Testimony of

Gia D. Schneider

Chairman and CEO

Natel Energy, Inc.

Before the

Committee on Natural Resources, Subcommittee on Water and Power

United States House of Representatives

"Investment in Small Hydropower: Prospects of Expanding Low-Impact and Affordable Hydropower Generation in the West"

July 29, 2010

Introduction

Good morning Chairwoman Napolitano, Ranking Member McClintock, 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 Subcommittee, and to discuss the prospects for expanding low-impact and affordable hydropower generation in the western U.S.

Natel Energy Background

Natel Energy, Inc. is a California-based company that is commercializing a patented new hydropower technology called the Schneider Linear Hydroengine or SLH, which extends the economic low head hydropower resource to drops as low as 5 feet, and cuts costs 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.

We have chosen to focus on the low head market because 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; installation was completed in December 2009; and connected to the grid in April 2010.

We have discussions ongoing with a number of other irrigation districts, several municipal water treatment facilities and developers at existing non-power dams 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.

Natel Energy has been funded to-date by its founders, and by several committed early-stage investors. In addition, we are proud to have been awarded an ARRA Phase 1 SBIR grant from the Department of Energy in December 2009. This funding totaled $111,745 and went directly to improve the performance and reduce the manufactured cost of our SLH system. The results of the Phase 1 work will be deployed at the Buckeye project starting next month.

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; hydraulic efficiencies of 75-80% were demonstrated in tests conducted at the University of California, Davis hydraulics laboratory in 1979. He then built larger units, based on the early alpha designs, and installed them in field settings. The longest running alpha field unit ran for over 2 years. While the results from those early efforts were promising, the economic rationale to invest in further development and engineering 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 working with the early prototypes that our father built and that planted a seed which would later grow. Both of us went on to study at the Massachusetts Institute of Technology. My degree is in chemical engineering, but I decided to work in the energy space after graduation, 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. Abe 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. 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 low-cost, clean energy to America.

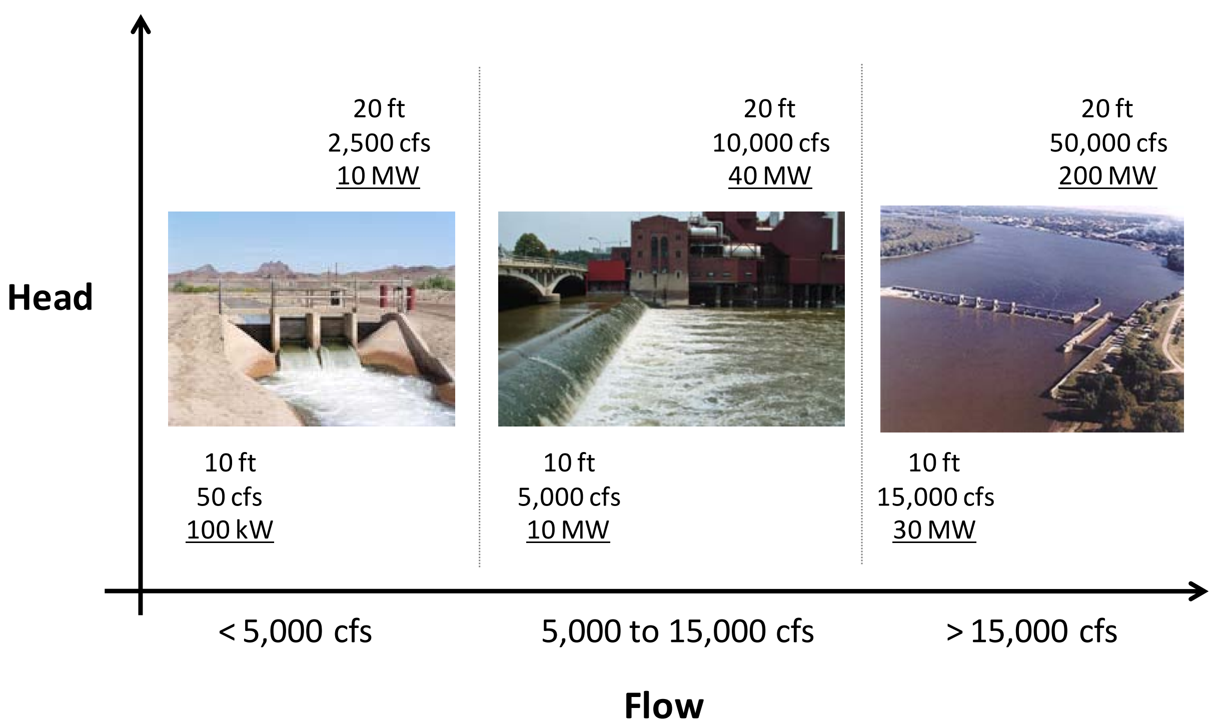
Opportunities for low-impact, affordable hydropower generation

Before delving further, I would like to lay out several terms commonly used, but not necessarily with common definitions, in hydropower. Hydropower is most often 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
    - 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. Since building new, high dams in the U.S. is unlikely to occur, most of the developable hydropower resource is either at existing facilities, or at low head. 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.

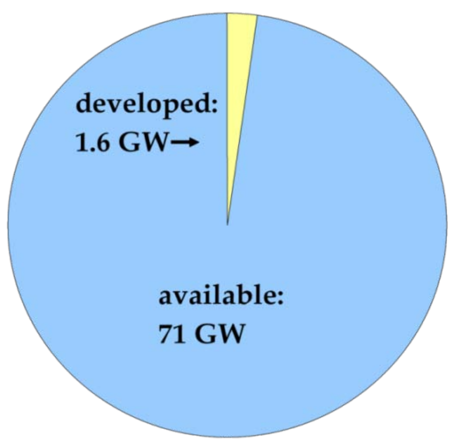
Maricopa-Stanfield Irrigation District Drop Structure; 100 cfs; 10 feet head; 200 kW potential

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

There are a number of opportunities for low-impact, affordable hydropower generation, much of it at lower heads and existing infrastructure. The potential for new low head hydropower in the U.S. overall 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, in-stream, low head resource at 71 GWa[1].

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



[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 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.

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 low head settings in constructed waterways, such as low irrigation drop structures.

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 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].

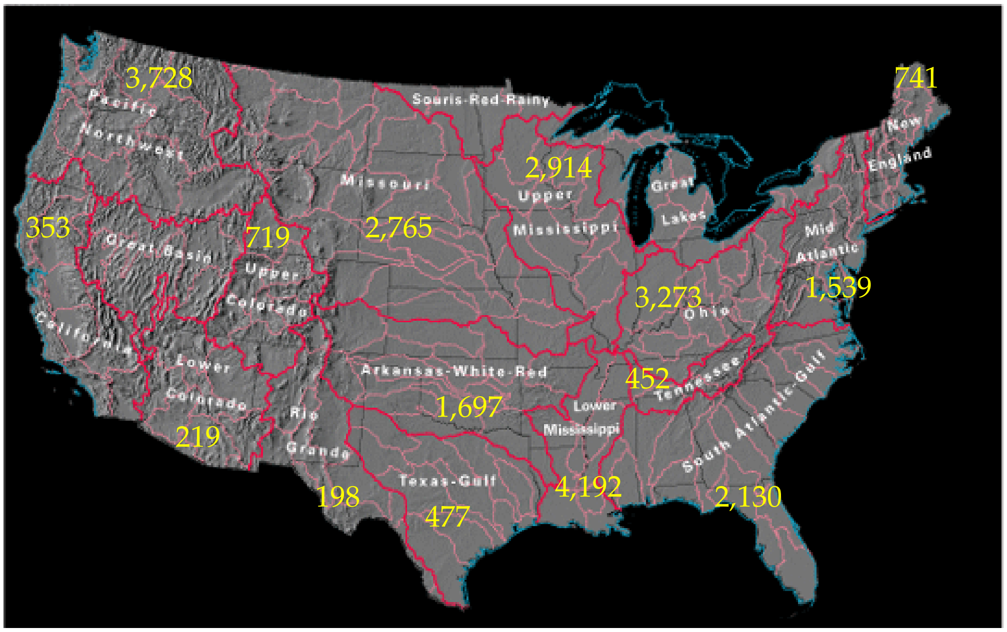
Based on data from these sources, the overall estimated 71 GWa of low head hydropower potential in the U.S. can further be described as follows. In the below table, low head refers to sites less than 30 feet tall; low power refers to sites with less than 1 MW of potential. All numbers in the table below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

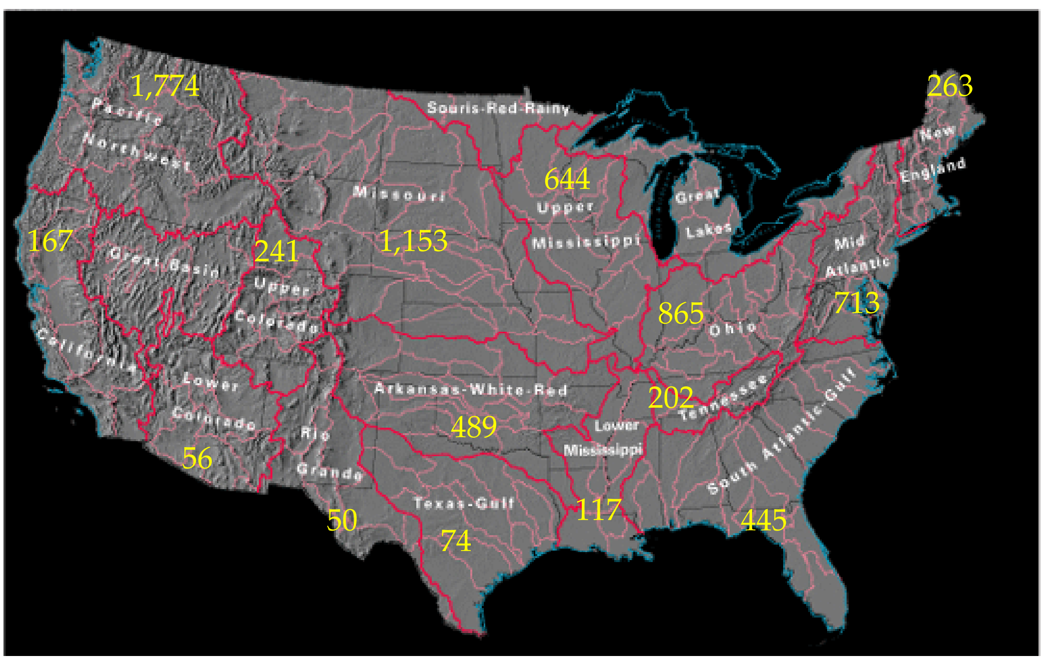
The site specific data underlying the 2004 DOE report can be further analyzed using the Virtual Hydropower Prospector to specifically screen for sites between 5 and 20 feet of head that are not in

[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
[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

wilderness or other excluded areas. This identifies a total of 33.5 GWa of potential across 24,000 sites distributed as shown below.

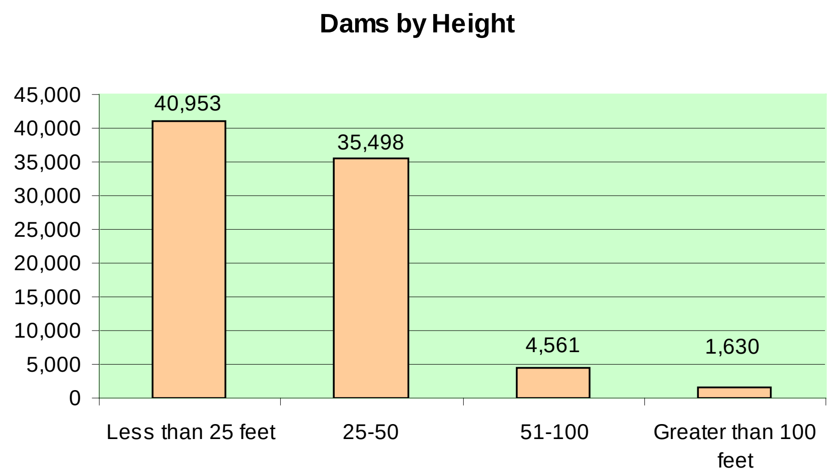


The equivalent dataset underlying the 2006 DOE report, which applies a project development model to the potential to identify developable projects, can be analyzed in a similar fashion. From this dataset, only sites with between 5 and 20 feet of a head that are not in wilderness or other excluded areas, 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.



<u>Opportunities for low-impact, affordable hydropower in the Western U.S.</u>

The opportunities for new, low-impact, affordable hydropower that could be developed relatively quickly in the Western U.S. exist primarily in constructed waterways, industrial water flows, and some existing non-power structures. There are over 800 irrigation districts in the U.S. operating more than 110,000 miles of canals with drop structures and flow control gates in the 17 Western Reclamation states.

Natel estimates that there is between 1 and 5 GW of low-head potential that could be harnessed in constructed waterways in the Western U.S. primarily at low, irrigation drop structures and gates. This is hydropower that has minimal to no incremental environmental impact, qualifies for simpler permitting processes, and creates additional revenue streams for irrigation districts which will help them continue to make canal improvements without raising rates on farmers. Of all of the hydropower opportunities in the Western U.S., the niche in constructed waterways has a particularly attractive combination of affordability, low-impact, simpler permitting and co-benefits.

---

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

The interest in small hydropower has grown rapidly in the past two years evidenced by strong participation in the National Hydropower Association's Small Hydro Council and a number of well-attended meetings focused on small hydropower issues.

Existing incentives for entities developing new hydropower

There are several incentives that are available to entities developing new hydropower in constructed waterways and at existing non-power dams; depending on the nature of the developer entity. The primary incentives are:

- Section 45 production tax credit: a number of new, low-impact hydropower projects that are developed by private entities are eligible to receive a production tax credit that is half of the credit available for wind and solar projects
- Investment tax credit and the 1603 In-lieu Grant: 30% of the total project cost is available as a rebate either in the form of a tax credit or a direct grant, for certain projects, again targeted at private entities, not public ones
- Renewable Energy Credits: various states designate certain kinds of hydropower projects as eligible for RECs; and certain utilities have established pricing for RECs from small hydropower projects
- Clean Renewable Energy Bonds: Entities that can borrow funds on a tax-exempt basis are eligible to participate in the CREBs program and in general, small, low-impact hydropower projects are eligible projects

Barriers faced by entities in developing new hydropower

The primary barriers faced by entities developing new hydropower projects, particularly at low head, where much of the lower-impact opportunity exists are cost (driven by technology choice), regulatory process (driven by environmental concerns) and interconnection process.

Technology & Cost Barriers

A major factor inhibiting the development of affordable, low-impact hydropower resources in the Western U.S. 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

[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.

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.

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. This is the challenge that Natel has set out to address – develop a system that delivers similar performance to conventional turbines, but at 50% of the cost, while providing safe operating conditions for fish passage. Meeting that challenge means that irrigation districts and other owners of low-head, existing infrastructure sites are able to develop their sites at a lower cost and with faster permitting. Based on analysis of multiple projects currently in the sales process, Natel forecasts a levelized cost of electricity over a 25 year plant life between 5 and 7 ¢/kWh on an unlevered, no-incentive basis.

Regulatory Barriers

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:

---

[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.

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

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.

Interconnection Barriers

Many of the most immediately developable, low-impact, low-cost sites in the Western U.S. are smaller in individual site size, even though the aggregate generation potential across all of an irrigation district's sites may be significant. Thus, the cost of connecting each individual project to the grid is an important development cost consideration. On the positive side, in general these projects are tying into lower-voltage distribution lines, decreasing the cost of the physical grid connection. However, on the negative side of things, the overhead (interconnection studies, etc) of the interconnect process varies widely in our experience and in many cases, the process is neither standardized nor tailored to different project sizes. For example, smaller projects under 100 kW should qualify for a less bulky interconnect process than larger projects over several megawatts in size.

Areas where federal support would be useful

Federal support will be most effective at bringing more low-impact, affordable hydropower online by focusing on supporting deployment of newer, lower cost technologies. 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;
- Beyond the immediate RDD&D needs:
    - A long term extension of the Production Tax Credit (PTC) / Investment Tax Credit / 1603 In-Lieu Grant 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 Standard.

Closing

I would like to thank the Subcommittee again for inviting me to testify and for its attention to the issues before the Subcommittee. It has been a pleasure to appear before the Subcommittee today and Natel Energy stands ready to work with the Subcommittee 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 Subcommittee or their staff would like additional information, please do not hesitate to contact Natel Energy at your convenience. Contact information is found below.

Gia Schneider
Chairman & CEO
P: 510 984 3644
M: 917 558 2718
E: gia@natelenergy.com
Website: www.natelenergy.com