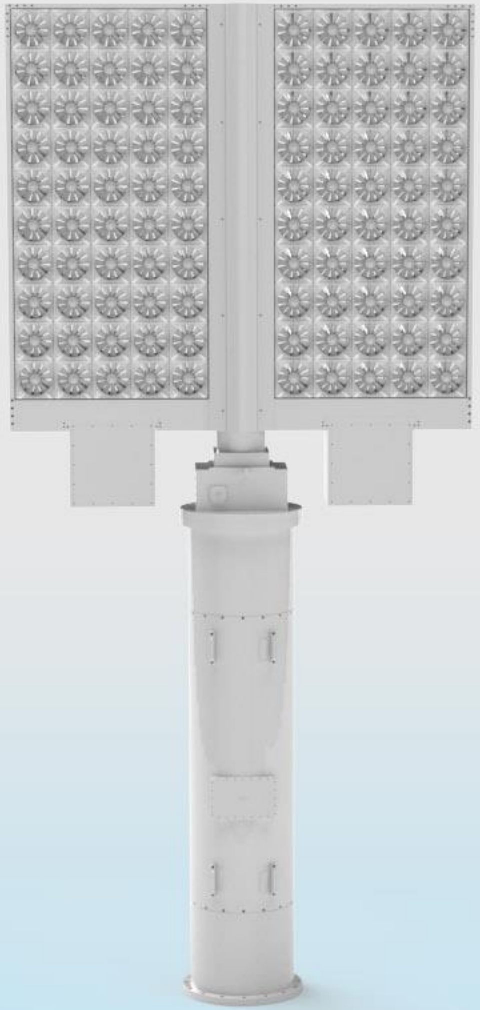
AMERICANWIND®



How a small company from Alabama is making a name for its self in the marketplace

And how you can do it too.

Presented By: Robert Yost, President/CEO

About your Presenter

Robert Yost – President/CEO

- 40+ years of Engineering experience across multiple disciplines.
- Inventor of the MicroCube™
- Multiple Patents
- 2018 European CEO – Entrepreneur of the Year, Energy Technology.

Our Mission

"We believe to create a better future for our children and our planet we must bring power to the people. We can achieve this with our state of the art wind turbine systems that are beautifully designed, astoundingly powerful, completely renewable, incredibly space efficient, whisper quiet, extremely versatile, while working anywhere in the world."

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Know Your Story. Know your Why.

Our Story- Why it matters

- April 27th 2011. Over 280 tornados came through the Tennessee Valley.
- Massive powerline damage.
- Power generation facilities were not hurt! The long transmission line network was mangled.

Why we do, what we do.

- Because of our beginning, our why was clear, power generation needed to be closer to the point of use.
- The slogan Power to the People was born.

Do not get lost in visions of others.
Keep with your vision, because in the end,
people don't buy what you do, they buy why you do it.

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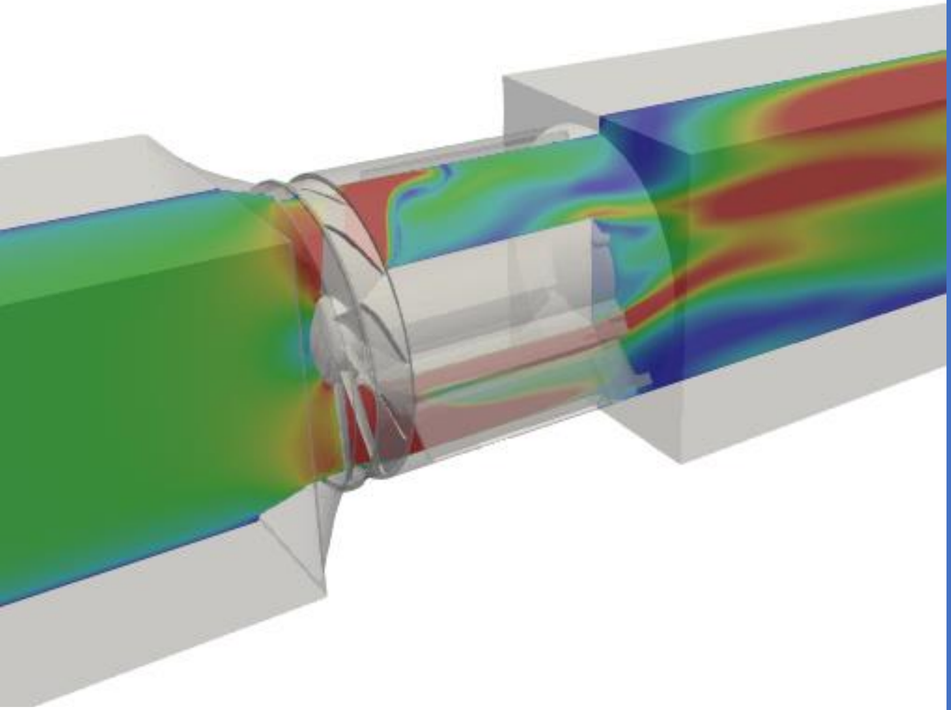

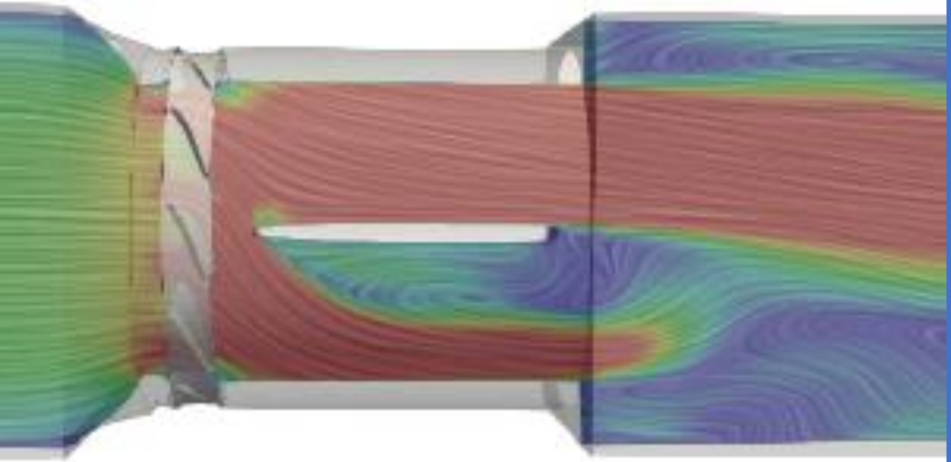

Overcoming Obstacles

- 36 Design Changes.
  - Redesigning the generator, was not easy!
  - First generator that uses multiple AC generators in <u>Series</u>.
  - A lot of small parts, some things were very brittle.
- Manipulation of air pressure
  - Increases efficiency
  - Created a recirculation issue as shown bottom left
  - CFD modeling was used to improve engineering designs
  - Revalidated new design through CFD modeling
- What if the machines didn't exist?
  - Using 3D Printing to build tools and machines to build parts.

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Thinking Outside the Box

- Research your market.
  - For us, this meant finding and reading the Albert Betz postulate paper written in 1919 (After the fact)
  - *"We would accordingly be able to obtain any desired amount of energy with a windmill of quite small diameter by simply widening the vanes or increasing their number, which is contrary to all experience."* – ***Direct quote from Betz paper on page 13.***
- Find the problems in the market.
  - Too large
  - Too much loss in the single system.
  - Too much friction and eddy currents in the generators
  - Extreme loss in gearbox
  - Loss in the transmission lines.
- Pull upon past experiences to innovate.
  - Smaller not larger, increases each units efficiency
  - Use many small turbines to cover surface area differently
  - Design blades like a jet turbine to manipulate the air pressure to increase efficiency.

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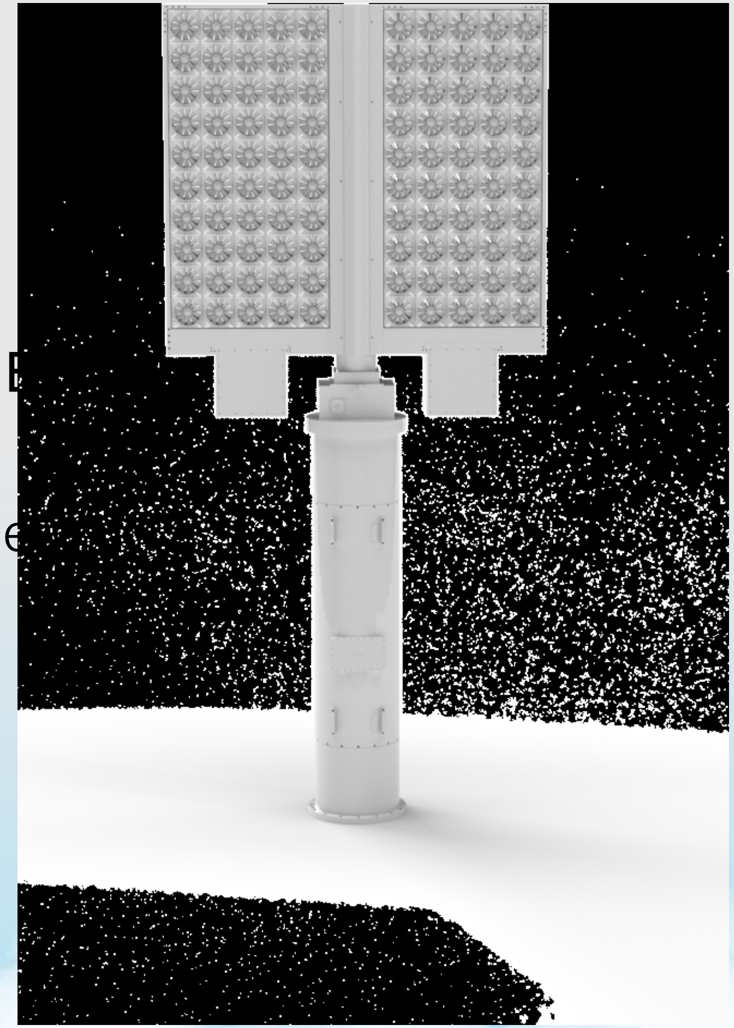
Utilizing Emerging Technologies

- How do you test a product that's never been made, with very little capital and on a short timeline?
    - CNC machine?
    - Tool Up – Dies or molds?
    - Rely solely on graphic models?
        - What if the models don't exist?
        - Guess?
- 3-D Printing
    - 36 versions to get it right.
    - Real parts to test.
    - Verify the manufacturing process.
    - Saving over $7,000,000 in tooling by getting it right in 3D printing.
    - 3D printed parts with the quality and tolerances of CNC machined parts.

How to Innovate and Make Your Company Innovative

- Know your own story
- Know your why
- Know how your story applies to your why
- Fail and fail often. Learn from every failure
- Think outside the box, do not ask how it IS done, ask how can it B done
- Levy your past experiences. Something you might not think applie might be the key to making it work
- Utilize emerging technologies
- If the tool doesn’t exist… build it!
- Never forget why you do what you do



Thomas Edison quote: "I have not failed. I've just found 10,000 ways that won't work."

EXTRA SLIDES

Power Equation

Power Watts

rho

Surface Area (m^2)

$$P = \frac{1}{2}\rho S V^3$$

Velocity m/s

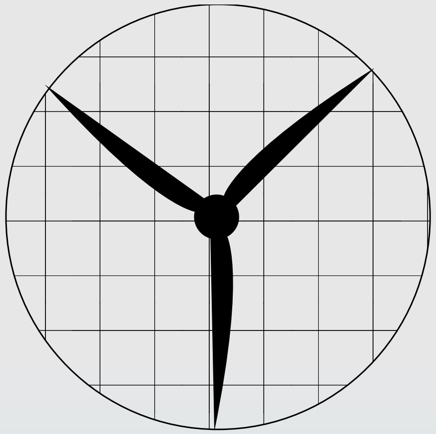
Rho – standard temperature and pressure (STP) = 1.25 – dry, clear air at sea level

S – also known as Rotor Swept Area

Surface Area vs Swept Area

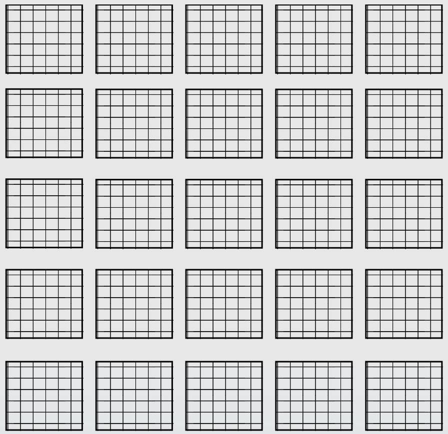
- American Wind products rely on Surface Area, not Swept Area. These sound like the same thing. Using Surface Area you can cover it in multiple fashions to manipulate the air as needed. Swept Area you must rely on a single system and on mother nature to relieve back pressure caused during energy conversion.
- Using multiple smaller systems allows for distributed energy as well as greater power range.
    - Swept Area based turbines max out power at 20mph. Swept Area turbines avoid additional energy production by utilizing their pivot systems.
    - Using smaller systems based upon surface area are capable of high RPMs increasing the energy captured.

Traditional Model



3% Coverage

American Wind Model

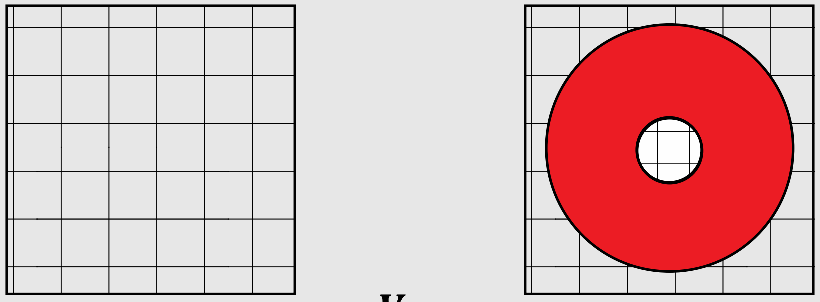


90% Coverage

Conclusion: By using multiple small systems to cover square footage in a different way, higher efficiencies closer to Betz theoretical limit of 59.6% can be achieved. Furthermore, using multiple smaller systems allows for greater transformation of energies in all wind speeds.

Ducted Wind Turbine Difference

- When air is ducted into a smaller area, the speed or the value of V increases. This key value increases the potential power output of American Wind products.
- Ducting in the MicroCube increases wind speed at the blades by a factor of 1.92. The chart to the right shows you the difference that ducting makes on available power. The value of 1.92 was rounded to 2 for simplified calculations.
- Over ducting problem creates higher back pressures.
- Solution: Use blade designs similar to jet turbine blades to reduce back pressure.



	$\boldsymbol{V}$	
$1^3 = 1$	1 m/s	1 x 2 = $2^3 = 8$
$2^3 = 8$	2 m/s	2 x 2 = $4^3 = 64$
$3^3 = 27$	3 m/s	3 x 2 = $6^3 = 216$
$4^3 = 64$	4 m/s	4 x 2 = $8^3 = 512$
$5^3 = 125$	5 m/s	5 x 2 = $10^3 = 1000$
$6^3 = 216$	6 m/s	6 x 2 = $12^3 = 1728$
$7^3 = 343$	7 m/s	7 x 2 = $14^3 = 2744$
$8^3 = 512$	8 m/s	8 x 2 = $16^3 = 4096$
$9^3 = 729$	9 m/s	9 x 2 = $18^3 = 5832$
$10^3 = 1000$	10 m/s	10 x 2 = $20^3 = 8000$

$$P = \frac{1}{2}\rho S \boldsymbol{V}^3$$

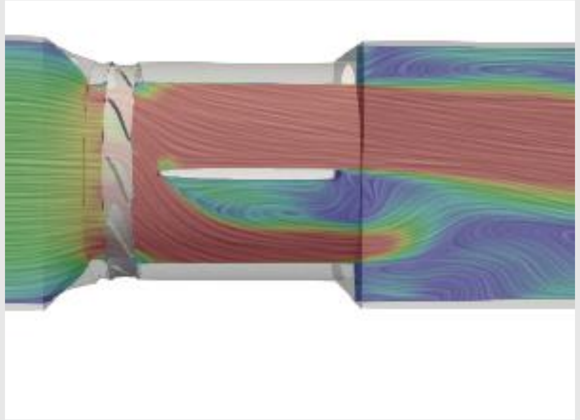
This is a basic example using whole numbers, this does not show MicroCube™ output.

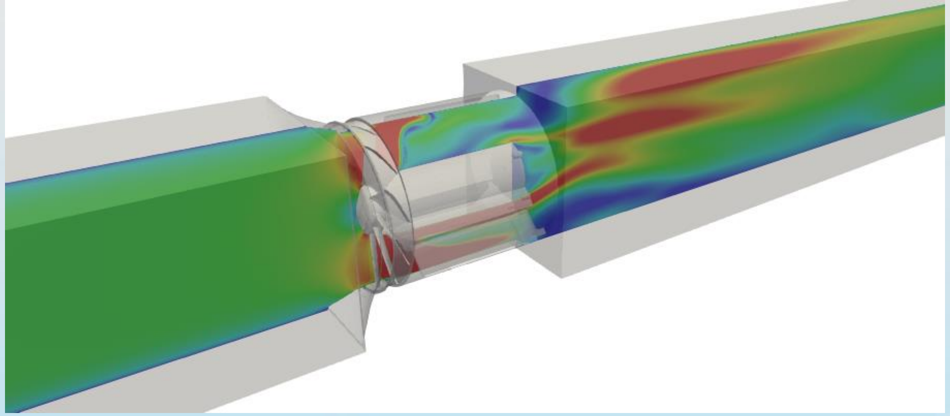
Proof Ducting Works – CFD Modeling

- By ducting the wind turbine and compressing the air, the air pressure decreases at the same moment the wind speed increases, resulting in a net increase in wind velocity.
- With the drop in air pressure some air recirculation on the back side of the wind turbine occurred.
- This has been corrected since this CFD was completed. A second CFD analysis has been completed with an overall power increase of 17%.

Wind Speed Key

- Very Low
- Low
- High
- Very High





Computational Fluid Dynamics By: SIMSCALE