Alternative Energy Systems in the Yukon Watershed

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ACEP Blue Loon Lecture Series
Dave PM
Rural Energy Coordinator
Tanana Chiefs Conference
Who knows what a kWh is? How about a watt?

Who knows what a BTU is? How many BTU’s per Gal of Propane? Gal of #2 Heating Oil?

“You keep track of your pennies, and the dollars will take care of themselves”
- Robert Messier Sr.
Energy Definitions

- 1 kilowatt Hour is ten, 100 watt lightbulbs on for 1 hour. In Fairbanks, this currently costs $.20/kWh

- A BTU, British Thermal Unit is the amount of energy it takes to heat 1 lb (~2 cups) of water 1 degree Fahrenheit
  - 1 gal of diesel = 134,000 BTU’s ($4/gal = $.029/1000 BTUs)
  - 1 gal of propane = 93,000 BTU’s (4.65/gal = .05/1000 BTUs)
  - 1 cord of Birch = 20 Mil BTU’s (300/cord = .015/1000 BTUs)
Hydrokinetics = Power Generation from flowing water
Flowing Water = Energy
Big Push in the 70s for Hydrokinetics… Then Nothing…

“Before you think too far outside the box, it helps to be damn sure what’s inside the box”
Ruby Hydrokinetic Project
Yukon River Inter-Tribal Watershed Council

- 3 years, $350K, 1 PhD, 4 different project managers, Army Corps Permits, Coast Guard, Alaska Fish and Game, Heavy Equipment, 900 ft of Cabling, Barge with 460 HP engine, Underwater Bathymetry report, Debris diverter, Moose Butchering, Pirates, 30+ airline trips to/from Ruby

- Less than 500 kWhs of Energy = $700/kWh
And this is what it felt like
Lessons Learned

- KEEP IT SIMPLE
- Make It something the Community WILL BE ABLE TO MAINTAIN and Take on
- “We want to be on the cutting edge of technology, not the bleeding edge”
- How to Butcher a Moose
CCHRC Home, Anaktuvuk Pass, AK

- High Efficiency House built by CCHRC
- 800 watts of Solar PV
- Ampair "600 watt" Wind turbine, 50 ft tower
Wind is very site specific, transmission is expensive, minimum of 1-year of wind data on the site is required for most commercial projects.

If the wind is blowing you NEED to do something with the power.

Big 100kW turbines in the YK Delta, cost $1 million/ea O&M estimates are $20k/yr.

Interior has a poor wind resource.
Wind Integration

WIND TURBINE “WILD AC”

Shutoff at Tower Base

Rectifier “Wild AC” \( \rightarrow \) DC (in home)

Inverter DC-AC (in home)

Home Electrical System
Introduction to Wind

- Power from Wind is not linear, it increases exponentially
- As you get higher wind speeds your power increases exponentially...
Wind Resource Assessment

…Or, if you don’t have wind your power production DECREASES Exponentially

<table>
<thead>
<tr>
<th>Average Power Density</th>
<th>71</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wind Power Class</td>
<td>1</td>
</tr>
<tr>
<td>Power Rating</td>
<td>POOR</td>
</tr>
</tbody>
</table>

Oh.....Shit.....
“600” watt wind turbine, tower and equipment, inverter, rectifier, wiring, independent monitoring, 12 trips to Anaktuvuk Pass, Cost $12k?

Production 200 kWh = $60/kW
Lessons Learned

- Again, Keep it SIMPLE STUPID
- DO YOUR HOMEWORK
- Be Wary of Manufacturer Claims
2010, Nenana Rec Center. 4.4 kW Solar Array, Heating Controls, Solar Thermal

- Installed for $5/watt, approx $20k

- In the first month we produced more Energy than we had During 3 yrs in Ruby

1 yr of wind in AKP
Nenana Solar Monitoring

- O&M last 3 years = $180
Solar Panels

Inverter mounts to back of panel

Disconnect

Home Electrical System
# Nenana Results

<table>
<thead>
<tr>
<th>Technology</th>
<th>5 yr $ Savings</th>
<th>Cost of Materials/Install</th>
<th>5 yr Energy Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>$4,400</td>
<td>$20,000</td>
<td>22,000 kWh</td>
</tr>
<tr>
<td>Hot Water</td>
<td>N/A</td>
<td>$7,000</td>
<td>N/A</td>
</tr>
<tr>
<td>Zone Valves, Programmable Thermostats</td>
<td>$19,150</td>
<td>$2,000</td>
<td>5,000 Gallons of Diesel</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$25,270</strong></td>
<td><strong>$29,000</strong></td>
<td></td>
</tr>
</tbody>
</table>
Lessons Learned

- EFFICIENCY FIRST!!
- REMOTE MONITORING IS KEY
- OPERATIONS AND MAINTENANCE COSTS CAN BE KEPT LOW
Anaktuvuk Pass, Efficiency Projects

Original setup
- 12 x 400 watt/ HID Highbay = 4.8 kW
  4.8 kW x 6000 hrs x .25/kWh = $7,200

Option 1: Replace with t5
- 12 x 324 watt/fixture t5 = 3.88 kW
  3.88 x 6000 hrs x .25/kWh = $5,820

Option 2: Replace with LED Highbay
- 12 x 120 watt/LED highbay = 1.44 kW
  1.44 x 6000 hrs x .25 = $2,160
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Can you guess when we changed the lights?
# Anaktuvuk Pass Efficiency Work

## RESULTS

<table>
<thead>
<tr>
<th>Building</th>
<th>5 yr $ Savings</th>
<th>Cost of Materials</th>
<th>5 yr kWh Savings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corp Office</td>
<td>$20,370</td>
<td>$4,000</td>
<td>54,245 kWh</td>
</tr>
<tr>
<td>Store</td>
<td>$29,523</td>
<td>$12,000</td>
<td>96,532 kWh</td>
</tr>
<tr>
<td>Shop</td>
<td>$28,419</td>
<td>$13,000</td>
<td>93,226 kWh</td>
</tr>
<tr>
<td>Restaurant</td>
<td>$68,760</td>
<td>$7,000</td>
<td>170,400 kWh</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>$147,072</strong></td>
<td><strong>$38,000</strong></td>
<td><strong>414,403 kWh</strong></td>
</tr>
</tbody>
</table>

Gallons of Diesel Saved at 13.8 kWh/gal: 30,029 Gal @ $8/gal flown into AKP = $240,232 over 5 yrs
Had we just replaced those 75 watt lights in the photo with a 20 watt LED ...

- Avg savings: 55watts x 4000 hrs = 220 kWh/yr
- Avg Production/solar panel = 220 kWh/yr

- Installed Cost/Panel = $1000
- Installed Cost/LED light = $300
Energy Planning Step by Step

1. Collect Data & Plan!

2. Efficiency First
   (Efficient Electric Loads, Insulate and Seal Shell!)

3. Renewable Energy
Let’s Put that Model into Practice

Manley Hot Springs Tribal Council

- 4 Buildings
- 35kW Max Load Generator @ ~2gal/hr
- 17,000 gal/yr

$70,000 in Diesel/yr
1. Collect Data and Plan

Main Electric Loads:
- 6kW Electric Heat
- 9kW Electric Dryer
- 4kW Lighting
- Double Coil 3kW Electric water heater
- Freezers/computers
- Well Pump
2. Efficiency!

Main Electric Loads:
- 6kW Electric Heat → 92% Efficient Toyo Stove!
- 9kW Electric Dryer → 80% efficient propane dryer
- 4kW Lighting → LED lighting
- Electric water heater → on Demand Propane
- Freezers/computers
- Well Pump
- Air Compressor

New Max Load: 35kW – 19kW = 16kW
3. Renewable Energy

THE GOAL: Add Solar PV to the System!

• Store Energy During the Day In Batteries → TURN GENERATOR OFF AT NIGHT
• Potential Diesel Savings: $40k+/yr
There is NO Silver Bullet

(but who makes bullets out of silver anyway, they’d be really expensive and only useful on werewolves. I’d take a brick of lead bullets with brass casings, over a silver bullet ANY DAY of the week)

- Energy is Expensive
  - It’s cheaper to CONSERVE Energy than it is to PRODUCE Energy

- Energy Data allows us to pinpoint opportunities
Energy Independence → Healthy Communities

- Tribes/Cities/School Districts in our rural communities all need to work together

- Local Energy Creates Jobs, builds capacity, keeps $ in the communities

- Must be Simple, Easy to work on
Tanana’s Biomass Project

- Garn Wood Boilers on the City Washeteria, Village School, City Shop, New Teacher Housing

- Yearly Fuel Imports 2005: 30,000 gal/yr
- Yearly Fuel Imports 2013: 12,000 gal

@ $4/gal = $72,000 in Fuel

The difference: 150 Cords of wood @ $250/cord = $37,500
A cord of wood = 80-120 gal of diesel (dependent on efficiency)

In the interior we received well over 5 million gallons of fuel oil last year for heating, electricity etc. that represents $12,500,000 of money that we could KEEP in our villages!
Spill Response BIOMASS!
Moving Forward

Smart Grid with intelligent controls, battery

BASIC SYSTEM DESIGN
(WITH DATA LOGGING/DISPLAY)
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