDA financial support

Section 187

·Authorizes CEDA to issue direct loans, letters of credit, and loan guarantees to deploy clean energy technologies
·Requires CEDA's Administrator to:
(1) Establish an expected loan loss reserve
(2) Use a portfolio investment approach to mitigate risk and diversify investments across technologies and limit to 30% the amount of financial assistance provided to any one technology
·Requires projects supported by CEDA to pay prevailing wages to their workers
·Prohibits CEDA from providing support to projects that receive loan guarantees under Title XVII of the Energy Policy Act of 2005.

H.R. 1698 was introduced to the house on May 24, 2009. It is currently being considered by both the House Ways and Means Subcommittee and the House Subcommittee on Energy and Commerce. It includes the following provisions:[80]

·Establishes the Green Bank as a federally owned independent corporation with a 20-year charter

·Requires the Secretary of the Treasury to issue Green Bonds to acquire the Bank's capital stock
·Requires the Bank to establish a program to provide, on a competitive basis, loans, loan guarantees, debt securitization, insurance, portfolio insurance, and other forms of financing support or risk management for qualifying energy or energy efficiency projects

·Requires the Bank to assess reasonable fees on its activities to cover its costs and expenses, provided the Bank operates as a not-for-profit

·Gives the Bank immunity from impairment, limitations, or restrictions by or under laws and administrative or other action.

A key difference between H.R. 1698 and H.R. 2454 is that H.R. 1698 would set up the Green Bank as a separate entity and not under the Department of Energy.

[80] Gov Track.US; http://www.govtrack.us/congress/bill.xpd?bill=h111-1698; Accessed June 3, 2010.

Figure 6 illustrates the basic operating procedures of the Green Bank.

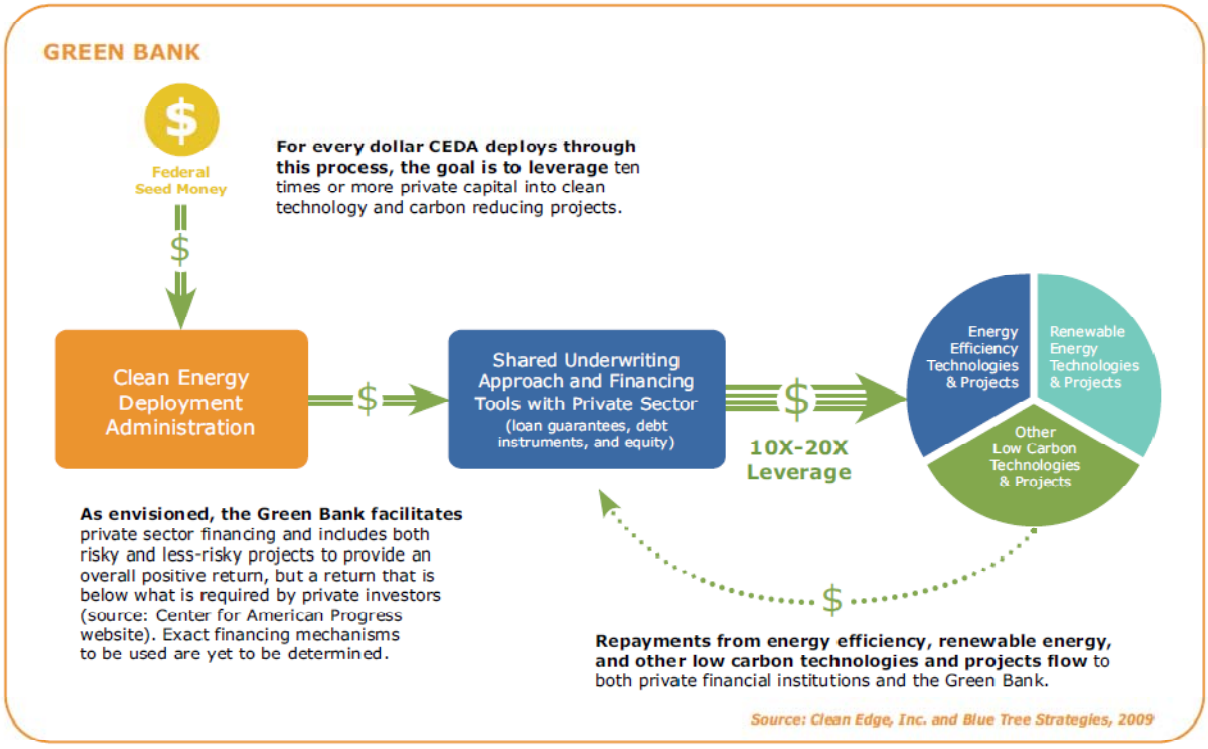

Figure 6. Green Bank Basics[81]

Clean Energy Victory Bonds

Clean Energy Victory Bonds follow the familiar model of World War II War Bonds. Like the WWII Victory Bonds, Clean Energy Victory Bonds would allow participation by average citizens—with annual returns between 3 and 5 percent, backed by the U.S. government this program democratizes the ability to participate in and profit from the CleanTech revolution.[82]

[81] Pernick, Ron and Wilder, Clint. Five Emerging U.S. Public Finance Models: Powering Clean-Tech Economic Growth and Job Creation. Clean Edge, October 2009. p. 5. ©2009 Clean Edge Inc.
[82] Pernick, Ron and Wilder, Clint. Five Emerging U.S. Public Finance Models: Powering Clean-Tech Economic Growth and Job Creation. Clean Edge, October 2009. p. 6. ©2009 Clean Edge Inc.

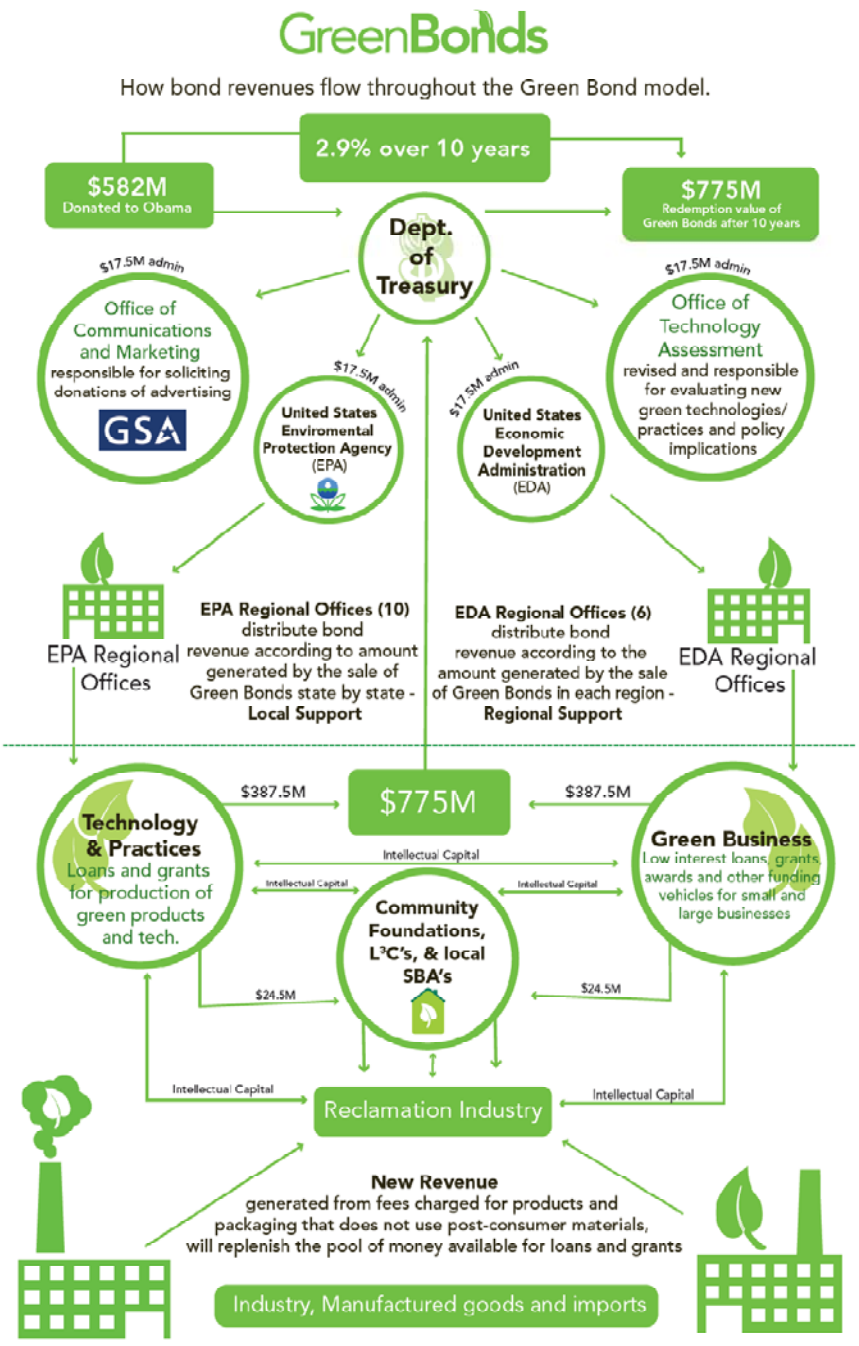

Figure 7. How bond revenues flow throughout the Green Bond Model[83]

Green Bonds would be a loan from the American people to the U.S. government to help finance national and local environmental efforts. The bonds would be available for purchase for four years in denominations of $25 to $10,000 at 75 percent of their face value. Maturity might be ten years with a

[83] Green Bonds; http://www.greenbonds.com/wp-content/themes/greenbondstheme/images/detailedflowchart.pdf; Accessed June 7, 2010.

likely penalty for early withdrawal and potential restrictions including prohibition of a secondary market, availability to U.S. citizens only, and no corporate or business purchases.[84]

Tax Credit Bonds

Tax Credit Bonds allow cities, states, or tribal governments to raise money to fund CleanTech projects. Businesses receive federal tax credits in lieu of interest payments. Clean Edge reported Clean Renewable Energy Bonds, Qualified Energy Conservation Bonds, and Build America Bonds (BABs) as those most likely to fund clean-energy projects and create jobs.[85]

Federal Loan Guarantees

The U.S. Department of Energy's Loan Guarantee program was established in the Energy Policy Act of 2005. This program has not proved to be popular however due to the laborious application process, including the need to hire a variety of consultants to submit a competitive application. More recently President Obama and Secretary of Energy Steven Chu have pushed the program leading to an additional $30 billion in DOE loan guarantees and $750 million of electric transmissions projects that start prior to 2011.[86]

Clean Tech City Funds

City funds vary by location; however in the basic model homeowners borrow money to fund sustainable projects that are paid back either through property tax or utility bills. Cities with this program include Berkeley, California; Cambridge, Massachusetts; Portland, Oregon; and Boulder, Colorado.[87]

Policy

In an April 14, 2009 speech at Georgetown University President Obama presented renewable energy as a cornerstone in the goal to stabilize and strengthen our nation's economy:

> The third pillar in this new foundation is to harness the renewable energy that can create millions of new jobs and new industries. We all know that the country that harnesses this energy will lead the 21st century. Yet we have allowed other countries to outpace us on this race to the future…The investments we made in the Recovery Act will double this nation's supply of renewable energy in the next three years…But the only way to truly spark this transformation is through a gradual, market-based cap on carbon pollution, so that clean energy is the profitable kind of energy…If businesses and entrepreneurs know today that we are closing this carbon pollution loophole, they will start investing in clean energy now. And pretty soon, we'll see more companies constructing solar panels, and workers building wind turbines, and car companies manufacturing fuel-efficient cars. Investors will put some money into a new energy technology, and a small business will open to start selling it. That's how we can grow this economy, enhance our security, and protect our planet at the same time.[88]

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[84] Sanco, Melanie M. Green Bonds for Green Technologies and Solutions, 2009, United States Department of the Treasury, ©www.greenbonds.com

[85] Pernick, Ron, Wilder, Clint, Gauntlett, Dexter, and Winnie, Trevor. Clean Tech Job Trends 2009, October 2009. p. 21-22. ©2009 Clean Edge, Inc. (www.cleanedge.com)

[86] Pernick, Ron, Wilder, Clint, Gauntlett, Dexter, and Winnie, Trevor. Clean Tech Job Trends 2009, October 2009. p. 22. ©2009 Clean Edge, Inc. (www.cleanedge.com)

[87] Pernick, Ron, Wilder, Clint, Gauntlett, Dexter, and Winnie, Trevor. Clean Tech Job Trends 2009, October 2009. p. 22. ©2009 Clean Edge, Inc. (www.cleanedge.com)

[88] President Barak Obama, Speech at Georgetown University, April 14, 2009, N.Y. Times.

Under the Recovery Act, The American Recovery and Reinvestment Act (ARRA) of 2009, the Department of Energy is responsible for spending $16.8 billion of which $6.7 billion is earmarked for energy efficiency and renewable energy specifically.

Aside from sheer dollars, sustainable energies and other forms of CleanTech are becoming legitimized by governmental focus and policy making. This is evidenced by President Obama's appointment of Carol Browner as Assistant to the President for Energy and Climate Change. Ms. Browner's previous position was as Administrator of the Environmental Protection Administration. The Obama Administration distinguishes itself from previous administrations on this issue. While previous administrations have emphasized increasing or maintaining physical supply by production or achieving similar supply results through conservation and dealing with the deleterious byproducts of fossil fuel combustion, the Obama Administration seeks to shift from oil to electricity[89]—especially electricity generated through sustainable energies.

Two issues of contention surrounding the development of sustainable energies are cap and trade and renewable energy and transmission.

Cap and trade sets a maximum value for carbon emissions. Companies who come in under the cap, i.e. emit less than the maximum, would be able to sell the excess emissions to others. The central idea is that by having to pay for pollution, companies will be motivated to adopt sustainable, green technologies. There is a great deal of debate regarding cap and trade, however, the President indicated support in his Georgetown speech when he described cap and trade as a means to "close the pollution loophole."[90] Cap and trade is supported by Joe Lieberman and Henry Waxman who sponsored the Climate Security Act of 2007. "This bill was proposed in a previous session of Congress. Sessions of Congress last two years, and at the end of each session all proposed bills and resolutions that haven't passed are cleared from the books. Members often reintroduce bills that did not come up for debate under a new number in the next session." A proposed alternative to cap and trade is a carbon tax, which Senator Bob Corker believes would be simpler than cap and trade.[91]

In order to facilitate widespread adoption of renewable energies the current electric grid must be updated. This is a two-part problem. First there is the simpler problem of getting the electrons from here to there. That is, transmitting the electricity from where it is produced to where it will be used. This problem can be minimized by harnessing sustainable energies close to population centers. The second problem is more complex and necessitates the design and construction of a "smart grid."The Electricity Advisory Committee to the Department of Energy made this statement in a December 2008 report:

> While much of the technical and policy discussion about how to ensure a sustainable energy future focuses on energy efficiency, renewable energy sources, storage, and plug-in electric cars, it is often forgotten or underemphasized that these solutions all depend on a smarter grid to

[89] Holden, Jr., Matthew. Energy Policy and the Obama Administration: Some Choices and Challenges, 2009, Energy Law Journal, 30: 405-414.
[90] Holden, Jr., Matthew. Energy Policy and the Obama Administration: Some Choices and Challenges, 2009, Energy Law Journal, 30: 405-414.
[91] GovTrack.US; http://www.govtrack.us/congress/bill.xpd?bill=s110-2191; Accessed June 4, 2010.

> achieve scale and cost effectiveness. A Smart Grid is therefore foundational for a sustainable energy future; and if there is a growing consensus within the United States that clean energy is a platform for rebuilding the American economy, then it follows that the realization of a Smart Grid is also critical to economic growth.[92]

A particularly important characteristic of a smart grid is that it can respond to changes in electron flow without crashing. Sustainable energies such as wind and solar are notoriously irregular unlike a typical coal-fired power plant that has a steady output. Aside from economic benefits and improved reliability, a smart grid will have the ability to reduce carbon emissions by:[93]

·Leveraging demand response/load management to minimize the use of costly peaking generation, which typically uses generation that is comparatively fuel inefficient

·Facilitating increased energy efficiency through consumer education, programs leveraging usage information, and time-variable pricing

·Facilitating mitigation of renewable generation variability of output—mitigation of this variability is one of the chief obstacles to integration of large amount of renewable energy capacity into the bulk power system

·Integrating renewable energies including hydrokinetics.

Or, in simpler terms, with respect to hydrokinetic power and other sustainable energies, the smart grid is accommodating. It can accept energy from virtually any fuel source free of sags, spikes, disturbances, and interruptions.

Given the benefits of developing a smart grid it is likely to be a hotly debated topic due to land acquisition and placement of new high voltage electric lines. Fred Smith, head of the Energy Security Leadership Council, suggested that, "…Congress should grant the Federal Energy Regulatory Commission the same primary authority for high voltage electric transmission lines under the Federal Power Act that it already possesses for interstate natural gas pipelines under the Natural Gas Act."[94] Clearly this will be a contentious issue in the near future. Regardless, given the renewable portfolios standards that have been adopted by many states (See Figure 8) action must be taken. Renewable portfolio standards set targets for the purchase of renewable power generation by electric utilities as a percentage of total electricity sales.

[92] Electricity Advisory Committee, Smart Grid: Enabler of the New Energy Economy; http://www.oe.energy.gov/final-smart-grid-report.pdf; Accessed June 4, 2010.
[93] Electricity Advisory Committee, Smart Grid: Enabler of the New Energy Economy; http://www.oe.energy.gov/final-smart-grid-report.pdf; Accessed June 4, 2010.
[94] Holden, Jr., Matthew. Energy Policy and the Obama Administration: Some Choices and Challenges, 2009, Energy Law Journal, 30: 405-414.

STATES TAKING ACTION:

30 states have developed and adopted renewable portfolio standards, which require a pre-determined amount of a state's energy portfolio (up to 20%) to come exclusively from renewable sources by as early as 2010.

STATE	AMOUNT	YEAR	RPS ADMINISTRATOR
Arizona	15%	2025	Arizona Corporation Commission
California	20%	2010	California Energy Commission
Colorado	20%	2020	Colorado Public Utilities Commission
Connecticut	23%	2020	Department of Public Utility Control
District of Columbia	11%	2022	DC Public Service Commission
Delaware	20%	2019	Delaware Energy Office
Hawaii	20%	2020	Hawaii Strategic Industries Division
Iowa	105 MW		Iowa Utilities Board
Illinois	25%	2025	Illinois Department of Commerce
Massachusetts	4%	2009	Massachusetts Division of Energy Resources
Maryland	9.5%	2022	Maryland Public Service Commission
Maine	10%	2017	Maine Public Utilities Commission
Minnesota	25%	2025	Minnesota Department of Commerce
Missouri*	11%	2020	Missouri Public Service Commission
Montana	15%	2015	Montana Public Service Commission
New Hampshire	16%	2025	New Hampshire Office of Energy and Planning
New Jersey	22.5%	2021	New Jersey Board of Public Utilities
New Mexico	20%	2020	New Mexico Public Regulation Commission
Nevada	20%	2015	Public Utilities Commission of Nevada
New York	24%	2013	New York Public Service Commission
North Carolina	12.5%	2021	North Carolina Utilities Commission
Oregon	25%	2025	Oregon Energy Office
Pennsylvania	18%	2020	Pennsylvania Public Utility Commission
Rhode Island	15%	2020	Rhode Island Public Utilities Commission
Texas	5,880 MW	2015	Public Utility Commission of Texas
Utah*	20%	2025	Utah Department of Environmental Quality
Vermont*	10%	2013	Vermont Department of Public Service
Virginia*	12%	2022	Virginia Department of Mines, Minerals, and Energy
Washington	15%	2020	Washington Secretary of State
Wisconsin	10%	2015	Public Service Commission of Wisconsin

Figure 8. States Taking Action: Renewable Energy Portfolios. *States that have set voluntary goals for adopting renewable energy instead of portfolio standards with binding targets.[95]

[95] U.S. Department of Energy, *The Smart Grid: An Introduction* (Washington, D.C.: U.S. Department of Energy, 2008).

Hydrokinetic Companies & Products

Since the product maturity in the market is in its infancy stage with most if not all hydrokinetic technologies still under development, the number of barriers to entry are low, which is reflected by the sheer number of hydrokinetic companies.[96] Other than Verdant and Free Flow Power, most companies are relatively unknown by potential customers and have overall low brand recognition. While the volume of companies may account for this, the lack of a clear communication channel to interested parties and consumers, the lack of a fully commercialized and mainstream product, and the lack of a distinguishing brand likely also play a role. In conjunction with this, most companies are relatively new players in the field.

The number of permits for the Mississippi River Basin would leave one to believe that on-grid river hydrokinetics is the crux of the market.[97] However, this is not to say that there are not a sufficient number of competitors approaching the other identifiable market segments. MTDS a Scotland-based company, while also focusing on river hydrokinetics, has looked to the Amazon River Basin in Brazil for some of their preliminary product testing, and it is not a stretch to gather they are looking at the Brasilia frontier and other developing parts of Brazil for off-grid river hydrokinetic applications. Additionally in terms of international markets, Verdant has actively wooed the Chinese, Indian, and Vietnamese markets. Bourne Energy, while they also are developing river hydrokinetic applications, has looked to developing portable hydrokinetic applications for the military.[98] The U.S. military, particularly the Navy, is displaying significant interest in renewable energy, and Bourne Energy has looked to offer a small portable back pack unit in addition to more affixed off-grid installations. Others, such as Hydrovolts, Natel Energy, and eGen have looked at the canal and aqueduct market to take advantage of the conduit exemption. Additionally, some companies offer small hydro solutions for people living in an off-grid rural environment, such as Smart Product Innovations and their EcoAuger™ technology and ESD in Canada. Lastly, there has been notable activity in the piggy-back approach of hydroelectric dams where companies are looking to utilize the "tailrace" of existing hydroelectric structures to power hydrokinetic structures. Particularly, Hydro Green Energy has embraced this piggy-backing approach with a hydroelectric dam in Hastings, MN.[99]

One of the noteworthy aspects of the competitive landscape is that hydrokinetic technologies may be competing directly with small hydropower in a number of applications, particularly in manmade structures and off-grid residential. [100] Natel Energy and Leroy-Somers offer low head, small hydropower solutions as a feasible solution in canals and irrigation channels. [101] While they rely on energy generated from the vertical drop of the water as opposed to the horizontal velocity as in hydrokinetic solutions,

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[96] According to FERC, http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics.asp (Accessed June 14, 2010) there are currently 37 companies with FERC permits to test their technology. This does not begin to account for companies that have taken an approach completely outside of the permitting process or international companies.

[97] According to FERC, http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics.asp (Accessed June 14, 2010) there are 86 permits outstanding for the Mississippi River.

[98] Bourne Energy; http://www.bourneenergy.com/vision.html; Accessed June 14, 2010.

[99] Popsci; http://www.popsci.com/environment/article/2009-06/hydro-power; Accessed June 14, 2010.

[100] Hydropower differs from hydrokinetics in that hydropower traditionally involves "head," a vertical drop in the water flow necessary to generate electricity.

[101] Natel Energy; http://www.natelenergy.com/products/; Accessed June 14, 2010; LS News; http://www.leroy-somer.com/pdf/lsnews/LSNews22_UK.pdf; Accessed June 14, 2010.

there is some overlap in the spaces in which they can compete. There may be an opportunity for these technologies to complement one another in the same space, but there would likely be reluctance on both sides. In residential applications, ESD offers a small hydropower solution that utilizes a process that minimizes environmental harm through a filtered diversionary process. Thus, these technologies may further develop alongside hydrokinetics and could be useful in applications where hydrokinetics may not be feasible, and vice-versa. One application that may need to be evaluated in the future is the existence of unutilized dams in areas such as Connecticut with an old mill-industry infrastructure. Whether small hydro or hydrokinetics will be more suitable in these areas can only be determined over time.

There also seems to be a technological battle in terms of maximizing the usable landscape for hydrokinetic technology, and maximizing the energy output of the technology. One of the limiting factors of hydrokinetic technology to date is the amount of flow needed in the water system in order to generate sufficient power. MTDS has honed in on that limitation in developing a technology that they hope can operate in environments as low as 3.28 feet per second (fps). eGen has offered the most promise with a technology that can operate efficiently in environments as low as 1 fps. However, the number of technologies capable of operating in low flow environments remains unclear as many companies guard the exact specifications of their proprietary technology. The competing interest is making the technology as robust as possible in order to reduce maintenance costs and provide a dependable power source. Thus, many of the larger scale applications tend to trade off the minimum flow speed in exchange for maximizing the energy output from a harsh environment. However, this is not to say they cannot create a system for overcoming this obstacle. Verdant in particular has developed a patented technology that would allow them to obtain the optimum flow speed necessary for their turbines in a canal or aqueduct system, which would also reduce the flow speed after passing through their turbines.

The biggest limitations for any competitor in the field are lack of capital, lack of an adequate communication channel, and lack of a proven technology. As some industry analysts have suggested, many venture capitalists seem to be waiting out the market either because the technology has not been tested enough or because they are holding out for government subsidies and other green incentives to either increase or hedge their return on investment. Many potential investors and customers have either not heard of hydrokinetics at all, or are completely overwhelmed by the number of product offerings and companies. As mentioned before, there seems to be an absence of big players in the market able to take full advantage of the lack of brand recognition of the smaller start-up companies. Absent a powerful brand name, if a company does not have a pre-existing network through which to communicate to the consuming public their product's benefits and features, then they are likely to be confused as to how to properly approach the market. While there is also much ado about vertical *versus* horizontal axis turbines and other technical details, there is also a limited amount of comparison testing of these technologies and sound historical data. The situation is exacerbated as each new start-up offers a new approach to how to effectively provide a hydrokinetic energy solution to the market.

Off-Grid Applications

Off-Grid applications refer to settings that are not connected to the electrical grid and therefore lack power. Off-grid locations exist within both the continental U.S. and Alaska. In addition, developing countries are rife with off-grid opportunities. The problem in this situation is a general lack of assets and the ability to fund projects by residents of these remote locations. Within the U.S. the off-grid community is price sensitive and difficult to target. Internet sales are popular. Sales to developing countries tend to occur at the local level through aid organizations such as the United Nations Development Programme and missionary groups.

Company Analysis

We conducted an analysis of the following companies and product offerings. While some of these companies are not hydrokinetic technologies specifically, such as ES&D and Power Pal, we have included them in this report since they compete in similar markets to hydrokinetic technologies.

Andritz

Andritz's HYDROMATRIX® turbine-generator unit also competes in the existing hydropower (dam) market. Their unit requires the existence of a dam or gate structure. The Andritz unit is illustrated in Figure 9.[102] As touted on the Andritz site, "The HYDROMATRIX® design utilizes a factory assembled grid or "matrix" of small propeller turbine-generators units. The complete module, including necessary mechanical and electrical equipment, is shipped intact to the project site where it can be readily installed into the existing gate or bulkhead slots.

When river discharges in excess of the capacity of the module (or modules) must be passed, or when the unit needs servicing or maintenance, the module can be easily raised or removed from the operating position similar to a gate or bulkhead."[103]

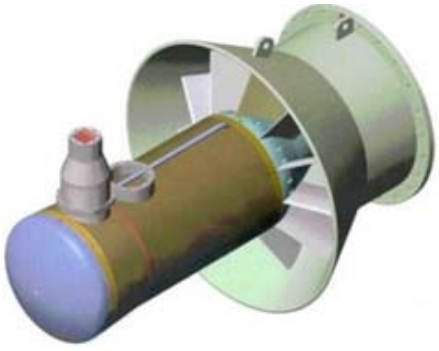

Figure 9. HYDROMATRIX turbine-generator unit. [Source: Andritz]

Andritz is a company with a global presence having offices in:

- Europe

[102] Andritz; http://www.andritz.com/ANONID17CD96CE1B1209D5/hydro-products-and-services-large-hydro-hydromatrix; Accessed June 23, 2010.
[103] Andritz; http://www.andritz.com/ANONID17CD96CE1B1209D5/hydro-products-and-services-large-hydro-hydromatrix; Accessed June 23, 2010.

  - Austria, Czech Republic, Denmark, Great Britain, Finland, France, Germany, Hungary, Italy, The Netherlands, Norway, Poland, Romania, Russia, Slovakia, Spain, Sweden, Switzerland, Turkey, and Ukraine
- Africa
  - South Africa
- America
  - Brazil, Canada, Chile, Colombia, Mexico, Peru, Uruguay, USA, Venezuela
- Asia
  - China, India, Indonesia, Iran, Japan, Malaysia, Philippines, Singapore, Taiwan, Thailand, Vietnam
- Australia.

Andritz is headquartered in Graz, Austria and has approximately 13, 400 employees worldwide. Aside from a hydro business area, Andritz also works in pulp and paper, metals, environment, and biofuels.[104]

Bourne Energy

Bourne Energy has produced a portable power generator that weighs approximately 30 lbs and is expected to be released in 2012 for $3000/unit.[105] The opportunity for a portable power generator using hydrokinetic energy has numerous applications in a military setting for allowing portable renewable energy generators for communications equipment; applications for RVs, yachts, and sailboats in a consumer leisure travel application; and potentially emergency situations.

eGen

eGen is unique in that its units can function at the lowest flow rates in the industry—as low as 1 foot per second. They also have a scalable product with a modular design for ease in manufacturing, installation, and maintenance.

The capacity to operate at low flow rates allows eGen to target unique markets with less onerous regulatory requirements such as segments utilizing conduits. Conduits, or manmade waterways, exist in a number of industries worldwide that utilize water flow including waste water treatment facilities, the chemical industry, the paper industry, the mining industry, and the agricultural industry. eGen's unique low-flow technology also allows targeting of aqueducts and irrigation canals.

eGen's technology generates electricity through the Magnus effect as illustrated in Figure 10 below.[106] eGen is launching its first unit in the Pfizer New London facility in Fall 2010. Their technology has gone through significant testing at both the University of Connecticut and the University of Rhode Island both in flumes in a laboratory environment and for an extended period of time at a Mystic River site.

[104] Andritz; http://www.andritz.com/ANONID17CD96CE1B1209D5/about-us/about-company-profile.htm; Accessed June 23, 2010.
[105] Ubergizmo; http://www.ubergizmo.com/15/archives/2010/03/bourne_energy_bpp-2_hydroelectric_backpack.html; Accessed July 27, 2010.

[106] eGen; http://www.egenhydro.com/Technology.html; Accessed July 28, 2010.

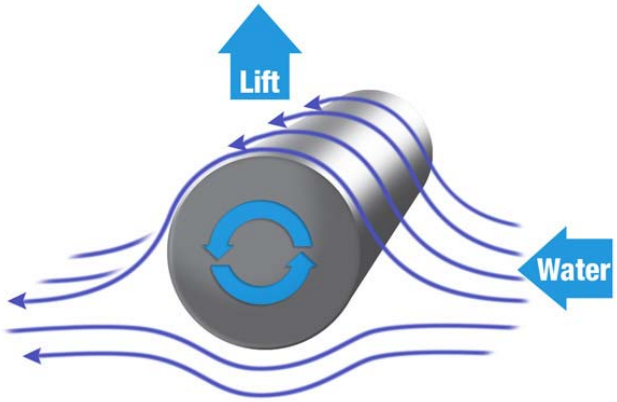

Figure 10. eGen's competitive advantage is fueled through its unique ability to operate across a wide range of water flow conditions. Based on the Magnus effect, eGen can harvest more energy at lower flows than traditional turbine blade solutions of equal size. [Source: eGen Hydro]

Energy Systems and Design, Ltd. (ES&D)

ES&D targets off-grid homeowners, both primary and secondary homes, for units that require head. They have two technologies, their regular product that operates with water drops of 6-30 feet and a low-head product for water drops of 2-10 feet.[107] Current prices are $2345 and $2975 for the standard and low-head units, respectively.[108] Water drop, or head, is generated by passing water from a stream or other source through a pipeline which can be used to generate both DC and AC electricity. DC electricity can be stored in batteries for later use. The ESD systems operate at 12, 24, or 48 volts and are installed by the homeowner; however, phone support is available.

Figure 11. Marketing material from the ES&D web site targeting home owners.

[107] ES&D; http://www.microhydropower.com/Low%20Head.htm; Accessed July 14, 2010.
[108] ES&D Price List; http://www.microhydropower.com/Energy%20Systems%20web%20price1-09.pdf; Accessed July 14, 2010.

Free Flow Power

Free Flow is well known in the hydrokinetic industry for their approximately 47 FERC permits they have on the Mississippi River. The map in Figure[109] 12 below illustrates all pending FERC hydrokinetic permits while Figure 13[110] illustrates issued preliminary permits.

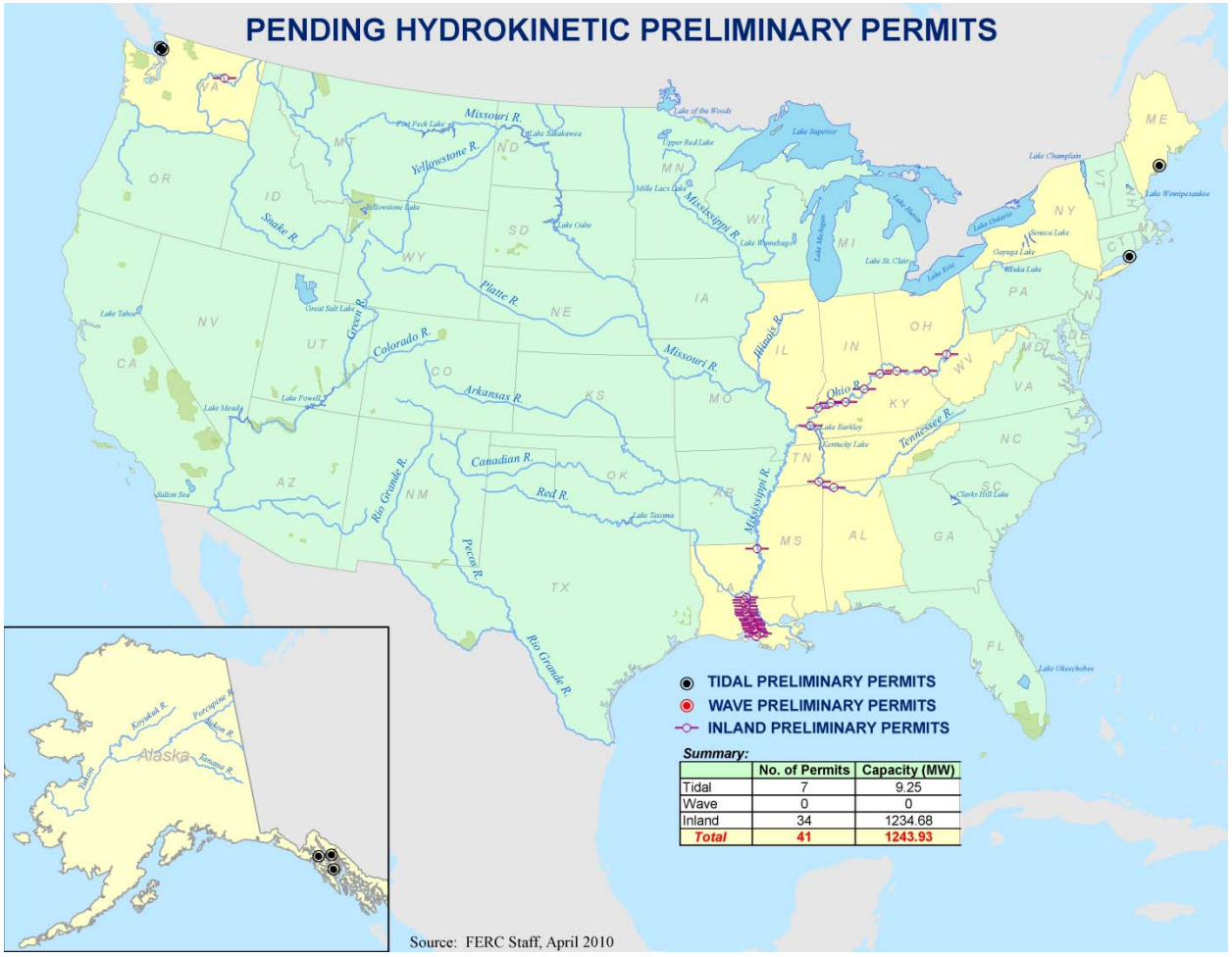

Figure 12. Pending FERC Hydrokinetic Preliminary Permits as of April 2010. [Source: FERC.gov]

[109] Federal Energy Regulatory Commission; http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics/pending-hydrokinetic-permits-map.pdf; Accessed June 22, 2010.
[110] Federal Energy Regulatory Commission; http://www.ferc.gov/industries/hydropower/indus-act/hydrokinetics/issued-hydrokinetic-permits-map.pdf; Accessed June 22, 2010.

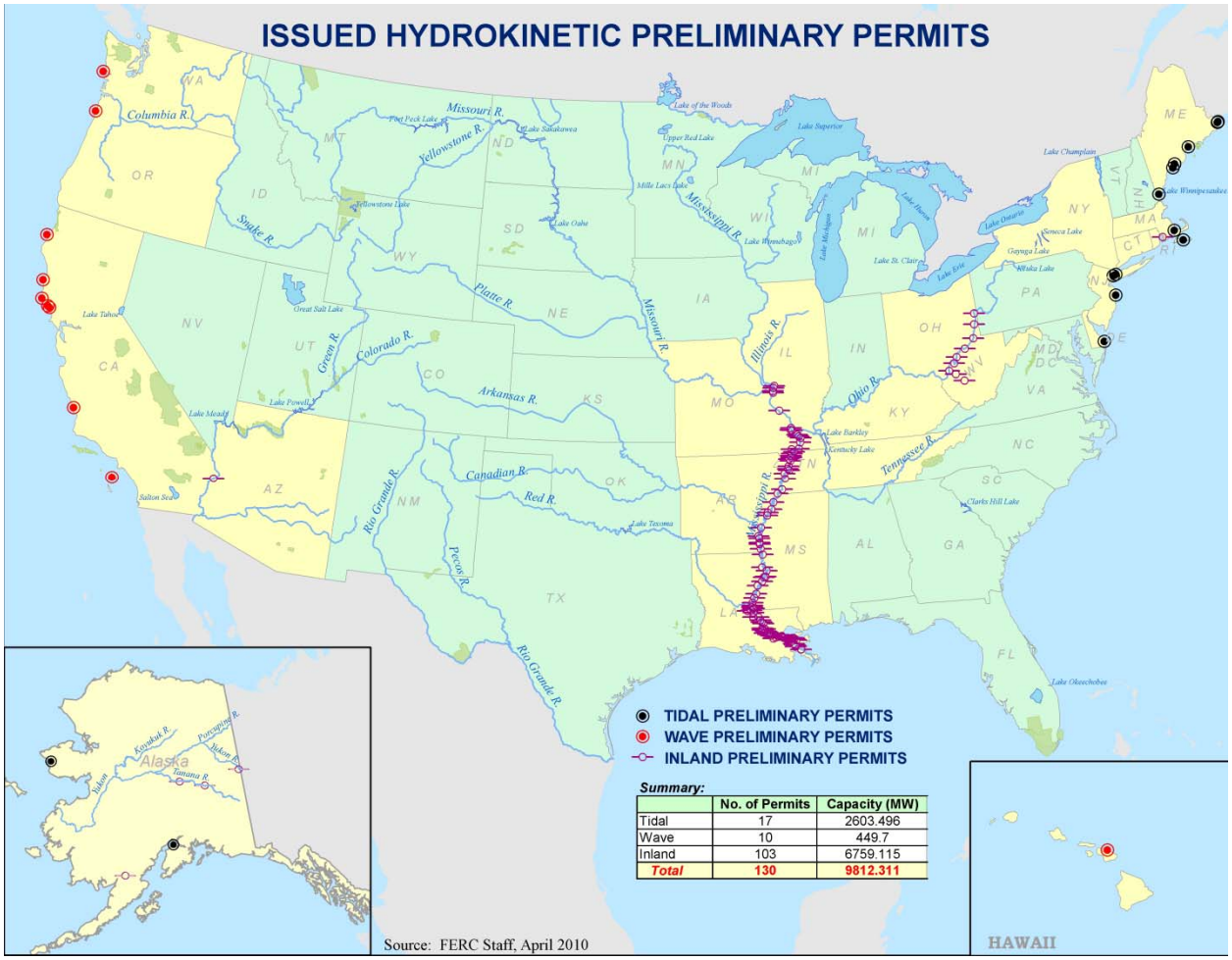

Figure 13. Issued FERC Hydrokinetic Preliminary Permits as of April 2010. [Source: FERC.gov]

Free Flow has 20-25 employees of which 5-10 work on regulatory issues. They have been running on angel funds as well as one DOE grant from the waterpower office. Free Flow is currently focusing on U.S. markets and chose the Mississippi in particular due to the mega wattage that can be generated, the potential to bundle environmental studies, and the fact that there is only one endangered species in the area under consideration.

Free Flow Power's 3-meter SmarTurbine™ generates 10 kW in a 2.25 m/s flow and 40 kW in a 3 m/s flow.[111]

Hydro Green Energy

Hydro Green Energy has the first FERC approved hydrokinetic power license in the U.S. They placed an in-stream, no-head hydrokinetic unit in the tailrace of an existing dam. Below is an aerial view of the Hastings, Minnesota project.[112]

[111] Free Flow Power; http://www.free-flow-power.com/Technology.html; Accessed June 22, 2010.
[112] Hydro Green Energy; http://www.hgenergy.com/hastings.html; Accessed June 21, 2010.

Figure 14. Aerial view of Hydro Green Energy project in Hastings, MN. [Source: Hydro Green]

The Hydro Green unit has a cut in speed of 1 meter per second with a maximum rated capacity of 3.5 meters per second. Rated output is 98 kW at 3.5 meters per second.[113] Hydro Green worked with the city of Hastings, Minnesota to add additional energy output to an existing 4.4MW hydroelectric dam. In addition, Hydro Green hired independent consultant, Normandeau Associates, to study the effect of the turbines on fish safety using their "HI-Z Turb N' Tag" methodology. Results were that 1 out of the 402 fish were injured or 0.2%.[114]

HydroVenturi

HydroVenturi touts its technologies as being capable of functioning in the following environments:

- Reservoirs;
- Navigational waterways;
- Irrigation systems;
- Flood defense installations;
- Tidal barrages and causeways;
- Weirs and large volume industrial outfalls.[115]

Primarily, however, they compete in the hydropower (dam) market, advertising their technology as both increasing hydropower output and improving downstream water quality as a result of:

[113] Hydro Green Energy Specification Sheet; http://hgenergy.com/Product%20Spec%20Sheet.pdf; Accessed June 21, 2010.
[114] Hydro Green Energy News Release; http://www.hgenergy.com/Final%20Fish%20Study%20Release.pdf; Accessed June 22, 2010.
[115] HydroVenturi; http://www.hydroventuri.com/venturipower-hydroelectric-power-technology.asp; Accessed June 22, 2010.

- increasing the amount of residual head recovery available that would otherwise be required for aeration on hydropower discharges, through enabling lower tailrace levels or the removal of downstream aeration weirs;
- improved overall efficiency of residual head recovery and conversion;
- better utilization of available water resource that would otherwise be required to be 'spilled' rather than passed through the turbines, in order to aerate and increase downstream temperature;
- a much broader operating regime being potentially enabled during those periods when temperature differentials between the surface and deeper waters of the forebay are problematic to maintaining downstream water quality.[116]

HydroVenturi's core technology operates according to the Bernoulli principle; it was developed at Imperial College in London. HydroVenturi is based in South Wales in the U.K. with a satellite location in Delaware, U.S. They are currently seeking strategic partnerships to commercialize their product through licensing or through a rental business model.[117]

Hydrovolts

Hydrovolts uses micro turbine technology in order to target the "micro system" market. They are currently working with the U.S. Navy under a cooperative research & development agreement to test their Flipwing™ technology. The Flipwing™ is a self-contained small power generation device that produces 1 – 20 kW.

Their primary market is water management organizations including irrigation districts, flood control and dam projects, existing hydropower plants, shipping canals and locks and other constructed waterways. These waterways are managed by engineers, usually have no environmental concerns or permits needed, are easy to access and have very predictable water flows. Their secondary market is customers with remote sensors powered by batteries. Oceanographers, navies and others can use Hydrovolts micro-turbines to generate power from currents and wave action. The distribution channel is direct sales to large water management organizations and to existing distributors of small-scale solar, wind and micro-hydropower systems.

Lucid Energy Technologies

Lucid Energy Technologies is an Indiana based company formed through a partnership between Terra Group, LLC and GCK Technology, Inc. In 2007, Lucid partnered with Light Engineering to launch turbines in the South China Sea to generate energy from coastal tides.[118] More recently, on October 22, 2009, a partnership between Lucid and Free Flow was announced. The two companies have developed a joint technology for use in both coastal areas and rivers.[119] Another recent innovation is the Northwest

[116] HydroVenturi; http://www.hydroventuri.com/hydroelectric-power-increase-output.asp; Accessed June 23, 2010.
[117] HydroVenturi; http://www.hydroventuri.com/water-technology-company-hydroventuri.asp; Accessed June 23, 2010.
[118] Inside Indiana Business; http://www.insideindianabusiness.com/newsitem.asp?ID=26307; Accessed June 22, 2010.
[119] Renewable Energy World.com; http://www.renewableenergyworld.com/rea/news/article/2009/10/free-flow-energy-signs-development-agreement-with-lucid-energy; Accessed June 22, 2010.

PowerPipe™. Images of this turbine, developed exclusively for use in conduits, are shown below in Figures 15 and 16[120] while technical details are included in Figure 17.[121]

Figure 15. Lucid 4-bladed turbine for use in conduit.

Figure 16. Lucid turbine in conduit.

[120] Lucid Energy Technologies; http://www.lucidenergy.com/water/northwest-powerpipe/; Accessed June 22, 2010.
[121] Lucid Energy Technologies Technical Data; http://www.lucidenergy.com/water/northwest-powerpipe/technical.html; Accessed June 22, 2010.

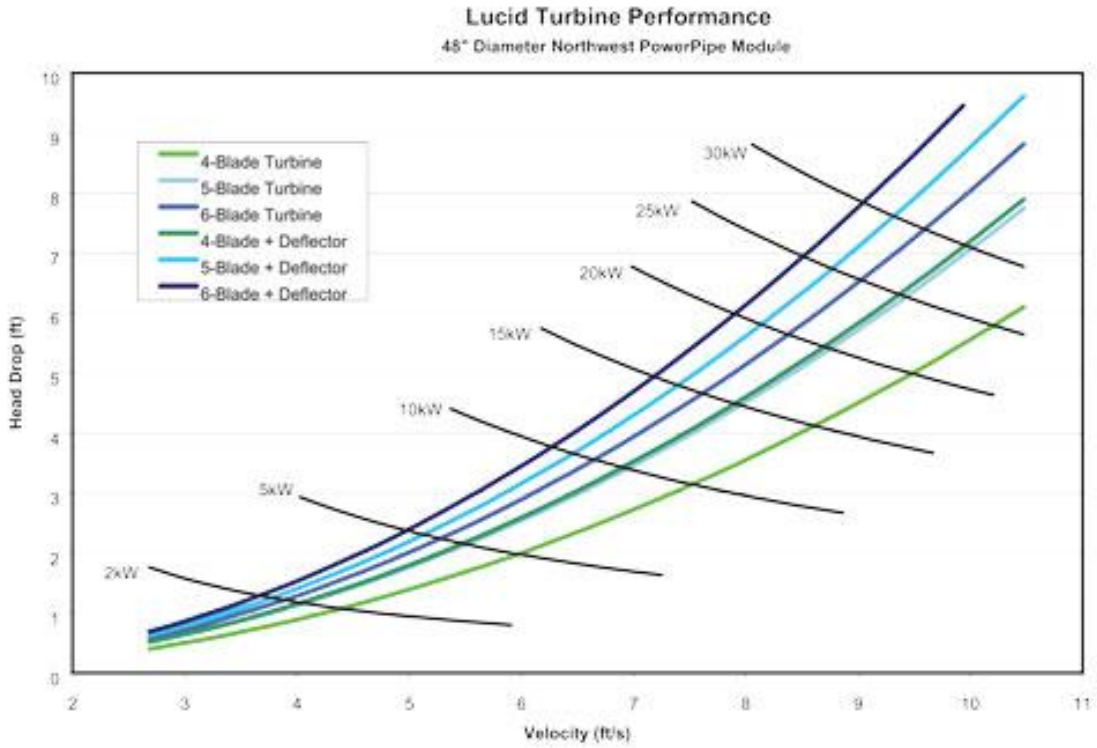

Figure17. Technical specifications of Lucid's Northwest PowerPipe turbines for use in conduits.

The PowerPipe™ operates at flow rates as low as approximately 2.5 feet per second. Power output varies as a function of turbine type. It was developed with Northwest PowerPipe:

> "From a small loft office in Goshen, [Indiana,] a team of energy engineers is plotting to take over America's water pipelines with a revolutionary goal: putting turbines inside the largest pipes to produce electricity as water flows past.
> So goes the thinking at Lucid Energy Technologies, which has partnered with Northwest Pipe Co., a major manufacturer of steel pipes, to develop the 'Northwest PowerPipe.' It hopes to begin selling the ingenious infrastructure to utilities starting next year." [122]

Natel Energy

Natel's products operate at heads ranging from 3 to 25 feet. According to Natel's web site, their technologies have optimal performance in high flow, low head environments.[123] Figure 18 is an image of their technology.[124] Natel recently completed installation of their first commercial project in collaboration with the Buckeye Water Conservation and Drainage District in Arizona. The project is off-grid pending an interconnect agreement with Arizona Public Service.

[122] Lucid Energy Technologies; http://www.lucidenergy.com/press/2009/22; Accessed June 22, 2010.
[123] Natel Energy; http://www.natelenergy.com/products/technology.html; Accessed July 14, 2010.
[124] Natel Energy; http://www.natelenergy.com/products/; Accessed July 14, 2010.

Figure 18. Natel Energy's technology operates optimally in high flow, low head environments.

Natel's target markets are low dams, irrigation canals, and streams.

New Energy Corporation

New Energy is based in Calgary, Alberta and was founded in December 2003. They have been focusing on developing their smaller units as a means of learning with the goal of scaling up to higher wattage 125 and 250 kW models. Below is a map detailing locations of New Energy projects utilizing their EnCurrent technology.[125] The EnCurrent technology generates electricity from in-stream sources.

Figure 194. Map detailing current and past locations of New Energy projects.

[125] New Energy Corporation; http://www.newenergycorp.ca/OurClients/DeploymentMap/tabid/83/Default.aspx; Accessed June 23, 2010.

Current or past projects were located in wastewater treatment plants, irrigation districts, upstream from an existing dam, a creek, a tidal zone, and three rivers.

The graph in Figure 20 displays power output of the 5 and 10 kW turbines as a function of water velocity in meters per second. Figures 21 and 22 are images of the 5 and 10 kW units, respectively.

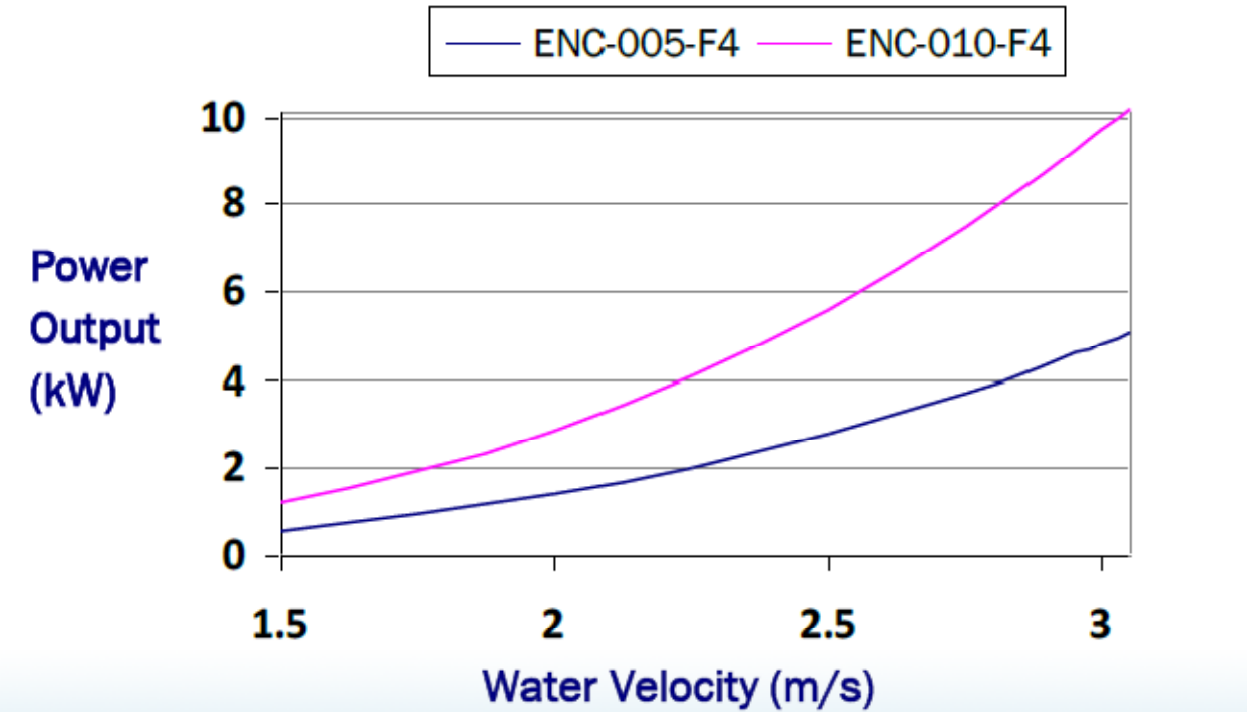

Figure20. Power output as a function of water velocity of New Energy's 5 kW turbine, ENC-005-F4 & 10 kW turbine, ENC-010-F4.

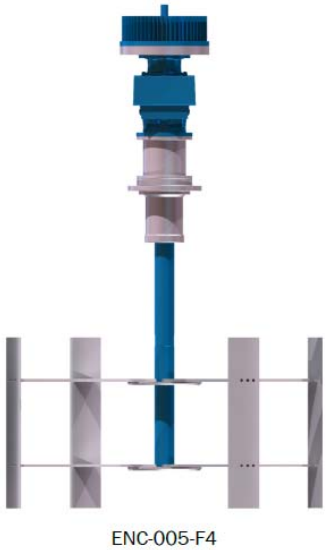

Figure 21. New Energy's 5 kW turbine.

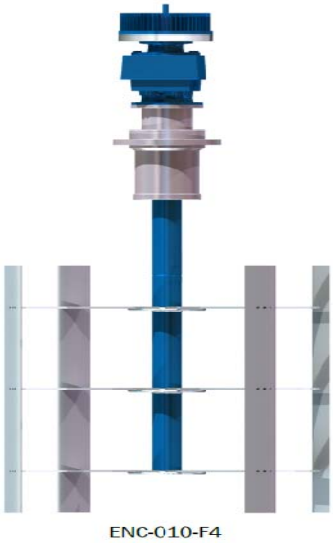

Figure22. New Energy's 10 kW turbine

The graph depicting power output of their 25kW unit is shown in Figure 23.[126]

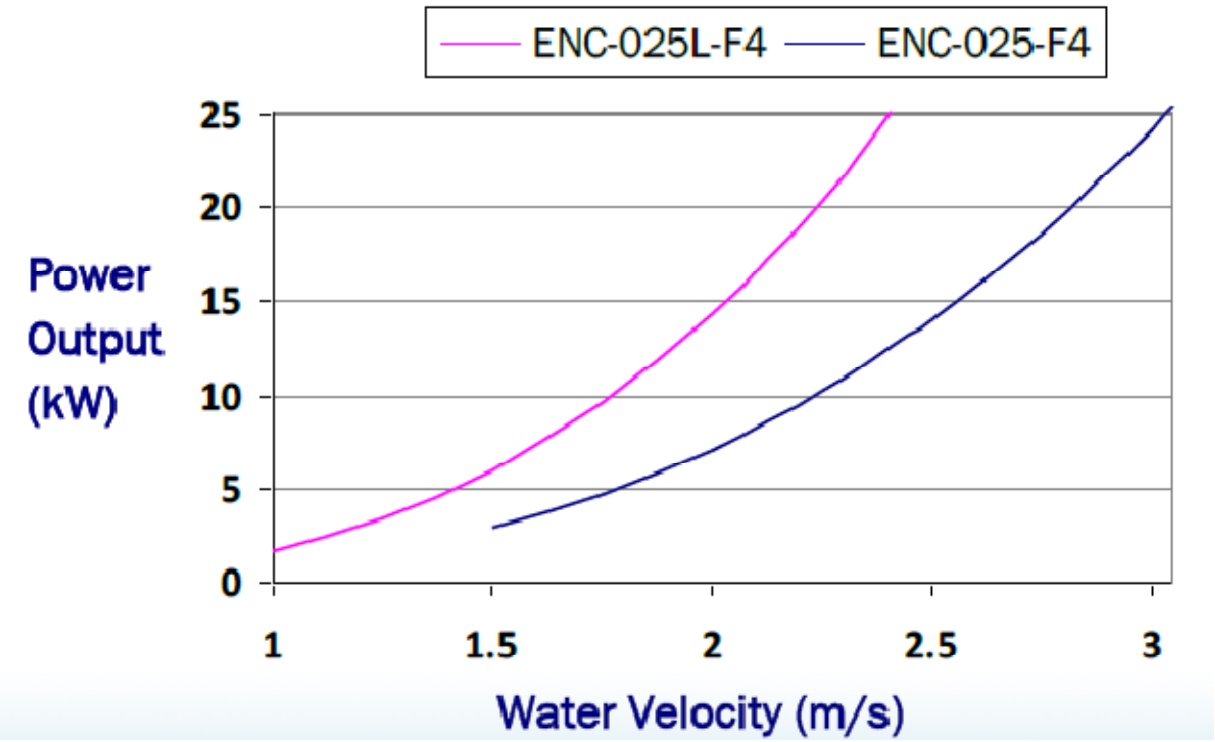

Figure23. Power output as a function of water velocity of New Energy's 25 kW turbines.

New Energy has also developed ancillary products to aid in the installation and maintenance of their hydrokinetic turbines.

Power Pal

Power Pal is a Canadian company manufacturing its product in Vietnam. Founded by exploratory geologists who hoped to both fulfill a need, electricity in developing nations, and generate a profit, it was soon realized that the indigent nature of the populace in their target market meant that they were essentially functioning as a non-profit organization. That was back in 1998—today they are still in operation and still doing it out of their hearts and without making a profit. They have one employee in Vietnam who works with the factory and the rest of the business is run over the Internet from the President's home in British Columbia.

They manufacture five different units all of which require head. Typically residents divert waterways to generate the necessary water elevation to generate electricity. Power Pal is well-known in the non-governmental organization sector as supplying a robust product that has been extensively field tested at a reasonable price.

[126] New Energy Corporation; http://www.newenergycorp.ca/LinkClick.aspx?fileticket=YLMXwKuf7io%3d&tabid=87&mid=477; Accessed June 23, 2010.

Figure 24. A Power Pal unit operating *via* diverted water flow.

Rentricity

Rentricity is a key player in the in-pipe solutions segment. A core attribute of Rentricity is their ability to bring a project to installation in 12-18 months. After the payback period, Rentricity states that they are competitive with coal on a cost per kWh basis. It seems that they are trying to build momentum at this point with the early adopters of the technology by targeting different groups in order to generate publicity. Rentricity's initial market strategy was to target the "greenest" states but has since expanded to approximately fifteen states. They are also exploring opportunities to develop strategic partnerships with wind and solar distributor. Rentricity calls their conduit turbines Inflow Power™.[127]

[127] Rentricity; http://www.rentricity.com/serv_overview.html; Accessed June 24, 2010.

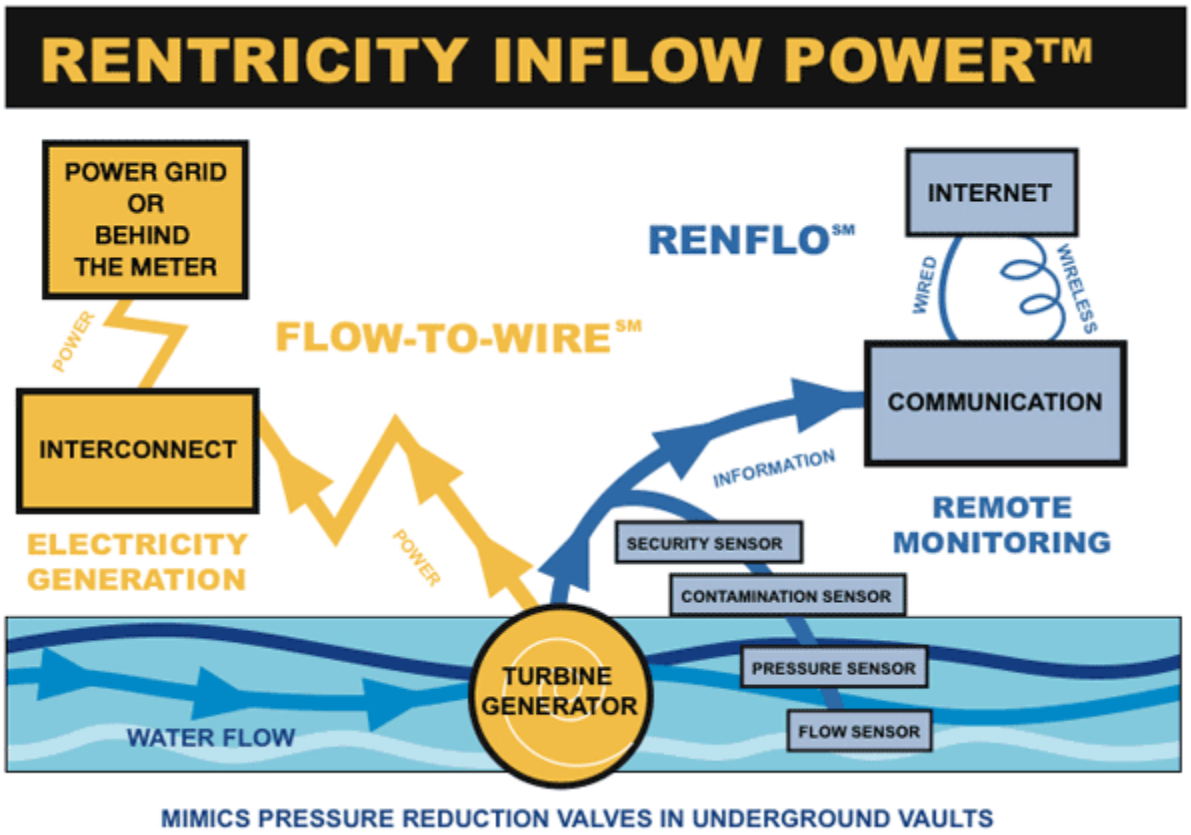

Figure 25. Rentricity marketing material.

Smart Product Innovations

Although the company is a relatively new player, it has already attracted media attention with its EcoAuger™ device. The EcoAuger™ has been featured in the June 2010 issue of Popular Science as one of the top 10 innovations of 2010.[128] Its design uses a "bladeless" auger like shape to avoid any real or perceived threat to aquatic life. They estimate a minimum water flow of 3 to 5 knots to be effective, but the technology is still under development and thus these technical constraints may change over time. SPI sees a strong potential in the off-grid residential market domestically and abroad as a means of helping bring energy to communities that don't have access to affordable power. The technology would be limited to small scale, micro power applications in its current form and would need to be secured to a bridge or another man-made structure for stability. The product is estimated to take another 5 years of development time. Their biggest constraint is obtaining additional capital to develop the business.

Underwater Electric Kite (UEK)

UEK, located in Annapolis, Maryland, was founded in 1981 by Philippe Vauthier. UEK was the original choice for the Alaska Power & Telephone (AP&T) project that is scheduled for installation this summer in the Yukon River in Eagle Alaska; however, Vauthier passed away in 2008 at which time UEK apparently went out of business. They still have an active web page—albeit it one ridden with misspellings and poor grammar—but no one at UEK has returned either emails or phone calls.

[128] Popsci Invention Awards; http://www.popsci.com/diy/article/2010-05/invention-awards-fish-friendly-tidal-turbine; Accessed July 27, 2010.

The follow link: http://www.uekus.com/Prototype%20History%20A.pdf provides a history of their prototypes. Their turbines function in the 0.5 to hundreds of MW range.

Verdant Power

Verdant, with a company history of 10 years, seems to have the longest history in the hydrokinetic market. Their most notable project has been the RITE Project on the East River of New York City, from which they have moved out of the preliminary permit phase and are fully licensed. While their preliminary testing has received lots of positive feedback, some of the early turbine durability difficulties is still talked about among environmental consultants and industry analysts.[129] However, their "Generation V" system appears to be fully commercialized and will be utilized in their East River Project. Their ability to overcome the regulatory hurdles in obtaining their FERC license in the East River was no small feat, and came at the expense of $3 million of environmental testing and associated costs, and after 6 years of operating under a preliminary FERC permit. While some other companies may be able to utilize Verdant's research in attempting to obtain their own FERC permits, the idiosyncrasies of each hydrokinetic site, as well as the differences in hydrokinetic products, will create their own problems and there is still a feeling among regulators and non-profit environmental groups that the technology is still largely untested and will have unknown effects. Thus, it seems other hydrokinetic companies are unable to be "quick to copy" the years of research and sweat equity poured into overcoming the large regulatory hurdles in the U.S. However, the caveat being that is unclear that the years spent by Verdant in bringing the East River project to fruition would reduce the amount of time spent for projects elsewhere in the U.S.

Verdant appears to be well aware of this problem as it seeks to build relationships in developing countries. The lower regulatory hurdles of these developing countries will ironically create a much shorter development time for their green, renewable energy source abroad than for the U.S. and more developed countries. Through professional relationships and networking, Verdant is tapping into the Chinese, Indian, and Brazilian markets and is actively pursuing the Vietnamese market. Verdant's collaborative joint venture agreements and business and governmental allies give the company a distinctive competency that will be difficult for its competitors to replicate in targeting developing markets.

Markets

We classify segments based on factors including size, customer needs, and technology application. Segments can roughly be divided based on whether energy generation is grid-tied or off-grid.

Grid-tied and off-grid applications will produce one or more types of revenues based on a company's operating strategies. Revenues can be derived from long-term sales of electricity, the lease of equipment, or the direct sale of equipment and services.

Grid-tied applications encompass segments in which energy production is distributed over a shared grid. Grid-tied applications generally produce revenue streams based on long term energy purchase

[129] New York Times; http://www.nytimes.com/2007/08/13/nyregion/13power.html; Accessed July 14, 2010.

contracts, product leases, and maintenance contracts. Additionally, grid-tied projects carry higher startup costs, planning, and regulatory requirements.

Off-grid applications encompass segments in which energy production is controlled and consumed by an individual or small group of individuals. Off-grid applications generally produce revenues derived from the initial sale of the hydrokinetic equipment, training, and installation contracts. Point sales carry lower liability, with the consumer or installer assuming some risk associated with maintenance, ongoing operation, and repairs. Additional opportunity for long-term revenue streams through training, maintenance, and upgrade contracts exist in the off-grid market when considering sales involving state, federal, or large private institutions.

Each revenue stream has inherent benefits and disadvantages. Long-term sales of electricity, or power purchase agreements (PPAs), represent the most predictable income stream (5.8 - 10.0 cents per kWh), however dictate that a company own and operate its own generation systems. Ownership requires overcoming large initial capital, regulatory, and logistics hurdles as well as the ongoing burden of operation and maintenance costs.

Lease-based revenue streams are similar to ownership schemes, except that most initial and long-term risk is mitigated as the system operator assumes these liabilities. Leases generate long-term revenues from installation revenues ($3.00 per watt installed) as well as royalties (2.0 – 4.0 cents per kWh or another $2-3 dollars per watt installed over the unit's lifetime) derived from ongoing energy generation. Lease schemes still carry relatively high initial capital requirements, and significant manufacturing and distribution expertise.

Direct sales carry the least risk but do not produce any long-term revenues. Direct sales revenues may be vulnerable to seasonal demand fluctuations as well as shifts in market trends and economic conditions. Direct sales are expected to produce revenues of $3.00 - $15.04 per watt installed depending on targeted segments. Manufacturing and distribution can be scaled according to short-term demand. Most direct sales segments will have lower capital requirements than lease or ownership segments and avoid many regulatory requirements associated with long-term revenue generation.

Target Segments

In identifying our preliminary market segments we looked to segments that had one or more key characteristics. Specifically, we looked for market segments that (1) generate realizable revenue from the sale, lease, or PPAs of equipment, (2) focus on projects that avoid or reduce regulatory requirements, (3) provide free feedback on performance and engineering, (4) are publicized freely by purchaser or can be publicized at minimal cost, (5) have project timelines with low risk of budget or time overruns, and (6) compete on features rather than cost per kWh or dollars per watt installed.

As a key metric we present estimated or market consensus target revenues for each segment. Where revenues are based on sales of equipment we report revenue per watt installed. Where revenues are based on the continuous sale of electricity we report revenues per kWh and attempt to estimate equivalent cost per watt installed when possible.

Preliminary Analysis of Target Segments

We utilized a mixed model built around critical success factors (CSFs) to analyze each segment within the industry. CSFs are frequently used by organizations to achieve success.[130]. We identified our CSFs and analysis weights based on review of secondary literature and discussions with subject matter experts. We classified our CSFs into three broad categories[131] as industry, contextual, or positional factors and use a balanced category mix (30% industry, 35% contextual, and 35% positional) in assembling our segment scorecards.

Our model combines quantitative data with qualitative data to provide an overall scoring of the attractiveness of each segment. Qualitative data are measured on a scale of 1 to 10 and reflect general consensus expectations, trends, or opinions within our body of subject matter experts (SMEs) (N_{total} = 104) and secondary research literature (N_{total} = 280). We provide sample sizes for each quantitative and qualitative measure identifying the number and type or resources used in providing a numeric assessment. SME interview data and secondary research literature may be applied to multiple factors.

Our model is designed to incorporate a balanced mix of quantitative and qualitative data. Quantitative data is weighted to compose 50% of the overall segment score. We view quantitative data as a lagging indicator of segment trends and expectations since quantitative data is derived mainly from historical industry data. Qualitative data is weighted to compose 50% of the overall segment score. We view qualitative data as a leading indicator of segment trends and expectations since qualitative data is derived from SMEs asked to provide forward-looking insight as well as secondary research literature predicting future trends in market development.

We selected our metrics to create a weighted mix of external and internal factors. Our analysis is weighted 65% towards external factors and 35% towards internal factors when computing each segment score. We weighted our analysis towards external factors since market research (N=104 SMEs, N=8 VOE, N=280 Literature) indicated that external regulatory and economic factors were the key drivers in the development of the hydrokinetic market. Secondary drivers were identified as the core competencies of the enterprise. Table 1 below lists our key factors utilized in the scoring of each segment.

Factor Description	Weight	Units	Force	Data Type	Category
Total Market Capacity	5%	mW	External	Quantitative	Contextual
Annual Capacity	10%	mW	External	Quantitative	Contextual
Revenue Metric	10%	$/mW	External	Quantitative	Industry
Capitalization	10%	$	External	Quantitative	Positional
Project Timeframe	10%	years	External	Quantitative	Contextual
Competitors	5%	n/a	External	Qualitative	Positional
Collaborators	5%	n/a	External	Qualitative	Positional
Customer Profile	10%	n/a	External	Qualitative	Positional

[130] Morrison, 2009; Daniel, 1961; Rockart, 1979
[131] Morrison, 2009

HR Requirements	5%	#	Internal	Quantitative	Positional
Manufacturing Expertise	5%	n/a	Internal	Qualitative	Industry
O&M Expertise	10%	n/a	Internal	Qualitative	Industry
Logistics Expertise	5%	n/a	Internal	Qualitative	Industry
Regulatory Expertise	10%	n/a	Internal	Qualitative	Contextual

Total Market Capacity describes the total mega-watts installed when the segment is saturated. This metric captures the overall size of the segment. We assign a 5% weight because total market capacity reflects the long-term segment potential.

Annual Capacity describes the segment's ability to support the installation of new power generation equipment. We use a conservative estimate and do not account for compounding capacity growth since we are focused on short-term scoring. We assign a 10% weight to annual capacity because it captures the short-term growth velocity of the segment. For segments where annual capacity is not directly available, we derive the value by dividing total market capacity over a 35 year development period.

Revenue Metric describes the expected return per mega-watt of equipment installed. For revenue models derived from ownership or leasing schemes and the sale of energy we convert from cents per kilo-watt-hour to dollars per mega-watt installed by assuming an effective equipment lifespan of 20 years and adjusting to the present-future value of all revenue.

Capitalization describes the minimum capital resources an enterprise must have access to or have obligated to undertake planning, licensing, and construction activities associated with a specified undertaking and is measured in dollars ($USD). We assign a 10% weight to capitalization as under-capitalization is a key contributor to the failure of most start-ups.

Project Timeframe describes the duration necessary to complete a project and is measured in years. We assign a 10% weight to the project timeframe as a factor in measuring short-term value creation prospects.

Competitors describe the number and strength of competitors within the segment. We assign a 5% weight to competitors because target segments are relatively young and we do not see competition to be a major driving force in short-term scoring of segments.

Collaborators describe the number and strength of collaborators within the segment. We assign a 5% weight to collaborators because target segments are relatively young and the industry as a whole ranks collaboration low on a list of key external drivers.

Customer Profile describes the needs of customers within the target segment. We subdivide the customer profile into price, technology, environmental, O&M, time, and intangible needs. We assign a 10% weight to customer profile as the industry has identified customer needs as a poorly understood key driver in external forces affecting segments.

Human Resources describe the minimum number of personnel required to undertake a project within a specified segment. We assign a 5% weight to human resources as human resources are a secondary factor in determining ability to enter a segment as well as a reflection of organizational structure and efficiencies within each segment.

Manufacturing Expertise describes an enterprise's internal competency in manufacturing. We assign a 5% weight to manufacturing as internally, industry indicates enterprises primary concerns are regulatory and organizational costs.

O&M Expertise describes an enterprise's internal competency in managing ongoing costs from the operation and maintenance of equipment and reflects the risk associated with such responsibilities. We assign a 10% weight to O&M expertise because it impacts short and long-term value creation and has been identified by industry as a primary concern in determining the successful development of targeted segments.

Logistics Expertise describes an enterprise's internal competency in managing distribution and system installation components of a project's implementation. We assign a 5% weight to logistics expertise due to low industry focus on developing advanced logistics capabilities in the short-term.

Regulatory Expertise describes an enterprise's internal competency in meeting or mitigating a project's regulatory requirements. We assign a 10% weight to regulatory expertise to reflect industry focus on regulatory requirements as a key factor in determining the feasibility of projects within targeted segments.

Mixed Model Validation

We qualitatively validated our scoring model by comparing number and type of key external and internal drivers between the hydrokinetic industry and the small wind energy industry. We found that the wind energy industry focuses on a set of key external drivers, although drivers differ from those identified in the hydrokinetic segments due to the maturity of the wind industry. Key metrics for wind were: installed capacity, cumulative capacity, consumer education, state incentives, environmental and regulatory concerns, difficulty securing financing, manufacturing trends, and fluctuation of basic material costs. [132] Our model includes many of the key factors mirrored in AWEA's 2008 report, however also includes drivers specific to the hydrokinetics industry identified through our SME and secondary research.

Interpreting Scores

Scores are meant to complement our qualitative descriptions of the market and can be used as a tool to gauge early market interest. Scores are relative, and a low or high score does not indicate the overall importance of the segment within the hydrokinetics market. Higher scoring segments generally have lower barriers to interest and may be more attractive in the short term due to customer needs and expectations within that segment. Lower scoring segments are generally viewed as long-term markets that have higher barriers to entry and associated risk.

[132] AWEA, 2008

Segment Descriptions & Scores

The Green C&I (commercial and industrial) segment consists of medium to large commercial and industrial enterprises whose interest in installing mini hydro-kinetic systems is based on positive PR generated by utilizing a renewable energy source. Green C&I customers are ideal because they are ready to accept installation costs upwards of $10.64[133] per watt with virtually no expectation to offset the initial investment with the value of electricity generated. Green C&I projects are typically expected to have output capacities of 1-20kW. Furthermore, Green C&I projects are often situated on sites that have little to no regulatory requirements (waste water or cooling discharges). The Green C&I segment contains many low risk opportunities capable of generating the best returns over the next 5 years while hydro-kinetic technologies remain in their nascent stage. There is moderate risk associated with ongoing operation and maintenance (O&M). Score: 70

The US watercraft segment represents an opportunity of approximately 165,000[134] boat and yacht owners capable of installing pico and micro-hydropower devices on their vessels. Specifically, this segment includes semi-portable and non-portable hydro-kinetic units ranging from 300 watt to 2 kW solutions for boats, yachts, and barges ranging in length of 26' to 150'+. We estimate revenues of $15.04 per watt installed[135]. Downsides of entering this segment include its relatively small size, as well as significant investment required to setup a manufacturing environment capable of supplying sufficient quantities of small, standardized units. Since these are private applications there are no regulatory hurdles. Score: 70

The military segment encompasses the Army, Navy, Marine Corps, Air Force, and Coast Guard. The military has a sustainability goal of 25% renewable energy by 2025 with currently 9% of its electricity generated sustainably[136]. Domestic electrical generation is approximately 10% of the Department of Defense (DoD)[137] energy consumption of 1100 trillion BTU[138]. Additionally, 18.8% of oil, which accounts for 75% of DoD energy consumption, is used for remote power generation in buildings and other immobile structures. Bourne energy produces a mobile hydrokinetic device that retails for approximately $6.58 per watt installed[139]. SME research indicates military needs differ significantly based on applications within the various divisions and include factors such as unit weight, deployment, visibility, robustness, ease of use, and integration options. Score: 45

The Residential segment describes small private residences looking to generate renewable energy to offset dependence on grid-tied infrastructure or compensate for lack of infrastructure. Base revenues are estimated at $3 per watt sold[140] with demand for systems between 300 watts and 2 kW. We anticipate maximum revenue to hover around $5-6 per watt installed after development of strategic partnerships and appropriate marketing. Complementary wind and solar technologies often cost

[133] Confidential Industry Interview, 2010
[134] NMMA, 2009
[135] Duogen, Aquair, 2010
[136] US Pentagon, 2010
[137] DoD, 2009
[138] DoD, 2006
[139] Confidential Industry Interview, 2010
[140] ESD, Harrison, Aquair, PowerPal, 2010

upwards of $7-9 per watt installed with roughly 50% of the installation cost associated with labor and secondary materials.[141] Initial interviews (N=6) indicate the current residential segment is characterized by do-it-yourselfers relying on poorly developed marketing, manufacturing, and distribution networks. Additionally, the residential segment avoids regulations. Barriers to entry include the fragmented nature of the off-grid residential segment. Score: 65

The utility segment describes installations competing with conventional, grid-tied technologies such as coal and natural gas. Utility installations could be placed in limited locations across the U.S. where both water flow and transmission requirements can be met. We anticipate revenues of $2-3 per watt installed based on per watt installation cost of conventional coal power of $2.10 in 2007.[142] Entry into the utility segment requires significant capital, manufacturing, distribution, and O&M expertise. For instance, Verdant, a manufacturer of in-river hydrokinetic turbines, has invested over $20 million over seven years developing a 5MW project on the Mississippi and is still undergoing regulatory approval.[143] Score: 40

The Public Works segment encompasses state and federal facilities that manage water resources including wastewater, aqueducts, canals, sewers and transmission pipes, as well as other manmade and natural waterways. In 2004, the U.S. EPA estimated that 21,604 publicly owned treatment works existed.[144] Public facilities have a combination of sustainability and efficiency goals that are enforced by state and federal mandates. Public facilities managing water resources in artificial conduits have the additional benefit of avoiding most regulatory requirements.[145] Ongoing energy sales vary based on geographical location and have the potential to generate between 5.0-10.0 cents per kWh. Facilities operating in high population density areas generally have higher electricity generation costs. Score: 70

The C&I segment overlaps with the Green C&I segment, however C&I customers are focused on cost and efficiency rather than environmental or sustainability goals. In addition to competing with other hydro, wind, and solar technologies, low flow start-ups will face competition from inexpensive natural gas and high efficiency coal technologies. Our initial research indicates that power purchase agreement (PPA) sales will generate revenues of 5.0 – 12.0 cents per kWh. Important competitive factors include availability of government subsidies for differing levels of green technology as well as the market value of carbon credits as both these incentives can be used to offset high installation costs. Score: 60

The South American off-grid and grid-tied segments deserve mention as they and other international markets will become more important as the hydrokinetic market matures. Hydro equipment sells for as little as $0.75 per watt installed or 2.3 to 4.0 cents per kWh generated.[146] Minimal activity in the off-grid segment may be beneficial as developing countries have little to no regulatory control and act as excellent, low-cost testing grounds for developing technology. Low cost systems ranging from 100 watts to 1 kW could easily be setup for R&D testing. Risks of operation include intellectual property (IP) theft

[141] Solar Power Authority, 2008
[142] Schonfeld, 2007
[143] Verdant, 2010
[144] EPA, 2004
[145] FERC, 2010
[146] ESMAP, 2009, PowerPal, 2010

and political/socio-economic instability. Additional challenges facing the grid-tied segment included disorganized regulatory bodies, corruption, and political bias towards domestic solutions.[147] Score: 45/35

The integrated solutions market consists of segments requiring multiple technologies (hydrogen, compressed air, purification, environmental) to be combined onto a single platform. These segments present significant long-term opportunity to generate both spot sales revenue as well as ongoing revenues through short-term leases and O&M contracts. Products within integrated segments are characterized by strategic partnerships and successful innovation around existing and emerging technologies. Very little information exists on expected revenues for integrated solutions; however their complexity suggests a price premium over other segments. Pursuing integrated solutions is very risky since many of the complementary technologies and partners are also emerging enterprises and information on segment characteristics and trends are difficult to quantify. Score: N/A

Further Analysis

We chose three model market segments based on interviews with potential customers and people within the industry, subject matter experts, and hydrokinetic manufacturers; a literature review; and validation through our scoring model. The three model segments are: (1) Public Works, (2) Watercraft, and (3) Green C&I. Our model segments are meant to highlight key attributes of small, medium, and large hydrokinetic applications as well as typical customer needs, project risks, competition, and barriers.

Methodology

We administered surveys *via* telephone and internet to create a detailed customer analysis for each segment. Electronic surveys were distributed using Zoomerang.com, a proprietary web-enabled software used to create, distribute, and provide basic analysis of survey results. We analyzed our data using SPSS and a proprietary GIS platform. We performed both qualitative and quantitative analyses according to the amount and quality of data received. A methodology breakdown for each segment follows.

Public Works

The survey was administered via a hyperlink distributed through state and national associations to various municipal and regional water resource management organizations. There was no direct control over the number or type of water resource management organizations associations to which the link was distributed. In addition to distribution through external associations, we emailed approximately 60,000 state employees from departments of transportation, public works, environment, and utilities through publicly available email lists. Additionally, a smaller follow-up telephone based survey (N=30) was administered to random facilities across the U.S. to determine the preferred financing method for a hydrokinetic project. Data was analyzed using SPSS and GIS.

[147] World Bank, 2009, ESMAP, 2009

Watercraft

Surveys were administered through online forums of boater's associations, sailing magazines, and popular media sites with articles relating to green energy and boating. The online users self-identified themselves as potential customers. We estimate social networking strategies allowed access to roughly 20,000 viewers and potential survey takers. Surveys were also emailed to an additional 3,000 boat owners from contact lists of yachting associations across the U.S.. Finally, the survey was administered through the American Boating Association's July, 2010 news letter, The Beacon. The ABA Beacon has a listed readership of approximated 30,000 members. Data was analyzed qualitatively with MS Excel and Zoomerang's built-in summary statistic functions.

Green C&I

We conducted telephone surveys with commercial and industrial enterprises that were identified by reviewing public water resource permit lists (NPDES, etc.) issued to private enterprises utilizing large amounts of water in their industrial processes. We telephoned companies working in the mining, chemical, agricultural, food, pharmaceuticals, and manufacturing industries. Several industry associations distributed the survey *via* email or electronic news letter. We used SPSS and Zoomerang's built-in summary statistic functions to analyze data.

Results Overview

Over five weeks we collected survey responses for each segment detailed in the table below. Complete responses represent surveys where the participant finished and submitted the survey. Not all survey questions were mandatory so an individual could complete a survey without answering all questions. Partial responses are surveys where the participant answered several survey questions but did not finish submitting the survey. Partials generally contain less information than complete surveys; however, provide valid data for analysis.

Segments:	**N Complete**	**N Partial**	**N Total**
Public Works	528	162	690
Green C&I	102	9	111
Watercraft	71	46	117

Survey Data

Raw survey data is available upon request in .PDF format. Raw survey data has been formatted to remove respondents' confidential or identifying information.

Segment Discussion

Luxury Watercraft

Data gathered within this segment suggested the renewable aspect of hydrokinetic technology is less important that initially anticipated. 28% of boaters have integrated renewable energy into their vessels--mostly solar and wind, but the key interest points in adoption were ease of integration, cost, and impact on the boat's performance. Only 26% of boaters surveyed had not considered using renewable energy at all. 87% of those that had considered renewable energy reported that cost of the product

would be important or very important to them. This result was higher than expected considering that boating is a luxury hobby, which usually entails a demographic with a higher disposable income than average. Within this segment, we also identified that the channels of information are clearly defined. From our interviews, we identified that most boat owners use one or two distribution companies for all of their needs, primarily relying on catalogues or e-commerce sites to research and obtain aftermarket boating parts. Catalogues and online media already feature advertisement for solar and wind power substitutes that can be purchased for a vessel. By partnering with catalogues and online distributors, the hydrokinetic industry would be able to target most, if not all, of its potential market without a minimum wasted selling effort. Another identifying trait of this market was the 5-6 national associations and magazines that most people read or subscribe to. With these direct and concise marketing channels defined, product recognition would be much easier to achieve.

Clear advertising channels do not, however, convince potential customers to accept the technology. From our survey, 61% of people said that proof of the technology working, in terms of other successful projects or installations, was important or very important to them. In order to capitalize on this market characteristic, any hydrokinetic company would need to have succinct data for its target audience before people would accept the technology and consider integrating it. The most important factor for boat owners before they considered the technology would be the impact on the performance of the vessel (speed and maneuverability), with 60% of survey takers noting that an impact on performance would be a very important factor in their decision to purchase or install hydrokinetic technologies.

Although the external factors outlined above suggest a viable market segment, our interviews with naval architects, boat builders, and marina owners emphasized that the hydrokinetics industry has not yet engineered a suitable product to meet the needs of boaters. Intensive re-engineering would be required in order to comply with the needs of the customers in this segment, as most hydrokinetics companies currently develop their technologies with large scale energy production in mind. Our research also indicated that a hydrokinetic technology would primarily be of interest to sail users rather than motor users. Motor users have generators installed in larger vessels and a hydrokinetic technology could only be deployed while the boat is anchored or moored. Sail users would benefit more from the technology, as many sailboats do not have onboard generators and rely on battery packs and shore electricity to power equipment. A hydrokinetic device could be deployed while sailing or anchored in a current to power a sailboat's house load.

The watercraft segment highlights key issues for several of the other small hydrokinetics segments such as residential and off-grid solutions. The segments require technology re-engineering since most hydrokinetics companies have engineered their products for large-scale energy production. Additionally, while marketing channels exist, few hydrokinetics companies are actively building awareness in these small consumer application segments.

Green C&I

Key elements of this market included poor ability to identify and differentiate Green C&I and C&I customers. We identified companies and facilities with infrastructure that could support in-pipe or outflow hydrokinetic installations using NPDES permits. NPDES stands for National Pollutant Discharge

Elimination System, and the permit allows for a facility to have an effluent stream into a national water source. Typical NPDES permits cover all intake or outflow pipes at a facility that are used for animal feeding operations, combined sewer overflows, pesticides, pretreatment, sanitary sewer overflows and peak flows, and storm water.[148] We cross-referenced permit lists with self-identified green companies through company websites, sustainability rankings (i.e. Forbes, Business Week reviews), and "green" areas of the country based on census surveys. Lastly, for a more complete review of this segment, we recognized industries with high water usage under the assumption that the infrastructure was available within their facilities. The industry leaders for water usage in the United States are paper and pulp manufacturers, primary metals manufacturers, chemical production companies, nuclear power generation facilities, electrical power utilities, irrigation districts, and petroleum refineries.[149] Industry specific associations such as SOCMA,[150] AFA,[151] and PPMA[152] were contacted to help solicit sustainability directors within target companies.

Based on the methodology above, we achieved a 20% response rate. Of those surveyed, 33% conveyed that their company had not considered renewable energy. Another 21% noted that renewable energy was impractical for their company.

Cost was the main reason most companies avoided renewable energy resources, with 78% of those that were not looking into renewable energy technologies indicating the cost of the technology was not acceptable. Additionally, Green C&I and C&I customers were looking for short payback periods, with 88% of those surveyed looking for a zero to two year payback period on renewable energy technologies before they would consider purchasing. Shorter payback periods and higher cost sensitivity would prevent many early stage hydrokinetic companies from pursuing this market. Another notable result was that 0% of respondents were willing to accept a payback period longer than 10 years. Short payback expectations highlight private industry concerns with internal financing, where equipment is preferentially amortized over shorter time spans, as well as private companies having limited access state and federal subsidies to offset the costs of renewable energy projects.

We also tested whether or not marketing channels were well defined within the Green C&I and C&I segments. There were no correlations between channels that the customers used to learn about renewable technologies and renewable energy practices at the company. Additionally, there were no leading marketing channels, with customers relying heavily on local engineering and consulting groups, a myriad of industry associations, tradeshows, journals, and word of mouth. These results are not surprising as respondents operate in different spheres depending on their product or service. We did find, however, that many companies were aware of state-wide initiatives and occasionally looked to state programs or associations for information on alternative energy solutions. State information sources, however, were never the sole source of information for any of these groups, and state based regulations and initiatives were not key drivers for pushing sustainability initiatives within the surveyed

[148] About NPDES; http://cfpub.epa.gov/npdes/about.cfm?program_id=0; Accessed June 13, 2010.
[149] Confidential interview with DOE. June 2010.
[150] Society of Chemical Manufacturers and Affiliates; http://www.socma.com/; Contacted via phone, June 2010.
[151] American Farmer's Association; http://www.americanfarmersassociation.com/; Contacted via phone, June 2010.
[152] Pulp and Paper Manufacturers Association; http://www.ppmausa.com/; Contacted via phone, June 2010.

private industries. A partial explanation for lack of state influence can be attributed to the fact that larger companies operate several facilities across states boundaries, leading to the conclusion that internal company policies are not always aligned with individual state initiatives.

Green C&I and C&I, however, preferred shorter evaluation and installation times relative to other medium sized segments. 42% of respondents said they would be able to evaluate a hydrokinetic technology within six months or less, and 61% would want it installed in less than one year. Quick evaluation and installation desires indicate that the segments would be able to execute on deals quickly, the key challenges being the ability identify facilities that would be capable of undertaking these projects.

The Green C&I and C&I segments highlight the marketing and cost restraints facing the hydrokinetic industry in medium sized private hydrokinetic projects. The hydrokinetic industry must improve on payback periods, marketing techniques, and cost models to attract this customer base.

Public Works

The public works segment is a model example of a large-scale hydrokinetics segment and highlights barriers including regulatory challenges, capital restraints, customer education, and long project lifecycles facing hydrokinetic companies. With a market potential exceeding 3,400 MW,[153] many hydrokinetic companies have focused on public works and similarly large private utility scale segments without fully understanding key risks within the market space.

Our survey of public works facilities indicated foremost a lack of understanding of hydrokinetic technology with 87% of respondents having little to no knowledge of hydrokinetic technology. Additionally, there was general confusion between hydrokinetics and traditional hydropower, with many respondents associating hydrokinetics with the negative connotations of hydropower.

While respondents lacked knowledge of hydrokinetics, 62% still indicated interest in renewable energy technologies including hydrokinetics. Interest was bolstered by actual adoption rates; for instance 22% of wastewater facilities surveyed had already adopted some form of renewable energy. Generally, solar was the first choice of renewable technology with wind and methane/biomass following.

Unlike the C&I segment, where educational and marketing channels were poorly defined, the public sector benefits from 4-5 key national organizations that freely distribute information relative to public facilities sustainability goals and renewable energy. Survey respondents identified organizations such as WERF, ICMA, APWA, and the DOE as prime sources of information on renewable energy trends and technologies. While these organizations exist, few hydrokinetic companies have approached them as potential educational partners.

Adding to customer education challenges, longer project lifecycles constitute another key issue within larger market segments such as public works. While 71% of public works facilities were willing to accept a payback in excess of 5 years, 88% of organizations believed they would require more than 6 months to

[153] Cada, Glenn, et al. Potential Impacts of Hydrokinetic and Wave Energy Conversion Technologies on Aquatic Environments, April 2007, Fisheries, 32, 4: 174-181.

evaluate the technology and 57% would require more than 1 year. Because typical projects can range anywhere from roughly 10 KW to several mega watts, public works and other utility scale projects have complex project lifecycles and capital requirements. Several hydrokinetic companies have noted capital needs exceeding $10 million to finance installations as well as estimated project timelines that span one and a half to seven years.[154]

Small utility scale installations within the public works segment carry significant risk due to purchase models utilized within the industry. Because capital requirements are high, purchasers do not always consider out-right purchase of the hydrokinetic units – instead preferring power purchase agreements (PPAs) where the hydrokinetic company installs, operates, and maintains the hydrokinetic equipment and the end user simply purchases the electricity produced. Hydrokinetic PPAs, while still more dependable than similar agreements used in solar and wind industry utility scale projects, carry some volatility associated with seasonal and annual fluctuations in water patterns. Because long-term O&M costs, environmental, and geographical factors to operating a PPA are poorly understood hydrokinetic companies often pursue PPA type revenue models without fully understanding risks or the extent of realizable profits.

Conclusion

Hydrokinetic technologies offer a unique solution to tap into energy reserves that were once elusive for the hydropower industry. The hydrokinetics market is still undeveloped and companies that find the right mix of marketing, technological innovation, and project management are bound to emerge as industry leaders. However, several key obstacles must be realized and overcome in order for the hydrokinetics industry to grow. Of particular importance are public and consumer education and government support through sustainability initiatives, grants, and funding. In addition, a streamlined regulatory process will increase the appeal of hydrokinetics projects to consumers while allowing developers to bring hydrokinetic energy generation projects to completion on time and on budget. Without continued support from private and public sector enterprises, the hydrokinetics industry will continue to lag behind other renewable technologies such as solar and wind. Initial success in the hydrokinetics business will not be realized in terms of monetary gains for hydrokinetic enterprises, but through widespread recognition and adoption hydrokinetic technologies and installations alongside wind and solar projects.

While hydrokinetic technologies are not the final solution to the U.S.'s energy independence and sustainability problems, they can provide clean, renewable, dependable electricity to millions of citizens and thousands of enterprises across America. Hydrokinetic technology, as a cornerstone of the CleanTech industry, should also be considered a promising asset in the U.S.'s renewable energy portfolio.

[154] Confidential Industry Interview, 2010.

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Zoomerang Survey Results

University of Connecticut: Luxury Watercraft

Response Status: Completes | Partials
Filter: No filter applied
Aug 03, 2010 10:31 AM PST

1. I own a motor and/or sail boat(s):		
Motor	28	24%
Sail	60	51%
Both	16	14%
Neither	13	11%
Total	117	100%

2. My boat/yacht/vessel is the following length (ft):		
Less than 25'	23	32%
25-35'	29	41%
36-45'	13	18%
46-65'	4	6%
66-100'	0	0%
100+	2	3%
Total	71	100%

3. I use my vessel for recreational and/or commercial purposes:		
Recreational	72	92%
Commercial	1	1%
Both	5	6%
Total	78	100%

4. I use my vessel:		
Every day	8	10%
A few times a week	20	26%
A few times a month	20	26%
Seasonally	29	38%
Less than once a year	0	0%
Total	77	100%

6. I have the following types of equipment onboard my vessel:		
Refrigerator	28	42%
Electric Stove or Microwave	21	32%
Pumps	49	74%
Navigational equipment	57	86%
Television	15	23%
Water Heater	30	45%
Air Conditioning	17	26%
Lighting	59	89%
Water Purification System	13	20%
Other and additional, please specify	15	23%

7. I have considered renewable energy for my vessel:		
No, I am not considering renewable energy.	20	26%
Yes, but I have found it impractical for us.	12	15%
Yes, but I have not identified a good solution.	21	27%
Yes, and I am ready to purchase.	3	4%
Yes, and I already use renewable energy on my vessel.	22	28%
Total	78	100%

8. I decided not to consider renewable energy for the following reason (check all that apply):

Aesthetics	0	0%
Too costly	9	50%
Affects boat's performance	7	39%
Too hard to install	4	22%
Power output too low	4	22%
Power output not dependable	5	28%

9. I considered the following types or renewable energy for my boat (check all that apply):		
Solar	28	85%
Wind	13	39%
Water	4	12%
Other, please specify	5	15%

10. I have installed or plan to install the following types of renewable energy (check all that apply):		
Solar	31	72%
Wind	20	47%
Water	6	14%
Other, please specify	8	19%

The following questions will ask you about hydrokinetic energy. A hydrokinetic power harvester is a device which can convert the energy in moving water into useable electricity without significantly impacting the performance of your boat. Small, portable or fixed hydrokinetic technologies can be installed under or aft of your boat and produce from 100 watts to 2 kilo watts of power when the boat is underway or anchored in currents.

11. The following factors would be very important in my considerations to purchase a hydrokinetic product:

Top number is the count of respondents selecting the option. Bottom % is percent of the total respondents selecting the option.	**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
Aesthetics of device	10	6	21	18	12
	15%	9%	31%	27%	18%
Warranty and maintenance requirements	3	4	3	29	27
	5%	6%	5%	44%	41%

Price of device	3	0	6	18	40
	4%	0%	9%	27%	60%
Ease of installation and use	4	0	10	27	26
	6%	0%	15%	40%	39%
Impact on boat's performance	2	4	4	17	40
	3%	6%	6%	25%	60%
Commercially proven technology	3	5	18	20	21
	4%	7%	27%	30%	31%
Reputation of the manufacturer	3	7	15	25	17
	4%	10%	22%	37%	25%
Desire to be environmentally friendly	4	9	12	18	24
	6%	13%	18%	27%	36%

12. I reside in the following state:		
Alabama	1	2%
Alaska	0	0%
Arizona	0	0%
Arkansas	0	0%
California	7	11%
Colorado	0	0%
Connecticut	11	18%
Delaware	0	0%
Florida	4	6%
Georgia	0	0%
Hawaii	0	0%
Idaho	1	2%
Illinois	1	2%
Indiana	0	0%
Iowa	0	0%
Kansas	0	0%
Kentucky	0	0%
Louisiana	0	0%
Maine	1	2%
Maryland	6	10%
Massachusetts	8	13%
Michigan	0	0%
Minnesota	0	0%
Mississippi	0	0%
Missouri	1	2%
Montana	1	2%
Nebraska	0	0%
Nevada	0	0%

New Hampshire	0	0%
New Jersey	2	3%
New Mexico	0	0%
New York	6	10%
North Carolina	0	0%
North Dakota	0	0%
Ohio	2	3%
Oklahoma	0	0%
Oregon	1	2%
Pennsylvania	1	2%
Rhode Island	1	2%
South Carolina	2	3%
South Dakota	0	0%
Tennessee	0	0%
Texas	2	3%
Utah	0	0%
Vermont	0	0%
Virginia	1	2%
Washington	2	3%
West Virginia	0	0%
Wisconsin	0	0%
Wyoming	0	0%
Total	62	100%

5. I obtain information for yacht accessories, upgrades and technologies from the following (please be specific, associations, magazines, retail locations, internet, forums, etc.):

#	Response
1	magazines and word of mouth
2	trade publications, internet
3	Magazines, internet, retail locations
4	magazines
5	internet, forums
6	Da internet
7	Y&Y
8	soundings, sail, defender industries
9	national fishmen defenders boayyard
10	everywhere
11	Internet, West Marine.
12	internet, forums
13	Internet; BoatsUS; West Marine; Downwind Marine; Latitude 38; Sailing and Cruising Forum; World Cruising and Sailing Forum.
14	CRUISERS FORUM, INTERNET IN GENERAL AND GOOGLE.
15	Forums, internet
16	SSCA, Practical Sailor, Ocean Navigator, Bluewater Sailing, etc.
17	Boat US, Cruiser's forum, talking with other boaters
18	Sail Magazine, Good Old Boat Magazine, Cruising World Magazine, Cruisers Forum, Sailnet
19	Practical Boat Owner
20	From my family, yacht club, and other boaters
21	magazines, internet
22	West Marine, ABA
23	WindCheck Magazine
24	magazines, retail, internet, word-of-mouth
25	internet forums, Practical Sailor, retail locations, other boaters
26	magazines, retail locations, internet, forums
27	internet, retail locations (fisheries supply, west marine), sailinganarchy.com
28	US Sailing. Flying Scot Sailing Association (FSSA.com) Internet Searches on Specific Topics. Word of Mouth
29	Boat US west mrine
30	Sailing World, Seahorse, Cruising World magazines Scuttlebutt, Sailing Anarchy Google Local retail, ie Rex Marine in Norwalk and Landfall and Hathaway's in Stamford
31	Latitude 38
32	West Marine, Boat US, ABA
33	Annapolis performance sailing website and emails Various internet news
34	US Boat Internet Boston Whaler Forum
35	Boat US, West Marine Catalogue, Trailer Boats (magazine) Sail Anarchy, Latitude 38
36	I own a naval architecture firm.
37	Sail Magazine, West Marine stores, Boat U.S.,
38	online information (websites, newsletters, community sites, e-mails), as well as printed magazines and word-of-relevant-mouth

39	magazines, internet, sailing associations
40	Boat US publications; Cape Dory discussion board (capedory.org); yacht club friends
41	Practical Sailor Magazine, Sail Magazine, Boat US, US Sailing, sailing Anarchy web site, Scuttlebut e-mail, Speed & Smarts e-mail
42	Boat Shows, Marine stores
43	Sail and Cruising World magazine
44	magazines
45	as for upgrades I look to whats new on the market, as a matter of fact I am looking to get in to boat repair, upgrading ETC.
46	too many to list!
47	Magazines(Sail, Sailing, Sailing World, Cruising World and Good Old Boat)
48	Internet, Magazines, Retail stores, other sailors
49	Internet, west marine and boat US
50	BOAT/US,US SAILING, SAILING ,BOATOWNERS.COM SAILING WORLD, WEST MARINE-DANVERS MA, DEFENDER CATALOGUE, HAMILTON MARINE CATALOGUE, NAUTICAL TRADERS-SALEM MA.
51	sailnet, westmarine,
52	Hatteras forums, boattest.com,

Zoomerang Survey Results

University of Connecticut

Response Status: Completes | Partials
Filter: No filter applied
Aug 03, 2010 7:38 AM PST

1. My facility pays the following price per kWh for electricity:		
Less than 5 cents	5	5%
5 to 10 cents	19	18%
10 to 15 cents	40	37%
15 to 20 cents	7	6%
More than 20 cents	0	0%
Don't know	37	34%
Total	108	100%

2. My organization has considered renewable energy at our facility:		
No, we are not considering renewable energy.	37	33%
Yes, but we have found it impractical for us.	23	21%
Yes, but we have not identified a good solution.	23	21%
Yes, and we are ready to purchase.	8	7%
Yes, and we already have renewable energy at our facility.	20	18%
Total	111	100%

4. My facility has not considered renewable energy for the following reasons: (Check all that apply)		
Too costly	18	78%
Sustainability a low priority	13	57%
Technology hard to integrate	5	22%
Power output too low	4	17%
Power output not dependable	2	9%

5. A payback period is the length of time required to recover an initial investment. My organization would require the following payback period before we considered a renewable energy project at our facility:		
0-1 years	18	51%
1-2 years	13	37%
2-4 years	3	9%
5-10 years	0	0%
More than 10 years	0	0%
Does not matter	1	3%
Total	35	100%

6. My organization has considered the following renewable energy sources: (Check all that apply)		
Solar	33	79%
Wind	29	69%
Water	10	24%
Methane/Biomass	9	21%
Other, please specify	7	17%

8. A payback period is the length of time required to recover an initial investment. My organization would want the following payback period before we considered a renewable energy project at our facility:		
0-1 years	2	5%
1-2 years	10	24%
2-4 years	18	43%
5-10 years	8	19%
More than 10 years	0	0%
Does not matter	4	10%
Total	42	100%

9. My organization plans to install or has installed the following renewable energy sources at our facility: (Check all that apply)		
Solar	32	62%
Wind	19	37%

Water	8	15%
Methane/Biomass	12	23%
Other, please specify	15	29%

11. A payback period is the length of time required to recover an initial investment. My organization expects the renewable energy project we have installed or will install to have the following payback period:		
0-1 years	2	4%
1-2 years	10	18%
2-4 years	20	35%
5-10 years	13	23%
More than 10 years	1	2%
Does not matter	11	19%
Total	57	100%

The following questions will ask you about hydrokinetic energy. A hydrokinetic energy harvester is a device which can convert the energy in flowing water into useable electricity without damming or pressurizing. Hydrokinetic technologies can be installed in various environments including pipes, free-flowing streams, rivers, and man-made canals or aqueducts. Hydrokinetic power harvesters can produce from 100 watts to several mega watts of power.

12. I have previously heard of hydrokinetic technologies:		
Yes, I am very familiar with hydrokinetic technologies.	12	12%
Yes, but I have little knowledge on hydrokinetic technologies.	34	35%
No, I had never heard of hydrokinetic technologies before this survey.	52	53%
Total	98	100%

13. If my facility were to consider adopting a hydrokinetic energy harvester, I would have the following impact in the decision making process:		
I have the final say in the purchase decision.	25	26%
I make the decision in conjunction with others.	44	45%
I influence the decision.	21	21%
I have little influence over the decision.	5	5%
I do not influence the purchase decision.	3	3%

Total	98	100%

14. My organization considers the following factors to be very important in determining whether to purchase a hydrokinetic technology:

Top number is the count of respondents selecting the option. Bottom % is percent of the total respondents selecting the option.	**Strongly Disagree**	**Disagree**	**Neither Agree or Disagree**	**Agree**	**Strongly Agree**
Cost	6	1	0	25	61
	6%	1%	0%	27%	66%
Power output	2	2	9	31	48
	2%	2%	10%	34%	52%
Ease of integration within your facility	1	1	16	42	32
	1%	1%	17%	46%	35%
Commercially proven technology	3	8	31	39	12
	3%	9%	33%	42%	13%
Reputation of the manufacturer	5	25	23	26	14
	5%	27%	25%	28%	15%
Environmental friendliness or social responsibilities	9	9	11	25	38
	10%	10%	12%	27%	41%

15. My organization could evaluate a hydrokinetic technology in the following time frame:

Less than 6 months	41	42%
6 months to a year	33	34%
1 to 2 years	13	13%
2 to 4 years	4	4%
More than 4 years	6	6%
Total	97	100%

16. If we decided to purchase a hydrokinetic technology, my organization would want it installed in the following time frame:

Less than 1 year	60	61%
1 to 2 years	24	24%
More than 2 years	14	14%
Total	98	100%

18. My job duties can be best described as:		
Management	55	57%
Engineering	7	7%
Operations & Maintenance	12	12%
Green & Sustainability Initiatives	13	14%
Other	9	9%
Total	96	100%

19. My facility is located in the following state:		
Alabama	1	1%
Alaska	0	0%
Arizona	3	3%
Arkansas	0	0%
California	2	2%
Colorado	0	0%
Connecticut	7	7%
Delaware	0	0%
Florida	0	0%
Georgia	0	0%
Hawaii	0	0%
Idaho	0	0%
Illinois	0	0%
Indiana	0	0%
Iowa	0	0%
Kansas	0	0%
Kentucky	0	0%
Louisiana	0	0%
Maine	29	29%
Maryland	0	0%
Massachusetts	2	2%
Michigan	3	3%
Minnesota	0	0%
Mississippi	0	0%
Missouri	0	0%
Montana	0	0%
Nebraska	0	0%
Nevada	1	1%

New Hampshire	0	0%
New Jersey	0	0%
New Mexico	0	0%
New York	1	1%
North Carolina	0	0%
North Dakota	0	0%
Ohio	0	0%
Oklahoma	0	0%
Oregon	0	0%
Pennsylvania	20	20%
Rhode Island	18	18%
South Carolina	12	12%
South Dakota	0	0%
Tennessee	0	0%
Texas	0	0%
Utah	0	0%
Vermont	0	0%
Virginia	0	0%
Washington	1	1%
West Virginia	0	0%
Wisconsin	0	0%
Wyoming	0	0%
Total	100	100%

3. I receive information on alternative energy and green products from the following places (please be specific; e.g. associations, journals, conventions, websites, forums, etc.):

#	Response
1	private consultant
2	a lot of different sources vendors, seminars, webinars by utilities, customers
3	Hired Consultants
4	Maine Pulp & Paper Assoc, Univ of Maine - Pulp & Paper Foundation, TAPPI
5	require suppliers to be proactive in supply nuclear news magazine power industry magazines
6	consultants
7	consultant
8	consultant
9	consultant at corporate level
10	Conference for hatchery and salt water site managers; Global Trust
11	Efficiency Maine
12	internet
13	energy engineers for my company
14	Home Energy magazine
15	Water Digest
16	Green Engine Program at UTC
17	Vendors and their newsletters
18	Colleagues
19	Industrial magazines like Pollution Control
20	PASA- PA assoc for sustainable ag Acres magazine
21	Pennsylvania Association for Sustainable Agriculture Penn Future
22	mostly web searches, PA government website, Penn state website, Penn state extension Office
23	Several farm/homesteading publications and organic farming conferences.
24	email listservs
25	Pa Assoc. of Sustinable Agriculture Chester County Citizens for Climate Control
26	websites
27	professional associations, contacts, friends in the business.
28	The Innovation Center for U.S. Dairy, Pure Strategies (consulting firm), Energy Maine, various magazines, webinars, etc.
29	Solar Power Today
30	ALl
31	PSU Renewable Energy Extension Working Group American Society of Agronomy
32	Local power company websites, company website, GOOGLE etc
33	magazines, internet, seminars
34	Seminars, Vegetable Growers News
35	give me a break
36	Suppliers at Ag Progress Days at Penn State and Empire Farm Days, NY
37	Pa Association for Sustainable Ag; Draft Animal Power online forum, Rural Heritage and Small Farmer's Journal magazines.
38	Mid-Atlantic Renewable Energy Association ATTRA
39	conferences, websites
40	USGBC, GBA of Pittsburgh, and many other sources

41	NYSERDA
42	Internet Mother earth news
43	na, not an organization, am interested in your research as we have a significant stream on our property. I was looking at the "Screw technology " to produce energy today.
44	Associations, journals, conventions, websites, newsletters
45	Yahoo Groups (Solarheat, Simply Solar, Little Houses, etc) Magazines (Mother Earth News) Websites
46	websites
47	All of the above
48	PASA
49	google search and then drove around and flew around to meet with companies
50	journals, conventions, internet

7. My facility considered renewable energy technologies for the following reasons:

#	Response
1	The dam is already there.
2	Lower electricity cost
3	cost
4	generate cheaper electricity
5	Green initiatives
6	Impractical as they did not have the area
7	lower cost; sustainability goals--but no real movement on them
8	Lower the electricity bill & meet sustainability goals
9	Lower costs and meet sustainability goals
10	Meet sustainability goals but ineffecient and don't make sense economically and payback period too long
11	lower electricity bill
12	Safety reason--getting away from the volatility of fossils fuels
13	economic reasons
14	Save money and improve image
15	we own a historic mill with intact raceway(non working water wheel)that we would like to preserve as living history. There is a significant creek here but dams are broken & creek path has changed over the years. We also have alot of barn roof space that we think would be ideal for solar.
16	conserve energy, save money, become grid independent
17	Economics, sustainability, independence
18	High production costs and insuring financial sustainability for the future.
19	conservation and pollution reduction
20	political pressure
21	Reduce the need for carbon based energy sources, possibly reduce future costs of energy required to power our facility.
22	We are in a very sunny part of the country, it made sense.
23	Cost and reduce carbon footprint
24	sustainability and community development
25	cost, sustainability, self-reliance
26	reduce monthly expenses, help reduce dependence on foreign oil
27	It makes sense not to depend on fossil fuels
28	dependance on off farm enery suppliers, price, CO2 emissions
29	we are not an organization but a home
30	sustainability, economy, robustness (future shortages & price spikes)
31	desire to see carbon at 280ppm
32	Green House Gas metric
33	environmental consciousness; savings 9in the long run) ; sustainability
34	Be more green
35	to be green

10. My facility installed or plans to install renewable energy technologies for the following reasons:

#	Response
1	Lower electricity costs
2	geothermal, solar
3	Lower energy cost
4	cost
5	Not planning to install as it's too costly and payback period is too long
6	Green intiatives
7	Impractical as did not have the area
8	desire to be GREEN
9	corporate sustainability initiative
10	Heavy part of future - fuel development, long-term production and development of renewable energy, reputation as green company, natural fit for vision
11	reduces hotel load, carbon footprint, as a utility renewable energy policy, want renewables
12	cost and sustainability goals
13	Save $$$$ on electricity
14	ecocertification goals through the Global Trust, lower carbon footprint
15	Lower carbon footprint
16	lower electricity bill
17	economic reasons
18	To lower electricity/heating bills.
19	Meet sustainability goals, be a leader in our industry, public image
20	Good return on investment, lessen our impact on the planet
21	save money
22	Becoming greener
23	Save money utilize available "green" energy to protect ecological health, reduce dependence on an unsustainable system
24	NA
25	High production costs and financial sustainability
26	Save carbon, save money, walk the talk
27	To reduce our carbon footprint and meet energy and water saving goals.
28	Reduce our dependence on coal generated electricity
29	Only makes since .
30	See earlier reasons
31	carbon footprint
32	Lower costs, decrease CO2 emissions, product advertising
33	Save money
34	reduce fossil fuel use good educational opportunity increase market share question 6 doesn't make sense, each technology has a seperate length of time
35	We have animals (horses and people) already, and all could use a little exercise.
36	Show leadership save money go green save the planet change the world differentiate our company from others get more business do the right thing.
37	Good winds at my site. Have 4 ponds, a 6 ft drop, a 12 ft drop, a 8 ft drop, a 10 ft drop from the dam overflows. Would like info on how to develop this resource!
38	dependance on off farm energy suppliers, price, CO2 emissions

39	not an organization but a family
40	be more green AND save money
41	sustainability, economy, robustness (future price spikes & shortages)
42	reduce carbon footprint, make operation sustainable after peak oil
43	Reduce Green House Gas emmissions
44	1) To eliminate future increases in the cost of electricity 2) To take advantage of Net metering FIT of .30 a kw 3) To reduce the carbon footprint of the facility
45	sustability
46	Be more green.
47	save $ while meeting sustainability goals

17. My job title is:

#	Response
1	CEO
2	Facilities Manager
3	Chief Engineer
4	Terminal Manager
5	Vice-President
6	Owner
7	Engineer
8	Environmental Director
9	Director
10	Vice-President
11	Environmental Director
12	CEO
13	Executive Director
14	Office Manager
15	Town Manager
16	Town Manager
17	Environmental Director
18	Environmental Engineer
19	Environmental Manager
20	Director of Energy
21	Supply Chain Manager
22	Energy Manager
23	Owner
24	Manager of Environmental Health & Safety
25	Environmental Engineer
26	Facilities Manager
27	Owner
28	Owner
29	Hatchery Manager
30	Hatchery Manager
31	Bookkeeper
32	Plant Manager
33	Owner
34	Plant Manager
35	Solid Waste Director
36	Manager
37	Energy Director
38	Owner/President
39	Facilities Manager
40	Energy Engineer
41	Superintendent of QA
42	Environment Engineer
43	Environmental Coordinator

44	President
45	Chief Engineer
46	Environmental Manager
47	co-owner/ farmer
48	Farm and Marketing manager
49	Owner/Operator
50	owner/operator
51	Chair, Ambler Environmental Advisory Council
52	Co-owner/Operator
53	owner
54	Environmental Director
55	environmental analyst
56	Director of MaineHousing
57	Executive Vice President and Chief Operating Officer, Owner
58	Farmer
59	GM
60	Senior Research Associate/Affiliate Instructor
61	Plant Manager
62	Energy Manager
63	Master Plumber
64	Owner
65	Sustanability Coordinator
66	Owner/Farmer
67	veterinary pathologist ; part time sustainable farmer
68	Technical Manager
69	CEO
70	Owner
71	President
72	Owner
73	Stockman/cheesemaker
74	head of household
75	Director of Sustainability
76	CEO
77	owner
78	farm manager
79	Manager of Environment Health & Safety
80	Principe
81	Facilities Manager
82	Owner
83	Owner
84	Owner
85	Manager
86	Manager
87	Co-Owner
88	Environmental
89	Operations Engineer

90	Maintenance Manager
91	Operations Engineer
92	Chemist
93	Owner
94	Director of Sustainability
95	Director
96	MGR

Zoomerang Survey Results

University of Connecticut

Response Status: Completes | Partials
Filter: No filter applied
Aug 03, 2010 7:17 AM PST

1. My organization works with the following water resource(s): (Check all that apply)		
Waste water treatment	425	69%
Aqueducts	33	5%
Irrigation canals	79	13%
Dams	155	25%
Other, please specify	223	36%

2. My facility pays the following price per kWh for electricity:		
Less than 5 cents	36	5%
5 to 10 cents	231	35%
10 to 15 cents	126	19%
15 to 20 cents	24	4%
More than 20 cents	6	1%
Not Sure	233	36%
Total	656	100%

3. My facility has considered renewable energy:		
No, we are not considering renewable energy.	177	26%
Yes, but we have found it impractical for us.	82	12%
Yes, but we have not identified a good solution.	241	35%
Yes, and we are ready to purchase.	48	7%
Yes, and we already have renewable energy at our facility.	140	20%
Total	688	100%

5. My organization has not considered renewable energy at my facility for the following reasons: (Check all that apply)		
Too costly	67	60%
Sustainability not top priority	49	44%
Technology too hard to integrate	19	17%
Insufficient power output	18	16%
Unreliable power output	12	11%

6. A payback period is the length of time required to recover an initial investment. My organization would require the following payback period before we considered a renewable energy project at our facility:		
0-1 years	7	6%
1-2 years	14	12%
2-4 years	14	12%
5-10 years	34	28%
More than 10 years	4	3%
Does not matter	47	39%
Total	120	100%

7. My organization has considered the following types of renewable energy: (Check all that apply)		
Solar	212	70%
Wind	142	47%
Water	74	24%
Methane/Biomass	100	33%
Other or additional, please specify	31	10%

9. A payback period is the length of time required to recover an initial investment. My organization would want the following payback period before we considered a renewable energy project at our facility:		
0-1 years	7	2%
1-2 years	19	7%
2-4 years	79	27%
5-10 years	140	48%

More than 10 years	25	9%
Does not matter	19	7%
Total	289	100%

10. My organization plans to install or has installed the following renewable energy sources at our facility: (Check all that apply)		
Solar	107	60%
Wind	34	19%
Water	31	17%
Methane/Biomass	85	47%
Other or additional, please specify	36	20%

12. A payback period is the length of time required to recover an initial investment. We expect the renewable energy project we have installed or will install at our facility will have the following payback period:		
0-1 years	6	4%
1-2 years	6	4%
2-4 years	24	15%
5-10 years	62	38%
More than 10 years	37	23%
Does not matter	27	17%
Total	162	100%

The following questions will ask you about hydrokinetic energy. A hydrokinetic power harvester is a device which can convert the energy in flowing water into useable electricity without damming or pressurizing, unlike conventional hydro power. Hydrokinetic technologies can be installed in various environments including pipes, man-made canals or aqueducts. Hydrokinetic power harvesters can produce from 100 watts to several mega watts of power.

13. I have heard of hydrokinetic technologies:		
Yes, I am familiar with hydrokinetic technologies.	67	13%
Yes, but I have little knowledge of hydrokinetic technologies.	196	39%
No, I had never heard of hydrokinetic technologies before this survey.	246	48%
Total	509	100%

14. I would have the following impact, if my facility were to consider adopting a hydrokinetic energy harvester:		
I have the final say in the purchase decision.	24	5%
I make the decision in conjunction with others.	117	23%
I influence the decision.	232	46%
I have little influence over the decision.	60	12%
I do not influence the decision.	72	14%
Total	505	100%

15. My organization considers the following factors to be very important in determining whether to purchase a hydrokinetic technology:					
Top number is the count of respondents selecting the option. Bottom % is percent of the total respondents selecting the option.	**Strongly Disagree**	**Disagree**	**Neither Agree nor Disagree**	**Agree**	**Strongly Agree**
Cost	15 3%	1 0%	37 8%	127 26%	305 63%
Power output	6 1%	7 1%	89 19%	226 47%	151 32%
Ease of integration within your facility	10 2%	7 1%	60 12%	208 43%	199 41%
Commercially proven technology	10 2%	8 2%	75 16%	184 38%	206 43%
Reputation of the manufacturer	8 2%	12 2%	109 23%	209 44%	142 30%
Environmental friendliness or social responsibilities	9 2%	19 4%	98 20%	186 39%	169 35%

16. My organization could evaluate a hydrokinetic technology in the following time frame:		
Less than 6 months	55	12%
6 months to a year	142	31%
1-2 years	135	29%
2-4 years	65	14%
More than 4 years	65	14%
Total	462	100%

17. If we decided to purchase a hydrokinetic technology, my organization would want it installed in the following time frame:		
Less than 3 months	14	3%
3 to 6 months	45	10%
6 months to a year	94	21%
1 to 2 years	162	36%
More than 2 years	140	31%
Total	455	100%

19. My job duties are best described as:		
Management	299	60%
Engineering	79	16%
Operations & Maintenance	46	9%
Green & Sustainability Initiatives	21	4%
Other	55	11%
Total	500	100%

20. My facility is located in the following state:		
Alabama	2	0%
Alaska	2	0%
Arizona	11	2%
Arkansas	5	1%
California	49	10%
Colorado	10	2%
Connecticut	18	4%
Delaware	4	1%
Florida	66	14%
Georgia	8	2%
Hawaii	1	0%
Idaho	8	2%
Illinois	10	2%
Indiana	6	1%
Iowa	9	2%

Kansas	18	4%
Kentucky	5	1%
Louisiana	0	0%
Maine	6	1%
Maryland	7	1%
Massachusetts	8	2%
Michigan	14	3%
Minnesota	10	2%
Mississippi	0	0%
Missouri	18	4%
Montana	2	0%
Nebraska	2	0%
Nevada	9	2%
New Hampshire	7	1%
New Jersey	6	1%
New Mexico	2	0%
New York	9	2%
North Carolina	29	6%
North Dakota	3	1%
Ohio	7	1%
Oklahoma	6	1%
Oregon	12	2%
Pennsylvania	11	2%
Rhode Island	3	1%
South Carolina	5	1%
South Dakota	2	0%
Tennessee	2	0%
Texas	13	3%
Utah	6	1%
Vermont	21	4%
Virginia	14	3%
Washington	14	3%
West Virginia	2	0%
Wisconsin	5	1%
Wyoming	1	0%
Total	488	100%

4. I receive information on alternative energy and green products and initiatives for my facility from the following: (please be specific; e.g. associations, journals, conventions, websites, forums, etc.)?

#	Response
1	journals, electrical company
2	Journals, conventions, engineers, salesmen for wind energy
3	Trade journals
4	None
5	Meeting with power plant directors. Meeting with our utility supplies for economic development (Westar).
6	AWWA, KRWA
7	WEF, Consulting Engineers, e.g. Wright Pierce, State Association
8	Associations, journals, and conventions.
9	Notices from state and federal government (NYSERDA and NYPA) Energy Savings Program (Green Innovative) Engr. Consultants (Rover and Assoc., Sterns and Wheeler)
10	utility companies, energy office, journals, websites,
11	websites
12	Department of Enviromental Protection.
13	most of that offered and typical media.
14	too numerous to list
15	Ruralite
16	http://www.solarnv.org/ http://www.thinkenergystar.com/ http://www.dsireusa.org/ http://www.eia.doe.gov/
17	all of the above
18	journals
19	Water Science and Technology Water Utility Management International Florida Water Environment Association (FWEA)
20	N/A
21	Nope.
22	I personally am extremely interested in renewable energy and green products.
23	ee
24	Vendors, other state agency
25	web sites journals
26	na
27	website and local news outlets
28	TPO Magazine has some infortmation about renewable energy in facilities from time to time.
29	Internal e-mails from my agency.
30	Journals , Websites and Email notifications.
31	IDEA- International Distric Energy Association
32	Independant research
33	A variety of state, local and federal contacts who send me links. I attend a county-wide and state-wide conferences several times each year.
34	VLCT Town Energy Committee
35	Northwest Energy Efficiency Alliance The Northwest Power and Conservation Council creates a Northwest Reional power plan every five years and conservation and renewables are the priority

	resources.
36	NYSERDA, NYPA, Green Innovative program in NY, Sterns & Wheeler, Rover & Associates
37	Websites.
38	e-mails
39	None
40	n/a
41	Although I am not certain about renewable energy plans the agency I work for has, I need up-to-date information for my private engineering practice. Collaboration is welcomed through the following e-mail address: vardryaustin@bellsouth.net
42	The Turnpike Enterprise Communicator Paper, and e-mail messages from time to time.
43	Do not receive
44	various
45	e&e publishing greenwire; websites; forums
46	associations, websites, listserves
47	BOMI/BOMA, SOUTH FLORIDA FACILITIES TODAY..
48	yes
49	all of the above
50	journals, websites
51	Journals, forums, websites, meetings
52	NC Denr, Magazines, State Energy Conferences, NC State University, the NC Center for the Environment, the NC Solar Center
53	websites, individuals
54	Science Journal, Green News,Stormwater, water efficiency.
55	journal pubs, conferences
56	Recycle Coordinator
57	TV, Magazines, Radio
58	Journals, seminars, websites, networking.
59	mother earth news
60	FDEP memos and directives
61	Journals
62	journals,associations
63	Recycling
64	WERF
65	I do not receive information for my facility
66	I agree that there is good reason to find alternate power sources, but as for this excessive green kick,, I dont believe that there is global warming. I think it is man made idea to create a massive "the sky is falling" tactic. There is proof that there were samples of fake info at high levels driving this information. Those who believe in "gloabal warming" REFUSE to look at "ALL" the facts and info. Not to mention, they state that there has been an increase in the average world wide temp. yet, they dont have the data as to what it was before that. There is no way to actually find that info,, "world wide" so was the average temp for the past 2 or 3 centuries lower or higher. If it were actually higher, then the temps are going back to normal. No one wants to go there because it messes up the theory. Why has there been evidence from NASA about higher temps on Mars and the Moon. Proof of solar sun flares, again the dooms day global warming believers dont want to go there either. "IF" there is global warming and everyone is panic stuck over a SLIGHT increase in temp, what if it starts to drop in the next 100 years. We would be back to normal. But what if we spend billions and we find out that it continues to drop in the next 100 years, do we then start

	building more gas fueled cars, or start burning more forest? If all are so concerned about a marginal temp increase, why arent't they screaming about the $13 trillion increase in out debt that will be a much worse crush on the US in the next 100 years and our children dealing with that. Why is one crisis such an issue and they dont have ALL the facts put into a room full of bright scientist but we KNOW full well what the deficit is and where it is going but you and all the rest of you REFUSE to get bent out of shape over that. So I can care less about all the green insanity crap until you all get the REAL facts,, look completely into it to include why so many at the UN quit their jobs when the leaks about false info came out!
67	Websites
68	All of the above. It's difficult to be very specific, as info comes from many different sources. We also get approached by companies/vendors/manufacturers.
69	trade magazines, salesmen, utiltiy emails/websites
70	none
71	Internet, newspaper articles and engineers from our area, sorry no specifics...
72	various public works and electric distribution journals as well as the American Public Power Association and the Missouri Public Utility Alliance.
73	Local Utility
74	journals, websites, in person
75	American Public Works Association
76	Agency
77	Assoications Conventions Web Sites Forums
78	associations
79	n/a
80	None
81	Efficieny Vermont
82	multitude of sources
83	conferences
84	General Industry Sources, WEF, Vendors
85	EPA (CHP Partnership), DOE, USGBC, and WEF
86	NA
87	WEF, WEF, Journals, Conventions, webinars and websites
88	Our power supplier, Portland General Electric, WEF publications
89	Associations
90	journals
91	webinars; conventions; journals; electric utility companies; magazines; articles on the web; our engineers
92	associations, journals, conventions, websites, forums, etc
93	City has green commission, wastewater seminars, EPA
94	No
95	websites, internal info, magazines
96	Associations, websites and forums
97	lots of email newsletters from EPA, HomeBuilders, other state agencies, etc.
98	Websites, WEF, Oregon Association of Clean Water Agencies.
99	Linkedin.com, Inteligent Utiliies, AURI, CERTS, Minnesota Renewable Energy Society, American Solar Energy Society, Sustainability
100	Green Energy Coalition

101	ASES Home Power Mag. Solar Today Vendor sites Dealer sites such as: -Back Woods Solar -NESolar -AltEStore
102	www.energiisolare.com
103	West Texas Wind Energy Consortium Integrity Wind WorldWater and Solar Energy, Inc Many websites
104	Please note: I am responding on behalf of a large industrial firm with hundreds of facilities. Response to Q4 includes World Resources Institute Green Power Market Development Group; EPA Green Power Partners; vendors.
105	journals and conventions
106	associations, journals, conventions, websites, forums, etc
107	Journals and websites
108	When cost effective alternatives become available, I will study them, but until then, I will maintain use of petroleum based energy.
109	emails
110	conferences, Solar, Wind and general renewable industry publications
111	Mother Jones, Wall Street Journal
112	websites.
113	associations, journals, websites, media
114	Journal of Science
115	associations, journals, conventions, websites, forums, Mostly Trade Magazines such as Electrical Contractor Magazine
116	Assoc - AEE, ACEEE, USGBC, VGBN, REV, ASHRAE, CSI Magazines - High Performance Buildings, Green Builder
117	Web sites
118	USEPA's CLU-IN
119	off the internet - doe, Google searching
120	exhibitors local gov't local water co.
121	All of the above
122	Clean Tech
123	Sessions at National Conferences - APWA and Green Cities. Also through publications.
124	none
125	we are a regulatiory agency not an operational agency
126	all forms
127	WEF presentations, Association presentations, Consultant presentations, Papers in journals, Independent papers
128	We at the La Grange Texas office do not, to my understanding, use renewable energy. We should, we have alot of sunny days.
129	NH OEC, PSNH.
130	all of the above
131	associations journals
132	None at this time.
133	various publications and websites.
134	state agencies (DEP), consultants, EPA
135	Newsletter with the electric bill.
136	All the above mentioned plus emails, seminars, sales people, state energy programs, federal grant programs, etc. The products are endless, but usually not focused.

137	associations, websites, forums, listservs
138	Associations, journals, websites
139	American Public Power Association AWEA ASME Iowa Dept Natural Resources Iowa Energy Center
140	associations, state regulatory agency
141	n/a
142	Cedar Falls Utilities is a municipal electric, gas, water and communications utility. We generate electricty from coal, wind, natrual gas, and tiny amount of oil. WE have done R&D on burning biomass in the form of corn cobs, corn stalks, switchgrass, oat hulls, and wood pelets.
143	Vendors, conventions, websites, webinars, magazines
144	Efficiency Maine Constellation New Energy (provider)
145	CT Clean Energy Fund CTGBC USGBC
146	journals and websites
147	This is just for me looking at a career change.
148	Journals and web sites
149	NC Department of Environment and Natural Resources directly in e-mails and mailings
150	waste water and environmental magazines and Idaho Office of Energy Resources
151	trade journals
152	Our own agency (Florida Fish and Wildlife Conservation Commission
153	Varying sources to inlclude websites, articles produced by the maryland Municpal League.
154	I don't think we receive any
155	Consultants, Vendors, Seminars
156	Journals,
157	WEF, Biocycle, WERF
158	associations, vendors, industry, workshops
159	We are currently perfoming a feasibility study for both microhydro power generation and digester gas power generation.
160	No, NRCS does not own facility therefore we have little say in the type of energy used.
161	AWWA, journals, conventions
162	This information is hardly, if ever, distributed.
163	SWANA, journals, sepcialized newsletters, networking
164	Journals, trade publications, conventions, websites
165	EcoTech, Inc., Sea Technology Magazine, Ocean Futures Society, NRDC, Sierra Club, Environment California
166	NEED, solar schoolhouse, clean air challenge
167	Journals, web sites, Popular Science magazine, local media, Pacific Gas and Electric (PG&E),energy fairs, etc.
168	all the above
169	forums: San Diego Association of Governments. There are on going discussions between the city of Tijuana, Mexico and San Diego County. Climate Change, Soft energy paths, air quality, and population structure are all part of the discussion.
170	None
171	Associations: WEF, MWEA Journals: TPO, Polution Engineering, WE&T
172	APPA email, Kentucky Municipal Utilities Assoc., American Municipal Power
173	AWWA and WEF
174	AWWA, WEF, consulting engineers
175	journals

176	Consultants, conferences and conventions, magazines
177	Journal, Consultants, Websites
178	New England Water Works
179	Power Magazine Sustainability Newsletter Water Environment Research Federation WEFTEC US EPA
180	From the Southern CA Alliance of POTWs (SCAP)
181	Vendors, Strand Associates, WEF conferences
182	Please send your information that may be a useful resource in my high School Environmental Science course I will be teaching this next school year. -David Allan Pacific Valley School 69325 Highway 1 Big Sur Ca 93920
183	Annual Conference
184	All
185	trade journals, WEF and CWEA annual conferences
186	whatever may be written in the journal I currently receive: Underground Construction Public Works Water Efficiency
187	Catalyx, Inc.
188	Vermont Efficiency
189	Yes
190	na
191	na
192	journals, conventions, websites, etc.
193	Associations, journals, consulting engineers, APWA, WEF, CWEA, conventions, websites, equipment providers.... anywhere and everywhere
194	N/A
195	journals, conventions, websites, etc
196	WEF, NEWEA, NACWA,ASCE, CSCE, multiple trade journals, consulting engineers
197	Water Environment Federation journal and forums DOE website EPA website
198	Journals and websites.
199	Vendor and professional contacts
200	websites and associations
201	APWA, and various public works related magazines
202	all of the above
203	too many to list
204	All of the above.
205	American Water Works Assn, Water Environment Federation
206	Anything in the library or internet -- too numerous to be specific
207	sustainability colleagues, International Society for Sustainability Professionals (ISSP), Solar City, Energy Trust of Oregon, Partners for a Sustainable Washington County Community (PSWCC)
208	seminars, websites, contractors/providers
209	websites, lectures (UCTV), conferences, articles, consultants, seminars
210	our power provider - Salt River Project; consultants during the design phase for facilities are required to evaluate green products; associations such as AWWA and WEF
211	Trade assocations, websites, journals, architects, engineers, staff
212	associations,mags,conferences,wedsites,newsletters,journals,publications.
213	Vendors, journals, websites, forums and one member of City Council who works for General Electric

214	State Energy Office
215	web sites, emails from suppliers, Universities
216	National League of cities Wholesale power provider
217	Municipal Electric Association of Georgia
218	Missouri Public Utility Association
219	EPA, CT Clean energy fund, trade journals, ICMA
220	Maryland MUnicipal League Energy Consultants
221	My coomunity is a member-owner of PowerSouth Engergy Cooperative, a G&T, and then we sell teh power we purchase wholesale from PS. I sit on the board and therefore have many forums on alternative energy and green products.
222	Associations, journals, conventions, advocates, consultants, contractors, other government entities.
223	Environmental Expert; ASHRAE; BOMA; EERE
224	journals, webinars
225	Associations, various publications
226	Georgia Municipal Association, Georgia Planning Association,
227	ICMA communications, VA Municipal League communications, industry journals
228	conventions, our sewer engineeer, journals
229	readings, internet, meetings
230	Municipal gov't trades, solid waste management trades and websites
231	Our Electric Utility, professional journals, organizations,
232	ICMA, APPA, OMPA, In cooperation with the economic development arm of our organization, Wind Power Association
233	Professional Engineer's Recommendation
234	ICMA,ICLEI, DOE - EERE,Energy Star, EECBG Technical Assistance, Sustainable Jersey
235	All of the above plus we have hired an energy consultant who has obtained grants for performance contracting in our buildings and is formulating solar power
236	organizations, conventions, websites
237	n/a
238	professional associations and journals ie. ICMA, League of KS Municipalities, Governing magazine and various emails, as well as conferences hosted by ICMA, LKM, KACM ect
239	all of the above
240	journals, websites
241	ICLEA, websites
242	American Municipal Power; AWWA; ICMA
243	Regional organizations, journals, suppliers of Elctricity,associations
244	various, trade journals
245	ASHRAE, USGBC, FGBC (Florida Green Building Coalition), Central Florida Solar Roundtable workshops
246	Journals
247	Associations
248	Energy companies
249	multiple sources, non specific sources
250	NYSac alligned vendors and national periodicals and NACO newsletter.
251	DOE/EERE EPA ICMA
252	Vendors and Utilties

253	Wisconsin Public Power, Inc. (WPPI Energy, a regional power company owned by 51 WI, MI and IA municipal utilities, including our city. WI Governor's Office of Energy Independence
254	Conventions and utility companies
255	NYSERDA and Engineering firms
256	APPA, Minnesota Municipal Power Agency
257	journal
258	ICMA
259	NREL
260	on line
261	All of those sources
262	WAPA, MEAN, CAMU, APPA
263	All of the above. If we bought every advertisement I've received we'd spend millions.
264	Building publications, journals and websites.
265	I do not have any reliable sources for information. Salesmen tend to be the main people reaching out to us.
266	Publications and conferences
267	Websites, Forums, Federal, State, and Local governments, NPO's, Green Businesses
268	Arizona Department of Commerce, and Websites
269	All of the above
270	Primarily associations and vendors
271	Other City employees, associations, journals, emails, seminars, conventions, local residents
272	professional publications unsolicited email websites
273	salesmen, forums, e-mails
274	We receive information from trade journals, associations, conventions, websites, vendor visits, meetings with other governmental agencies, etc. Survey Note: The city government has over 90 buildings and many other facilities such as parks.
275	EPA, Google searches, consulting engineers, journals, Johnson Controls
276	Council of Governments Professional Associations Professional and Technical Journals Conventions
277	associations universities
278	ICMA/UCMA conventions and seminars, APA/APA-UT conventions and seminars, websites, trade shows, interactions with renewable energy contractors.
279	Mid-Ohio Regional Planning Commission, various vendors, etc,
280	ICLEI FECC US EPA Team Plan USGBC
281	League of Municipalities conferences, contacts through economic development organizations, cold calls from vendors.
282	Trade publications, NYS DEC,
283	Mass CEC MA DOER
284	Our only energy cost is for street lights,which are utility-owned. We have not been able to agree with the utility as to the value of the lights.
285	Journals
286	journals
287	Emails, websites, etc.
288	all the above
289	Princilpally from engineering firms, consultants and internal resopurces.
290	Dedicated Staff research. We have an energy coordinator whose job it is to minimize energy costs

	and to identify alternative energy sources.
291	associations, journals, conventions, websites, forums
292	journals , newletters and e-mails
293	Journals, vendors
294	associations, journals
295	Local non-profits PG&E websites
296	associations, journals and our own research
297	Suppliers, Journals, Conventions
298	Lots. Do not add me to any e-mail lists.
299	apwa, enr, leed, green building
300	Web, Forums and trade Journals
301	USBBC Professional Journals
302	Professional magazines
303	APWA
304	consultants, associations, journals
305	associations, journals, conventions, websites, forums, consultants
306	AWWA, WEF, APWA1
307	Contractor, suppliers, websites
308	emails and websites; Green Build, APWA, etc.
309	ICMA publications and website; ICMA conference; direct mail solicitations
310	APWA Various Periodicals
311	APWA, ASCE, ENR, WET magazine, and WateReuse Association
312	journals, websites
313	ICC
314	associations and websites
315	AWWA, WEF, APWA, Edmond Electric (City owned utility), Water Reuse Association, American City&County, Water World, Water Efficiency Journal.
316	Journals, websites, and forums.
317	e-mail from outside organizations
318	ASCE, WEF, APWA, vendors
319	Texas Water Utilities Journal
320	Associations, Journals, County's Climate Change Workgroup, Consultants, Webinars
321	websites; seminars and workshops and conferences; emails from vendors and suppliers
322	associations, journals, conventions, websites, forums
323	associations,ACCA convention and government Journals
324	WEF WERF from consulting engineering firms presentations at PNCWA conferences
325	associations, journals, websites
326	Media outlets; vendors; websites
327	media outlets; vendors; websites; consultants
328	ASSOCIATIONS
329	International City Managers Association and Virginia Municipal League
330	U of A
331	journals and conferences
332	MML, ICMA, US Green Building Council, UM, MSU, and various magazines
333	magazines, emails, conventions, associations
334	American Public Power Association, OK Municipal Power Authority, trade journals

335	ASCE, APWA, City's climate action plan consultant.
336	journals, websites, conventions
337	associations, journals, peers
338	associations, journals, contactors, consultants, other government agencies and their websites
339	All of the above
340	journals, website subscriptions
341	Public Works magazine
342	websites
343	websites, magazines
344	Currently we have installed a wind turbine to assist in the power used at our School facility building and solar panel on our TOwn Hall Annex. WInd turbine is a 5KW and the panels 3KW
345	Journals and websites
346	Energy Conservation INC.
347	APWA publications, WEF publications, misc literature
348	WEF'd "Water Environment & Technology" journal "WaterWorld" "Water & Wastew Digest" "Texas Water" annual conferences WEFTEC
349	AWWA Journal, annual water conventions
350	Associations, forums
351	University of Florida, other local government(s), regulatory agencies, conferences, contractors, websites including Powermarketers.com
352	Associations, journals, conventions, websites, forums
353	Chevron energy provided an analysis for the WWTP; not cost effective at this time
354	ICMA Alliance for Innovation ICLEA
355	Websites forums associations
356	Presentations by vendors
357	associations, journals, conventions, websites etc
358	I receive e-mails, bulletins, websites, forums, journals etc....
359	We are a municipal electric, natural gas, and water utility, so we have in-house expertise on alternative energy. In addition, we gather information from associations, news articles, meetings, etc.
360	APWA Monthly newsletter and magazine, AWWA Journal, Fleet Management Magazine numerous other publications
361	journals
362	AWWA Consultants
363	waste-water journal
364	leed contractor, websites
365	journals, websites
366	I work for the municipal utility, so I am the source of renewable energy info to our customers. My sources are TVA, trade organizations, journals, websites and manufacturers.
367	websites, magazines, webinairs
368	I am not the facilities person for our agency. Our building is leased by the State of North Carolina for our use. It is possible we will be relocating within the next 12 months.
369	all
370	ASES, MREA, U. Wisconsin, newspapers, web
371	Utilities, websites, and vendors.
372	ICLEI, NRDC, APWA, APA, magazines, DOE, newspaper articles, web, etc

373	Intelligent Energy Portal Mass Dept of Energy Solicitations from energy wholesalers NSTAR newsletters
374	Brochures; websites; information from purveyors
375	WERF, TPO & WEF magazines, web searches, WEFTEC
376	Chelan County Public Utility District, Chelan County Port District
377	None
378	all of the above
379	Governor's energy office, Utility provider Xcel Energy, conferences, marketing from private companies.
380	green building conferences, emails, discussions with our mechanical and electrical engineers
381	Websites: DOE, EPA, USGBC, EERE, brighterenergy.org
382	local newspaper Tribune of San Luis Obispo and personal contacts (engineers)
383	associations, journals, conventions, websites,
384	Electric utility (direct mail & website); trade association journals, newsletters & conventions (Water Environment Federation, Oregon Association of Clean Water Agencies); websites (EcoWorld, EPA, Oregon DEQ; Vendor sponsored publications (WaterWorld, Pollution Equipment News); Design Engineering Consultant Newsletter Publications
385	Federal,state,local government agencies and private sector profit and non-profit organizations
386	Trade journals, professional organizations, the State of Colorado energy department, Ameresco (our energy consultant and partner in our energy reduction programs)
387	associations, journals
388	trade journals American Water Works Assc Water, environment and Technology
389	None
390	NYSERDA, AWWA, NYEWA Rural Water
391	industry organizations (WEF, WERF, IWA)
392	email blasts, associations
393	ICMA, Sustainable New Jersey, Engineering firms and Cooper Union University
394	forums
395	DEP sources.
396	associations, journals, conventions, websites, forums
397	WEF, local electric utility (XCEL)
398	Texas Municipal League (annual conference, Cities Going Green seminar, monthly magazine)

8. My facility considered renewable energy technologies for the following reasons:

#	Response
1	reduce electrical costs
2	Because the wind blows fairly consistently in Western Kansas
3	Cost saving, environmental benefits.
4	High cost of energy consumption for drinking water treatment plant
5	Interested in being green and saving money on electricity (currently 10% of budget)
6	High Cost.
7	Time is right
8	energy efficiency, cost reduction
9	We run a state forest with lots of biomass.
10	protect the natural resources
11	Cost savings; civic leadership
12	Save money.
13	cost; the environment
14	wind farm
15	cost
16	Energy COnservation/cost
17	As an agency of state government, we want to lead by example.
18	reduced energy use, cost effectiveness
19	lower cost of operation.
20	lowering energy costs
21	To luminate a 24 water access points for boats.
22	energy savings
23	Save money
24	Going Green, Cost-savings
25	u
26	Budget
27	Political and economical advantages
28	energy efficientcy
29	We have a solar powered LED area light for one boat ramp and have considered use for other access areas as well.
30	heat water in remote shower; move water to sensitive wetlands via windpower
31	It's the right thing to do
32	to reduce energy sosts
33	cost, environmental stewardship, state mandates
34	conserve resources and public perception
35	cost savings
36	We are the Department of Environmental Protection, it is our goal to lead the way in clean renewable energy trends.
37	No particular reason other than reducing our footprint.
38	Energy Savings
39	environment
40	We want to do our part to save the environment.
41	high energy costs

42	Because they are kissing the gov. but and are a bunch of limpwristed chicken shits.
43	Energy efficiency
44	It is the state's Natural Resources Agency - it should be green...
45	"goog idea"
46	To reduce enerdy cost st City Hall and to show a green inititive for the city.
47	To greatly reduce or offset our engergy consumption in a reasonal payback period of time.
48	economic payback and environmental
49	save energy, lower expenses
50	Save money. The right thing to do
51	Lower costs
52	help lower electric bills and save energy
53	We are a State government environmental regulation organization
54	Save Money
55	To stabilize energy costs
56	Stewardship,
57	Energy savings, green initiatives
58	Future cost of non-renewable energy
59	reduce or hold operating expenses relating to electricity; greater efficiency; non-CO2 producing
60	Reduce the cost of energy used.
61	Not sure
62	cost savings to the people of ND
63	save money, go green for our future- we are a state nusery
64	Economic and environmental sustainability, energy efficiency, and cost reduction.
65	research based on theoretical an practical invest finance and infos
66	Economic diversification
67	politics
68	demonstration of alternative energy
69	cost savings/efficiency/long term stability and grid independence
70	Environmentally Conscious, Self-Suataining, Cost-effective
71	I don't know
72	practice what we preach
73	Electricity savings and renewal source of methane.
74	to reduce the carbon footprint of a government facility
75	I would like to find a way to produce at least enough energy to operate the wastewater facilities plant so funds can be set aside to expand the facility.
76	Cost reduction
77	biogas is a product of our anaerobic digestion process and utilized in boilers to heat water to maintain the process and building heat in the digester complex.
78	Carbon footprint reduction Reduced dependance on foreign oil supply Increased job opportunities within the energy sector Increase in technology based jobs Reduction in environmental impacts
79	Responsible to future
80	The right thing to do through a sustainable initiative. To be an example for the citizrens of good stewardship.
81	To see if there was any cost savings and efficiencies
82	to lower costs ,good for enviroment
83	utility costs, agency image

84	future cost increases, carbon footprint
85	To help reduce our power consumption from the grid and indirectly reduce our carbon footprint.
86	revenue generation cost containment
87	Cost savings, social leadership
88	Reduce green house gases, improve air quality, improve water quality, create jobs in green industries, and save money
89	To save money.
90	It's the right thing to do, it reduces our dependance on coal and oil, and in the long run it makes good economic sense.
91	just the right thing to do david
92	Cost Savings, Environment Prudence.
93	Cost savings, societal pressure, environmental consciousness
94	Lower costs and self sufficiency
95	Cost Savings
96	Rate reduction
97	The high cost of energy is costing people there jobs, we have to cut back on personnel to pay the recurring cost of electricity
98	long term savings, power is one of our largest costs
99	heavy useage and high cost of electricity
100	operating cost reduction, sustainability goal
101	To reduce electrical bills.
102	cost of operations
103	cost savings available to the budget in general from avoided costs
104	Good for the wallet and the enviroment
105	Cost of operation
106	availabity of biogas; further use of anaerobic units for reducing sludge for disposal
107	Energy conservation and eventually cost containment
108	Cost savings, enviromental
109	Reduce waste stream while producing energy
110	Primarily because it will save modest amounts of money while reducing our carbon footprint. Thus, any alternative at this point has to make both environmental and economic sense.
111	Carbon reductions and cost savings
112	we look at all options and ROI
113	Available to us through a grant program.
114	To reduce costs and to improve air quality
115	Ease of permitting, ROI
116	Reduce cost, improve working conditions,
117	Gvoernment regulations
118	To save on escalating utility costs
119	Cost savings and social benefits
120	1. Reduce carbon foot print and reduction of greenhouse gases 2. Be a supportive leader in the community for renewable energy technologies 3. Reduce long term cost to the taxpayer
121	to cut costs
122	Long term cost savings and to forward efforts for organization to be more "green".
123	It could save money, it helps the environment
124	Cost savings

125	Sustainability and efficiency, decreased operating costs
126	To save on utility costs
127	Off-set fossil fuel, attempt to stabilize energy costs, reduce CO2
128	We have a turbine blade manufacturer in our community.
129	Solar energy was considered in the design of our new public library. We understand the importance of sustainability and the impact that our current use of fossil fuels has on the environment and would like to move toward more renewable sources if it were feasible & affordable, which it hasn't been up to this point - we are a small community of 10k with limited revenues & unlimited wants!
130	Cost carbon emissions
131	"Going Green", conservation
132	Sustainability
133	Reducing Village's carbon footprint a goal of Council; energy cost savings
134	Costs (current and future)
135	Reduce waste stream, lower energy costs
136	Better for the environment
137	Reducing emissions, saving money.
138	With great elevation differences, the city uses PRV,s to reduce pressure which produces wasted energy that could be converted to electricity, but unlike solar and wind FERC views this power the same as a hydro plant. Requiring exhaustive permits for amounts to plumbing in a vault in the street.
139	We are home to the North American headquarters of a solar panel manufacturing facility and we are planning one of the largest solar farms in the country currently. We also have good wind resources. In addition, we have a dam that currently does not generate power, and we are looking to recommission it potentially. All of these renewable energy projects are being driven by the need to cut costs and provide a more sustainable community.
140	Good public relations, reduce carbon footprint.
141	Reduce high energy bills
142	Control raising fossil fuel cost, improve the environment and set an example for the community.
143	Mulvane has our own electric utility. Renewables on a comercial scale would work against the profitablity of our electric utility.
144	As a means to use methane from a landfill.
145	green policy, lower costs, sustainability
146	cost savings over time and it seems like the right thing to do
147	Save money/generate revenue Availability of the renewable resource
148	Cost of power continues to climb. It will be easier to budget with a set cost.
149	We are an electric utility and need to offer alternatives to our residents and reduce peak load demands on our system.
150	reduce the cost of operations
151	To reduce current energy costs and heighten public awareness of Sustainability throughout the community.
152	Cut operational expenses
153	wastewater treatment, reduce energy bills, educational/demonstration purposes, remove power lines (less suceptible to weather/hurricanes/wind)
154	Cost savings
155	Save $, lower carbon footprint
156	Reduce carbon footprint.

157	Environmentally sensitive community; concern about dependence on fossil fuels; increasing energy costs.
158	Sustainability and costs
159	Cost savings, greenhouse gas credits
160	Environment Cost Effectiveness
161	Cost savings, environmental benefits, social benefits
162	Reduce carbon footprint & potentially save dollars
163	lower costs
164	Lower costs, energy efficiency, energy sustainability, reduced fossil fuel emissions
165	because of the high volume of energy use at the wastewater plant, and the high volume of biogas available at the landfill.
166	To save electrical costs.
167	cost reduction
168	Our City has made an effort to be more sustainable. Our Board has/is working toward setting design standards that require certain sustainable and green features, especially for all public buildings.
169	sustainability values; economic savings
170	Cost, green
171	We were approached by a company that wanted to use our methane and nutrients to grow algae to produce biodiesel. The deal fell thru in the end for lack of direction by the algae company. We also did not have enough left over methane to serve the purpose.
172	cost savings; resource conservaton
173	reduce costs
174	Recommendations by consultants
175	Policy requirement; commitment to the environment
176	sustainable initiatives, reduce operating costs, stop "wasting" biogas
177	Reduce energy costs and for environmental considerations
178	TO LOWER OPERATIONAL COSTS.
179	To be Green while updating our facilities with economical sources of energy.
180	substainabilty
181	Cost Savings, responsibity
182	energy savings
183	Desire to save money, desire to show leadership and protect the environment, and reduce dependence on fossil fuels.
184	sustainability
185	Solar electric
186	Environmental stewardship and reduced energy costs
187	long term energy savings, economic development
188	Long term cost stability and renewable resources
189	utilize existing resources
190	Have a landfill that currently generates renewable energy with landfill and anaerobic digester gas (methane) and have looked at our methane production and MSW/biomass as fuel sources to produce energy and ethanol, geen gasoline, LNG, etc.
191	Sustainability/cost savings
192	The general think its cheap, cool, green, good for the environment, etc. But nuclear power is still cheaper.

193	Wants to be more sustainable
194	Grant funding
195	We had hoped there was a cost savings.
196	Reduce the cost of our energy bills
197	$ savings & reducing carbon footprint
198	Cost savings, community demonstration
199	Attempt to reduce carbon footprint and control escalating energy prices
200	Reuse of methane generated in our anaerobic digesters
201	we have a lot of roof space for solar, we have wind and we are pumping water so there could be under water generator if the flow is fast enough
202	Lower operational costs
203	incentives available,good for the planet
204	Building sustainable facilities
205	cost control, lower carbon footprint
206	Save on energy costs; reduce overall costs to end users
207	To reduce our energy costs.
208	Cost Savings
209	reduced cost
210	To gain experience with renewables and to improve the environment.
211	Lower operating costs and sustainability
212	environment
213	Cost, environmental benefits
214	As demonstration projects and more specifically on new facilities being planned.
215	Cost savings Pressure from local energy activists Concern for environment
216	to reduce the cities carbon foot print
217	Solar lighting
218	Cost savings
219	save money
220	sustainability
221	The wastewater utility could benefit by producing biodiesel from FOG to power the plant and provide fuel to fleet vehicles.
222	Reduce energy costs and carbon footprint
223	Good Stewardship of the environment
224	Cost, Going green to set an example
225	To provide enhanced electrical services to our community at a reduced cost.
226	Electric power is a large part of our operating expense.
227	To remove dependency on Electric companies and fossil fuels. To use renewable sources that are already available to us, and promote green energy.
228	alternative green infrasructure consciousness
229	save energy
230	enviromental friendly.
231	We would like to be an example to our residents and also help some of these technologies get going.

11. My facility installed or plan to install renewable energy technologies for the following reasons:

#	Response
1	Save $
2	save money
3	We are in the planning and design stages of installing solar generation panels at two different sites within this location.
4	Education/demonstration
5	to educate about renewable energy
6	Demonstration purposes, and greenpower credits
7	Can't pay for heating oil
8	Save on energy
9	1. Utilizes internal resources 2. Lowers purchased energy costs 3. Provides revenue stream (RECs) 4. Good for environment 5. Helps meet organization's renewables & conservation objectives
10	cost savings
11	Lack of access to power in remote areas
12	Cost savings
13	cost effectiveness, reliability, environmental stewardship
14	Reduce cost of operations
15	We have had bigas congerneation with engines for over 20 years. Are planning to replace and expand and additng a brown grease facility. We are also evaluating a small solar installation for yard lighting.
16	Why wouldn't you? In question 7, payback varies from 1 to 8 years for us, depending on project
17	Being green, sustainability commission, personal responsibility
18	to reach a statewide goal, to stablize energy prices
19	City Council adopted sustainability policy to pursue renewable sources.
20	Cost
21	Independence, lower cost, environmental, ...
22	Corporation's public commitment to increase use of renewable energy. Corporation manufactures materials for photovoltaic cells and for wind power.
23	Environmental stewardship
24	Costs and "going green"
25	Reduce carbon emissions and achieve savings on reduced fossil fuel costs.
26	Qick payback in our scientific world and great outreach tool for tours of our facilities.
27	Save energy costs
28	Reduction of fossil fuel use, strengthen the local market for the product, meet goals set
29	ISO 14000 EOS in place, want to be energy independent
30	Lower operating costs pubic demonstration job creation get off imported fuels CO2 mitigation
31	It agrees with our sustainabiltiy vision
32	state funding incentive
33	It's the right thing to do.
34	Cost control, source relaiblity and operational flexibility
35	Makes sense(cents)
36	We are considering the use of heat pumps to draw heat in the winter and cooler temperatures in the summer out of waste water.
37	To meet mandated Renewabel Energy Standards RES/RPS

38	use of digester gas for boiler fuel to provide building and process heat
39	We aanticipate future federal & state renewable energy mandates.
40	Lowere lectric cost; and as a demonstartion site for other Municiplaities and businesses. Stimulus money that supported this effort assisted the movement forward for this project greatly.
41	produce more energy to reduce our energy costs and also to reduce our carbon footprint.
42	benefit the environment
43	Sustainability, Renewable Portfolio Standard, Energy Cost Reduction
44	organizational mission to recover resources, self generation of electricity for reliability, economics, demonstration of new technologies
45	Grant - demonstration project
46	Hedge our energy prices and to promote sustainable resources
47	cost and envirnomental
48	energy showcase for teachers and students
49	makes sense
50	Because we are concerned about sea level rise and global warming we look at both adaptation and mitigation. Passive design and additional pv panels will address mitigation at a very local level. Real mitigation requires policy change at the state, federal and international level to decrease carbon loading and climate forcing. Green energy paths will be and important part of this process if it is done correctly. Energy efficiency is the best way to go prior to pv or wind. GREEN ENERGY MAY NOT BE SO GREEN: Centralized stationary power production from wind, solar and geothermal sources may not be as environmentally friendly as many of us think. In order to transport power from production to use will require transmission lines that will tie into the grid network. The power towers and lines will cross public and private lands potentially creating great controversy and ecological destruction to sensitive habitat for many species including already threatened and endangered species. It is in the best interest of the big power companies to encourage transmission lines as the tax structure and rate base are in their favor. There is great potential for transmission lines crossing dry forested areas and chaparral to cause massive wild fires. Wind turbines will require a network of roads for maintenance in addition to siting these massive machines in relatively pristine areas in many cases. It is difficult to establish wind farms so they do not impact bird migration corridors along major flyways including off shore which will be devastating to many avian species that are already on the edge. Centralized solar production will use up large amounts of land in very sensitive areas like the south western deserts putting species and endangered species at risk. Transmission lines will be required to transport the energy produced to the grid. Decentralized energy production in conjunction with energy efficiency is far superior to centralized production. Efficiency is the best way to create jobs, save energy and address environmental concerns. Retrofit existing houses and build new houses with optimal insulation, double or triple glazed windows and new energy efficient appliances then put solar photovoltaic panels on the roof after the efficiency standards have been met. Small wind machines can also be utilized the same way or in a decentralized fashion. This puts the energy production in proximity to use and uses the footprint of the existing community for siting rather than going many miles to despoil more land, resources and biodiversity. There are many roof tops, parking structures, residential, commercial, industrial and public buildings within an existing community. Use that which has already been despoiled. One way to encourage decentralized power production is by using Community Choice Aggregation Networks. State Law AB 117 allows cities, or counties in California to operate as public utilities. This means the public entity can choose to stay with their current utility or they can solicit bids for better pricing from other power producers or they can choose to become renewable electricity self sufficient locally. This has been

	challenged by Pacific Gas and Electric by putting $50 million into Prop 16 on the June ballot in California. Other states can certainly follow the California lead on community choice aggregation. Energy producers will become Energy Service Companies working with communities and rate payers producing clean
51	Pollitically expedient and an attempt to help meet CA AB32 requirements.
52	Operational efficiency
53	Environment Sustainability Demonstration Project
54	We teach about it to our students
55	reuse wasted methane gas to power blowers
56	The economics work with the local power utility subsidy and the federal subsidy. Payback is approximately 3 years.
57	na
58	"free" source of energy; efficiencies
59	Mainly because they are cost effective (with government subsidies) and they are good for the environment. Secondarily there are political benefits.
60	Hydro power is reliable and inexpensive.
61	Our goal is to be 100% run on onsite generated renewable energy. We are currently attemtping to increase our cogen output.
62	Save money
63	Waste heat recovery on WW biosolids incineration
64	cost savings of electricity
65	save on power costs
66	Cost savings, meet sustainability goals
67	electrical reduction usage
68	Financial savings, good public image
69	Cost savings (heat pumps promise to be cost-positive) and solar thermal, with grant money, is cost-effect. We are interested in renewable energy for cost and environmental stewardship
70	2 250KW fuel cells utilize anaerobic digester gas to produce electricity.
71	reduce carbon emissions, stabilize energy pricing
72	SB12 (Texas) requires we reduce energy use 5% to aid in air quality - we cannot, so to satisfy the spirit of the law we achieve 5% of our power as renewable. The projects implemented to date do have payback, but it is long.
73	reduce cost reduce carbon footprint
74	- Environmental impact concerns - lower and more predictable energy cost
75	technologies have to have an ROI or rebates/incentives that allow an ROI
76	long term energy cost savings demonstration projects to residents and business owners
77	Stabilize our electric cost, reduce our carbon footprint and other environmental benefits.
78	We have a large warm water supply to tap into
79	Reduced operating cost, increased efficiency and elimination of wasted methane.
80	Decrease Operations Cost
81	Financial Reduction of carbon footprint
82	Reducing utility costs and decreasing our carbon footprint, emergency hurricane preparedness
83	it's renewable onsite generation
84	Cost Reduction and to Meet Municipal Energy Independence Goal of Reducing Fossil Fuel Dependence by 25% by 2025
85	To demonstrate the community's commitment to renewable energy To reduce costs Because of

	various incentive programs currently available (helps reduce payback period)
86	Reduces cost of facility and source of heat is free.
87	Reduce consumption
88	Acheive state renewable mandate
89	efficiency
90	Reduce reliance on fossil fuels
91	Hot water thermal production
92	cost savings, reduced air pollution, public-private partnerships, community benefit
93	To provide renewable energy sources for the same energy costs that we would have normally paid.
94	Help us keep pace with rising energy costs and to help Arizona Public Service delay having to build additional power plants. Also to do what we can to support our planet.
95	Long term investment outlook, City Council goal to provide 100% renewable energy to our residents.
96	To be environmentally responsible and to reduce cost over time.
97	policy considerations, energy indepaendance, long term cost savings
98	Lack of electric source in some instances. Cost effective and lowers electric costs. Lowers carbon footprint.
99	Reduce carbon footprint, community education, promotion of renewable energy resouces and it's the right thing to do.
100	Reduce long term energy costs
101	Commitment to sustainability.
102	window of opportunity was there, cost savings, emergency power supply, water rate stabilization measure, good site for solar, diversifying power sources
103	public support
104	We are still evaluating.
105	It's the right thing to do.
106	LEED Platinum Construction of a new City Hall
107	Cost savings
108	REduce low term operations costs
109	used treated wastewater biosolids to fuel the treatment plant dryer.
110	To be a good environmnetal steward, reduce our crbon footprint and foster the devlopment of renewable resources in our community.
111	We are a wastewater treatment plant and we produce biogas, which we utilize for process heating.
112	To be more sustainable; lower long term costs;
113	Right thing to do and money savings.
114	Cost benefit; Agency philosophical position.
115	decreasing our carbon footprint
116	Save money
117	Short payback period
118	Federal money makes it doable
119	To lower our per killowat hour costs.
120	sustainability (directors want to be green)
121	Ongoing Operationa cost reductions.
122	City owns a solid waste boiler facility

123	typically government stimulus funding and mandates from elected officials.
124	cost effective
125	Completely off grid.
126	* reduce operational cost of electricity * provide an emergency energy supply * meet renewable energy goals of our agency
127	Had anaerobic digester gas available and needed something to heat the digesters and provide alternate electrical supply. Our engine generators do both.
128	Received a grant that made the installation cost effective
129	reduce energy costs
130	The right thing to do to promote alternative energy sources to our public. Save funds for other projects.
131	costs savings;clean air;carbon footprint reduction
132	Be a leader in the community and reduce carbon emissions.
133	Cost savings and minimizing environmental impact
134	Methane energy at our wastewater treatment plant, E-85 fuels, solar panels at our recreation facilities for savings and conservation of natural resources.
135	Energy recovery
136	Energy releability and cost savings
137	1. To reduce overall energy costs. 2. To reduce energy consumption. 3. To become more energy efficient 4. To help reduce reliance on foreign fossil fuel.
138	Reduce carbon footprint; conserve natural resources; promote clean energy technologies; regional leadership
139	backup power, waste heat capture, agree to fixed power costs instead of volatile (increasing) electric costs

18. My job title is:

#	Response
1	City Manager
2	Director of Engineering
3	City Manager
4	City Administrator
5	Water/Wastewater Manager
6	City Administrator
7	Sr. Water Treatment Technician
8	Director of WPCA
9	City Administrator
10	Director of Water Resources
11	City Administrator
12	Manager
13	Park Ranger
14	Engineering Technician
15	Environmental Specialist
16	Environmental Scientist
17	Environmental Specialist
18	Conservation Land Manager
19	Not sure
20	Associate Engineer
21	research engineer
22	Consumer Outreach Director
23	Engineer
24	Engineer
25	Wastewater Permitting Engineer
26	Biological Scientist III
27	ee
28	Deputy Secretary for Policy and Planning
29	Engineerimg specialist
30	Associate Research Scientist
31	Training
32	Park Services Specialist
33	WWTF Superintendant/Operator.
34	Mechanical Engineer 3
35	Environmental Administrator
36	Biological scientist III
37	O.P.S. Park Ranger
38	park ranger
39	Director of Facility Operation
40	FCO manager/ Emergency Coordinating Officer
41	Selectman; Town Energy Committee Member
42	Town Clerk
43	Clerk Specialist

44	Wastewater Facility Director
45	engineering specialist
46	Curator of Programs and Technology
47	OPS
48	VP, Administrative Services.
49	Energy Facilities Engineer
50	Project Manager, Energy
51	City Engineer/Director Public Works
52	Security and Emergency Planning Engineer EE-III
53	Director Facilities Operations
54	consultant
55	State of Florida Fish and Wildlife Conservation Commission- Freshwater Fisheries Biologist II
56	Senior Clerk(Support Services)
57	Facilities Mechanical Engineer
58	Benefits Specialist
59	environmental specialist
60	Associate, Architect
61	Facility Manager
62	Interpretive Specialist
63	Project Manager
64	Coral Reef Conservation Program Assistant
65	Geotechnical Operations Engineer
66	Environmental Scientist
67	Selectboard Chairman
68	Auditor
69	n/a
70	Water & Wastewater Superintendent
71	Professional Geologist I
72	Project Manager
73	Bldg Supt.
74	Personnel technician
75	Park Naturalist
76	Wastewater Operations Manager
77	Classroom Programs Coordinator
78	Lead inspector with 17 years experience
79	Support Services Specialist
80	energy manager
81	Wastewater Superintendent
82	Assistant Superintendent
83	PROGRAM SUPERVISOR
84	fish and wildlife scientist
85	supervisor
86	Director
87	City Administrator
88	City Administrator
89	City Administrator

90	Civil Engineer
91	General Manager
92	Director of Public Works
93	Project Manager
94	Superintendent
95	Program Manager
96	Park Ranger
97	Park Interpreter
98	City Administrator
99	City Administrator
100	Master Plumber
101	Environmental Specialist III
102	City Engineer
103	Technical Manager
104	District Engineer
105	Sustainability Initiatives Manager
106	Asset Manger
107	Recycling Manager
108	Technology Application Specialist
109	Wastewater Treatment Department Director
110	City Administrator
111	Manager
112	VP of Technology
113	Engineer - Director
114	Director
115	Preventive Maintenance Coordinator
116	nursery manager
117	City Administrartor
118	State Energy Manager
119	senior engineering advisor
120	Wastewater Services Manager
121	Sustainability Committee member
122	Manager of Process Engineering
123	homeowner
124	assistant research evaluation development
125	Manager, Global Environmental Stewardship
126	sales manager
127	petroleum engineer
128	Division Director
129	Administrative Assistant
130	public utilities Commissioner
131	Database Administrator
132	Director of West Region - Buildings and general Services, Vermont
133	Superintendent, Water Resources
134	Ecologist
135	Vermont Department of Environmental Conservation Permit Coordinator

136	Quality Assurance Superisor
137	State Energy Manager
138	Fish Culture Specialist VI
139	Buildings Engineer - Environmental
140	Environmental Program Manager
141	Director, Planning and energy resources
142	Group Manager
143	Director of Public Works
144	Environmental Scientist
145	Environmental Specialist
146	Director of Operations
147	Administrator
148	State Geologist
149	ITS Operations Manager
150	Project Coordinator
151	executive director
152	Deputy Director
153	General Manager
154	Water System Manager
155	Executive Director
156	Energy Analyst
157	Operations Director
158	City Administrator
159	Operations Division Manager
160	Archtect
161	Technical Writer and My answers to some question are not necessarily valid
162	clerk
163	Regional Engineer
164	District Superintendent
165	Roadside Program Administrator
166	shop superintendent
167	Research Administrator II
168	park ranger
169	Town Administrator
170	environmental biologist
171	TSCS Work Group Manager
172	Clerk Specialist
173	Biosolids Manager
174	Energy Manager
175	Director of Environmental Services
176	Clerk-Treasurer
177	Manager
178	District Conservationist
179	General manager
180	Environmental Scientist
181	Supervising Engineer

182	Public Works Director
183	Environmental Planner / Marine Biologist
184	Soil con Tech
185	Renewable Energy Program Manager
186	owner
187	Sr. Water Resources Project Manager
188	environmental educator
189	hydraulic engineer
190	Retired
191	director
192	I am on the Tijuana River National Estuarine Research Reserve Management Authority
193	Engineer
194	city manager / CFO
195	XCity Administrator
196	Admin Asst
197	Operations Manager
198	Spuerintendent of Water Operations
199	Technology Support Analyst
200	Principal Engineer
201	Assistant Chief Engineer
202	Engineer
203	Assistant General Manager
204	Wastewater Utility Superintendent
205	teacher
206	Supervisor
207	Operations Management Consultant II
208	Director of water treatment
209	General Manager
210	Director of Operations
211	Superintendent Water & Sewer Department
212	General Manager
213	chief engineer
214	Project Engineer
215	Senior Water Quality Engineer
216	Wastewater Superintendent
217	Wildlife Enforcement Officer
218	Cartographer
219	Trainee
220	Assistant manager
221	Senior Fisheries Biologist
222	Managing Engineer - Treatment
223	Civil Engineer
224	Water Operations Manager
225	WATER TREATMENT SUPERINTENDENT
226	Facility manager
227	City Engineer

228	Chief Operator
229	Senior Engineer
230	Assistant Director of Monitoring and Research
231	Operations
232	WWTP Superintendent
233	owner
234	program administrator
235	General Manager
236	Senior Environmental Specialist
237	Strategic Planner
238	Director of Public Works
239	Engineering Services Director
240	process engineer
241	President-Regulated Water Utilities
242	Deputy Manager of Technical Services
243	Assistant Water Resources Department Director
244	Town Manager
245	Township Manager
246	Chief Executive
247	City Manager
248	Town Manager
249	city manager
250	city administrator
251	City Manager
252	city manager
253	City Administrator
254	Town Manager
255	Town Administrator
256	city manager
257	City Manager
258	Twp Manager
259	Town Manager
260	Director, Middle Keys Operations
261	City manager
262	Director Facilities Management
263	City Manager
264	Town Manager
265	City Administrator
266	Town Manager
267	Borough Manager
268	City Administrator
269	City Administrator
270	City Manager
271	City Manager
272	Township Administrator
273	Town Manager

274	Env. Code Officer / Industrial Pretreatment Coordinator
275	City Manager
276	City Administrator
277	Town manage
278	City Manager
279	City Manager
280	Village Manager
281	City Manager
282	City Administrator
283	Energy Project Manager
284	County Administrator
285	County Administrator
286	County Administrator
287	Assistant to the City Manager
288	City manager
289	director of administration
290	City Manager
291	City Manager
292	City Manager
293	Sustainable Programs Coordinator
294	City Manager
295	City Manager
296	City Administrator
297	Village Manager
298	county administrator
299	City Administrator
300	Town Administrator
301	Township Superintendent
302	City manager
303	City Manager
304	City Administrator
305	Indoor Environmentalist Building Services
306	Town Engineer/Assistant Public Works Director
307	city administrator
308	Intern
309	City Manager
310	Town Manager
311	City Manager
312	city manager
313	City Administrator
314	City Manager
315	Citry manager
316	city manager
317	County Administrator
318	City Manager
319	Town Manager

320	Assistant City Manger
321	Service Manager
322	Assistant to the City Manager
323	City Manager
324	Village Administrator
325	Town manager
326	Town Manager
327	Village Manager
328	Environmental & Safety Manager
329	Environmental Compliance Manager
330	Town Manager
331	County Administrator
332	City Administrator
333	Manager
334	City Manager
335	Administrator
336	city manager
337	Director of operations
338	Manager
339	Water Resourcse Director
340	Director of Engineering
341	Manager
342	Engineering Project Manager
343	Senior Program Manager
344	Director of Public Works
345	Director of Public Works
346	Environmental manager
347	Principal Civil Engineer
348	Wastewater - Landfill supt.
349	Superintendent of Public Works
350	:Public Works and Utilisties Director
351	dpw director
352	Director of Engineering
353	Director of Public Works
354	CIP Manager
355	Town Manager
356	City Manager
357	Commissioner of Public Works
358	DPW Director
359	city manager
360	Associate Engineer
361	Director of wastewater / IT
362	City Manager
363	Community Development Supervisor
364	BUILDING OFFICIAL
365	Director of Public Works

366	Water Resources Superintendent
367	Water Resources Planning Manager
368	City Engineer
369	Director of Water & Wastewater Operations Division
370	Principal Civil Engineer
371	Maintenance Division Manager
372	Deputy County Administrator
373	Civil Engineer
374	Director of Maintenance Services
375	City Engineer
376	City Manager
377	Public Works Director
378	Town Manager
379	PWD
380	Water System Manager
381	Director of Public Works
382	Projects Director
383	City Manager
384	Township Manager
385	city manager
386	Public Works Director/City Engineer
387	City Manager
388	Town Manager
389	department manager
390	Town Administrator
391	Senior mechanical engineer
392	Town Administrator
393	Engineering Supervisor
394	City Engineer
395	City Manager
396	Utilities System Coordinator
397	senior exec. v. p.
398	District Engineer
399	Director
400	Energy Conservation Project Manager
401	Underground Utility Services Field Supervisor
402	Sr, Project manager
403	Director of Public Works
404	Director of Public Works
405	Wastewater Superintendent
406	Chief Chemist, Assistant Suuperintendant
407	Street/Sewer Maintenance Supervisor
408	Chairman energy committee
409	Senior Environmental Planner
410	Authority Manager
411	District Engineer

412	City Manager
413	City Manager
414	Civil engineering consultant
415	Administrator/Chief Financial Officer
416	City Manager
417	City Manager
418	Associate General Manager - Operations
419	Public Works Maintenance Manager
420	City Manager
421	city administrator
422	manager
423	City Manager
424	DPW & U/Community Development Director - City Engineer
425	Manager
426	Retired Public Works Director
427	City Manager
428	project engineer
429	Education and Training Specialist
430	Partner
431	Supervising Engineer
432	Economic Development Manager
433	City Administrator
434	town administrator
435	Plant Manager
436	Village Administrator
437	lead water operator
438	Operations Branch Manager
439	Director of Public Works
440	City Administrator
441	Director of Field Engineering
442	City Administrator
443	City Manager
444	Public Works Director
445	Director of social and environmental responsibility
446	Sustainability Program Coordinator
447	County Administrator
448	Public Works Director
449	Facility/Capital Projects Manager
450	Wastewater Plant Manager
451	Township Manager
452	city manager
453	Acting Utility Manager
454	Lead Process Operator
455	General Manager
456	Project Manager
457	Public Works Director

458	Project Manager
459	senior project engineer
460	engineering director
461	Engineer
462	Borough Administrator
463	VP
464	Park Ranger
465	Facilities Management Department, Deputy Director
466	Coordinator of Wastewater Treatment
467	City Administrator