Anemometer Loan Program

Data Results and Project Progress

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CAES
CENTER FOR ADVANCED
ENERGY SYSTEMS

A Little About Our Center…

Established in 1992 by Professor Michael R. Muller

"A multi-disciplined, full service center including thrusts in research, teaching, and outreach in response to an emerging national emergency, and fertile opportunities for important advances in technology and significant student interest"

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A Little About Our Center…

- Our Other Programs…
  - Industrial Assessment Center Program (IAC)
    - Funded by Department of Energy
    - Field Managers
    - Free Assessments for Industries
    - Focus on Industrial Energy Efficiency
  - New Jersey Manufacturer's Excellence Program (NJME)
    - Funded by NJ Department of Environmental Protection
    - IAC-Style program for New Jersey
    - Focus on Pollution Prevention (P2)

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Down to Business…

- Overview of today
  - Our Resource Assessment Method and Apparatus
    - Equipment Used
    - Data Analysis Techniques
  - REPORT: Stanley Theater, Jersey City
  - REPORT: Totten Family Farm, Hackettstown

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Resource Assessment Method

- Anemometer Towers purchased from NRG Systems
- 20 m TallTower
- Logs Wind Speed(MPH), Direction(Degrees), Timestamp
- Time-averaged at 10 minute intervals
- Plug can collect >6 months of data.

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Resource Assessment Method

- Project Components
  - Site Selection
    - 1st come, 1st serve basis, queue of about 10 clients
  - Tower Installation
    - Team of 4-6 people
    - 1 full work day to install
  - Data Collection @ 6 - month mark
    - Switch out data plugs, change the battery
  - Tower Take-Down
    - Team of 3-5 people
    - 1/2 – 1 work day (depending on anchors)
  - Data Retrieval and Analysis

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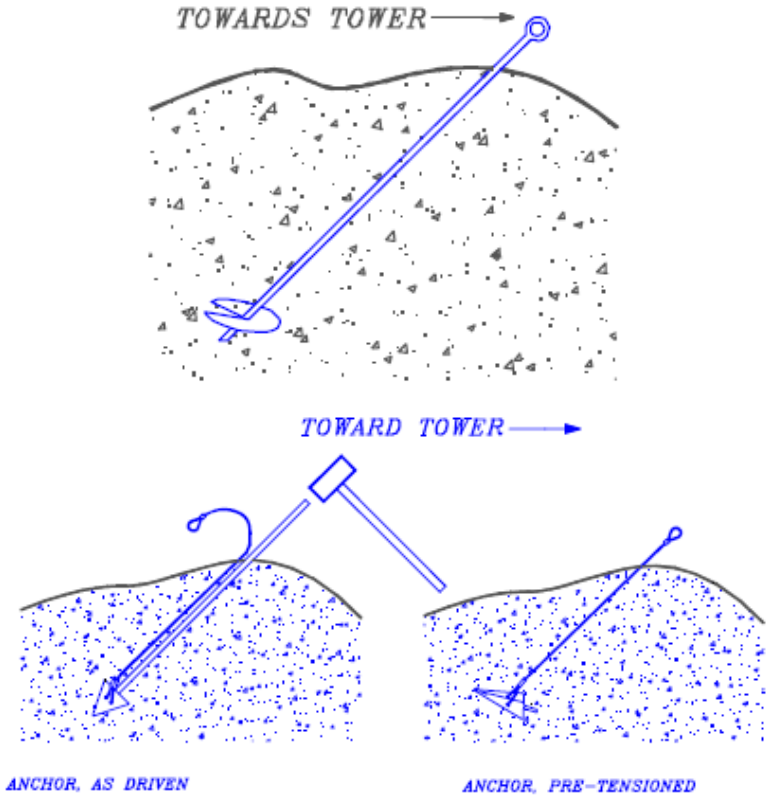
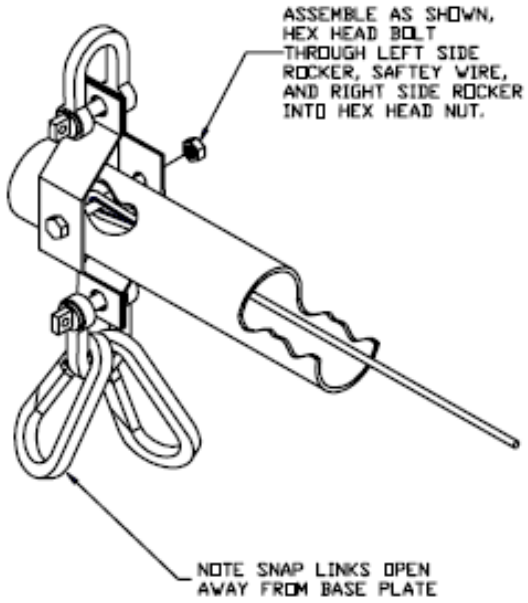
Problems with Installation

- Anchors!
  - **Screw-In anchors** useful if there are no rocks
  - **Screw-In anchors** useless if it hits 1 rock
  - Ended up using **Arrowhead anchors**
  - Easier to get in, very hard to get out
  - Hint: Put some oil on the tip of the rebar before you hammer in the arrowheads



Problems with Take-Down

- Make sure you use TWO carabiners to distribute the top and bottom guys onto.
  - If not, you'll rip your baseplate in half
- Digging up the arrowheads



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Data Analysis

- Wind with velocity V1 has kinetic energy of
$$(1/2)mV_1^2$$
- Wind also has a mass flux across a cross sectional area A of:
$$\text{Mass Flux} = \rho \times A \times V1$$
- Power is the flux of energy (Energy/time)
$$\text{Power} = \text{flux of kinetic energy}$$
$$=(1/2) \times \text{mass flux} \times V_1^2$$
$$\boldsymbol{=(1/2) \times \rho \times A \times V_1^3}$$

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Data Analysis

- So, Power = $\frac{1}{2} \times \rho \times A \times V_1^3$
- Power / Area = $\frac{1}{2} \times \rho \times V_1^3$
- This is called the **power density**
- Units: W / m^2
- Area is the circle created from the diameter of the blades

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Data Analysis

- Since power varies proportional to the cubic of velocity, taking the average velocity and plugging it into the equation does not give accurate results.
- Velocities are therefore classified into bins, usually 0.5 m/s.
- Cut-In speed for most turbines is > 3 m/s, so speeds under 3 m/s are neglected

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Stanley Theater

- Heart of Jersey City, in Journal Square
- They claimed high wind speeds on the roof, and had scaffolding in place to site the anemometer.

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Stanley Theater

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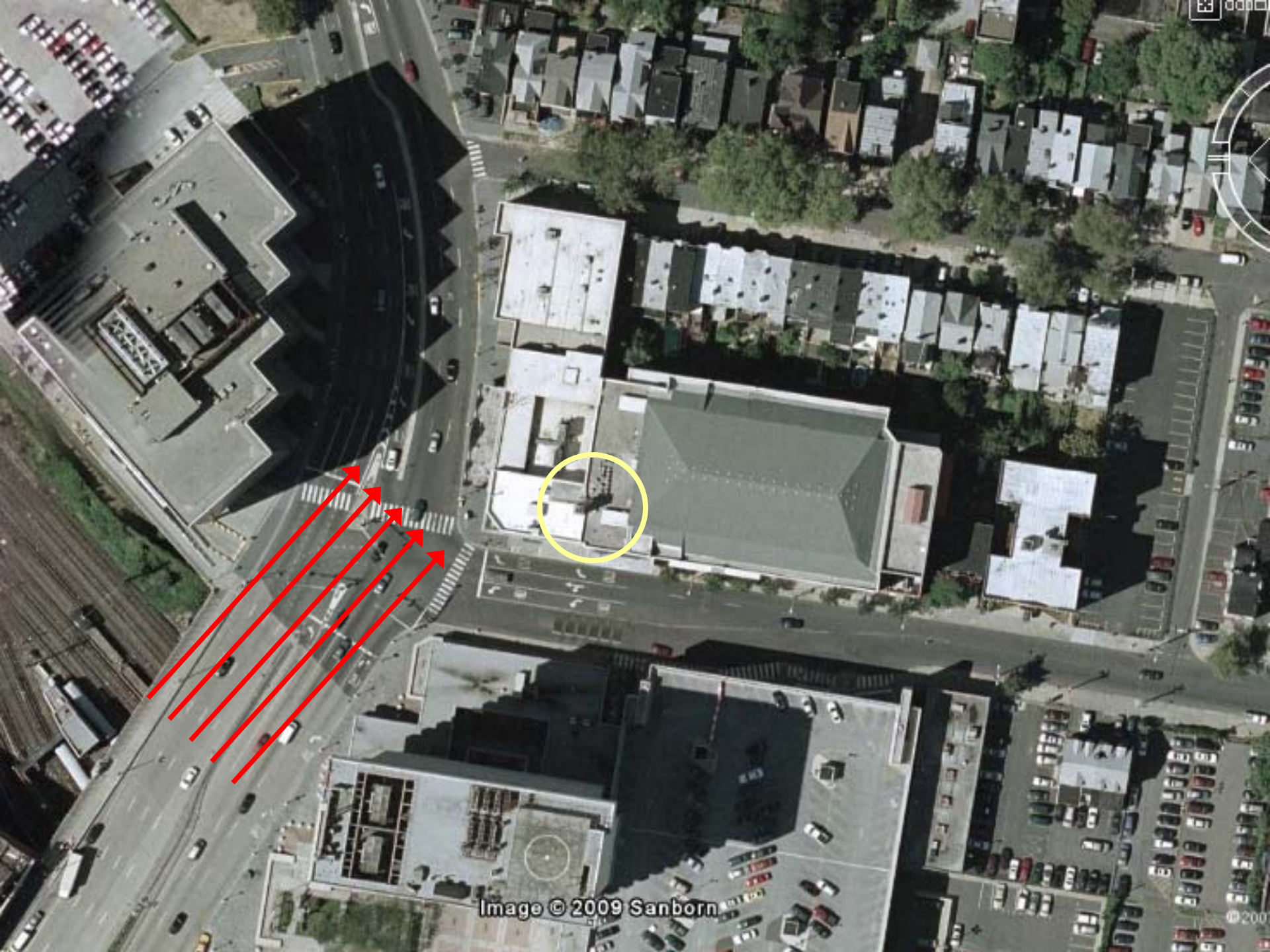
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Analysis Results

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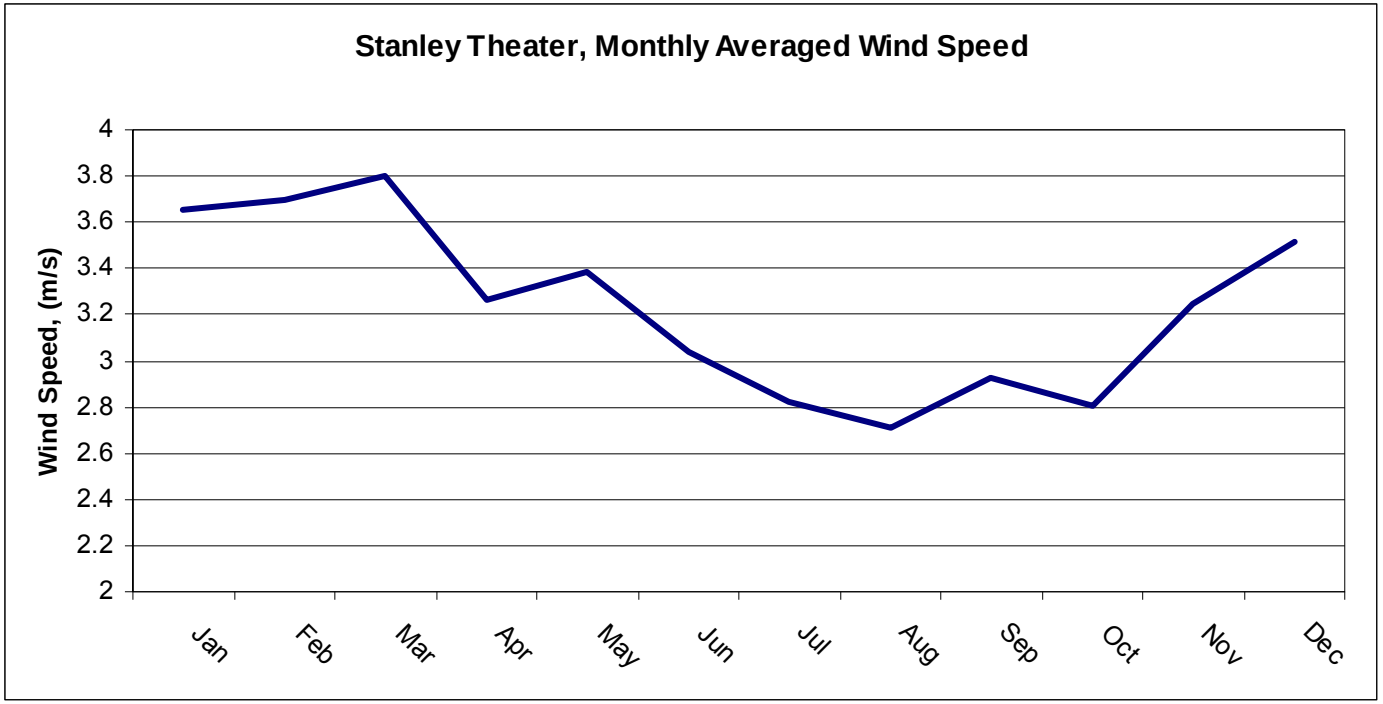

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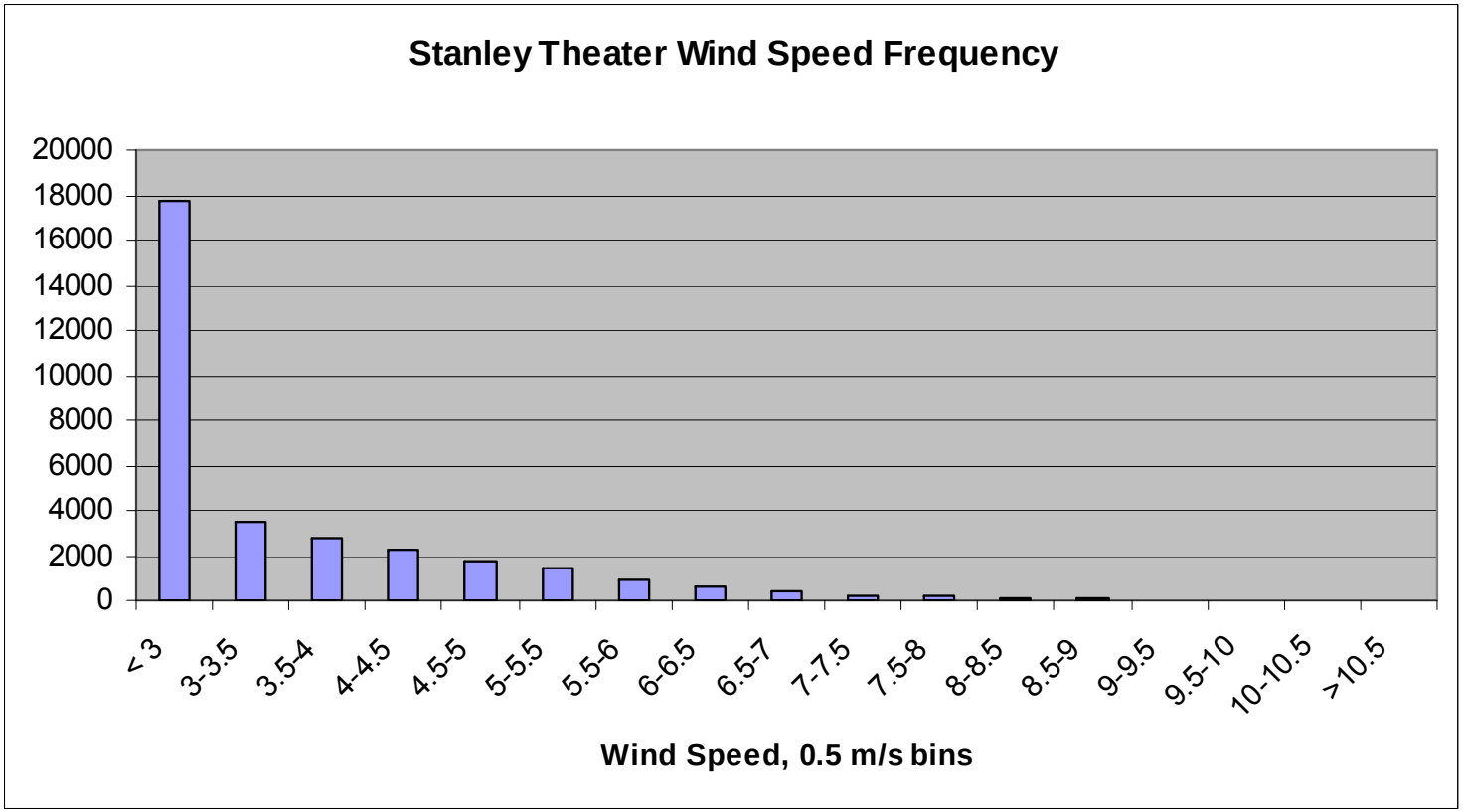
Analysis Results



Data Analysis

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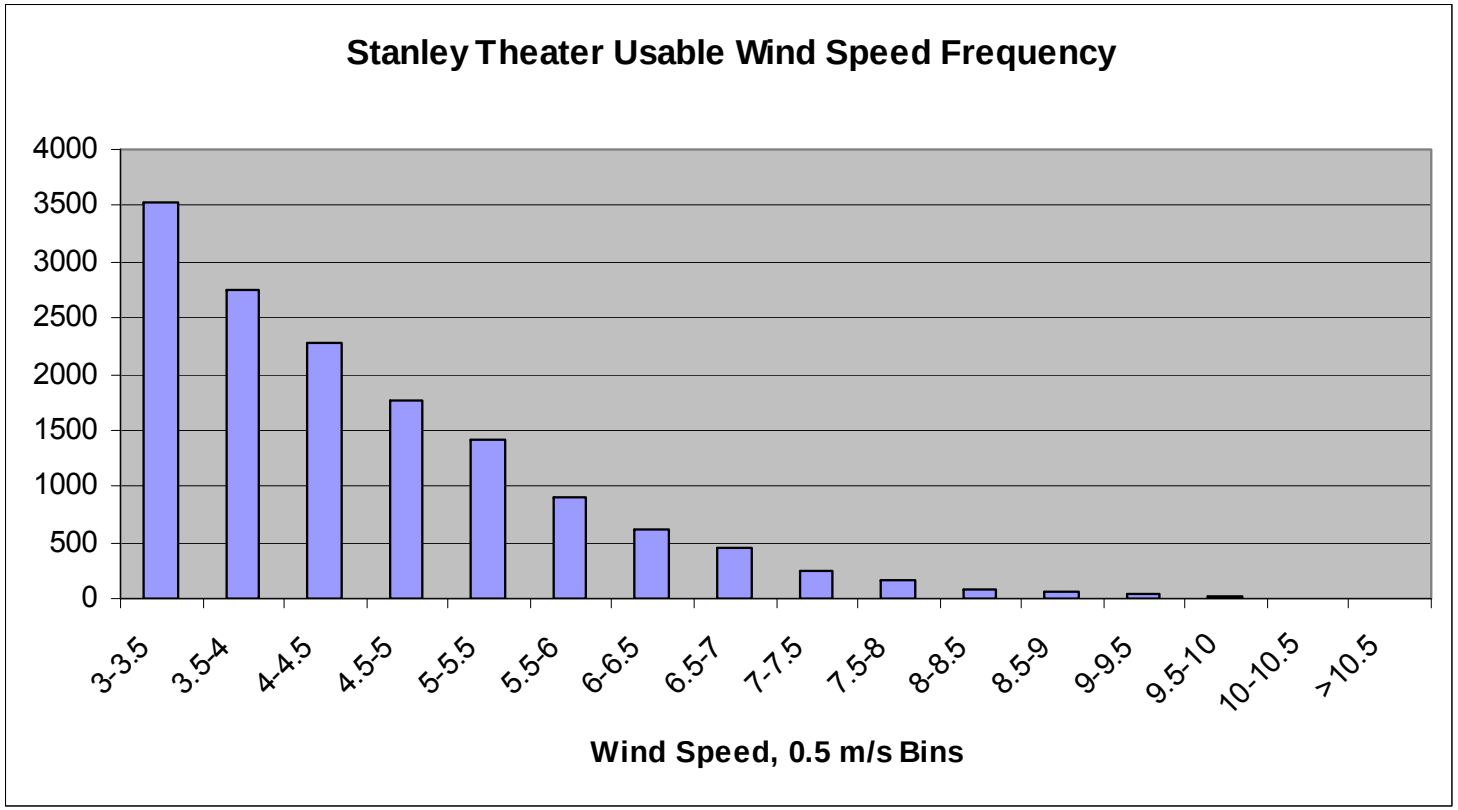

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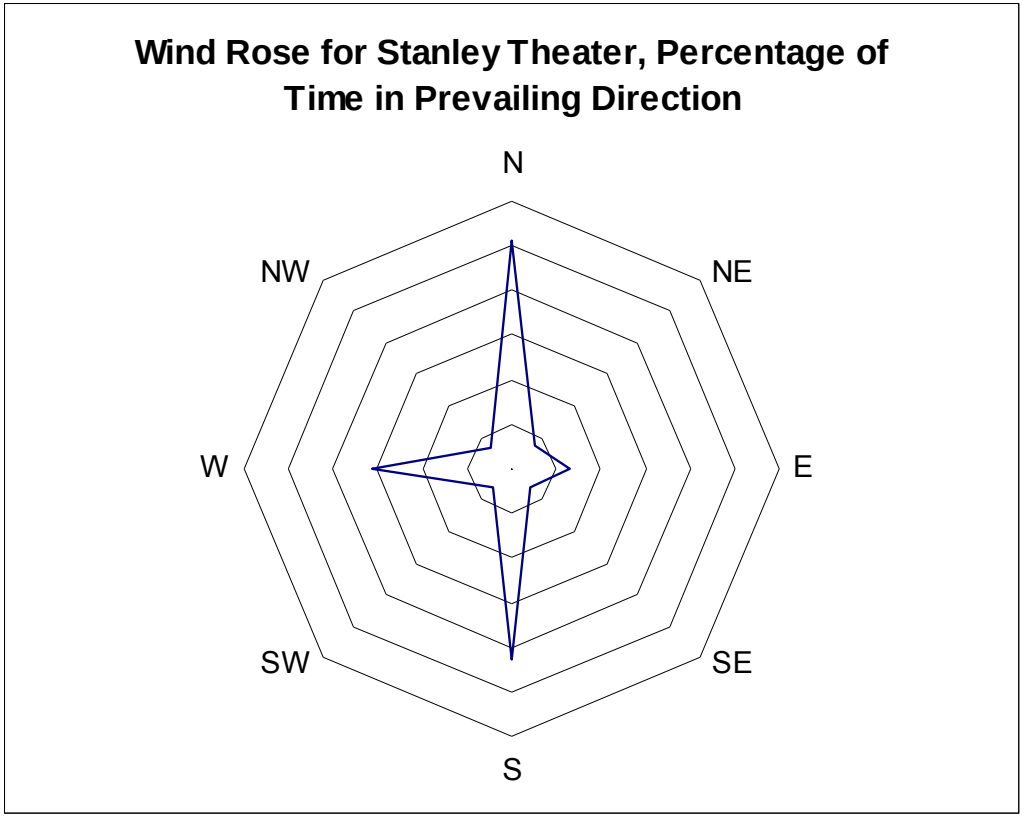

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Conclusions…

- Average Wind Speed: 3.2 m/s
- Average Power Density : 29.7 W/m
- Wind speeds below cut-in speed 55% of the time.
- Turbulence Intensity of 30%
- NOT a good spot for a turbine.
  - Maybe a VAWT?

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Totten Family Farms

- Hackettstown, NJ
  - Far north
  - Inland
  - Plenty of space for turbines

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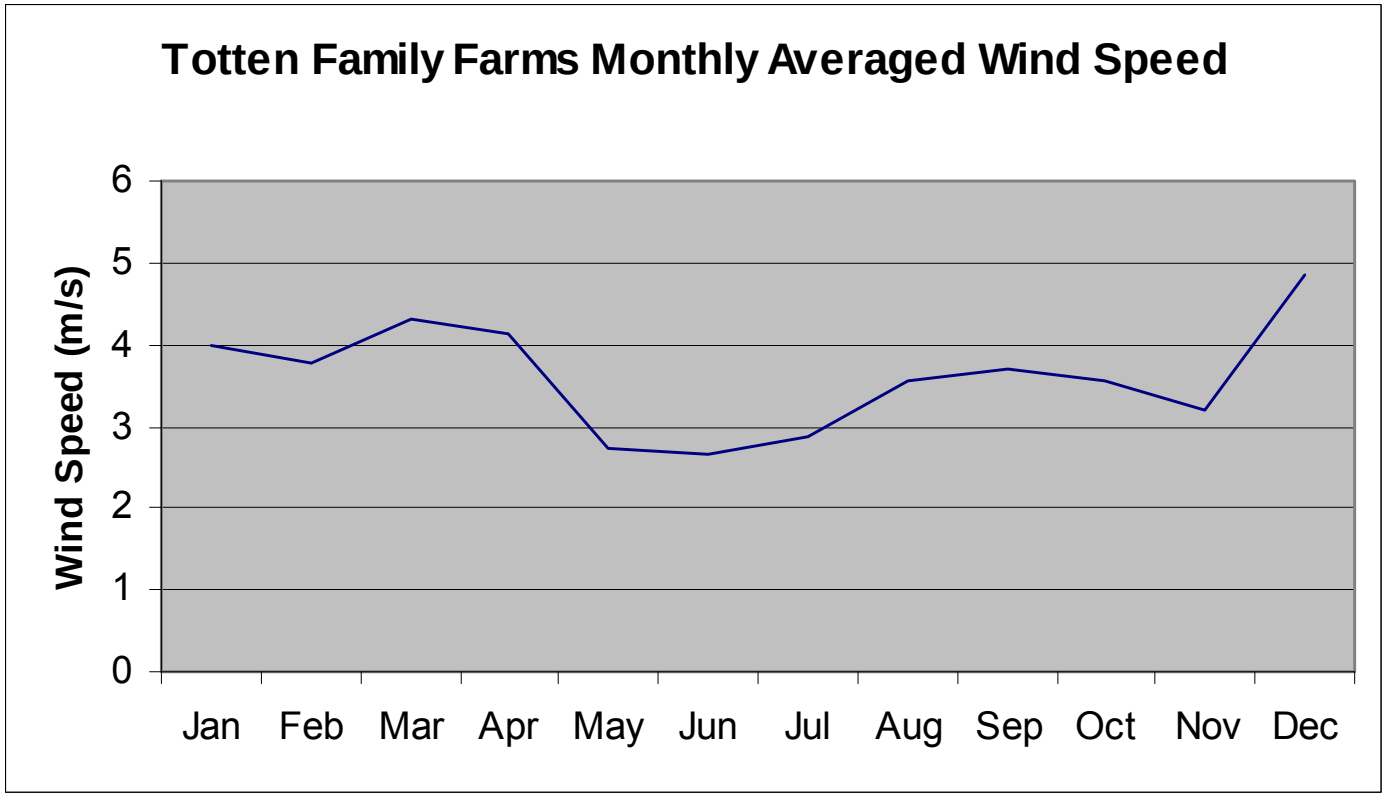
Totten Family Farms



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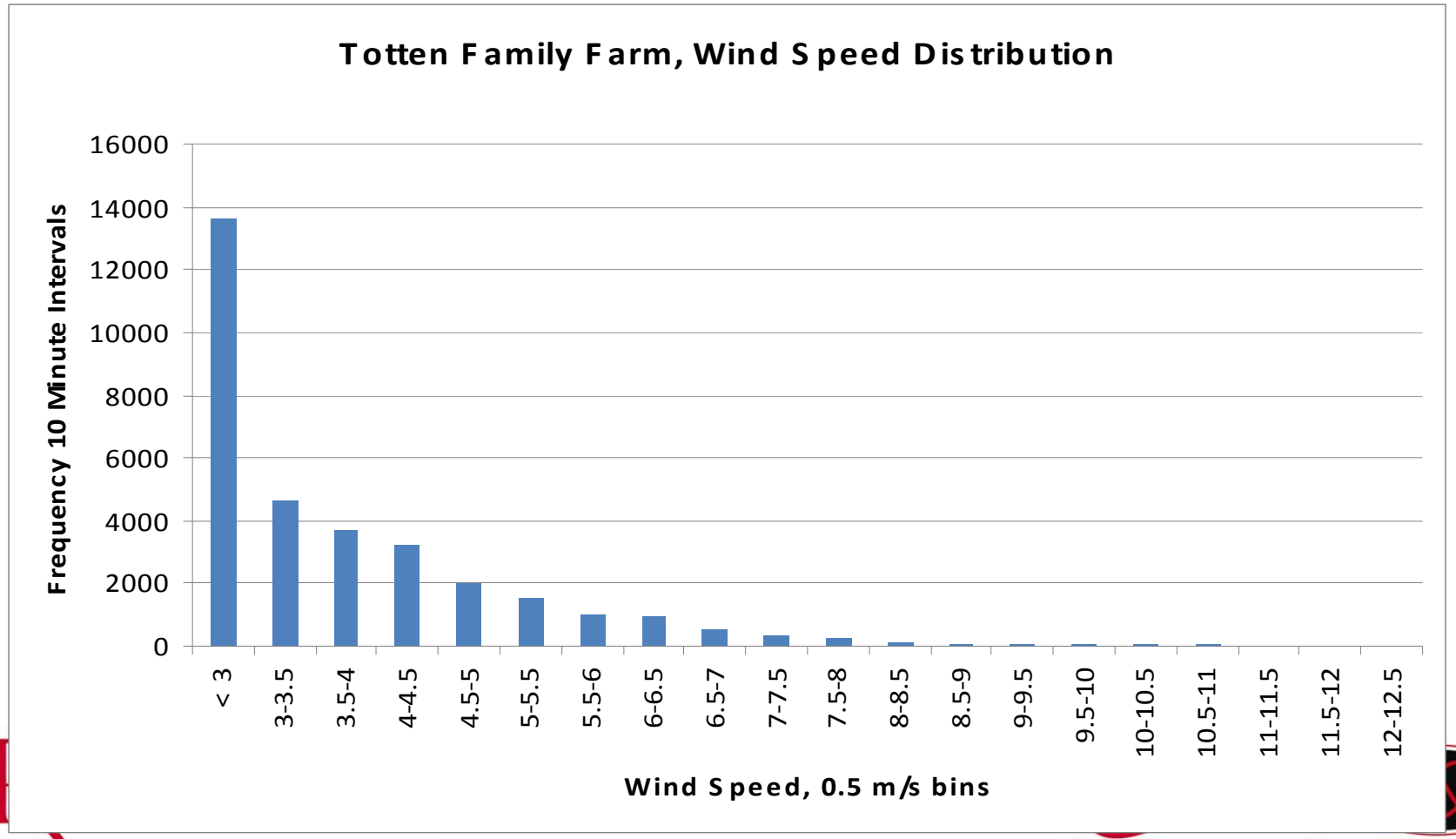
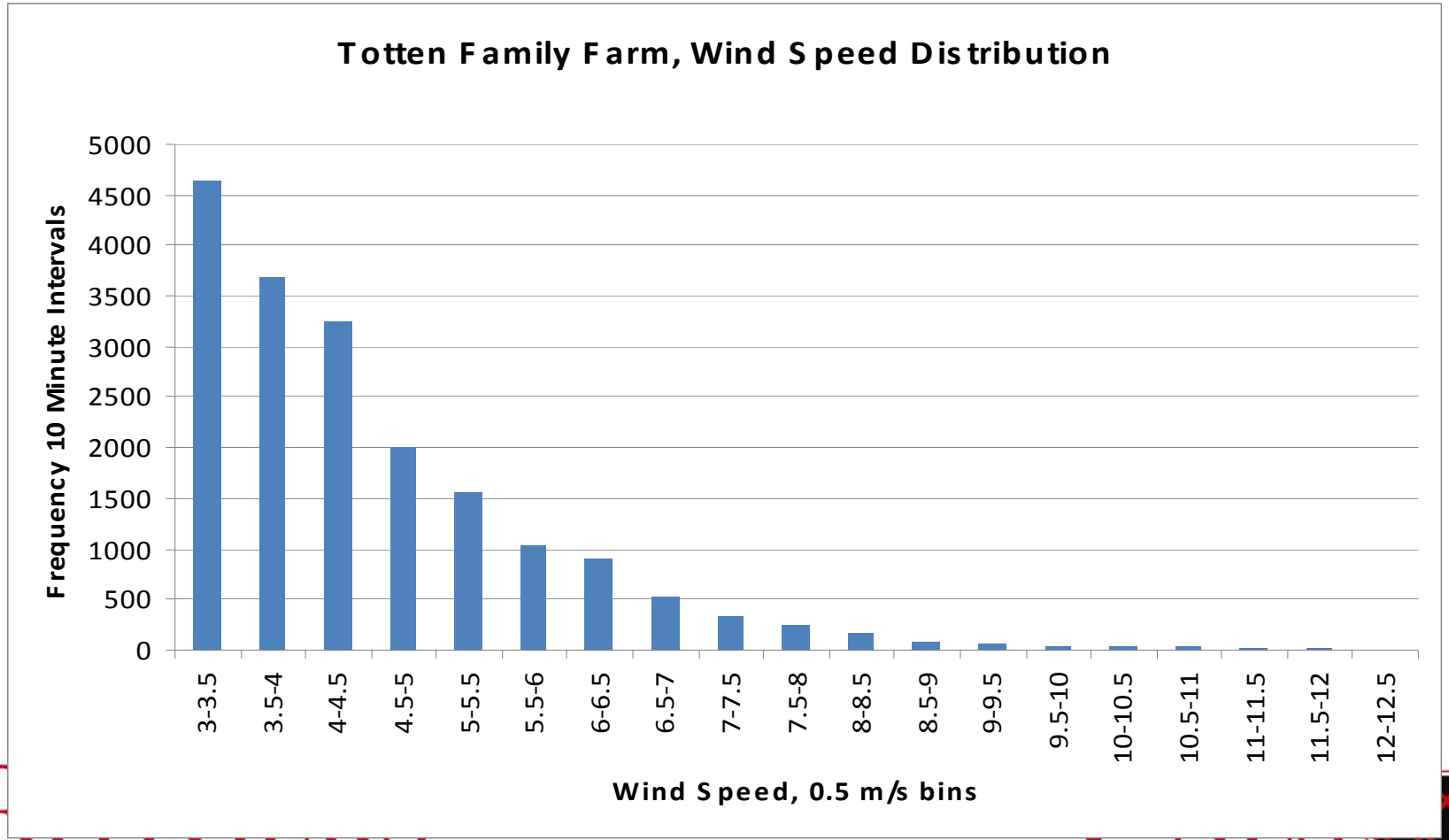
Totten Family Farms



Totten Family Farms



Conclusions…

- Average Wind Speed: 3.7 m/s
- Average Power Density : 49 W/m
- Wind speeds below cut-in speed 39% of the time.
- Turbulence Intensity of 34%
- Better spot for a turbine, but far from being cost-effective.

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