The 45 Mile Hydroelectric Project

The 45 Mile Hydroelectric Project, Formerly Known as the 51 mile Hydroelectric Project

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Project Overview

The 45 Mile Hydroelectric Project: The 45 Mile Project demonstrated innovative technology and advanced strategies that resulted in the development and construction of a 2.999 MW facility situated in Central Oregon. It was constructed at a reduced levelized cost of energy (LCOE) (below $0.07/kWh), successfully meeting the goals of the DOE in promoting commercial development of cost competitive, clean hydropower for America's energy grid.

The Challenge: This project directly assessed the issues of time delays, high costs, and lengthy permitting processes that can slow the growth of hydropower. The project evaluated and identified unique, innovative technology that has improved energy and environmental performance characteristics. This project also identified potential opportunities to further promote hydroelectric growth by optimizing production and reducing capital costs.

Partners: Oak Ridge National Laboratories: Dr. Boualem Hadjerioua as consultant and technical investigator providing publications, presentations, and collaborative efforts to help ensure the project's success. Apple, Inc. for funding and support, purchasing the project and incorporating it into their existing portfolio as an example of their dedication to promoting clean energy.

Next Generation Hydropower (HydroNEXT)

Optimization

- Optimize technical, environmental, and water-use efficiency of existing fleet
- Collect and disseminate data on new and existing assets
- Facilitate interagency collaboration to increase regulatory process efficiency
- Identify revenue streams for ancillary services

Growth

- **Lower costs of hydropower components and civil works**
- Increase power train efficiency for low-head, variable flow applications
- Facilitate mechanisms for testing and advancing new hydropower systems and components
- Reduce costs and deployment timelines of new PSH plants
- Prepare the incoming hydropower workforce

Sustainability

- **Design new hydropower systems that minimize or avoid environmental impacts**
- Support development of new fish passage technologies and approaches
- Develop technologies, tools, and strategies to evaluate and address environmental impacts
- Increase resilience to climate change

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The Impact

- Demonstration of small hydropower with significant cost reduction (less than $0.07/kWh) to be competitive with existing base-load power sources such as coal-powered plants
- Project that enhances the timely execution of innovative, commercial hydro technology with higher power efficiency and methodologies
- The purpose of this project is to provide a path forward to encourage broader hydropower deployment at small hydropower resources previously considered unfeasible or marginally feasible, increasing sustainable conventional hydropower generation in the United States
- The results of this project demonstrate the ability to develop low cost, small hydropower with an optimized level of performance that makes them financially viable. The success of this project is a proof of concept model that will promote the expansion of hydropower.

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The Impact

- Unique Canadian Hydro Components (CHC) turbine technology that requires a reduced structural and civil footprint with a unique powerhouse design suppressing external noise that together, reduce impacts to the environment
- Use of traditional systems such as trashracks, bypass/overflow protection, and similar features that can be designed, constructed, and installed at lower costs
- Installation of a hydropower facility in an existing irrigation canal. This removes potential effects on natural rivers by using water that is already diverted for irrigation where existing State regulations support the secondary use of water to generate power
- Citing a facility along an irrigation canal allows the use of thousands of existing chutes and drops, significantly expanding the opportunity for hydropower projects with reduced regulatory / stakeholder requirements, streamlined permitting, and faster timelines.

Innovative Hydropower Solutions

Technical Approach

- The ability to capitalize on the undeveloped resource potential offered by sustainable small hydropower, especially in existing irrigation canals: The use of an irrigation canal for the location of a hydro facility allows for a smaller footprint and reduces overall production time and complex engineering saving time and money (two of the biggest obstacles in hydropower development)
- Accelerate the commercialization of components and systems needed to design and construct hydroelectric facilities using CHC's innovative turbine technology across the United States: CHC has optimized its manufacturing processes utilizing their innovative design for assembly and design for manufacturing.

To date, the 45 Mile Hydroelectric Project has produced over 13.4 million kWh and is estimated to produce more than 9 million kWh by 2017.

Technical Approach

- Gather, validate and analyze actual data on the facility's economic and technical performance to facilitate replication of this technology across the United States: Earth by Design demonstrated the cost effectiveness of the design with limited staff while using existing water resources helping to protect the environment by reducing impacts on wildlife habitat and improving water conservation
- Effectively transfer the technical and economic results of the project based on real-world construction and operational experience to a variety of stakeholders to facilitate widespread adoption of innovative turbine technologies:
  - The success of the 45-Mile Project serves as a critical proof of concept that can be modeled for small hydropower development on irrigation canals expanding small hydropower in the United States.
  - The 45 Mile project is a good example that captures the benefits of reasonably short construction periods, fast startup times, and minimal staff requirements, all of which contribute to the overall attractiveness of small hydropower development on irrigation canals in the United States.

Accomplishments and Progress

The most significant accomplishments of this project are:

- Development and construction of a 3 MW hydropower facility under $0.07/kWh, with reasonably short construction periods and fast startup times
- Construction of an environmentally friendly, optimized facility situated alongside an existing irrigation canal – a model for small hydropower development on irrigation canals throughout the United States
- Demonstration of innovative Canadian Hydro turbines that are cost effective and more rapidly produced (moving into commercial readiness from the outcomes of this grant)
- Valuable knowledge gained (lessons learned) that can be utilized by future developers to streamline their projects and reduce costs, promoting an interest in hydropower growth
- Demonstrate the value of advanced project management skills and collaborative efforts to support the transfer of technology, location, and rapidly mitigate unforeseen obstacles.

Technical Performance

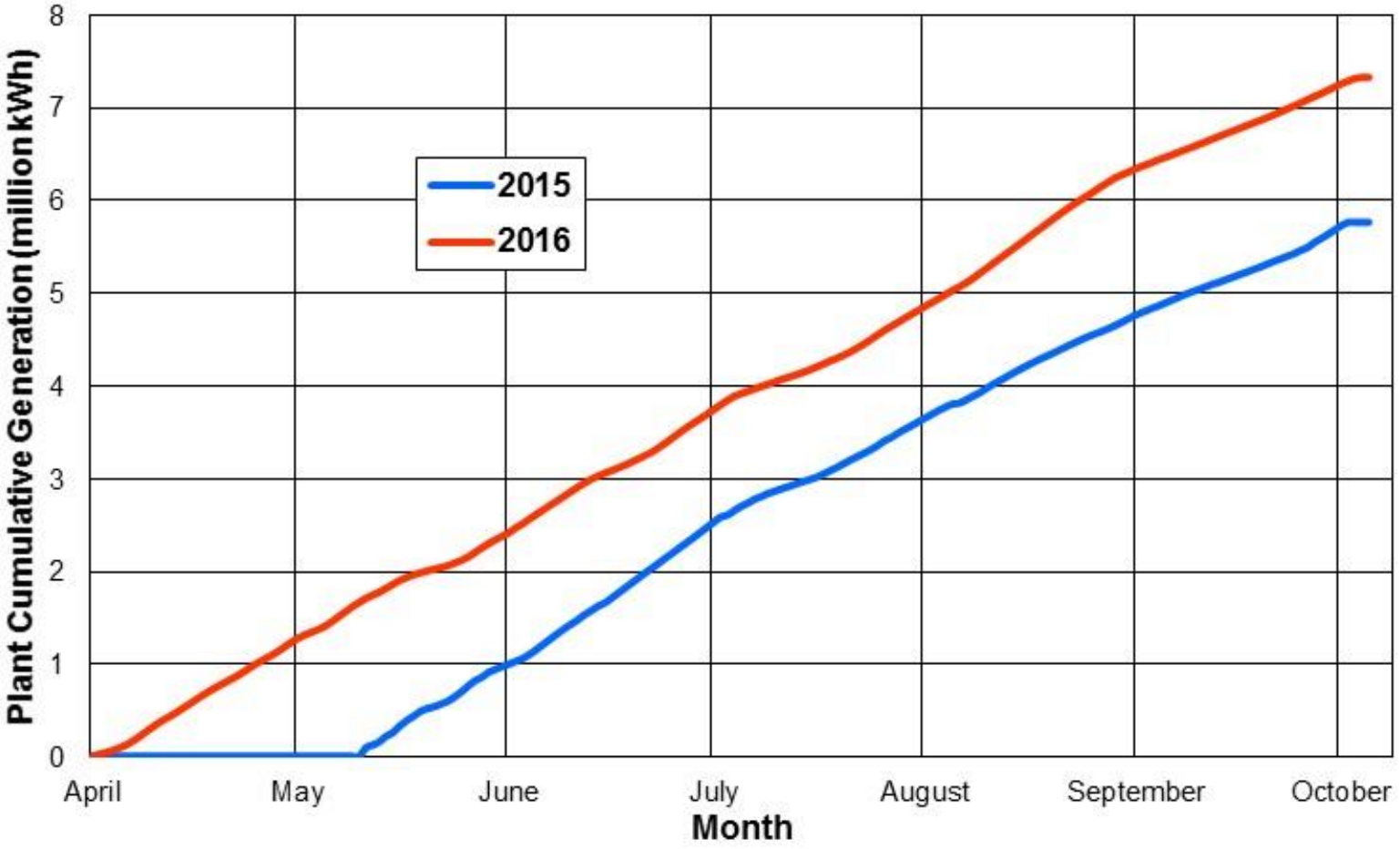

Figure 1: Plant Cumulative Generation (from Oak Ridge National Laboratory [ORNL])

Technical Performance

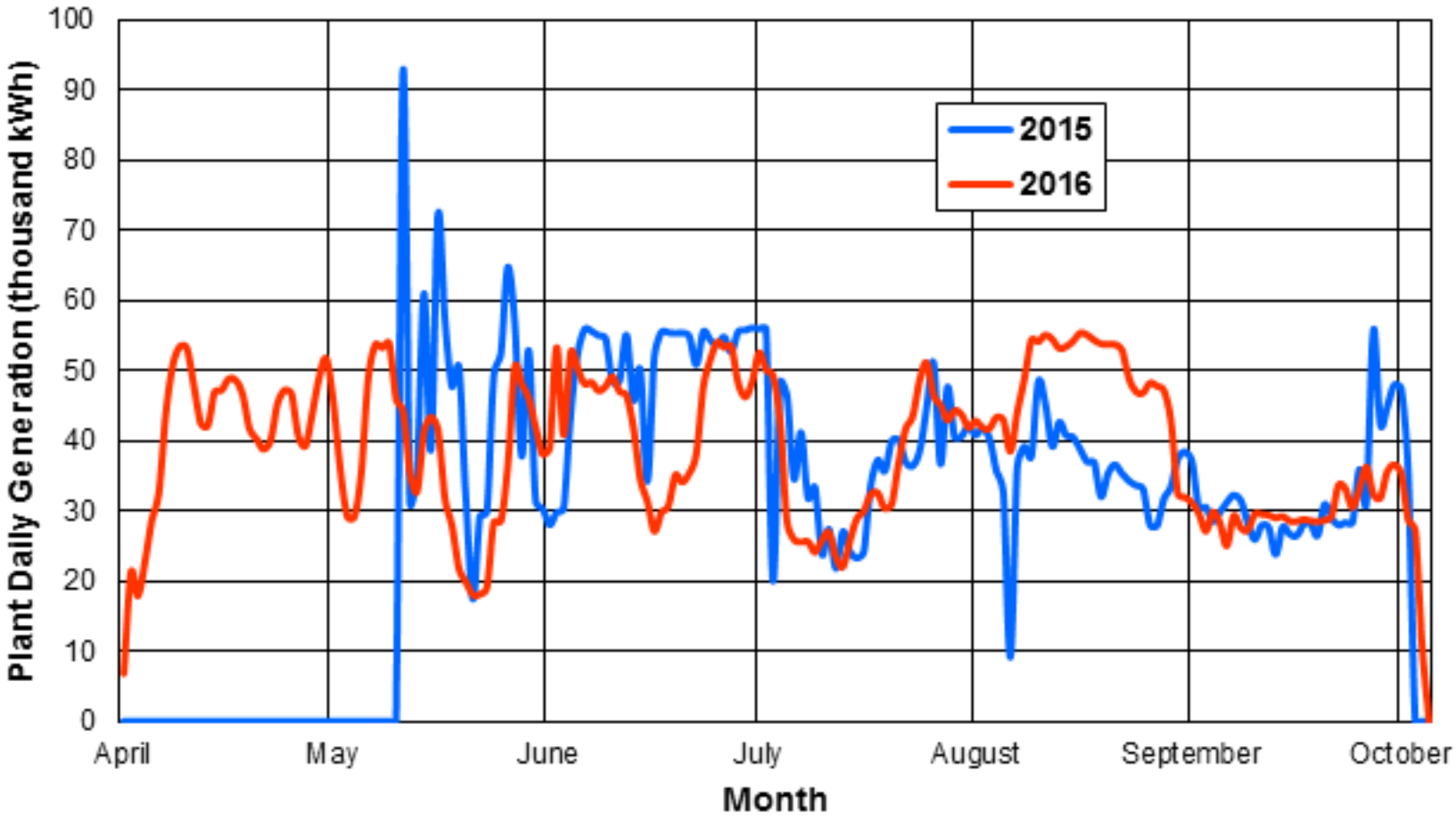

Figure 2: Plant Daily Generation (from ORNL)

Project Plan & Schedule

- This project began on 9/11/2011 and was scheduled for completion by 9/30/2014. Actual completion occurred on 9/30/2016 following two no-cost time extension requests for unforeseen delays. The primary purpose of the no-cost time extensions was to provide two full years of operational data to ORNL. The water flows for this project are seasonal.
- None of the milestones or tasks changed for this project. Instead, an alternate technology with similar costs and improved performance characteristics was selected.
- Additionally, the project was moved from the originally proposed 51 Mile site to the 45 Mile site to take advantage of the opportunity for a more comprehensive performance matrix that fully demonstrated the effectiveness of constructing small hydropower on existing canals to further the DOE's efforts of expanding hydropower in the United States.

Project Budget

Budget History					
FY2014		FY2015		FY2016	
DOE	Cost-share	DOE	Cost-share	DOE	Cost-share
$1,500k	$5,494.57k	$0	$2.692k		

- The original budget was $5,025.96k. Changes in cost came from the new, more comprehensive turbine technology (and additional equipment), and additional costs for a modified powerhouse structure at the new project site. Requests were submitted in December 2013–March 2014 with the DOE Project Team, who reviewed (and approved) the modifications.

Partners, Subcontractors, and Collaborators:

Oak Ridge National Laboratory; the Wind and Water Power Team with the Department of Energy; Noesis Engineering Services, P.C.; and Canadian Hydro Components, Ltd. as the turbine manufacturers. Apple, Inc., provided additional funding and support as part of their ongoing efforts to contribute to renewable energy.

Communications and Technology Transfer:

Presentations at the 2012, 2013, 2014, and 2016 International Hydrovision conferences on the various aspects of successes and opportunities from this project along with additional presentations at regional Hydrovision, and in the International Wind, Water, and Power Magazine.

Next Steps and Future Research

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Publications:

B. Hadjerioua, and K. Stewart, “Assessment and Evaluation of New Small Hydropower Technology to be Deployed to the United States 45-Mile Project: “The Turbinator®”, Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee, March 2013

B. Hadjerioua, S. DeNeale, Q. Zhang, and E. Hopping, “Evaluation of Canadian Hydro Component Small Hydropower Technology to be Deployed at the 45-Mile Project, Oregon, United States”, Oak Ridge National Laboratory (ORNL), Oak Ridge, Tennessee, May 2014

Proposed future research:

- Publication of the lessons learned and a technical roadmap for the development of future hydropower using the innovative technologies and solutions modeled
- Additional model sites along irrigation canals to further support competitive expansion of small hydropower.