ENTELEC
THE ENERGY TELECOMMUNICATIONS AND ELECTRICAL ASSOCIATION
2019 FALL Seminar Series
October 10, 2019 | Odessa, Texas

Remote Communication Power, Back Up & Control:
Successful Strategies & Survival

Presented by Mark Dettmer, Mission Critical Energy Inc.
dettmer@missioncriticalenergy.com

Details of this presentation can be found by visiting

OffGridProfessionals.Com

in·fra·struc·ture

/ˈinfrəˌstrək(t)SHər/

noun

the basic physical and organizational structures and facilities (e.g. buildings, roads, power supplies) needed for the operation of a society or enterprise.

Nunavut, Canada

44m Communications Tower

(2) SW350 48v Turbines at 40m

Photos: Courtesy Agnico Eagle Mines Ltd.

Government Mountaintop Radio & Repeater Station - Argentina


Photo Courtesy Croatia Telecom

Photo: Courtesy Inspire Net – New Zealand

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Remote Communication Power, Back Up & Control:
Successful Strategies & Survival

1. **Why do many remote & off-grid power systems fail?**

2. **How to assess a site for the right load strategy *without kidding one's self.***

3. **How to monitor & control your power, back up power and stay operational in an outage.**

What are the Main Reasons that Renewable Energy Powered Off-Grid Systems Fail?

1. **Battery Bank too Small for the Required Load**

2. **Battery Failure – Typically from 'Over Cycling', including:**
   Batteries never fully charged
   Batteries discharged repeatedly below 50% State of Charge
   Batteries Over Charged and potentially <u>Explosive!</u>

3. **Working Batteries not Charging; too Hot, and/or, Batteries *Frozen***

4. **Hobby Equipment used in place of Professional Gear**

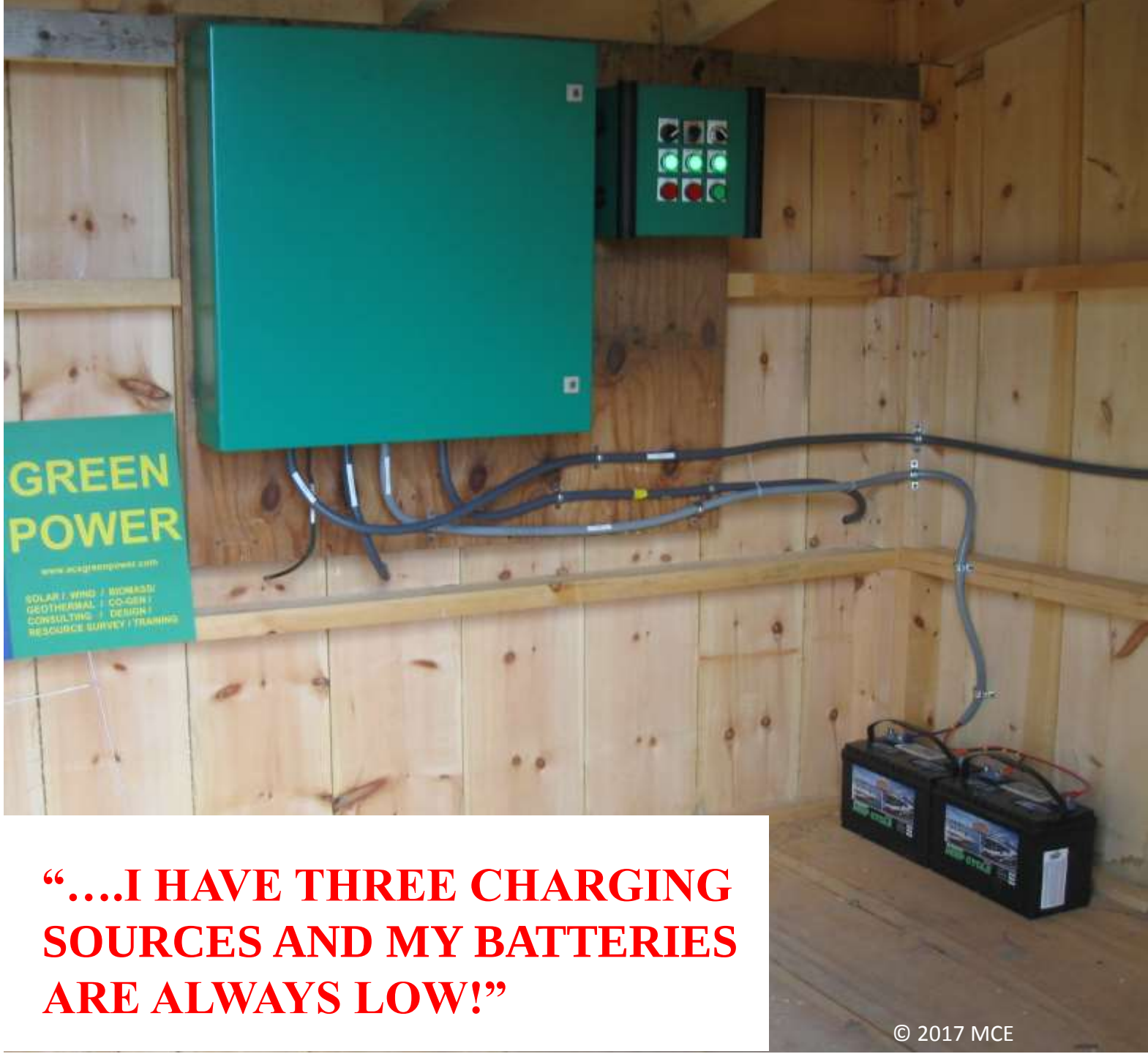
5. **Component Failure (often from poor design or low cost products)**

6. **Inappropriate, Conflicting, Malfunctioning Charging Sources**

7. **Little or No System Maintenance *("It works!" so you forget about it.)***

Source: Informal Survey Data, OffGridProfessionals © 2015

Size Matters?



"….I HAVE THREE CHARGING SOURCES AND MY BATTERIES ARE ALWAYS LOW!"


Photo Courtesy: InfoWest - Utah, USA

- Why a Wind Turbine in the Desert? *Batteries too HOT* and "M" Curve
- Why use Temperature Compensation Based Charging?
- Use of Remote Temp Sensors on your Charge Controller… Hot & Cold!

SUN FACT - High Irradiance on the rise…

The High Sun / High Heat

Solar "M" Shape I-V Curve

Heat Causes Loss of Solar Output & Hampers Battery Charging!

Sun Fact:

In the Southern USA, HEAT is a battery killer – but heat's two biggest accomplices to murder are:

1. **Unvented or improperly vented battery cabinets.**

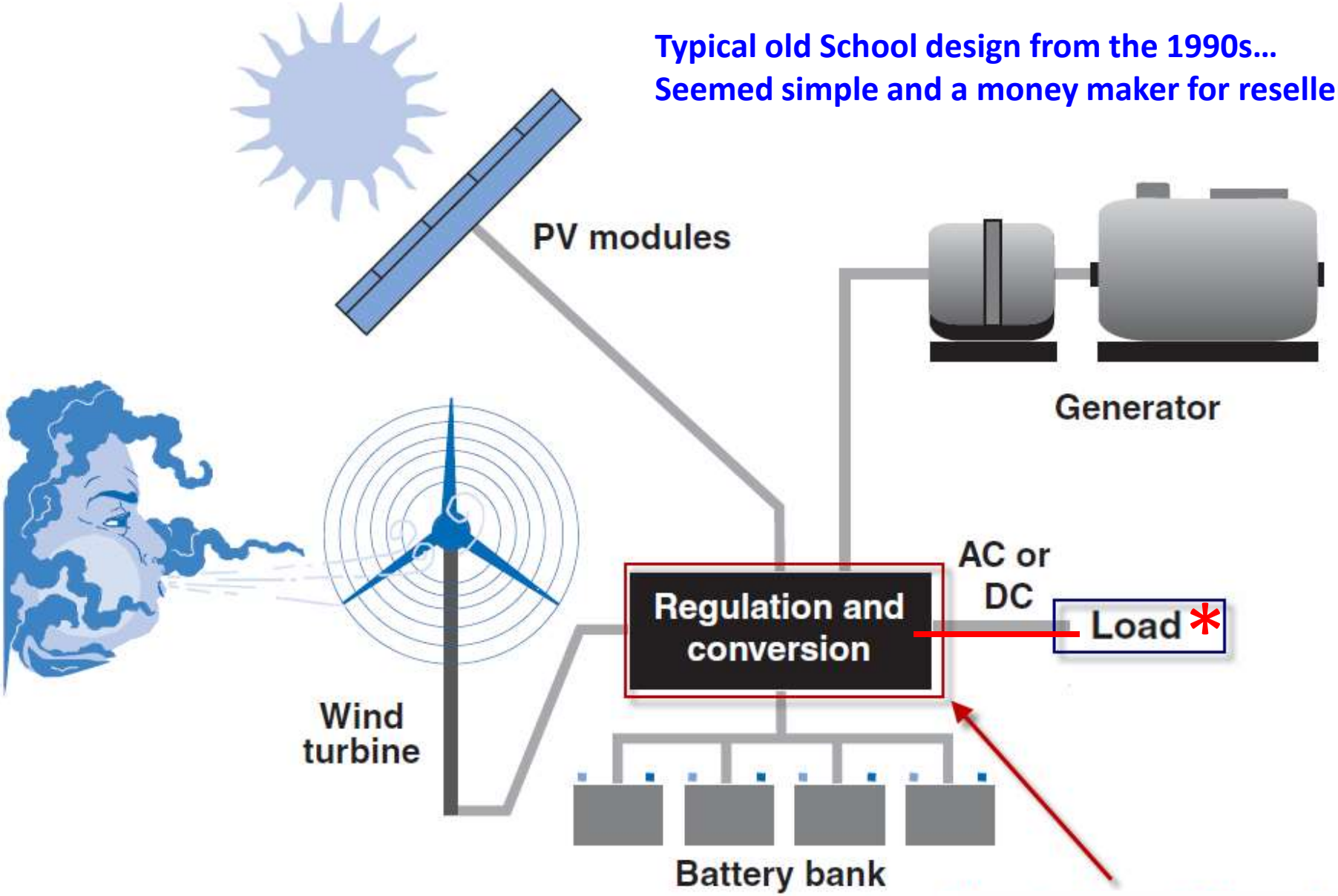
2. **AC Powered Battery Chargers.**

One stores the heat, the other produces it.

Without proper venting, batteries face a certain shorter life. Inexpensive vents can extend battery life. **Monitoring and SCADA systems not only help identify the problem, they can help solve it...**

- Shade the Battery Box With the PV Panels.
- Leave a space on the Bottom for airflow.
- Try for a reflective base.
- In the box: keep heat producers (AC chargers and radios) near the top and to one side, never below batteries especially in desert/hot regions.
- Vents: Side & Top of box.

Typical old School design from the 1990s…
Seemed simple and a money maker for resellers.



Never Should be an all-in-one device!

***Remote sites might also benefit from being full time DC powered – even if they are on a AC supply: Shaky Grid Kills! So charge the batteries with AC and operate a DC site.**

4. Hobby Equipment used in place of Professional Gear

5. Component failure (poor design and low cost products)

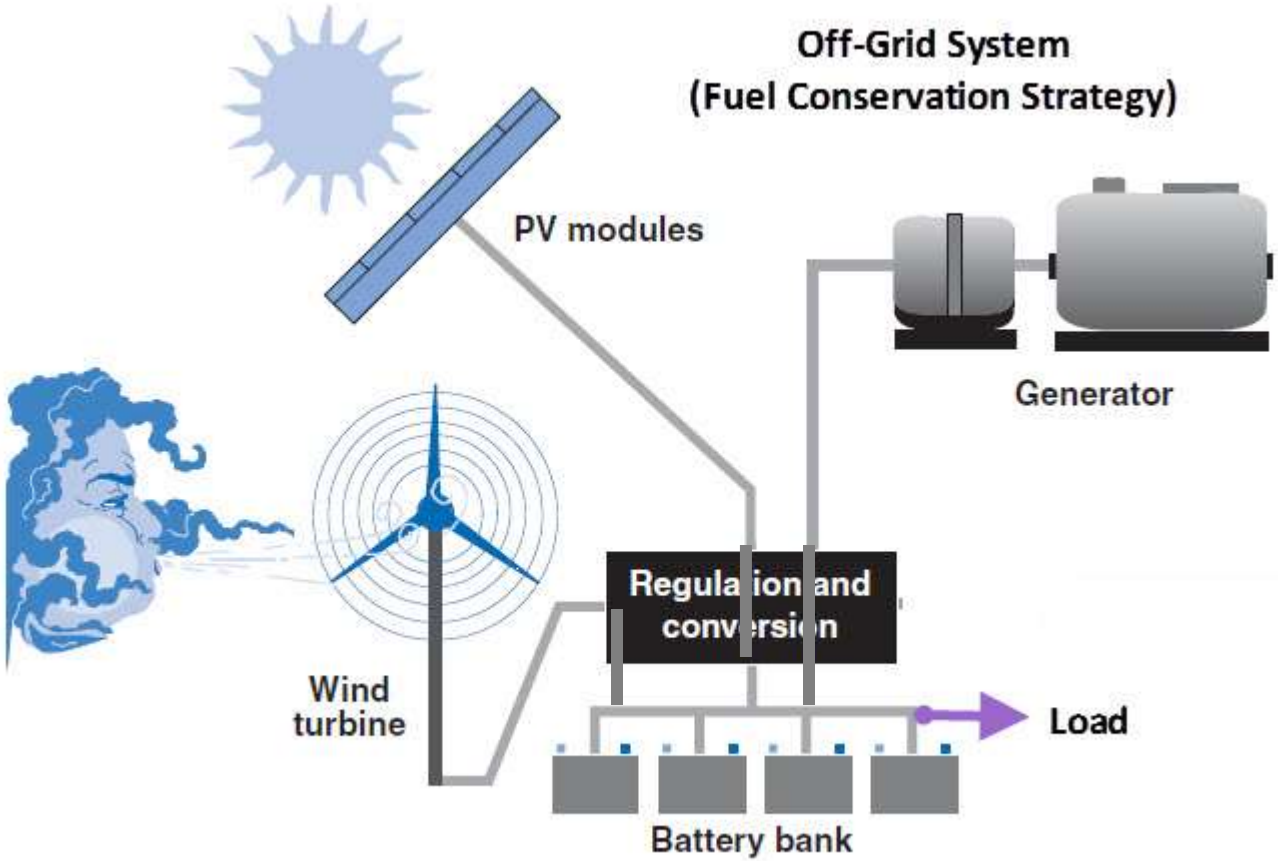
For instance, if a wind turbine uses battery power as part of its internal over-speed control, it will fail. Often, more than the wind charging equipment is damaged…

Fires are common!

Avoid this by using commercial rated charging sources – those designed to be integrated with other professional equipment.

Truly knowing your site allows you to know what Type of Battery is suitable…
Generally look for a Deep-Cycle, Maintenance Free Battery (Gel or AGM)

Build a **Battery Bank Charging Strategy**. Yes, it can be as simple as 'solar.' But often the best charging strategy for your site could be a combination of renewable energy power sources as well as fuel based generators (Gen-Sets and Fuel cells). Even the Grid.



Work only with charge controllers of high quality – and in dual (or multi) charging integrations, adjustable system voltage options are ideal.

<u>AVOID 'all in one' charge controllers!</u>

Build a charging system to produce at least 150% of the rated battery bank capacity amps. Batteries <u>USE</u> energy to convert their own chemistry from a state of discharge (no or low available power) to charged (stored energy) ready to power the system.

Well Planned Systems are best suited to SURVIVE Unplanned Events…

This Site has endured:

Proximate Brush Fires

Flooding & Mud Events (denial of refueling GenSet)

A Lightning Strike

High Winds (many times)

Winters Broadband

Winters California

Tower Power System Tips

- Solar
  - Use a split (dual) system with PV arrays optimized for sun at both sunrise and sunset
  - Regularly clean the PV arrays
  - Check voltage range of connected devices – voltage regulator required?

- Wind
  - Buy a commercial grade product with desired capacity & true over-speed protection

- General
  - Ensure your system uses low voltage disconnect to protect your batteries
  - Protect individual battery banks with fuses
  - Implement remote power monitoring
  - Use the correct type of batteries
    - AGM (Absorbed Glass Mat) Valve-Regulated Dual Terminal
      - 8A31 – 12V 110AH
    - Sealed Lead Acid
      - MU-1 – 12V 35AH

Off-grid system success starts when

1. **You know your true LOAD** (the peaks and long-term power needed to operate your site). …and **consider any future expansions** (more power needed) if the site is successful or to be shared.

2. **You know your site characteristics**:

   Grid available? Yes/Shaky/No Solar available? Wind Available?

   Access? Can staff easily get to it? Yes/Sometimes/Seasonally/No

   Can fuel be delivered if a Genset or Fuel Cell is used? Time? Cost?

   Is the site Hot? Cold? …a mix of both? Are those conditions extreme?

3. **By knowing your load and then evaluating your site conditions, the proper battery bank strategy (type and size) can be designed**. Top considerations given to a day's operations in the worst conditions, then calculations made for battery reserve power; measured in days.

4. Only with the first three variables well investigated and ideally tested (with an amp meter) can redundant layers of appropriate charging sources be identified. **No matter the power source or sources used, one must approach the project as a total system, subject to non-stop interactions between power sources available, actual power then created, stored, used and wasted** – keeping in mind that even wasted energy may benefit the site. Example: waste energy can be used to cool or heat.

Note: The most common mistake made in this process is any other combination or change in sequence of these steps. 1. Load, 2. Site, 3. Battery Bank, 4. Power.


Photo Courtesy: InfoWest - Utah, USA
Fuel Cell Hiding in this system!

Remember # 6. Inappropriate, *Conflicting*, Malfunctioning Charging Sources

Charge Controller Confliction:

All charge controllers set to the same "Yield Point"

(for example, 14.4V on a 12V system)

Ideally all the incoming charge sources should be 'stepped'

Fuel Cell/Diesel Genset at 14.0V,

Solar 14.2V,

Wind, 14.4V -> Diversion

It is important to have ADJUSTABLE charging regulators or controllers – or you may not be able to avoid problems. If just two out of the above three are adjustable – you have control!


TRISTAR MPPT
TRISTAR
L4
L4
L4
L4

Charge Diversion Strategy:
Charging source never stops producing power, instead the charge to (or through) the battery bank is diverted.

Strategy is supported by quality charge controller manufacturers and helps assure the Battery Manufacturer's warranty.

Make sure you are using commercially rated and properly sized resistors or load devices! *Caution: Many Wind Turbine companies say to use 'Diversion' but do not supply the equipment. Also beware cheap ceramic resistors…*

Photo Right:
Outdoor Rated Commercial .36Ω Load Resistor used in many Thermoelectric (TEG) and Small Wind Turbine System Integrations.

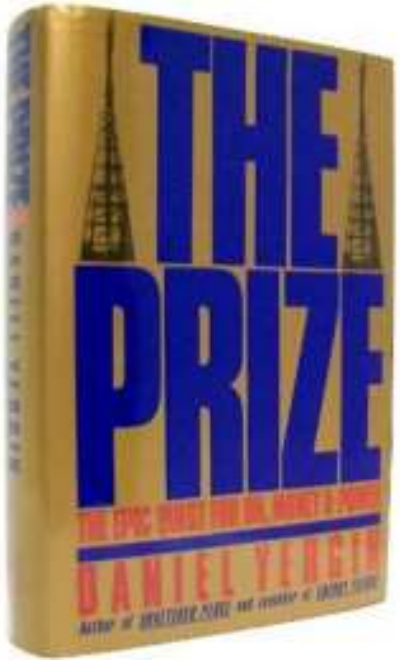
Charging Lithium Ion Batteries with Wind & Solar:

- Know your Battery Source Well & **Know the BMS (if there is one?)**
- **Nearly Flat SOC Curves** often result in **Special Charge Controller Settings –** can your system accomplish this?
- **Battery Based Diversion is a Not a good Idea** - If Diversion is used, it must be 'pre battery charge' diversion from a commercial rated adjustable charge controller.

Wires, Batteries, Charging Sources; but how do I know its all working?

1. **Test It!** **DC Clamp-on Amp Meter is your best trouble shooting friend in the field…**
2. **Protect It: <u>FUSES ARE A MUST</u>! Lightning protection might also be appropriate.**
3. **Maintain at minimum, and better yet: *Monitor it.***

<u>Your Customer's LOSS OF SERVICE is not a good monitoring system!</u> ™



1990

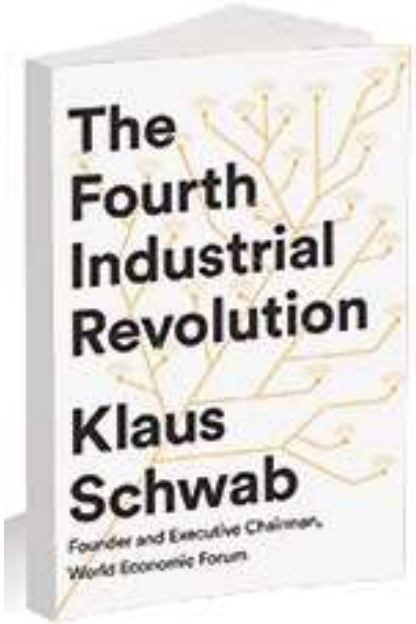
Two Important Books that influenced my talk today…

"THE PRIZE" - Daniel Yergin 1990

The first one talked about history of energy and a bit about the future – funny it also focused on people living in or near desert like conditions and how we would all get along. Many agree this book was very important to the industry in its time…

Almost 30 years later:

"The Fourth Industrial Revolution" – Schwab 2017



2017

It demanded belief [or one risks being left behind] and does so impartially. It also warned that the future would not care so much if we could get along with people. It did wonder about relationships with robots – another reason few took it seriously at first.

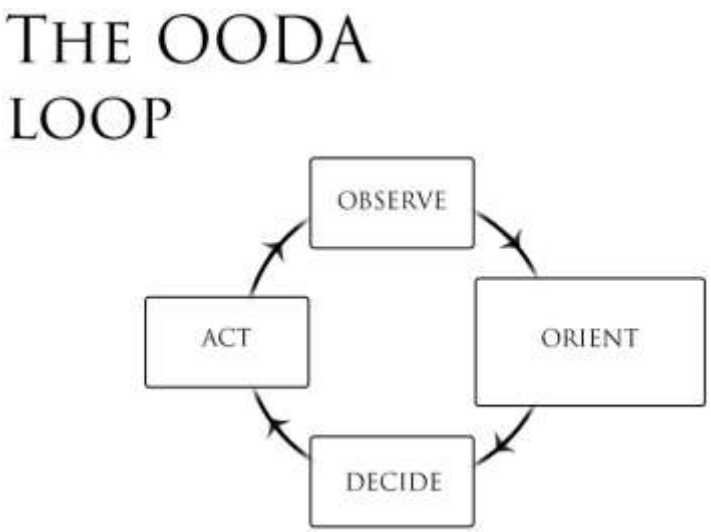
…it is now required reading by most of the world's military and diplomatic leaders.

"4IR" …or as we say in Germany: *Industrial Revolution 4.0*

interconnectivity, automation, machine learning, and real-time data

The Idea

- ✓ Better **Information**
- ✓ Based on real time & historical **Data**
- ✓ From **Sensors** and other interconnected systems
- ✓ With high reliability and **Low Cost**
- ✓ Allowing companies to **do more** with **less people**
- ✓ **Staying connected** even to remote hard to get to places
- ✓ Enabling more **safety and security**, and
- ✓ **Better decisions** and more **sustainability**



United States Air Force Colonel John Boyd.

If so:

We now have technology that has forever changed the way we do business at Off-grid & Remote Sites

What is *S.C.A.D.A.*?

Supervisory Control and Data Acquisition

Q: Why is knowledge of what is happening at your off-grid site important?

A: ***Your customer's loss of service is not a good monitoring system!*** ™

Off-grid considerations list:

Battery SOC/V, Duel Bank Status, Low/High WARNINGS

Charge Inputs: Solar, Wind, Fuel Cell, Genset, etc.

LOADs (consumers - what is using power) Draw V/A and On/Off

Sensors: Wind Speed, Irradiance, Temperature, Fuel levels

Security – Proximity Sensor, Tamper Alert, Door Alert, Lights, Sirens

Remote Control: Genset test/run, Wind Start/Stop, Fuel Cell Cycle

DATA: Storage, transmission, sharing, polling

POWER: Devices, Sensors, Radios, etc**. with remote reset on each item.**

Historically, reliable S.C.A.D.A. Technology was very complex and expensive.

Left:
Year 2000 RTU – *overtakes the entire cabinet…*

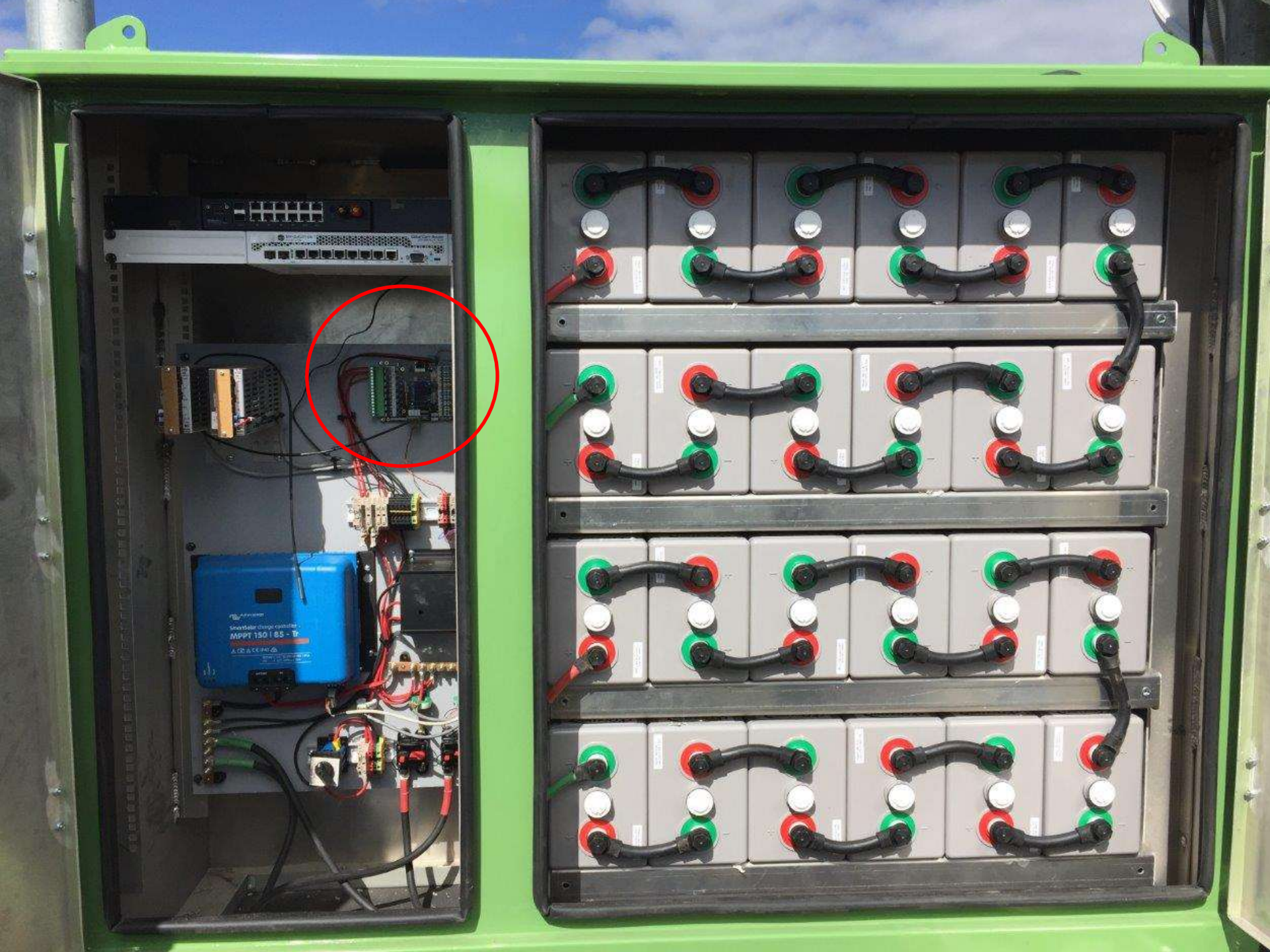
Lower Right: ‘Small’ RTU Circa 2015
Only 5kg, and uses 2A·h of continuous power.

The Challenge? S.C.A.D.A. & Monitoring - Built For Remote & Hostile Environments

With Low Cost, High Quality …. And Designed for the Future

- **Static Ram**
- **ARM Cortex 7**
- **Digital and Physical Fusing**
- **Arctic/Desert Temp Rated**
- **<u>Very</u> Low Power Usage**
- **Cyber Secure**

Alaska Microwave Station
Photo Courtesy - Communication Infrastructure Corporation (CIC-USA)

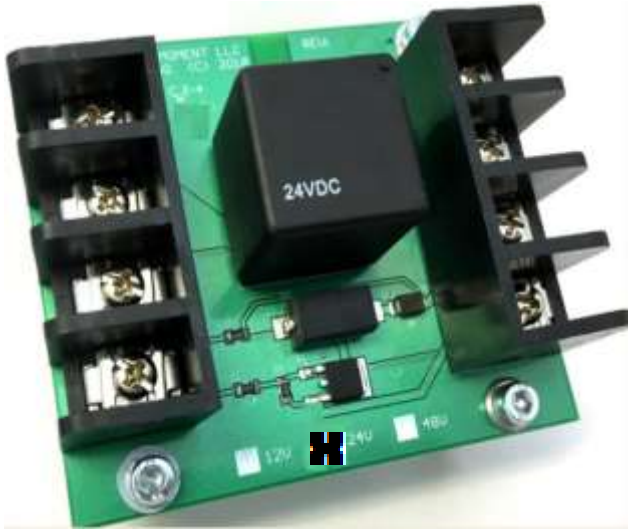

SmartSolar charge controller
MPPT 150 | 85 - Tr

1. 90 mph
2. **106 mph**

Spin-offs?

YES:

More innovations based on FlexSCADA are coming...



Once any monitoring system with a **dry contact** is on your site you can now allow your wind turbine to survive longer in storms, or even stop/start the wind turbine days or months at a time seasonally.

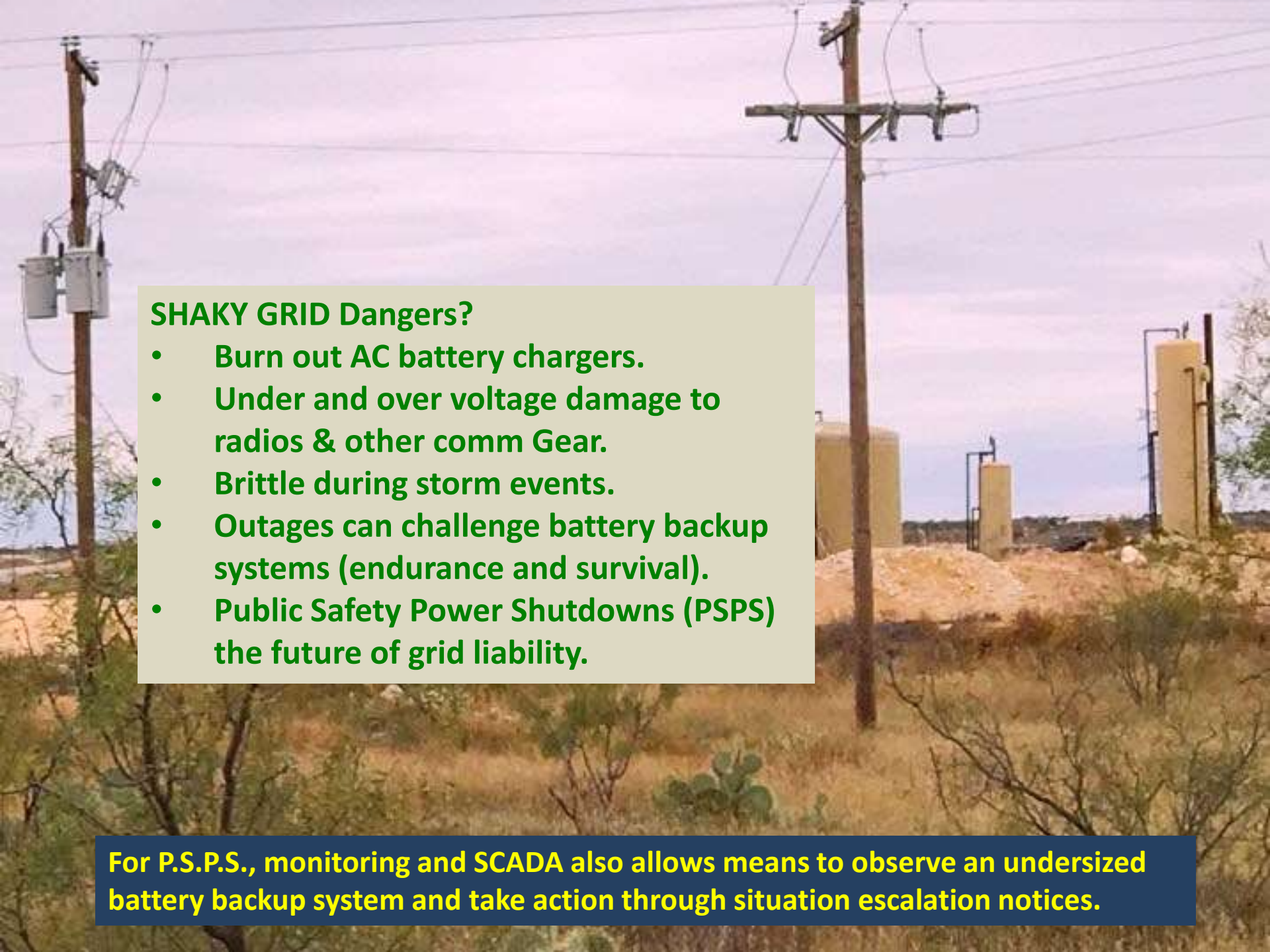
This is done by installing a **Remote Switch** System that (depending on your monitoring system) can work with **remote manual control, or autonomously** via additional sensors.

An RTU with MCE-ARS (Autonomous Remote Switching) can help a small wind turbine survive in several ways:

1. **Stop/Start operation remotely** – in NZ turbines can now be used in wildlife areas by shutting them off for several months during the bird nesting season.

2. **Automatically turning the turbine off if high amperage is detected** from the output – and restarted by time laps or when a person knows the storms have cleared. Stop notification is received by email on better systems.

3. **When combined with a wind speed indicator – turned off before a storm starts, and only restarts when winds are within operational limits.** <u>No person need be involved!</u> Event notification is received by email.



SHAKY GRID Dangers?

- Burn out AC battery chargers.
- Under and over voltage damage to radios & other comm Gear.
- Brittle during storm events.
- Outages can challenge battery backup systems (endurance and survival).
- Public Safety Power Shutdowns (PSPS) the future of grid liability.

For P.S.P.S., monitoring and SCADA also allows means to observe an undersized battery backup system and take action through situation escalation notices.

A quality monitoring system can be used in areas with 'shaky grid' – to monitor when the grid fails, or is in a brownout situation, and can notify the end user that the back up battery system is in use.

Remember, your 'off-grid professional skills' are useful for remote & rural grid tied applications such as this!

Photo Left: A FlexSCADA off-grid RTU in the outback of Australia.
Courtesy Gencom Wireless Solutions

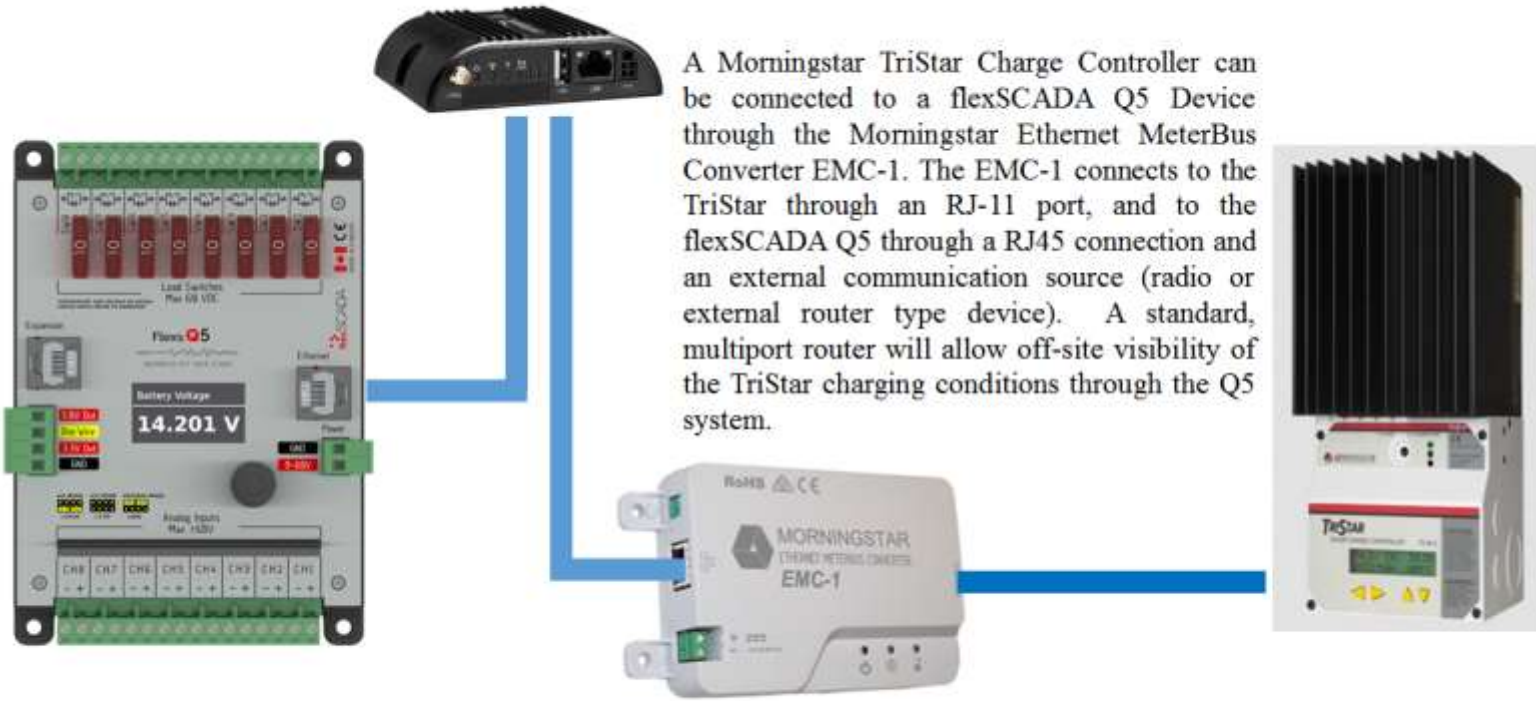
Remote SCADA & monitoring allows Smart Cycling to maintain operations and conserve fuel.

No more ‘under-sizing’ renewables to keep the fuel cell in active standby.

Photo Courtesy of Simark Controls – Canada
EFOY Fuel Cell at **Oil & Gas Facility** – Alberta Canada

So many apps, so little crossover. However professional equipment with True 4IR attributes allow for bidirectional communications with other platforms – allowing for enhanced data management and SCADA hierarchy. More simplicity and control.

MORNINGSTAR OUTPUT TO FLEXSCADA Q5



A Morningstar TriStar Charge Controller can be connected to a flexSCADA Q5 Device through the Morningstar Ethernet MeterBus Converter EMC-1. The EMC-1 connects to the TriStar through an RJ-11 port, and to the flexSCADA Q5 through a RJ45 connection and an external communication source (radio or external router type device). A standard, multiport router will allow off-site visibility of the TriStar charging conditions through the Q5 system.

flexSCADA

MORNINGSTAR
World's Leading Solar Controllers & Inverters

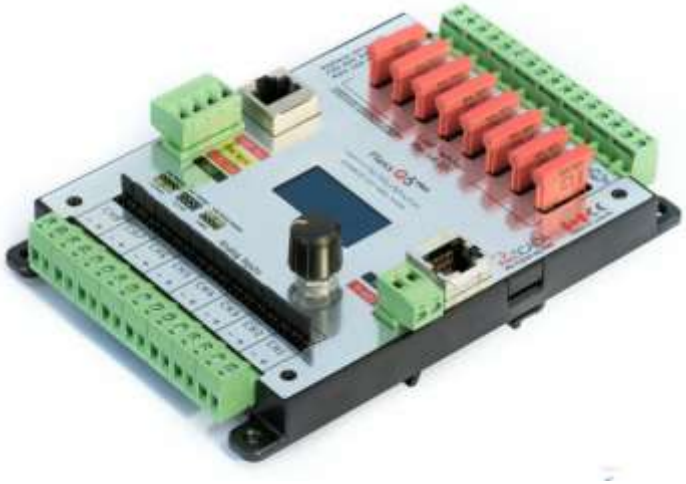
Except from "4IR, IoT and other important changes facing Off-grid Professionals by 2020."

By Mark Dettmer & Frank Lanier

"Imagine seeing 650 well head sites and pipeline control stations (along with their communication towers) all with green "OK and Working" indicators superimposed on a regional map highlighting roads and asset coordinates.

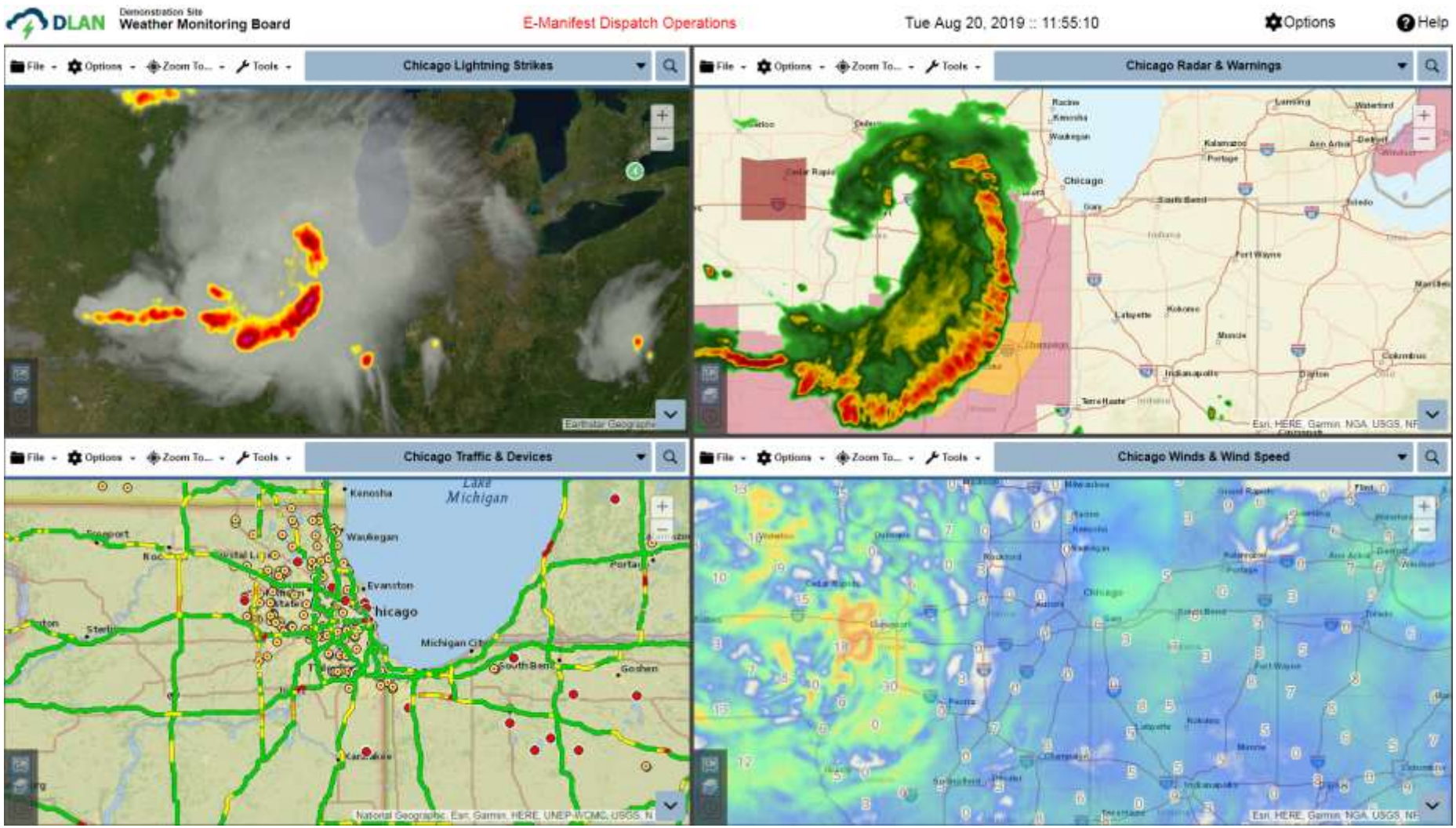
Now imagine a hurricane path warning map showing real-time radar data. As the storm approaches, users can plan for the contingency, even take pre-emptive actions to shut down equipment remotely via the FlexSCADA.

As the storm departs, the status of each site is displayed, allowing disaster planners to easily determine which sites are in need of attention, allowing them to prioritize the allocation of manpower for the fastest and most cost-effective recovery effort."



This is IoT meets 4IR in the off-grid industry. FlexSCADA, the boots on the ground device working and reporting into multifaceted, configurable GIS framework.

flex SCADA Fusion™ Software by DLAN



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Thank you for your Time.

Additional Resource Credits:

Wind Power for Home, Farm, and Business: Renewable Energy for the New Millennium by **Paul Gipe** ISBN-1-931498-14-8

National Renewable Energy Laboratory (NREL) NREL.gov

Thanks also to: Brad Berwald – Morningstar Corp. USA
superwind GmbH – Brühl Germany
Com Com Services Ltd – BC Canada
Complete Coms Ltd. – New Zealand

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Photo Courtesy SCC Broadband Ltd – Ireland