Testimony of

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Chairman and CEO

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Before the

Committee on Science and Technology, Subcommittee on Energy and Environment

United States House of Representatives

"Marine and Hydrokinetic Energy Technology: Finding the Path to Commercialization"

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Introduction

Good morning Chairman Gordon, Ranking Member Hall, and members of the Committee and Subcommittee. My name is Gia Schneider and I am a co-founder and the chairman and CEO of Natel Energy, Inc. I greatly appreciate the opportunity to share Natel Energy's story with the Committee, and to discuss the roles of the federal government and private industry in developing technologies suitable for low head hydropower energy generation.

Natel Energy Background

Natel Energy, Inc. is a California and Texas-based company that is commercializing a new hydropower technology called the Linear Hydroengine or SLH, which could cut the cost of low-head turbines by as much as 50%. Our mission is to maximize the use of existing water infrastructure in the U.S. to bring on-line cost-effective, distributed, baseload, renewable energy from low head hydropower sources with minimal negative environmental impacts. Indeed, in certain cases, we believe the potential exists to implement projects that both deliver renewable energy and create positive environmental co-benefits. For example, we are evaluating the potential to incorporate renewable energy into low dams in the Midwest whose primary purpose is to create wetlands that trap nutrient pollutants which are a primary cause of the dead zone in the Gulf of Mexico. If we can successfully incorporate low head hydropower generation into some of these projects, we could create an additional revenue source for Midwest farmers, bring new renewable energy onto the grid, and reduce nutrient pollution.

A patent on Natel Energy's core technology was recently approved by the U.S. Patent Office under application number 11/695,358. Natel's technology can be packaged into both low head and hydrokinetic configurations. We have chosen to focus on the low head market for several reasons. First, the economics of low head settings tend to be more favorable than hydrokinetic ones simply because the energy density is greater where a site has even a small amount of head. Second, there are numerous settings in the U.S. where existing low head infrastructure could be retrofitted to capture energy that is currently wasted. These opportunities include low drops and diversion dams in irrigation canals, water treatment plant outfalls and the approximately 40,000 existing dams less than 25 feet tall in the U.S., the majority of which do not produce power. Many of these sites with existing infrastructure are relatively close to roads and transmission lines; and would incur minimal additional environmental impact by virtue of being developed.

In-line with our focus on low head potential in existing infrastructure, our first pilot commercial project is with an irrigation district called the Buckeye Water Conservation and Drainage District in Arizona. The project is near the town of Buckeye, which is west of Phoenix, Arizona. We entered into a joint development agreement with the irrigation district in 2008, and filed for a FERC Exemption from Licensing in early 2009. The project received the FERC Exemption in September 2009; and installation has commenced this week. We hope to be online and generating electricity next month in January 2010.

We have had discussions with more than 10 other irrigation districts and several municipal water treatment facilities with promising sites totaling over 100 MW of potential capacity. We are in the process of working with them to evaluate their sites to identify those with the best overall economics. I will discuss the potential we see for low head hydropower development in this space in the next section, but suffice it to say that we believe that 100 MW is just the start – there are over 800 irrigation districts in the U.S.

Natel Energy has been funded to-date by its founders, and by several committed seed investors. We are in the process of raising a Series B round of funding, which we hope to close in the first quarter of 2010. In addition, we are proud to have recently been awarded an ARRA Phase 1 SBIR grant from the Department of Energy.

Natel Energy is an early-stage company that has its roots in my family's, in particular my father Dan Schneider's long-standing vision of environmentally friendly hydropower playing a significant role in mitigating the impacts of climate change while securing our nation's future energy needs. My father first thought of the SLH concept in the first energy crisis in the 1970's and was able to build early, small prototypes that showed promising efficiency results when tested in laboratory settings; a hydraulic efficiency of 80% was demonstrated at tests conducted at the University of California, Davis hydraulics laboratory in 1979. He then went on to build larger units, using those early alpha designs, and install them in field settings. The longest running alpha field unit ran for approximately 2 years. While the results from those early efforts were promising, the economic rationale to invest in further development disappeared when the energy crisis ended, and my father wound down his efforts in the early 1980's.

My brother, Abe, and I grew up tinkering with the early prototypes and that planted a seed which would later grow. Both of us went on to college at the Massachusetts Institute of Technology. I was a chemical engineering major, but decided to work in the energy space after school, working for Accenture in their energy practice, then Constellation Power, and then helping start the energy and carbon trading businesses at the investment bank Credit Suisse. My brother received both a bachelors and a masters degree in mechanical engineering from MIT and went on to establish himself in product design and development, with both large firms like Timken, where he worked in Advanced Product Development; and small, innovative startups such as the Google-funded high altitude wind company, Makani Power. Several years ago, in 2005, my father, Abe and I decided that our current energy crisis was here to stay, and that we wanted to put our respective talents to work to help solve America's clean energy challenge and that led to the start of Natel Energy. We, and the entire Natel team, feel blessed to work in a field which gives each of us great personal satisfaction and are committed to the cause of delivering new, clean energy technologies to America.

Low Head Hydropower Potential, Technology Challenges and Costs

The potential for new low head hydropower development in the U.S. is quite substantial. The last study done by the Department of Energy that made a clear distinction between low head and high head potential was completed in 2004 and estimated the total developable low head resource at 71 GWa[1].

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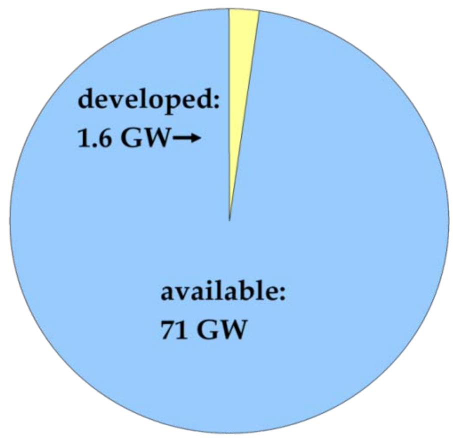
[1] GWa is the annual mean power which is a measure of the magnitude of a water energy resource's potential power producing capability equal to the statistical mean of the rate at which energy is produced over the course of 1 year. GWa can be converted to GW of installed capacity by dividing by the capacity factor, which on average is

The potential is significant, and yet less than 2 GWa of low head hydropower has been developed in the U.S. to date. In addition, none of the DOE's analysis includes the low head potential that exists in the thousands of non-stream low head flows, such as low irrigation drop structures. Natel estimates that there is between 1 and 5 GW of low head potential that could be harnessed at low, irrigation drop structures. Many of these structures are built specifically to dissipate energy to keep water velocities within the structural requirements of the irrigation canals.

U.S. Low Head Hydropower Potential in GWa (DOE/ID-11111, 2004)



Before delving further, I would like to lay out several terms commonly used, but not necessarily with common definitions, in hydropower. Hydropower is most commonly described in several ways as follows:

- Power generation potential – large, small, micro
    - Large generally refers to projects greater than 30 MW in size, though sometimes the lower end is stretched down to 10 MW
    - Small generally refers to projects anywhere between 100 kW and 10MW, though sometimes the upper end is stretched to 30 MW
    - Micro generally refers to projects less than 100 kW in size
- Head available – high, medium, low, hydrokinetic
    - High head generally refers to projects with large dams that are over 500 feet tall
    - Medium head generally refers to projects with between 30 and several hundred feet of drop
    - Low head generally refers to projects with less than 20 feet of drop, though some definitions move the low head upper limit to 30 feet

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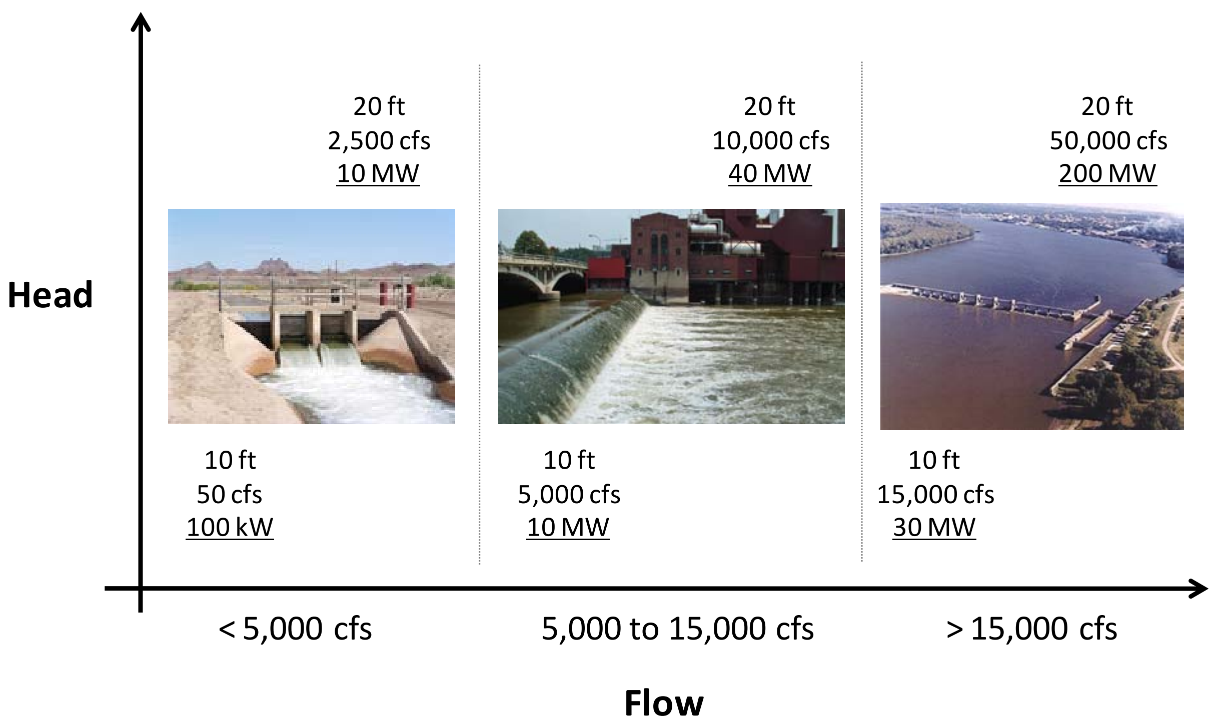
50% for the U.S. hydropower resource. See DOE study DOE/ID-11111 titled "Water Energy Resources of the United States with Emphasis on Low Head/Low Power Resources" for further details.

    - Hydrokinetic generally refers to projects where there is no head, and instead the energy is generated solely from the velocity of the water flow. This is analogous to the way wind turbines operate.
- Type of technology – conventional, unconventional
    - Conventional technology generally comes in two types – impulse and reaction turbines. Some common names of impulse turbines are Pelton and Crossflow; common names of reaction turbines are Kaplan, Francis, propeller, bulb, and pit.
    - Unconventional technology is a catchall bucket for a number of new turbine designs primarily aimed at hydrokinetic, marine and low head settings.

This creates a confusing landscape of terms, as they are not mutually exclusive. However, this can be somewhat simplified by remembering that for all sites, hydropower generation potential is defined by two variables – head and flow. Sites with either large flows or high head will generally create substantial amounts of power. Sites with both low head and low flows will generate small amounts of power. The below diagram illustrates the range of potential power across a hypothetical low head sites with 10 and 20 feet of head and varying amounts of flow. The photos illustrate the kinds of low head sites that would generally fall into the flow ranges described.



Some additional low head sites are shown below for further reference.

Maricopa-Stanfield Irrigation District Drop Structure; 100 cfs; 10 feet head; 200 kW potential

Gila Gravity Canal Headworks; 2,200 cfs max flow; 14 feet head; 2.4 to 5.9 MW potential

U.S. Low Head Hydropower Potential

As mentioned above, the potential for low head hydropower in the U.S. is significant. There is no one data source that details all aspects of the low head hydropower potential, but there are several good sources of data. The U.S. Department of Energy has conducted several studies of the hydropower potential in the U.S. with the most recent studies in 2004 and 2006[2]. The 2004 report specifically identified low head potential separately from high head; but does not appear to capture low head potential in man-made channels such as irrigation districts. The 2006 report dropped the categorization by head, keeping only categorization by rated power potential. However, the underlying data for the 2006 report can be queried directly through a tool developed by the Idaho National Laboratory called the Virtual Hydropower Prospector[3]. In addition to the DOE studies, there is a National Inventory of Dams, which seeks to identify and catalogue all existing dams in the U.S[4]. The Department of Interior, U.S. Army Corps of Engineers and the Department of Energy published a report in 2007 on the

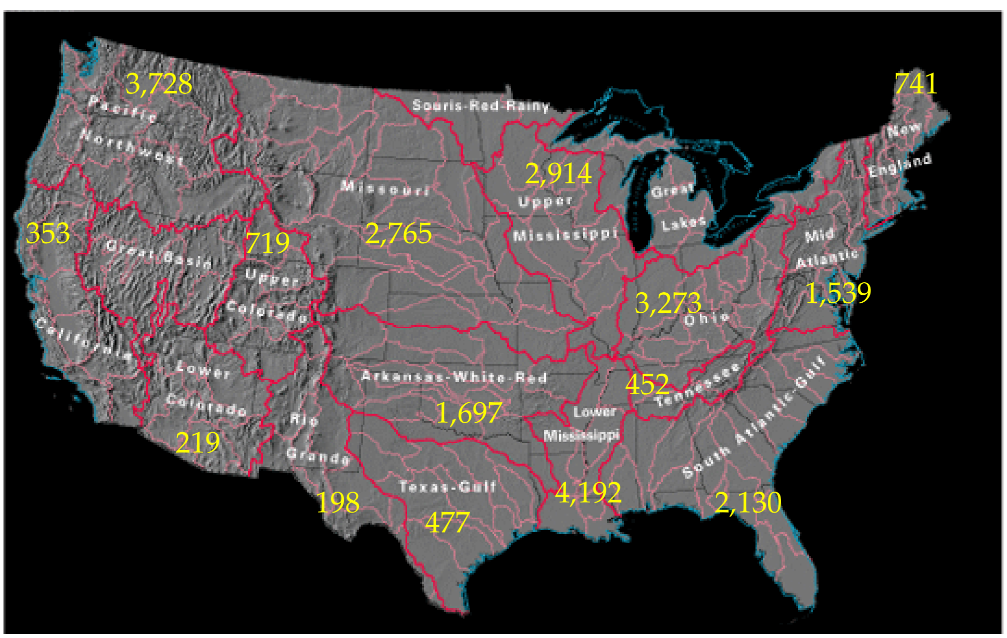
[2] 2004 DOE Report: http://hydropower.inel.gov/resourceassessment/pdfs/03-11111.pdf
2006 DOE Report: http://hydropower.inel.gov/resourceassessment/pdfs/main_report_appendix_a_final.pdf
[3] Virtual Hydropower Prospector: http://hydropower.inel.gov/prospector/index.shtml
[4] National Inventory on Dams: https://rsgis.crrel.usace.army.mil/apex/f?p=397:1:1280766746874154

hydropower potential at existing federal facilities[5]. Also in 2007, the Electric Power Research Institute published a report assessing the waterpower potential of the U.S. and development needs[6].

Based on data from these sources, the overall estimated 71 GWa of low head hydropower potential in the U.S. can further be described as follows. In the below table, low head refers to sites less than 30 feet tall; low power refers to sites with less than 1 MW of potential. All numbers in the table below are in MWa.

Annual Mean Power	Total	Developed	Excluded	Available
Total Power	289,741	35,430	88,761	165,550
Total Low Head Power	96,566	1,634	24,134	70,798
Low Head/High Power	72,022	1,173	21,400	49,449
Low Head/Low Power	24,544	461	2,734	21,349
Total High Head Power	193,175	33,796	64,627	94,752
High Head/High Power	157,772	33,423	55,464	68,885
High Head/Low Power	35,403	373	9,163	25,867

The site specific data underlying the 2004 DOE report can be further analyzed using the Virtual Hydropower Prospector to specifically screen for sites between 5 and 20 feet of head that are not in wilderness or other excluded areas. This identifies a total of 33.5 GWa of potential across 24,000 sites distributed as shown below.



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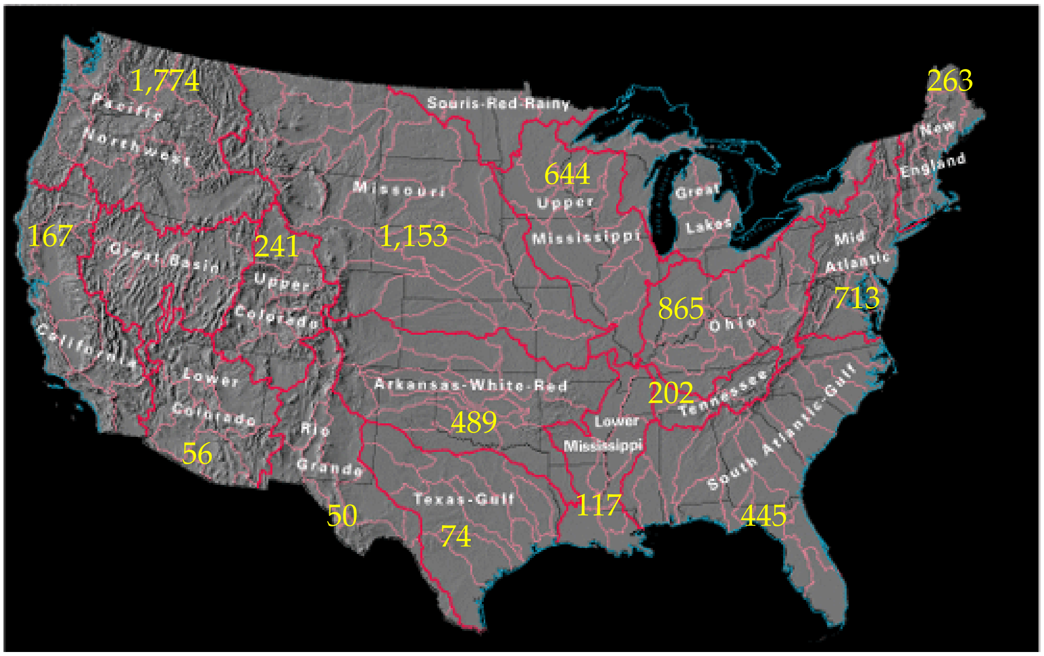
[5] DOI/USACE/DOE Report: http://www.usbr.gov/power/data/1834/Sec1834_EPA.pdf
[6] EPRI Report: http://mydocs.epri.com/docs/public/000000000001014762.pdf

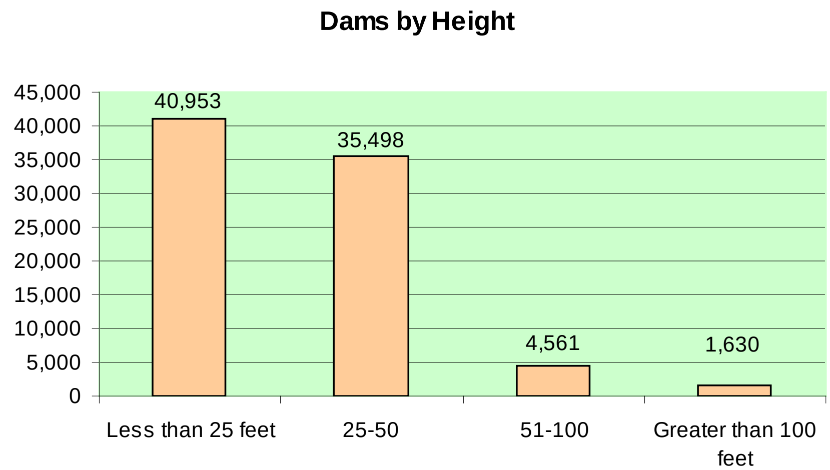
The equivalent dataset underlying the 2006 DOE report, which applies a project development model to the potential to identify developable projects, can be analyzed in a similar fashion. From this dataset, only sites with between 5 and 20 feet of a head that are not in wilderness or other excluded areas, and that are less than 1 mile both from roads and from some portion of the power transmission infrastructure were selected. This identifies a total of 8 GWa of potential across 10,100 sites distributed as shown below.



As mentioned previously, neither of these datasets appear to capture the low head potential in man-made channels and conduits. The only study I have seen to date specifically focused on the potential in man-made irrigation canals was done by Navigant in California[7]. They identified 255 MW of potential hydropower in man-made channels and conduits in California. It is interesting to note that the Navigant study identified more hydro potential in man-made channels and conduits in California than in in-stream settings in California based on the screened 2006 DOE data shown above.

The final data set for analyzing low head potential in the U.S. is to look at existing structures identified in the National Inventory on Dams. According to the NID, there are over 40,000 existing dams in the U.S. less than 25 feet tall. Less than 3% of existing dams in the U.S. generate hydropower and the majority of those power-producing dams are medium to high head.

[7] Navigant Report on Small Hydro in California: http://www.energy.ca.gov/2006publications/CEC-500-2006-065/CEC-500-2006-065.PDF



Technology Challenges

The technological challenge of generating electricity from water at low head settings comes from the fact described above that power is a function of head and flow. At low heads, the only way to scale to larger power output is to be able to pass larger volumes of water. Overcoming this hurdle, while keeping costs low and minimizing environmental impacts, has been the technological barrier to much development of low head hydropower resources in general.

Environmental Concerns

The environmental concerns for low head hydropower are driven by the characteristics of the site. Low head hydropower projects developed in existing, man-made channels or conduits with existing low drops or diversion structures will tend to have low incremental environmental impacts. Projects at existing low dams in stream settings will tend to higher potential impacts than projects in man-made conduits, though the magnitude of the impact will vary again depending on the setting. Arguably, putting power generation on existing structures such as locks and dams, provided that the installations do not interfere with transport and recreational uses, is another minimal impact kind of project.

The environmental concerns that projects in river settings will need to address include:

- Fish passage
- Water flow modifications, if any
- Impacts from any required civil works construction
- Disturbed riverbank habitat

However, I believe that low head hydropower projects also have the potential in certain cases to help address certain environmental concerns such as nutrient pollution and sediment loading. Indeed, some existing research indicates that low dams spread across a watershed can mitigate flooding from runoff of large intense storms and can also sequester significant amounts of nitrogen and phosphorus. A study completed in 2004 of a system of 26 low dams across the Red River Basin in south central Manitoba showed significant and consistent retention of nitrogen and phosphorous in the small ponds and wetlands created by the dams over the four years of study. More research needs to be done to better understand how to truly manage our watersheds to deliver water for human consumption, for agriculture, for healthy ecosystems, for power production, and for recreational uses. However, another tool in the waterpower development toolbox that enables cost-effective low head hydropower development will have great use in many settings that do not have a high degree of environmental sensitivity.

Costs

A major factor inhibiting the development of America's hydropower resources on man-made conduit or water conveyance systems and existing low head, non-powered dams has been the high cost of available turbomachinery. Conventional low-head waterpower technology, such as Kaplan turbines and similar devices (bulb, tube, and even propeller turbines) has proven to be too costly for widespread market adoption. For example, several recent surveys of low-head hydropower plants built with Kaplan turbines have reported values of over $2,800/kW for the electromechanical equipment alone, given a 100 kW turbine operating with 3 meters of head (Singal 2008, Ogayar 2009)[8] [9]. Natel's own survey of a variety of quotes from Kaplan turbine manufacturers indicates that the real market prices might be even higher. A surface fit following the same methodology disclosed by Ogayar, but using turbine quotes compiled from a range of feasibility studies conducted for low head sites, results in a predicted price of roughly $4,200/kW for a 100 kW Kaplan turbine at 3 meters of head[10]. Unfortunately for prospective low-head waterpower project developers, these numbers represent only the electromechanical equipment component of initial capital cost, covering the turbine runner, wicket gates, draft tube, generator, control system, and switchgear. Often, civil works and other project costs might equal or exceed the electromechanical component, leading to total installed costs which require extremely high capacity factors, high electricity prices, or both, to justify plant investment.

One of the primary reasons for the high cost of conventional turbomachinery is the complex blade shape of conventional turbine runners. According to the Electric Power Research Institute, the cost of a Kaplan runner may exceed 50% of the electromechanical component cost[11]. This is an indication of the complexity and fine manufacturing precision by which Kaplan turbine runners are characterized, but also is indicative of an opportunity for innovation in reducing an important barrier to low head hydropower development: cost.

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[8] Ogayar, B., P.G. Vidal. Cost determination of the electro-mechanical equipmentof a small hydro-power plant. Renewable Energy 2009;34:6-13.

[9] Singal, S.K., R.P. Saini. Analytical approach for development of correlations for cost of canal-based SHP schemes. Renewable Energy 2008;33:2549-2258.

[10] Turbine quotes compiled from feasibility studies including: http://library.wrds.uwyo.edu/ims/Park.html; http://www.yorkshiredales.org.uk/hydro-power_feasibilty_study_july2009; http://mydocs.epri.com/docs/public/TR-112350-V2.pdf

[11] Gray, D. Hydro Life Extension Modernization Guides Volume 2: Hydromechanical Equipment, TR-112350-V2 Final Report, August 2000. EPRI.

For comparative purposes, the table below describes the economics for a 1 MW site with 10 feet of head using current conventional turbine costs, Natel's current SLH cost; and Natel's projected SLH cost at full-scale commercial operation. For the purposes of this comparison, all non-electromechanical costs are assumed to remain the same and are set at $1.48M – this would cover civil works, permitting, interconnect, etc. In addition, the capacity factor is assumed to be the same in all three cases and is set to 65%. For clear illustrative purposes, the payback time period is calculated using a 10 ¢/kWh power price with no project leverage and no incentives (no Production Tax Credit or renewable energy credits).

	Conventional Turbine	**Natel SLH Cost Today**	**Natel SLH Cost @ Commercial Scale**
Turbine Package Cost per kW	$3,000	$1,700	$1,000
Total installed cost	$4.48 million	$3.18 million	$2.48 million
Levelized cost of electricity	8.6 ¢/kWh	6.6 ¢/kWh	5.5 ¢/kWh
Payback time	19 years	11 years	7 years

The purpose of the above table is simply to highlight that there is room for innovation in low head waterpower technology, and that innovation, if successful at lowering costs while keeping environmental impacts low, will enable the addition of significant new renewable generation to the grid. We have developed one new technology and there are a number of other companies working hard to innovate in the low head, marine and hydrokinetic space as well.

Areas where federal support would useful

The following kinds of federal support would help to reduce costs and transition our technology, and other innovative waterpower technologies more quickly into the market:

- RDD&D guidance and funding support to help reduce some of the costs of demonstrating and scaling up new low head waterpower technologies;
- Specific grant funds and research focused on better understanding the environmental issues for low head projects, particularly in river settings;
- Testing facilities for measuring the environmental and operational performance of new waterpower technologies;
- Tax credits or other incentives for companies investing in studies or monitoring programs that gather environmental performance data at installed new waterpower technology power projects;
- Beyond the immediate RDD&D needs:
    - A long term extension of the Production Tax Credit (PTC) and Clean Renewable Energy Bond (CREB) programs would foster investment in retrofitting the many existing low head, non-power structures to produce new, distributed, baseload, renewable energy, by encouraging private sector investment and providing low cost financing to public entities such as most irrigation districts;

- Section 45 Production Tax Credit parity for all low head hydropower, hydrokinetic, marine and other innovative water power technologies;
- Inclusion of all low head hydropower, hydrokinetic, marine and other innovative water power technologies at existing, non-powered dams in a federal Renewable Energy Portfolio Standard (RPS).

Closing

I would like to thank the Committee again for inviting me to testify and for its attention to the issues before the Committee. It has been a pleasure to appear before the Committee today and Natel Energy stands ready to work with the Committee in the future as needed. America is in a position to lead the world in clean energy technology development, but only by taking decisive action we will catch and surpass our international counterparts in waterpower technology development. In so doing, we, and many other innovative companies like us, will create new manufacturing and power sector jobs and help pave the way towards a clean, secure energy future for America while tackling the environmental issues we face as a country in an increasingly competitive world.

Thank you for your time.

Contact Information

If the members of the Committee or their staff would like additional information, please do not hesitate to contact Natel Energy at your convenience. Contact information is found below.

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