Good afternoon everyone

This is a picture of TDX’s high wind penetration wind-diesel system on St Paul Island, Alaska and the 80,000 sf Airport and TDX Renewable Energy Technology Center

After many decades of working around the world wearing many different hats I returned home to Alaska a little over 1-year ago to finish work on an idea conceived while working in the early 1980's as a wind developer, Renewable Combined Heat and Power (RCHP).

I also asked myself, . . .. and you might ask yourself:

What’s your organizations vision?

What is your Electric Utilities’ Value Proposition?

For most rural Alaskan’s and I expect many or most folks living in remote isolated communities, the answer needs to include . . . how energy costs can be lowered

I will also discuss why Fast Acting Dispatchable loads are a critical, and a necessary requirement for high levels of renewable utilization
Born and raised in SE Alaska, and after working my way through college in the Alaskan Seafood industry, I graduated from the University of Michigan with an engineering degree.

My first job was to manage the conversion of a 358 foot WWII Navy cargo ship into a seafood processing ship and then to run it.

Our constraints on-board were:
- Fuel
- Water
- Food
- Cargo and freezer space
- Bunk space for 134 people

Power generation, DC & AC electrical system, refrigeration, steam, water, sewage treatment (we were processing food after all), heating, cooling, ventilation, and the list goes on.

One major walk away or paradigm shift from that experience was that WHR, and energy efficiency pay for themselves very quickly in remote locations with high fuel costs, and they provide a competitive edge driving down costs, allow you to stay out longer, and process more seafood.
70-80% of rural Alaskan community energy needs and probably Maine’s offshore islands are heat related.
Why use Renewable Power?

What are We Trying To Achieve?

When Is There Too Much Renewable Power?

How Much Renewable Power Can A Utility Utilize?

What are Renewable Power Characteristics?

Traditional Utility Control Approach for Renewables

Power – Electricity – Energy, Different or The Same?

TDX Utility Control Approach for Renewables

Achievements by TDX – St Paul POSS Camp

TDX Vision – 80% Renewable (Power & Heat) by 2020

Challenges Ahead

Show of hands how many of you presently own or operate a renewable system?

How many of you have had to curtail the use of renewables?

How many of you think a renewable-diesel system can be operated diesel-off without electrical energy storage?

I will try to answer some of these questions today . . . . .

But first a little background on TDX
Alaska is a big State – TDX owns and operates Utilities across Alaska, or translated on a lower 48 scale, utilities located from Michigan to California, Texas to the Four Corners Area and Missouri

4 State Regulated Utilities
2 State Regulated Wholesale Utilities (Wind turbines)
1 Medium wind penetration wind-diesel in Sand Point
1 High Wind penetration wind-diesel in St Paul

Talk about the 2 GREEN Star locations - Wind
Talk about the 3 Red Star locations – for now Diesel or Turbine only

Deadhorse
Manley
Anchorage
St Paul
Sand Point
Adak
TDX or Tanadgusix Corporation is the Village Corporation for the Community of St Paul Island, located in the central Bering Sea

~500 people year around residents

The population doubles during Crab Season – Deadliest Catch fame processing 500,000 pounds per day

Superb Wind resource  Class 7, 8.1 m/s (18.1 mph) at 30 meters

Approximately 40 square miles, 7.5 miles x 12 miles

Largest of the Pribilof Islands

Volcanic in origin, wind swept island with Tundra vegetation and no trees (except those planted within the past century)

Average annual temperature is ~ 37 degrees
Why Use Renewables?

For most people, the primary focus are the top Environmental of “Green” reasons for using or promoting renewables.

However in rural Alaska and remote communities with high energy costs, my guess is that sustainability and economic survivability are the main drivers.

Typical fuel oil costs in rural Alaska is $5 - $10 per gallon, if you can get it

~70-80% of Energy is used for heating related needs in rural Alaska

Ask the folk in Nome – After almost running out of fuel in December, a Russian tanker delivered fuel to ice bound Nome in January 2012

The tanker, carrying 1.3 million gallons of fuel traveled through 300 miles of ice covered sea to deliver badly needed fuel supplies to the community of Nome after poor weather conditions prevented a previously scheduled delivery before winter ice conditions set in.

Meanwhile, the cost of energy in rural Alaska is prohibitively high.

Many people in Alaska’s rural communities spend over 50 percent of their take-home pay on energy. Nearly all of this money is leaving our local economies to pay for imported fuel.

Going forward, we can either continue to pay for energy waste, or pay for energy improvements that will save money over time.
Our electrical grid was designed a very long time ago, with the aim of providing a steady and predictable power supply.

Renewables are neither of those things. They are intermittent and highly variable sources of energy.

Consider that sunshine and wind come and go -- so do solar and wind energy generation. Without a place to store or use that energy, the grid can overload.

Electricity generation and demand must be kept in balance at all times to maintain reliability and power quality.

If electricity generated exceeds demand, the electric system can overload and become unstable
Yes, this is how variable wind generation can look like in any given month.

However with a good wind resource, wind turbine output is rarely zero.

However Wind generated electric power is highly variable at any given time, day or night and at high utilization levels, can cause stability problems with existing generation systems.
Solar is more predictable on a clear sunny cloudless day, but on a typical normal day . . . It can create havoc for a utility without energy storage

The lower graph zooms in on the green arrow day indicated on the upper graph. PV generated output is Highly variable on a partly cloudy days

And solar PV power goes off when the sun sets every night

In Northern climates, sunlight hours are limited

Are Utilities right about why the integration of renewables is problematic?
Control the Generation or Control the Load?

Two different approaches to achieve system stability

Fast acting dispatchable variable loads that can match, fast acting variable renewable generation, is the approach successfully taken by TDX.

Renewable Combined Heat and Power (RCHP)

Fast Acting Dispatchable loads (Heat so far) is not just a dump load, it is a critical and necessary component of control for the integration of renewables with conventional power systems.
St Paul is in the middle of the Bering Sea

~ 775 miles from Anchorage and although you can’t see Russia from St Paul, Russia is about 125 miles closer than Anchorage.
TDX the Village Corporation for the native community of St Paul

On St Paul TDX wears a number of different hats:
  TDX is: One of Two fuel providers for heating fuel
  Owner/Operator of the POSS Renewable Technology Center
  Tour Guides and Hotel operations
  Major land Owner

Board members asked Why should TDX compete with its self selling heat, won’t that drive TDX fuel sales down and put TDX out of business?

Let’s think about the value proposition: windfarm vs pump fuel, control integration, thermal installation, O&M

Energy = Power and Heat, more and better paying jobs, sustainability
The concept is simple:

Balance fast changing variable renewable generation

“Wind” in this case but it could be solar

With normal electrical “utility” loads

Plus

Fast acting dispatchable variable loads (heat, pumping, etc.)

That match variable renewable generation

Do this very quickly, and repeat again very quickly, again and again

In a cold climate like Alaska there is almost always a requirement for heat.
For the more technical inclined

Red = City of St Paul Electrical System

Black = Wind Turbines interconnect with City of St Paul Utility – export of clean stable power to City

Blue = POSS Camp – Renewable Technology Center

Flywheel addition is under construction – Electrical energy storage provided by the flywheel is expected to extend the wind-only, diesel-off mode by an additional 10-15%

Last month TDX won a nationally competed $1.2 m DOE Microgrid Grant – one of 7 recipients (Alstrom, ComEd, EPRI, GE, University of California at Irvine, and Burr Energy)

Microgrid Requirements – Improve reliability >98%, reduce fuel >20%, reduce GHG >20%
Controlling excess wind energy requires multiple levels of dispatchable control

Very Fast Response ~50 ms: dump loads near wind generation source – district heating loop within POSS Camp

Medium Response ~2-7 seconds: Frequency Controlled, Grid-Interactive Electric Thermal Storage (GET) or Electric Thermal Storage (ETS) scattered throughout the community on the existing electrical distribution system.

In the future Slow Response ~ 15 – 20 minutes: Future additional, Heat Pump, water pumps, compressors or other dispatchable load that need to run a minimum period of time to limit on-off operation

Metering, controls integration

Controls Integration with existing heating systems, these are still required due to intermittent nature of renewables.

Who owns, operates and maintains these systems.
Local jobs, community sustainability, future job training & knowledge export
Electric Thermal Storage

Steffes heaters

Smart Control Meter devices

TDX’s approach is to Identify, find, and learn to control dispatchable loads to match or equal generation from highly variable and intermittent renewable sources

Good dispatchable loads are:
- Hot water heating, domestic hot water
- Pumping – well water, irrigation
- And maybe Heat Pumps in the future

Intermittent renewable energy can and should be used to Displace other fuel sources without poaching or taking away existing electric loads
Fuel costs at $5/gallon are equivalent \(\approx 18 \text{ cents/kWh}\) used for heating purposes

Now let's turn to some actual results
Impressive results over the past 15 years:

Diesel Off = Maximum Fuel Savings  Yellow

Wind-Only > 20% of the time

13% year due to wind turbine gear cooling system failure that destroyed a gear box.

Remote sites have long shipping logistics and repair times.

Green = Best  Available Control Technology  BACT for emission reductions?
TDX Vision 80% Renewable by 2020

• 80% Renewable (Electricity, Heat & Ground Transportation) by 2020 for the community of St Paul
  • More wind turbines, hydro, hydrokinetic & solar
  • Dispatchable renewable heat in every home/building
  • Microgrid controls, measurement, verification
  • Community Energy Baselines
  • Regulatory Commission of Alaska issues
  • Utility integration issues
  • Electric Vehicles & Charging Stations

• 70% Renewable by 2022 for Sand Point
• 70% Renewable by 2023 for Adak

Community Energy Baseline Study – Document existing energy sources and uses, needed for bankable project financing or grant funding

Looking into residence by residence building by building to model and understand what will be required to meet this vision.

Is it better to insulate or weatherize than to just add renewable heat?

UAV mapping and thermo imaging of buildings

Complete documentation needed for bankable project financing and/or grant funding
Controls Integration

Fast dispatchable loads on remote feeders

Airport FAA sitting issues

Alaska Regulatory Commission issues

Wheeling rates and system loss calculations

Metering non-utility, intermittent renewable thermal loads

Integration of renewable thermal heat with existing spectrum of residential heater types

Ownership, maintenance, warranty, and metering of thermal systems
In Summary:

Think, Renewable Combined Heat and Power - or RCHP

Fast Acting Dispatchable loads (heat for now) are more than just dump loads, they make money, and are a critical and a necessary requirement for successful integration, of highly variable renewable power generation, with conventional power systems.

Balance the Load, not the renewable generation resource, if you want to extract maximum benefit and reliability from renewables.

And to teach, train, and mentor the next generation of Energy Champions

Thank you.

Any questions?