



# 2010 DOE Merit Program Review

## Tanadgusix (TDX) Foundation Hydrogen Project/PEV Project

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Presenter: Connie Fredenberg

TDX Power

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**Project ID #**

TV010

This presentation does not contain any proprietary, confidential, or otherwise restricted information.

# Overview



## Timeline

- Start: September 15, 2008
- Finish: March 30, 2011
- Percent complete: 50%

## Budget

- Total project funding
  - DOE share: \$246,000
  - Contractor share: \$93,148
  - Funding Received in FY09
    - \$85,026
  - Funding Remaining
    - \$160,974

The funding shown for FY09 and FY10 are actual expenditures, not DOE obligations.

## Barriers

- Lack of fuel cell vehicle performance and durability data
- Hydrogen from Renewable Resources
- Capital Costs

## Targets

- Appropriate Vehicles
- Hot Swappable Battery System
- Long life non-toxic batteries

## Partners/Collaborators

- Alaska Center for Energy and Power
- AK Wind-Diesel Application Center
- NREL
- Miracle Energy Systems, LLC
- Project Lead – TDX Power

# Objectives - Relevance

The main focus of this validation and demonstration project is to procure and evaluate the performance of commercially available and/or custom made alternative fueled vehicle(s) on St. Paul Island, Alaska. Initially the vehicles will be used for the eco-tourism operation owned by TDX Corporation, but the goal is village wide use.



*Tourists from around the world come for the chance to check rare Asian birds off their lifetime list and to see the thousands of fur seals that migrate to St. Paul Island to bear and raise their young each summer.*

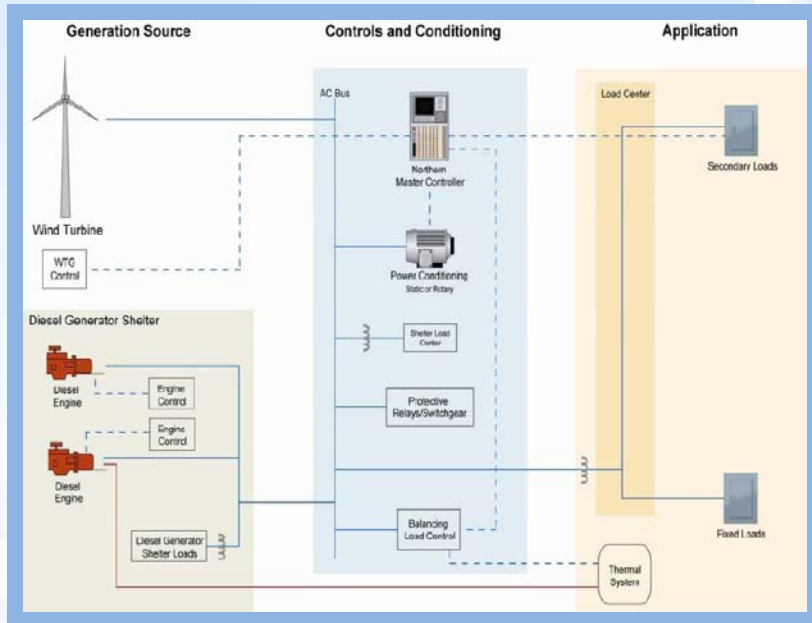
*Winter of 2008 fuel could not be delivered to the island due to sea ice. Fuel was rationed to 5 gal./vehicle/wk at \$12/gallon.*

# Objectives - Relevance

Excess electricity from the existing high penetration wind-diesel system on St. Paul Island will produce the transportation fuel.



*Excess electricity produced by the wind turbine heats water in a 6,000 gallon tank and which is then circulated throughout the POSS Camp to displace diesel fired heat. The integration of 2 additional 225 KW wind turbines will create a lot of extra electricity to produce more heat and fuel for transportation.*



# Milestones

Milestone	Progress Notes	Comments	% Complete
Draft Report of Technical and Feasibility Study	Provided to TDX August '09	Strongly favored plug-in electric vehicle technology as the most cost effective.	100%
Final Report on Appropriate Technology	Provided to TDX September 09	Validated plug-in electric technology as the most immediate cost effective choice.	100%
Outreach	St. Paul Wind Festival II September '09	2 community meetings; 2 full days of workshops on wind energy and hydrogen technology at St. Paul school; The first PEV/ATV was introduced to the community; Senator Murkowski was the first person to ride the ATV.	50%
Technology Demonstration	First Vehicle Introduced September '09	A Barefoot Motors M1 ATV was purchased and test driven by nearly 50 residents; ATV has been test driven nearly 200 miles in a variety of weather conditions; routes are being mapped within range of bike in preparation for rental agreements.	15%

# Approach Overview

## Comprehensive Study Report

Determine Results, Benefits, Issues, Trade-offs, and Comparisons

Present Draft to DOE

Distribute Final Report to the St. Paul Community



## Outreach

Initiate Community Awareness and Involvement

Promote Local School Education

Community Workshops to Present Findings and Introduce Vehicles



## Project Report and Managing

Provided in Accordance with DOE requirements



## Electric Vehicle Demonstration

Locate commercial vehicles or custom design and build vehicles to bring to St. Paul Island for demonstration purposes. Explore hot swappable batteries at charging station.

Test vehicles for ability to operate in local environment for appropriate purposes; Involve community in testing and assessment process.

# Technical Progress

POSS Camp Wind Farm production stats from (1) 225 kW V-29 Vestas turbine.

	2008	2007
Wind Generated Power	532,229 kWh	478,337 kWh
Diesel Generated Power	447,578 kWh	466,300 kWh
Total Power Production	979,807 kWh	944,637 kWh
Diesel Burned (Heat/Power)	33,402 gallons	35,483 gallons
Electricity Consumed	633,278 kWh	651,034 kWh
Electricity to Thermal	346,529 kWh	293,603 kWh
Est. Fuel Savings	33,147 gallons	30,877 gallons

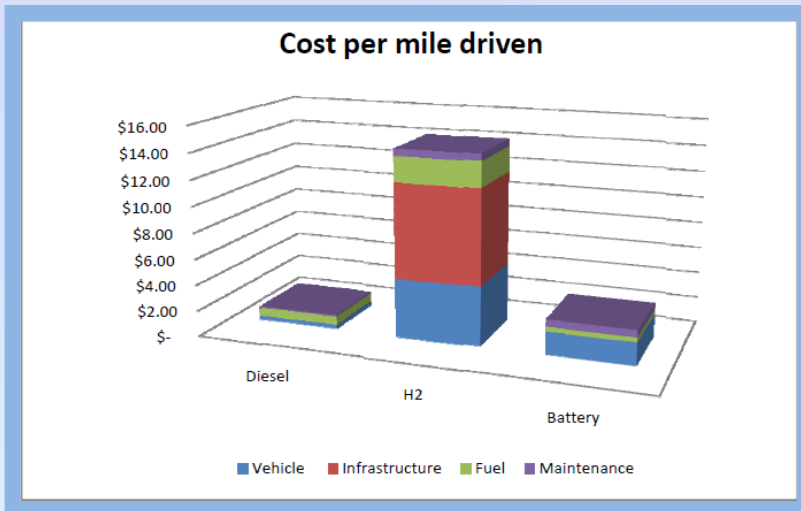
Expected production from two additional V-29 wind turbines when connected.

Turbines	T Diesel Gen.	T Wind Turbine	Electrical Load	Thermal Load	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

# Technical Progress

***Battery Electric Vehicles appear to be nearing commercialization, and require considerably less infrastructure investment.***

***Since this ACEP study was done, OAI contacted TDx about a Proton Energy 65 kW electrolyzer. The price was half that researched by ACEP. But at \$500K, it is still too high.***



## Alaska Center for Energy and Power Feasibility Study

- Link: <http://www.uaf.edu/files/acep/St.PaulWind.V.Chang%5B1%5D.pdf>
- Production of hydrogen from wind power is technically possible.
- TDx is a customer of hydrogen, not a technology developer, so cost is a relevant issue.
- Intermittent wind resource means that electrolyzers must be larger than would be needed if electrical power were available all the time, and storage must be larger.
- Some issues associated with variable power operation of the electrolyzers were identified.
- Lack of commercial vehicles for lease or purchase in appropriate size range was found.
- Costs associated with compression and storage of hydrogen were also identified.
- Hydrogen vehicles did not provide sufficient value even with government cost share to justify TDx investment.



# Technical Progress

TDX intends to procure several vehicles which serve their eco-tourism business needs as well as their community service providing transportation for local elders.

The tours travel a 50 mile route every day for 100 days per year. The senior van drives approximately 20 miles per day 300 days per year.

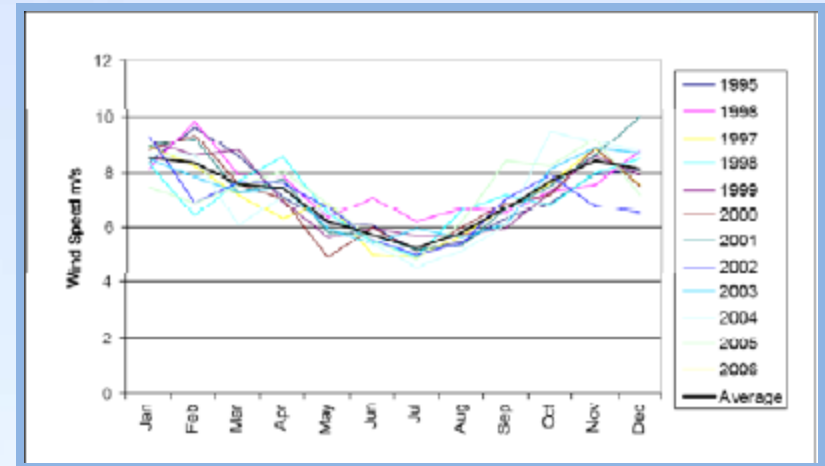
We anticipate an interest from touring visitors to lease a silent ATV for solo trips to observe birds and wildlife.

Vehicle	Range	Battery	Cost
ATVs			
Barefoot M1	40 miles	LiFePO4	\$12,900
Polaris Ranger	>50 miles	Flooded	\$10,700
Medium Pick-up	50 miles	?	~\$60,000 custom
Van or Large Pick-up	50 miles	?	~\$90,000 custom

# Technical Progress

## Estimates of kWhs required for Vehicles

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
<b>Typical Daily Load Conditions</b>		
Current Load	1,575 kWh	
Future Load with Electric Vehicles	2,035 kWh or a	25% increase in daily energy use.



**One significant challenge is that our wind resource is the lowest in summer, when demand for vehicle use is highest.**

# Technical Progress

Motor	Dual Sepex Drive; governed to 40 hp
Controller	Dual 28 kW (56 kW peak) PWM; Sealed
Drive System	4wd and 2wd
<b>Speed</b>	<b>0-30 can be governed</b>
Voltage	80 V
<b>Batteries</b>	<b>100 AH LiFeP04; Manufacturer rated for 1,000+ cycles</b>
Instrumentation	SOC, Odometer, Speedometer, Clock, Run Time, ReGen ind.
<b>Charge Time</b>	<b>7 hours with 120V/15 amp single onboard charger</b>
Brakes	Dual disc hydraulic front and rear
Descent Control	ARDeC (Active Regen Descent Control)
<b>Range - Mileage</b>	<b>Up to 40 miles, depending on usage and terrain</b>
<b>Range - Seat Time</b>	<b>3-8 hours work time</b>
Suspension	Adj. coil over double A-arm front; adj. coil over swing arm rear
Tires/Wheel	25x8 R12 front; 25x10 R12 rear
Max Tow Weight	1250 lbs
Clearance 11.9"	
Vehicle Weight	820 lbs
Warranty	12 months drive train, 6 months other

*The Barefoot M1 was introduced to St. Paul at the second annual Wind Festival. It has been driven by more than 50 different residents, and Alaska's Senator Lisa Murkowski, for over 200 miles.*



# Technical Progress

**Barefoot M1 has been tested in various conditions for nearly 200 miles of driving**

- The range is about half of what Barefoot advertises when not on flat dry surfaces.
- In soft sand the motor overheats and stops. After about 5 minutes it cools off and starts again.
- Had to seal the front edge of the battery box to keep dirt out.
- Tie wrapped the wires near where the steering rods connect to prevent problems during travel on rough roads.
- Applied grease to the contacts inside the plastic wire connector of the battery to prevent corrosion (which could cause a meltdown).



- Hunters really like the bike because it is silent.
- Mothers really like the bike because it has a governor with a top speed of 30 mph.
- Teenaged boys don't like the bike because it has a governor with a top speed of 30 mph.

# Collaborations

## Partners

- Alaska Center for Energy and Power: conducted the Economic and Technical Feasibility Study, wrote the final report, assisted with outreach efforts in St. Paul, and will write the evaluation of the PEV Demonstration Project.
- Miracle Energy Systems, Inc: researches latest battery technology advancements, evaluates commercial PEV product claims, will provide custom built PEV designs and construction if necessary; will provide guidance on testing, data collection, and the evaluation for PEVs introduced to St. Paul.

## Technology Transfer

- Paul Prokopius at Ohio Aeronautical Institute provided valuable insight on current pricing for H technology.
- Terry Penney at NREL provided valuable advice on battery technology.
- The City of Akutan, a boardwalk village (no roads, only sidewalk sized boardwalks) is very interested in our evaluations of PEV ATVs. They have a geothermal power project in progress that will provide them with low cost electricity.
- Many rural Alaskan villages are either planning or constructing renewable energy systems to displace diesel fueled power generation in their communities. This project is relevant for all remote communities in their efforts to displace transportation fuels with local renewable power.

# Proposed Future Work

- Procure a second plug-in electric ATV.
  - Determine and map routes within range of ATVs then lease ATVs to visitors of St. Paul Eco-tour business.
- Procure, or custom build, a medium sized pick-up truck and van (as funding allows).
- Design a portable charging station that can be hauled on a trailer.
- Design a hot swappable battery charging station.
- Present data on PEV Project to community of St. Paul.
- Present results of PEV Project to Alaska Rural Energy Conference in April 2011.

# Project Summary

**Relevance:** Demonstrate that excess power from wind energy can provide fuel for transportation in remote isolated grid communities.

**Approach:** Procure or custom build PEVs and test in real world conditions.

**Technical Accomplishments and Progress:** Have procured and begun testing a Barefoot M1 ATV.

**Technology Transfer/Collaboration:** Multiple rural Alaskan communities are watching the project closely for application in their communities. ACEP provides technical and reporting assistance. Miracle Energy Systems, LLC provides PEV technology research and custom vehicle construction.

**Proposed Future Research:** Procure, demonstrate, and evaluate other vehicles and battery technologies.

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# Questions?

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