Viability Whitepaper for 'Tower of Power' Project

Executive Summary

1) **Who are the Customers and users; Who would be the ideal Early Adopters?**
    a. Utility players both, power producers and carriers of power managing the lines and power distributers – all large players rather than a product at the whims of consumers. As a relatively small field and it only takes one to open the floodgates of demand.

2) **What are our customers 3 top problems? How are they currently addressed?**
    a. Create economical reliable power
    b. Deliver power reliably
    c. Keep the end customer base happy with reliable end point distribution

3) **What is our unique value proposition? What's our magic that begs participation?**
    a. What IF.. it was possible to know exactly where the damage was, significant time/money would be saved trying to isolate exactly where to go to fix the trouble.
    b. What IF.. it was possible to know in advance where trouble was beginning (like leaning poles and branches occasionally slapping a line) THEN crews could plan proactively work to resolve emerging problems before they became an emergency; reducing cost of business.
    c. What IF. Nefarious actors could be thwarted so our infrastructure could be secured.

4) **Put some meat on the bones of our solution.**
    a. The root problem is the vast scale of the installation. There is a sheer logistics problem due to the 140+ million of just the wood variety and the only current viable methods are exceptionally expensive requiring applying device directly to the high voltage lines or revisiting every last pole or tower every several years.

    b. Our already demonstrated solution can be installed once at safe distances by non-linemen once with no maintenance and still provide a wide swath of features not found on any system currently deployed.

5) **How will we reach our customers with our solution?**
    a. Our solution is readily demonstrated

6) **Where will our revenue come from? How timely and how reliably will it arrive?**
    a. The good part of having utilities as clients is they are nearly independent of normal market forces, so timely and reliable is the best part of that relationship.

7) **How will we protect our advantage? Are there competitors?**
    a. A provisional patent is filed. It is in good shape to file as full patent. It is the key protection as the implementation is readily duplicated. International protection will be immediately needed to protected worldwide.

    b. There is almost no market penetration as the existing solutions provided have serious mass implementation related drawback. That leaves the door open for a product that has no such drawbacks.

Headlines read: Millions without power in frigid cold, travel frozen as historic storm hits states –and worst may be ahead…Texas power grid hit by extreme storm

Presenting an Opportunity to Use a New Technology to Address a Huge Problem

I love the energy of this project's iconic namesake as metaphor for what we all want – High-Power, Non-Stop Energy. That is what the project, Tower of Power, aims to achieve for each Power Utility, distributors and their end point customers.

- Low down time
- Time and cost-efficient efforts for repair
- No wasted energy
- Reduced Utility company resources needed during emergencies
- Increased Company profits
- Lower Rate Payer cost
- Higher customer satisfaction.

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'Rate of power outages' times 'Time to repair' for utility providers is a direct hit to the cost of doing business and negatively impacts both customer satisfaction and business losses to those commercial customers. In some case it impacts customer safety. BloomEnergy.com

- Average U.S. electricity customer interruptions totaled nearly 8 hours in 2017
- Average frequency and duration of electric distribution outages vary by states
- Why doesn't the US bury its power lines
- 36.7 Million Affected by Power Outages in 2017, Per Eaton Study

For large companies, the cost of an outage can escalate into the millions of dollars per hour of downtime. In fact, the DoE recently estimated that outages are costing the U.S. economy $150 billion annually. BloomEnergy.com

The devastation of Hurricane Florence in North and South Carolina caused more than 1.4 million customers to lose power and Hurricane Michael has cut service to an estimated 900,000 customers in Florida, Alabama, Georgia, and the Carolinas. Soon, winter storms will bring wind and snow to much of the country.

These are extreme cases but even shorter outages hit the bottom line of utility companies:

Electricity service is valuable. A 2009 study from the Lawrence Berkeley National Laboratory estimated an economic cost of $10.60 for an eight-hour interruption in electricity service to the average residential customer. For an average small commercial or industrial customer, the cost grew to $5,195, and to almost $70,000. Ref Link

- **IF.. it was possible to know exactly where the damage was, significant time/money would be saved trying to isolate exactly where to go to fix the trouble.**
- **IF.. it were possible to know in advance where trouble was beginning (like leaning poles and branches occasionally slapping a line) THEN crews could plan proactively work to resolve emerging problems before they became an emergency; reducing cost of business.**
- **IF nefarious actors could be thwarted our infrastructure could be secured.**

The current state of affairs is that it takes considerable manpower to anticipate troubles in advance and in emergency, crews must cruse the roads and neighborhoods with powerful flashlights or fly helicopters to try and find the trouble – directly impacting down time and complicating triage.

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Viability of 'Tower of Power' Project

Obvious questions:

- How many power poles are we talking about? About 180 Million in the US alone.

- Are there any deployed technologies to monitor power poles? Yes but none too good!

  - **Inductive Energy Harvesting**: Vibration monitoring Symposium; This was addressing malicious attacks with these goals: The goal is to design a communications network of small inexpensive and low power electronic sensor platforms that mount on the conductors of an electric power transmission or distribution system. These sensors have the ability to communicate with each other and to pass communications to a monitoring station at the end of the line. Currently the platform has the ability to measure conductor borne vibrations, sense infrared (IR) movement, and measure conductor temperature. It derives its required power inductively from the transmission line and has the ability to store energy when the line power is interrupted

  - **Magnetic Energy Harvesting** Uses magnetic fields captured by a significant multi turn coil University study – not deployed.

  - **Battery Powered:** Atomation.net https://www.atomation.net/

  - **Cable System Powered** - Very invasive and not easily retrofitted

References:

- Deterring Attacks on Power Lines
- Residential power lines
- Types of power poles

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Project requirements:

- **Pole tilt and incident monitoring**
  Should periodically (at least every 20 min) report the current pole tilt degree and whether a significant impact (which could potentially not change the tilt) has occurred.
- **Non-Invasive Power Line Monitoring**
  Should measure and report the voltage on the power line.
- **Energy Harvesting**
  Should harvest energy from the Electric field produced by the power line.
- **Energy Self-Sufficiency**
  Should never require a battery recharge or replacement.
- **Weather-Proof Housing**
  Should work properly regardless of weather or climate.
- **Non-Invasive Installation**
  Should be easily and quickly installable by routine maintenance workers and should not negatively impact either the pole or the power line.
- **Temperature Monitoring**
  Should report the temperature of the conductor to monitor for power line sagging.
  Airspeed, direction and pressure can also be addressed.
- **Flash Detection**
  When a branch lands on a line a current spike occurs generating a local EMP event that can be detected at each pole. Even if there is no outage these events can be precursors and useful to preventative maintenance or a key incrimination during an outage.
- **EMP Detection**
  When a branch lands on a line a current spike occurs generating a local EMP event that can be detected at each pole. Even if there is no outage these events can be precursors and useful to preventative maintenance or a key incrimination during an outage.
- **Camera option**
  Incident recording possibilities, also provides deterrence from malicious tampering
- **Long Distance Communication 10 Mile range**
  Using LoRa or similar Poles can either use Point to aggregator or network. Nodes can be assigned point or buddy mode for addressing non-line of sight cases
- **User Interface**
  Should have an intuitive GUI to communicate with the utility company.
- **Low network load**
  Infrequent and small size data packets and randomized transmission period to mitigate network jamming (e.g. once in 20 min). Packets are compressed to only present trend and significant changes.
- **Emergency "Blue Phone" option**
  Makes every power pole a potential safe call box.
- **Installation by non-line-men**
  Install at far enough distance to not require qualified linemen or power shut off.
- **Lowest cost alternative**

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Technology Choices

Proposed Power Tech	Advantage	Drawback
Battery	Safe install Simple design Physically small	Must be periodically replaced Low power limits features
Inductive Coupling	Unlimited power	Must be Clamped on high tension lines More difficult to discern actions at pole Need community load current to work Expensive
Magnetic Field	Safe install	Need community load current to work Expensive due to large copper windings Physically may be large due to coil size Sensitive to local nulls in 3Phase
Solar	Safe install	Possible Maintenance issues, More fragile. Power related to size
Electric Field (Tower of Power)	Safe install Power impervious to system load Cheap Camera option, "BluePhone"	

Players in the game:

This topic has been a goal for some years. The need has been identified and some patents have been issued based on idea only but none have identified a realizable solution to the need, so the patents are not readily defended and the key feature that our solution puts forward – that of electric field energy harvesting for this purpose has not been previously proposed.

Patents:

US20160313209 application describes a perpetual motion system with no energy source to accomplish it
US20140278150A1 application describes a perpetual motion system with no energy source to accomplish it

Papers/Studies

Design of Wireless Networked Electricity Pole Line Multi-Fault Monitoring System
Battery/Solar 10 yr: Ekkosense_Case_Study_v3
Magnetic ECE University
Battery/Solar Tennessee EDU Team 5 – Smart Utility:
Energy Harvesting from the Stray Electromagnetic Field around the Electrical Power Cable for Smart Grid Applications
Key Prior art Electric Field Energy Harvesting Powered Wireless Sensors for Smart Grid
Energy harvesting from magnetic energy radiating from AC power lines
https://energycentral.com/c/gr/paper-title-monitoring-power-system-poles

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Customers /beneficiaries of the data

1) Power producers,
2) Power distributers
3) Power transporters
4) Telecom/Datacom
5) Major End point users (larger corporations)
6) Consumers

Owners of the power distribution Networks

Installation will be provided by the distribution owners

1) Power producers,
2) Power distributers
3) Power transporters

How to Monetize the solution

1) **Direct Hardware Sale:** There is in the US alone a market of 140 million poles –

2) **Monetizing the data:** There are several parties that would be interested in aggregating the data either generally or specially. For example, one entity may be interested in a general heath indicator. The provider, distributors would be interested in a general heath indicator but more specifically they would want proactive guidance as to where preemptive actions could be applied. When partial disruptions occur, like a branch intermittently striking a line, where to address that and during an outage by accident or nature – the precise location of the damage.
   Again, taking that same 140 million pole figure but this time charging a small per pole monitoring fee/year per customer, that would yield a revenue flow with little overhead expense.

Bonus points if you can guess why the company is called by the name Whitewater Power.