VIII.9 TDX Foundation Hydrogen Project/PEV Project*

Connie Fredenberg
TDX Power
4300 B Street, Suite 402
Anchorage, AK 99503
Phone: (907)830-6021
E-mail: cfredenberg@tdxpower.com

DOE Technology Development Manager:
John Garbak
Phone: (202) 586-1723
E-mail: John.Garbak@ee.doe.gov

DOE Project Officer: Jim Alkire
Phone: (303) 275-4795
E-mail: James.Alkire@go.doe.gov

Contract Number: DE-FG36-09GO88096

Subcontractors:
- TDX Power, Anchorage, AK
- Alaska Center for Energy and Power (ACEP), Fairbanks, AK

Project Start Date: September 15, 2008
Project End Date: December 31, 2011

*Congressionally directed project

Objectives

- Quantify how much excess wind energy is available at the existing wind-diesel plant on St. Paul Island and how much is needed to power transportation, in addition to heat and lights.
- Optimize the use of wind energy to produce fuel for transportation.
- Demonstrate the technical and economic feasibility and commercial availability of appropriate technology for non-fossil fuel forms of transportation on St. Paul Island.

Technical Barriers

This project addresses the following technical barriers from the Technology Validation section of the Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

(A) Lack of Fuel Cell Vehicle Performance and Durability Data

(B) Hydrogen Storage

(C) Lack of Hydrogen Refueling Infrastructure Performance and Availability Data

(H) Hydrogen from Renewable Resources

Contribution to Achievement of DOE Technology Validation Milestones

This project will contribute to achievement of the following DOE milestones from the Technology Validation section of the Fuel Cell Technologies Program Multi-Year Research, Development and Demonstration Plan:

- Milestone 33: Validate an electrolyzer that is powered by a wind turbine at a capital cost of $655/kWe and 62% efficiency including compression to 5,000 psi with quantities of 1,000. (3Q, 2009)

Accomplishments

- Conducted community meetings and school workshops in St. Paul September 9–12, 2009.
- Introduced the Barefoot Motors all-terrain vehicle (ATV) to St. Paul September 12, 2009.
- Presented on the project at the Native Peoples/ Native Homelands Climate Change Workshop II on November 18, 2009 (not funded through this grant).
- Presented on the project at the Alaska Rural Energy Conference on April 25, 2010.
- Have nearly completed modification of the grant from hydrogen vehicle demonstration to a plug-in electric vehicle demonstration project.

Introduction

St. Paul Island is a remote speck in the Bering Sea 300 miles west of the Alaskan mainland, in the heart of America's last rich fishing grounds. It is increasingly expensive, logistically challenging, and sometimes impossible to import fossil fuels to this location. The island has a class 7 wind resource and three Vestas 225 kW wind turbines that operate at a 47% capacity factor. TDX Power owns, operates and maintains the wind farm for the corporation, producing electricity and utilizing excess power for heat to a large industrial complex at the airport. TDX Power is in final negotiations with the City of St. Paul to sell wind energy to the city-owned electric utility, which now uses diesel to provide power for the 396 residents. TDX wants to stretch wind energy's power to transportation and then add more wind turbines.

TDX evaluated the prospect of using wind energy to produce hydrogen for use in transportation, particularly the small buses used in our tourism business that take

visitors to bird watching sites and northern fur seal rookeries. We researched the technical feasibility, commercial availability, environmental benefits, climate and geographic challenges, costs, additional applications for hydrogen, training needs and opportunities, operations and maintenance requirements, and the economic offset of diesel.

Approach

St. Paul Island has enough excess wind resource to produce fuel for transportation. Hydrogen could be the fuel of the future. TDX wanted to determine if hydrogen technology was ready for our remote location. We made site visits to two active hydrogen fueling stations and public transportation projects to collect real data and stories. We felt there were lessons to be learned by visiting facilities, site managers, fueling attendants, bus drivers, and bus riders face to face that cannot be found on project web pages. Our technical contractor visited the wind to hydrogen electrolysis project at the National Renewable Energy Laboratory to interview Kevin Harrison regarding the status of that project.

TDX contracted with ACEP to do a procurement study and produce a vendor and price list for the components we would need for a hydrogen demonstration project on St. Paul Island. TDX considers community education a critical piece of this project and conducts workshops and school events in St. Paul to present our findings and future plans.

Results

St. Paul Island has a class 7 wind resource and 47% availability for its one 225 kW Vestas wind turbine now in operation. Once interconnection of the two additional 225 kW turbines is complete, there will be a considerable amount of excess electricity available. Although plans are in process to tie two of the wind turbines into the city-owned community electric grid, there will still be excess power available. There is also a plan and space available to add three more wind turbines to the Petroleum Offshore Survey Support (POSS) Camp Wind Farm. St. Paul could become the first all-electric community run by wind energy.

The POSS Camp wind farm will produce an abundance of excess electricity when the two newest V27 wind turbines come on line [1]. Current power and production can be seen in Table 1.

According to the study completed by ACEP, the cost per mile driven of a hydrogen vehicle is considerably more than existing diesel technology (see Figure 1) [2].

Battery-powered electric vehicles are more expensive than diesel – at current prices – but show the most promise for near-term commercial availability. Battery technology is progressing rapidly.

TABLE 1. Power Production and Demand at POSS Camp Wind Farm (kWh)

Turbines	Total Diesel Gen	Total Wind Turbine	POSS Camp Electrical Load Demand	Thermal Load Demand	Excess
1	447,578	532,229	562,283	346,267	71,257
2	447,578	1,064,458	562,283	346,267	603,486
3	447,578	1,596,687	562,283	346,267	1,135,715

Originally funded to demonstrate hydrogen technology, TDX opted to modify the grant to demonstrate plug-in electric vehicle (PEV) technology (see Table 2). Although the modification is not yet complete, TDX did invest in a Barefoot Motors ATV, introducing the vehicle to the community at the Wind Festival in September 2009.

The ATV does not perform as advertised, due to the more challenging environment on St. Paul Island. But the ATV works well enough that TDX is optimistic about the potential to expand the use of wind energy on island with PEV technology.

Currently, the POSS Camp uses the energy from only one of the three V-27 wind turbines. A plan is in progress to sell the energy from the other two to the City of St. Paul electric utility. The wind farm has space available for three more turbines. TDX assumes there will be a minimal increase in daily energy use for the demonstration project [3].

One concern is that the lowest wind resource months coincide with the height of tourist season (see Figure 2). TDX is prepared to add more wind turbines as use of PEVs becomes more widespread to solve this problem [4].

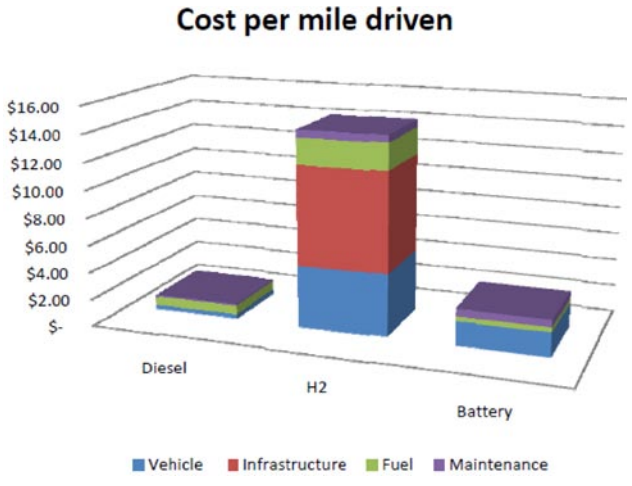

FIGURE 1. Estimated Cost Per Mile Driven by Vehicle Type

TABLE 2. PEV Type and Power Consumption

Vehicles	Peak Charging	Daily Power Consumption
4 buses	32 kw	160 kWh
20 light duty vehicles	40 kw	80 kWh
40 – 4 Wheelers	80 kw	200 kWh
Vehicle Totals	152 kw	440 kWh
Typical Daily Load Conditions		
Current Load	1,575 kWh	
Future Load with Electric Vehicles	2,035 kWh or a	25% increase in daily energy use.

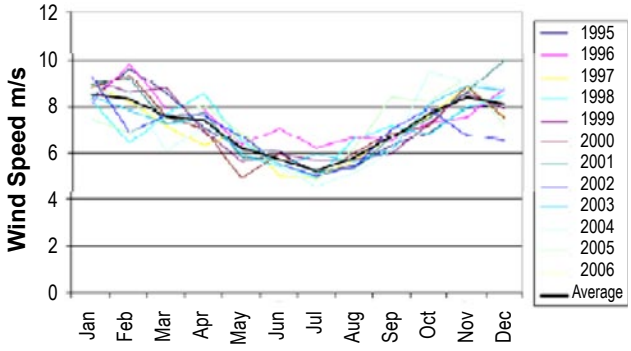

FIGURE 2. Wind Speed by Month for an 11-Year Period

Conclusions and Future Directions

- PEV technology is available today, advancing rapidly, and looks to be economically feasible.
- TDX, with community input, chose to modify the existing grant to focus our demonstration efforts on PEVs.
- TDX has purchased a Barefoot Motors plug-in electric ATV, has ordered a Polaris plug-in electric ATV, and plans to contract with Miracle Energy Systems, Inc. to purchase or custom build an appropriate plug-in electric van or small truck.

FY 2010 Publications/Presentations

1. Fredenberg, C., "St. Paul Electric Vehicle Project," 2009 Native Peoples/Native Homelands Climate Change Workshop II, St. Paul, MN, November 18, 2009. (http://www.nativepeoplesnativehomelands.org)

2. Fredenberg, C., "Alternative Transportation," 2010 Alaska Rural Energy Conference, Fairbanks, AK, April 25, 2010 (http://www.uaf.edu/acep/rec/)

3. Fredenberg, C., DOE Hydrogen Program and Vehicle Technologies Program Review, Washington, D.C., June 8, 2010.

References

1. Dabo, M., "POSS Camp Energy Calculations," TDX Power, 2008.

2. Keith, K., Witmer, D."Alternative Transportation Options on St. Paul Island," Alaska Center for Energy and Power, 2009. http://www.uaf.edu/acep

3. Coleman, C., "PE Vehicle Consumption by Type," TDX Power, 2009.

4. Keith, K., Witmer, D."Alternative Transportation Options on St. Paul Island," Alaska Center for Energy and Power, 2009. http://www.uaf.edu/acep