Remote Power Systems for PIT-Tag Arrays

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WDFW Wenatchee

Empowering remote fish monitoring

- In recent years ~ 2 million PIT-tags reported to PTAGIS annually
- 296 currently registered interrogation sites.
- Consistent power is critical to support uninterrupted detection and monitoring of tagged fish, contributing to effective fisheries and population management.
- Thermoelectric and Solar power sources can provide this for off-grid locations.

Goals for Today

- Cover the basics of thermoelectric and solar system configuration
- Strengths/weaknesses
- Real world application of each system

Questions to consider when planning remote array?

- Do I need my array to operate year-round?
- How much power does my system consume? *(Mux + 6 antennas = 26 watts), (IS1001MTS + 12 antennas + modem approx. 84-95 watts)*
- Does my site have good access for fuel delivery/clear view of sun?
- How much money do I have to operate this site after installation?

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Thermoelectric

Pros	Cons
Reliability 365/24/7	Cost; initial and operational
Low maintenance	Fuel delivery may be labor intensive
Rare issues with noise	Additional equipment

Solar

Pros	Cons
Low Maintenance	Needs clear unobstructed sunlight consistently
Low operational costs	May not work year-round
Works in unique locations, Scalable	Limited battery bank life

Thermoelectric Generator System aka (TEG)

Regulator 15-25psi

$100

Purchase or lease tanks

$1,200

$1,200

Supplier, set up contract for delivery and price

Propane Generator ($8.7k, $10.25k)

24V DC

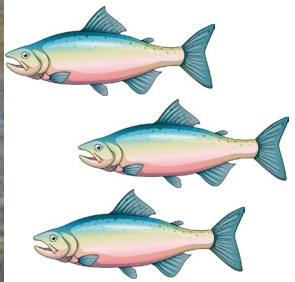
24V battery backup bank ($500)

Propane generator & equipment in photo would cost approx. $12.5k

Array & Accessories

Master controller

Modem



Antennas

Thermoelectric Generator aka TEG

GLOBAL power technologies

Security Housing

https://www.globalte.com/products/thermoelectric-generators-tegs/overview

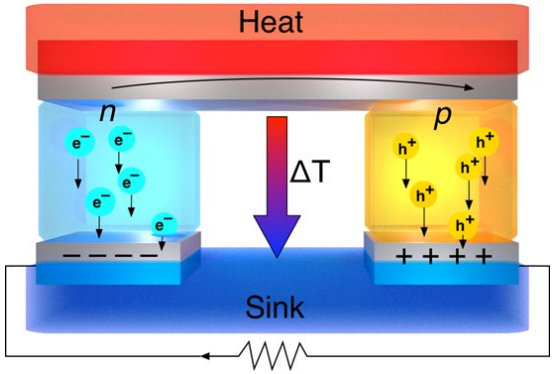
Model 5060 (*new model is P-5050*)

- Used for up to 6 antenna arrays
- 1.5 US gal/day
- 54 Watts @ 24 Volts
- Annual operation cost of $1,920 @ $3.50/gal
- Purchase price $8,700
- Remote start option now available

Model 5120(*new model is P-5100*)

- 3.0 US gal/day
- 108 Watts @ 24 Volts
- Used for larger arrays over 6 antennas
- Annual operation cost of $3,830 @ $3.50/gal
- Purchase price $10,250
- Remote start option now available, would allow supplementing a solar system

How?



Voltage Generation: The movement of electrons along a gradient from the higher temperature area to the lower temperature area of two different conductive materials creates a voltage potential between the ends of the two materials.

Fuel Storage

120 gallon portable

Model 5060; 75 days
Model 5120; 25 days

650lbs full

250/500 gal permanent set

Propane company fills on regular schedule

100lb/23 gallon portable

20 days
7 days

Additional Equipment For Fuel Delivery

Chain hoist for loading/unloading @office

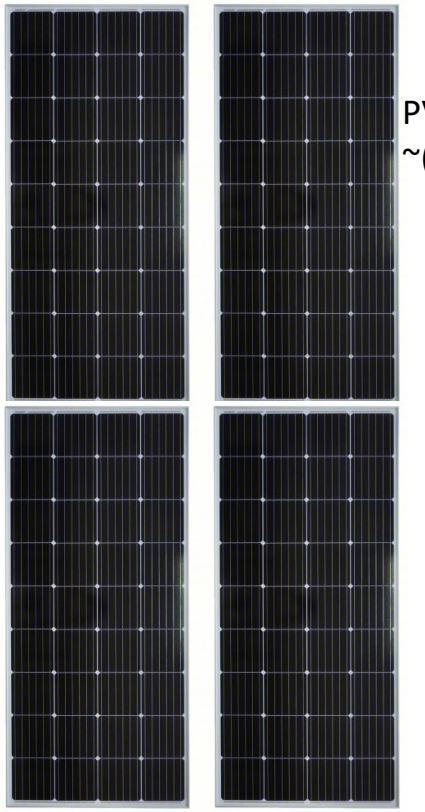
ATV ramp for bed to ground transition

Rear rack mounted winch for loading/unloading in field

Tracked Polaris Ranger for wintertime fuel delivery


DANGER
STAY
BACK

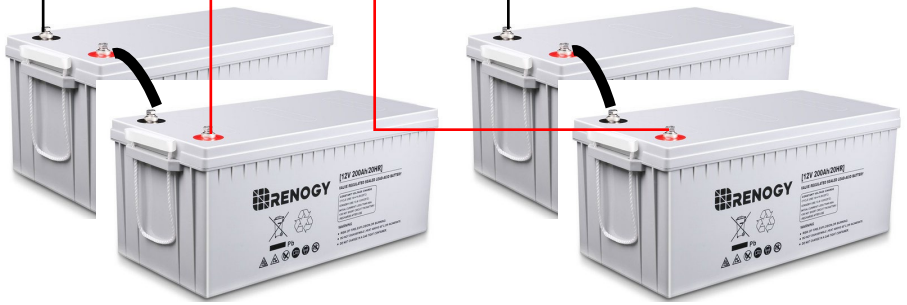

RIDGID



PV array
~($250/panel)

Charge
Controller
(MPPT)
($650)

Panel
Mast/Stand
($1200)



24V bank
($750)

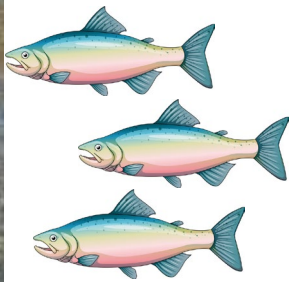
24V bank
($750)

Solar equipment in photo would cost approx. $4,500

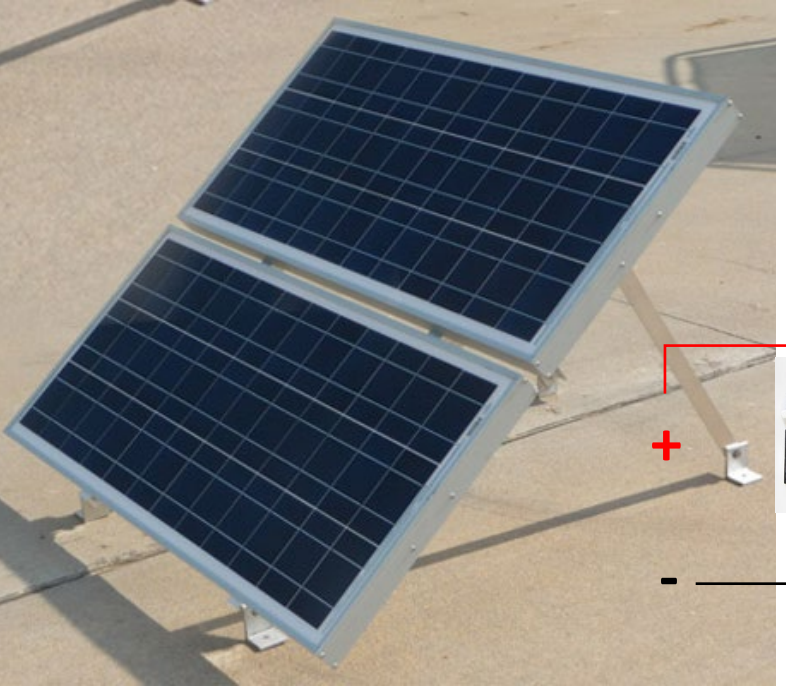
Array & Accessories

Master
controller

Modem



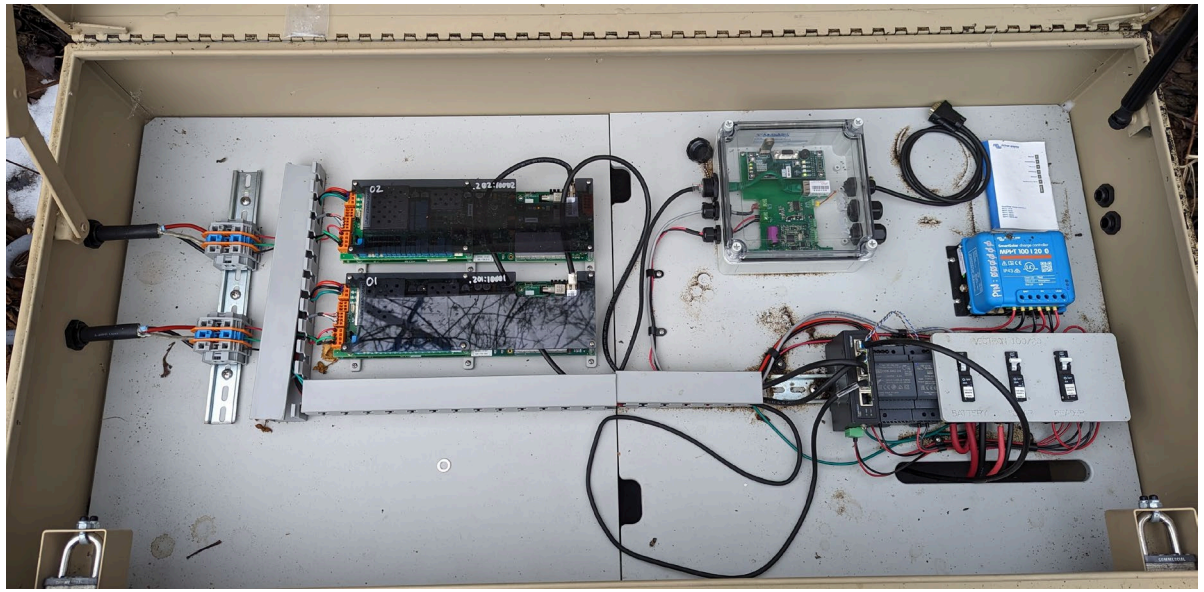
Antennas

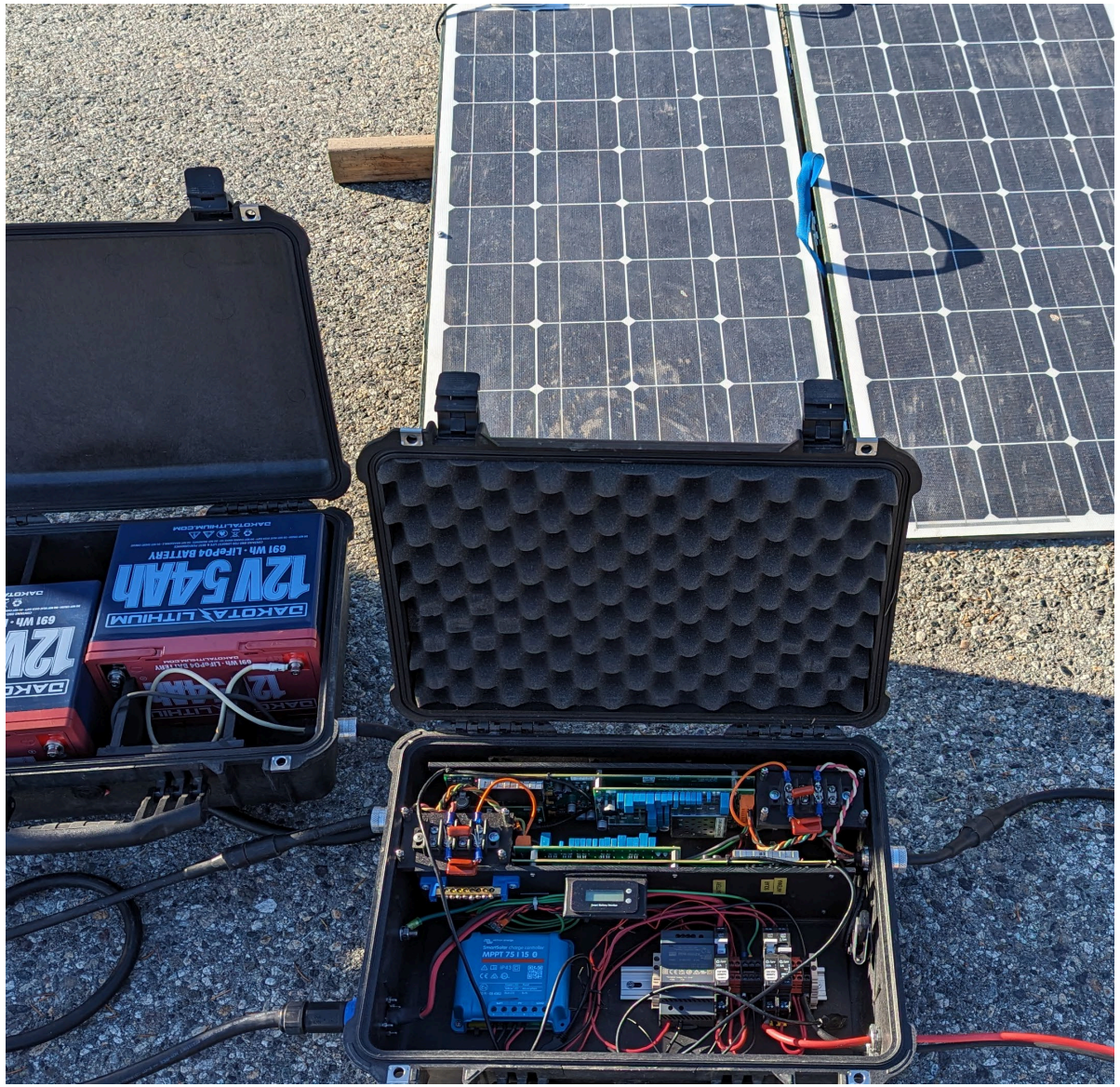


Charge Controller (MPPT) ($75)

Dual synched ACN boards

Small-Scale Solar Systems





Tips for solar arrays Watts=Volts x Amps

- **Sizing**: Plan for more solar wattage than your equipment consumes to account for the inevitable poor solar conditions encountered throughout the season.

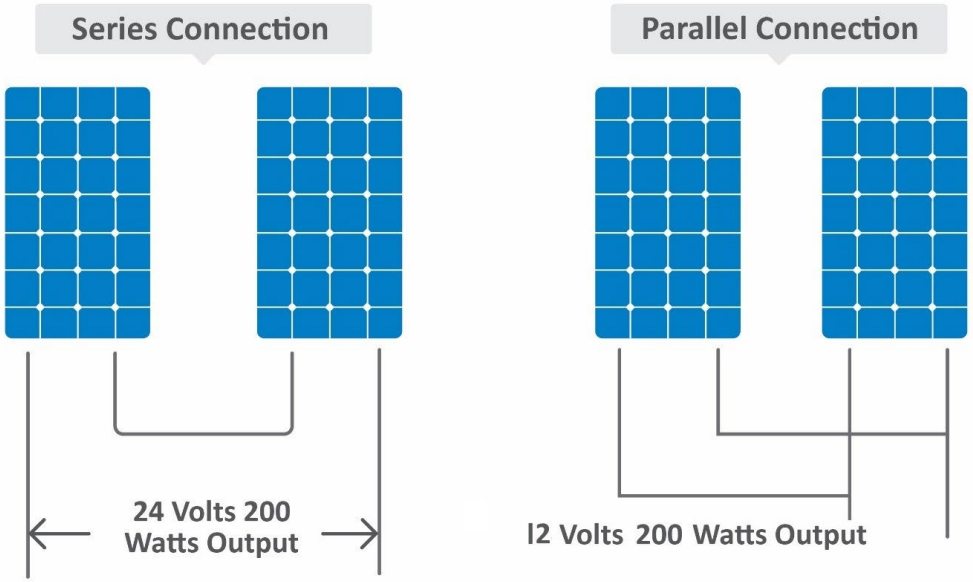
Number of Panels= Daily Energy Consumption/Sunlight Hours×Panel Power Rating

+

Tips for solar arrays Watts=Volts x Amps

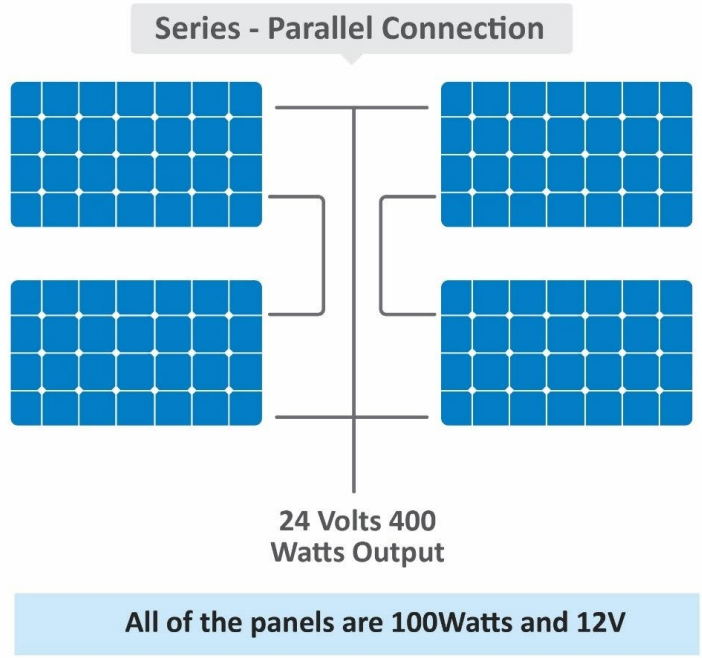
- **Sizing**: Plan for more solar wattage than your equipment consumes to account for the inevitable poor solar conditions encountered throughout the season.

- **Wiring**: Series, Parallel, or Both?



Series Connection: adds the voltage of each panel, current stays the same, vulnerable to shading.

Parallel Connection: Voltage stays the same, current (Amps) increases.



Series - Parallel Connection: If you have more than 4 panels this method provides nice balance of voltage and current which can improve system performance.

Tips for solar arrays Watts=Volts x Amps

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- **Wiring**: Series, Parallel, or Both? (Series + Volts) (Parallel + Amps) wire panels to keep within charge controller parameters

- **Batteries**: Lithium or Lead-Acid?

LITHIUM VS. LEAD-ACID COMPARISON

FEATURE	Flooded lead-acid	AGM	Lithium
Cycle Life	300 - 400 cycles	300 - 400 cycles	3,500
Max Usable Capacity	50%	50%	85%
Discharge Efficiency	50-90%	50-90%	99%
Maintenance	High	Medium	None
Charge Time	6 - 12 Hours	6 - 12 Hours	1 - 5 Hours
Partial Charging Capable	No	No	Yes
Weight Comparison	100%	100%	50%
Charge Efficiency	80%	85%	99%
Cost	$	$$	$$$

https://www.relionbattery.com/resource-center/technology/lithium-vs-lead-acid

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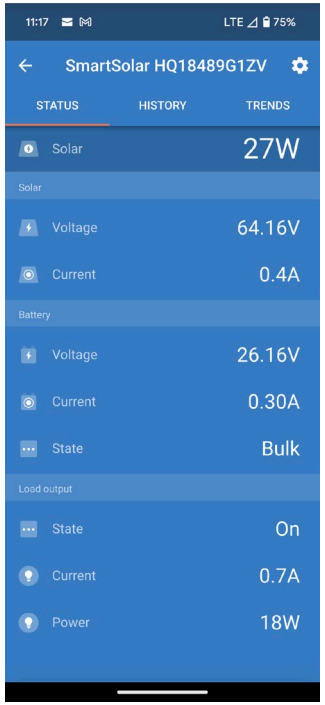
- **Batteries**: Lithium or Lead-Acid? Lithium performs better in every way but cost. However, lithium requires custom charge controller settings, which are necessary to prevent overcharging of batteries (which can result in overheating).

- **Charge Controller**: MPPT*(Maximum Power Point Tracking)* or PWM*(Pulse Width Modulation)* style?

Charge controllers from Midnight Solar and Outback Power Systems that have been used to operate our larger scale arrays.



Victron Bluetooth capable charge controllers are used on our smaller scale arrays. Sends live and historical performance data to phone app.

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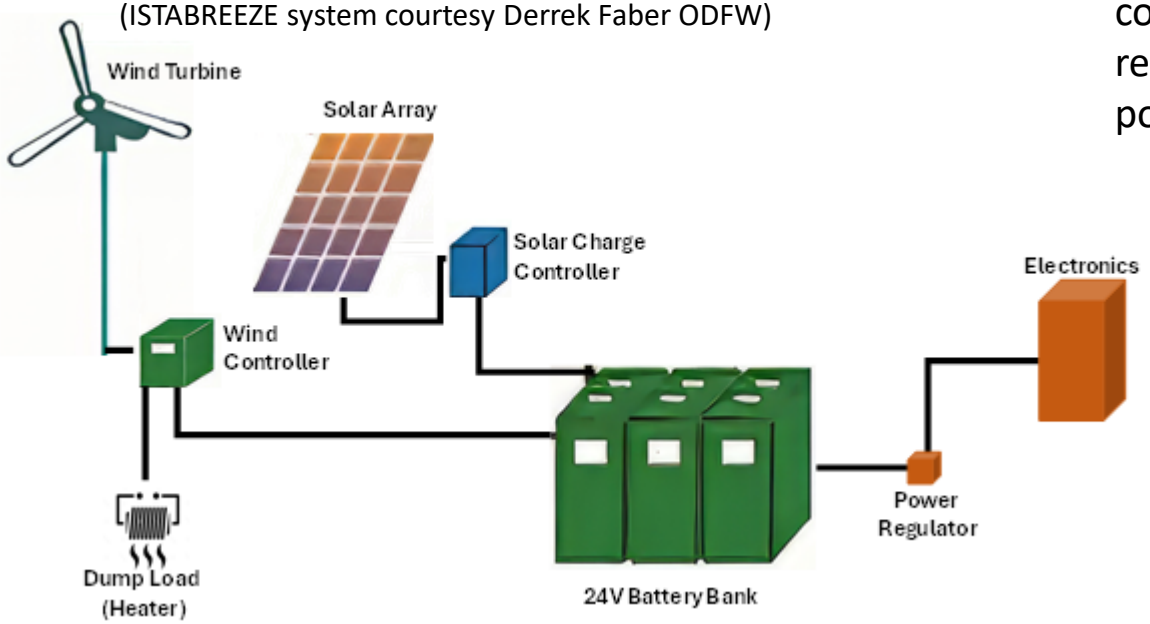
- **Charge Controller**: MPPT or PWM style? MPPT offers most efficient charging

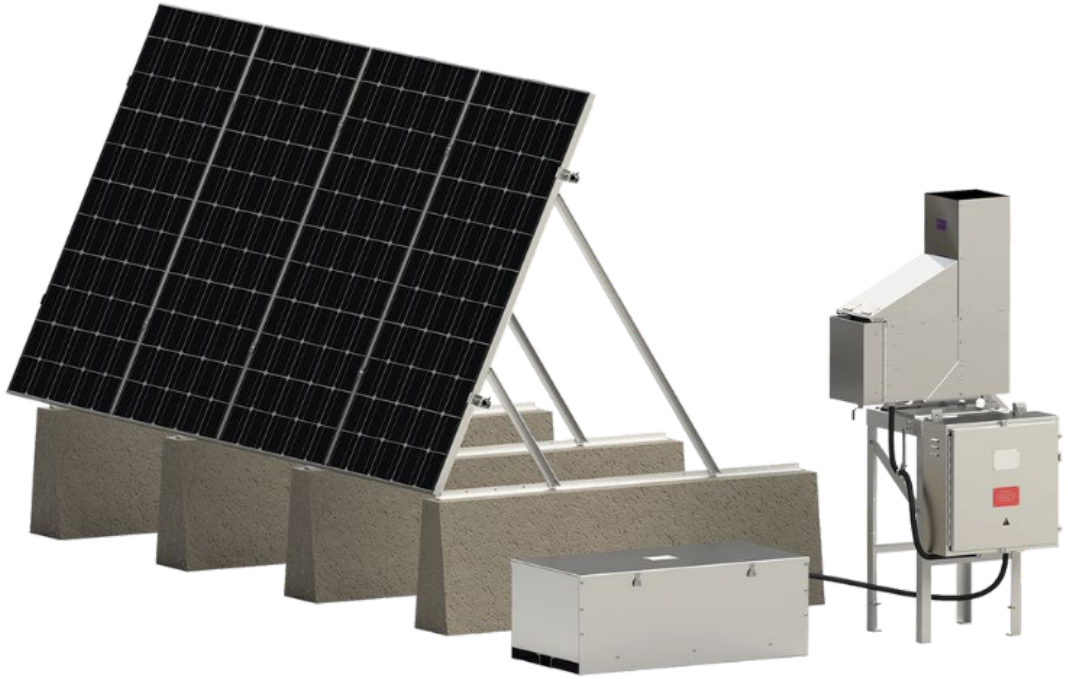
Solar-Wind Hybrid system

(ISTABREEZE system courtesy Derrek Faber ODFW)

- Adding a wind turbine can allow a solar based system to continue operation during periods of unfavorable solar conditions.
- Setup on the left has allowed solar arrays to continue operation in months of December and January with minimal power outages on the John Day and Deschutes River arrays.
- Some charge controllers can handle both PV panel input and wind power input or you may need a separate wind controller. Excess wind energy is discharged as heat. This requires a charge controller capable of offloading excess power from the wind turbine.



Solar-TEG Hybrid system



- Alternately adding a TEG to your system will also allow a solar based system to continue operation when conditions deteriorate.
- A low voltage sensing switch will trigger TEG to ignite and run until batteries are restored to a fully charged state. Can also be initiated through remote connection.
- This setup offers high reliability and fuel savings over 60% vs standalone TEG system during winter months.

(BioMark)

Real world examples

White River – TEG system

- Originally a solar system identical to Little Wenatchee
- Easy drive to site
- Public property
- Operates 12 antenna array (originally 6)

Little Wenatchee – Solar system

- Poor access road to site
- Private property
- Operates 6 antenna array

WTL and LWN are less than 1 mile apart so environmental factors are very similar

White River – TEG Powered System

- **12 antennas (1 MTS + 12 nodes)**
- **Cloudgate 4G Modem**
- **Model 5120 TEG (3 gal/day)**
- **Fuel storage 2 x 120-gallon portable tanks**

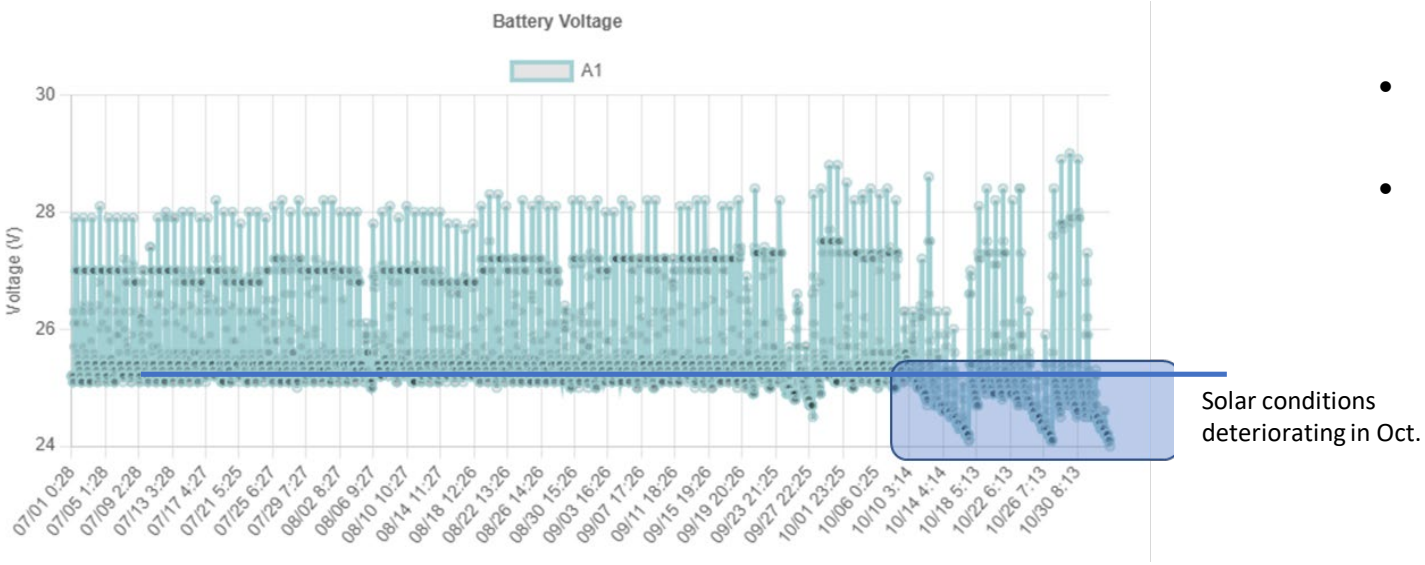
Little Wenatchee Solar System

- **6 antennas (1 MTS + 6 nodes)** upgraded from MUX 2023
- **Cloudgate 4G Modem w/ signal booster and directional antennna**
- **6 x 135W panels wired in series**
- **Outback 150VDC, 60A MPPT charge controller**
- **4 x 12V 200Ah AGM sealed Lead-Acid batteries**
- **Wired into 2 x 24V banks**

Operational results and challenges

Little Wenatchee Solar

- *Attempts to operate through entire year were unsustainable and caused damage to lead-acid banks from excessive discharge.*
  (e.g. gasoline generator, extra batteries)
- *Achieved very few wintertime detections*
- *Operates reliably during March-November solar window*
- *Requires very little maintenance during solar window*



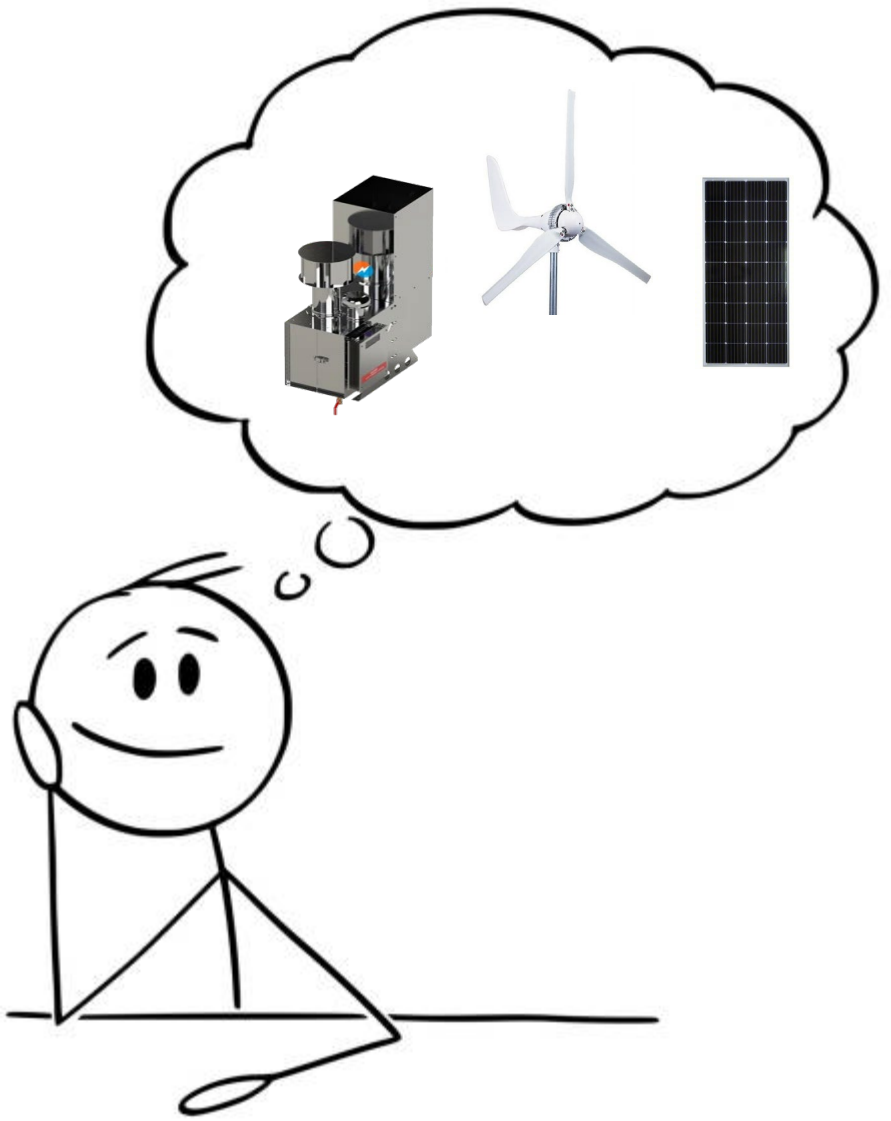
Solar conditions deteriorating in Oct.

White River Propane Generator

- *Originally was 6 antennas and a MUX reader powered by solar*
- *This was increased to 12 antennas ran by dual MUX units synced by a laptop at the site*
- *This was not sustainable for the solar system*
- *Site was moved to easier access spot and re-installed with IS1001MC and 12 ACN's powered by Thermoelectric*
- *Operates consistently year-round*
- *TEG itself requires very little maintenance*
- *Requires delivery of (15) 120gallon tanks per/year*

Final Thoughts

- Both thermoelectric and solar have the potential to power your remote Pit-Tag array.
- The question is what will work best for your situation?
- Hopefully, the information presented can help you make that decision.



In the afternoon hands-on sessions some of the remote power equipment discussed will be available to view and staff will be on hand to answer additional questions you may have.

Acknowledgments

WDFW: Jay Deason, Thomas Desgroseillier, Randy Johnson
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