Vortex Hydro Energy, LLC

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Overview

Landscape | Technology | Finances

- **The Problem:** Low-cost energy sustainability
- **Part of the Solution:** Marine energy
  - VIVACE: Taps into an untapped energy source: $V_{current} < 3$ knots*
- **First Market:** River/coastal energy production
  - Beta Customer: Detroit Wayne County Port Authority
- **Competition:** Cost competitive at maturity $0.055/kWh
- **Business Model:** GE-Wind: devices and service
- **Next Funding:** $3-$5 Million

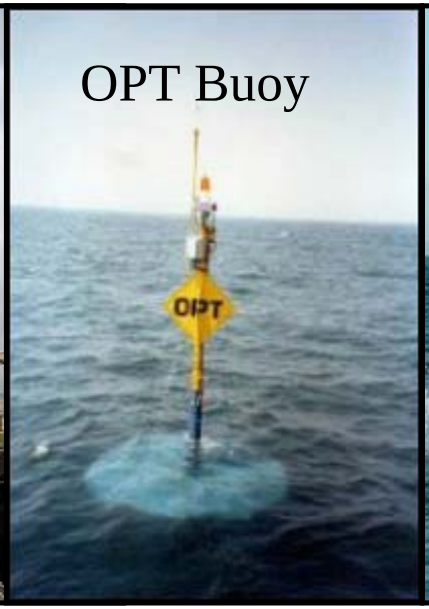
*1 knot = 1.15 mph = .514 m/s

Competition: Marine Energy Conversion

VORTEX HYDRO ENERGY

Landscape | Technology | Financial

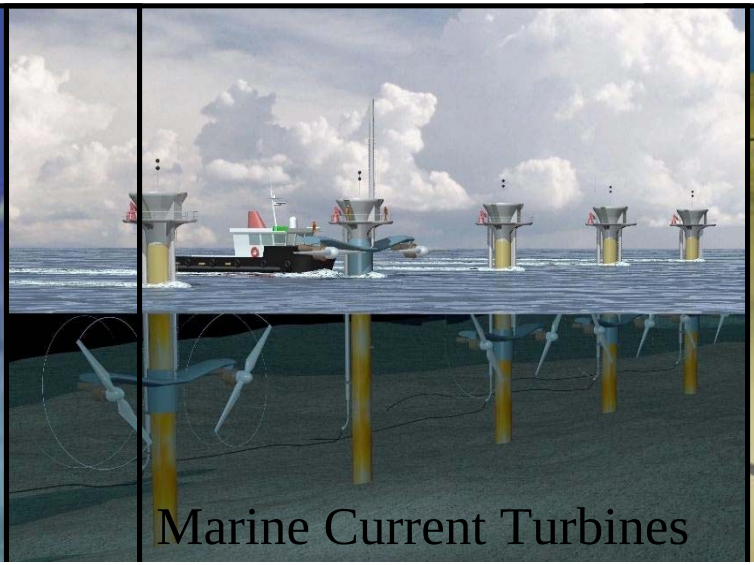

Energetech OWC

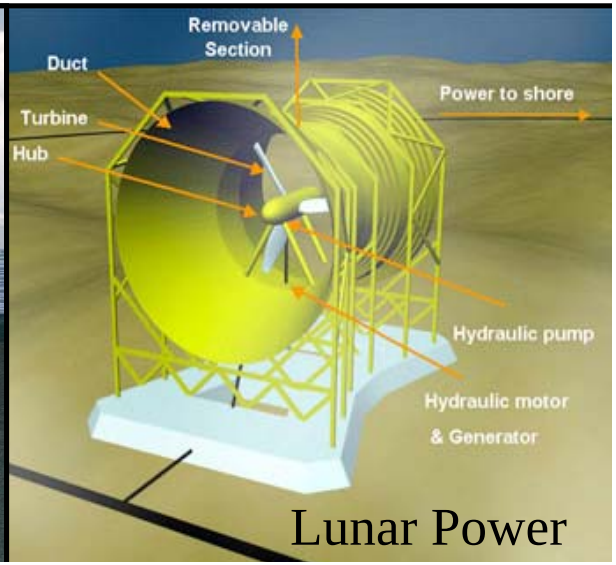


OPT Buoy


Pelamis


Verdant Turbines

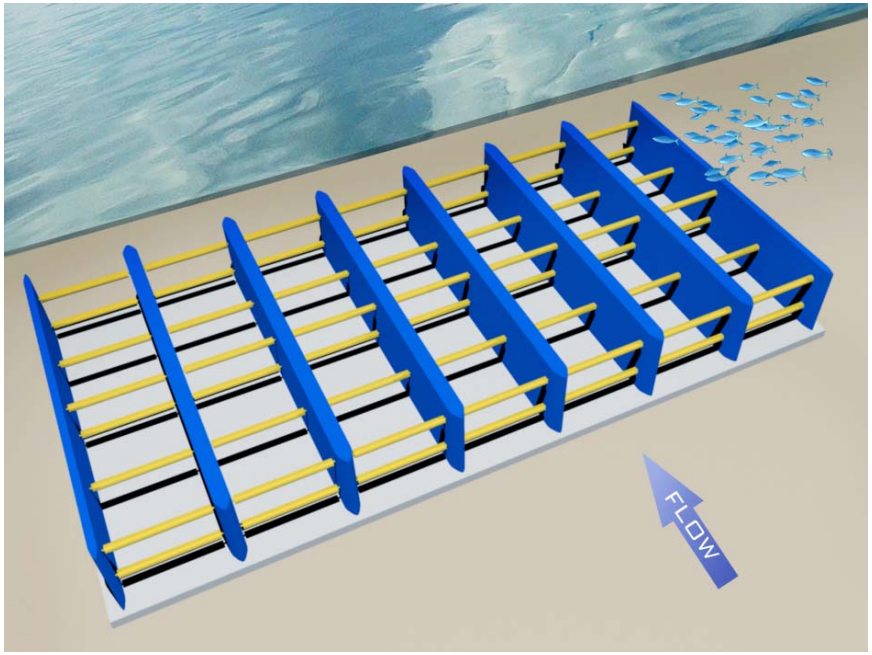

Marine Current Turbines

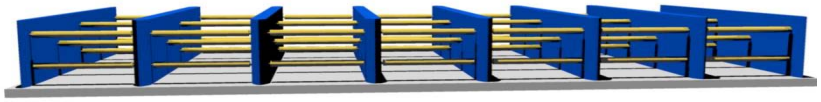


Lunar Power

VIVACE Advantage

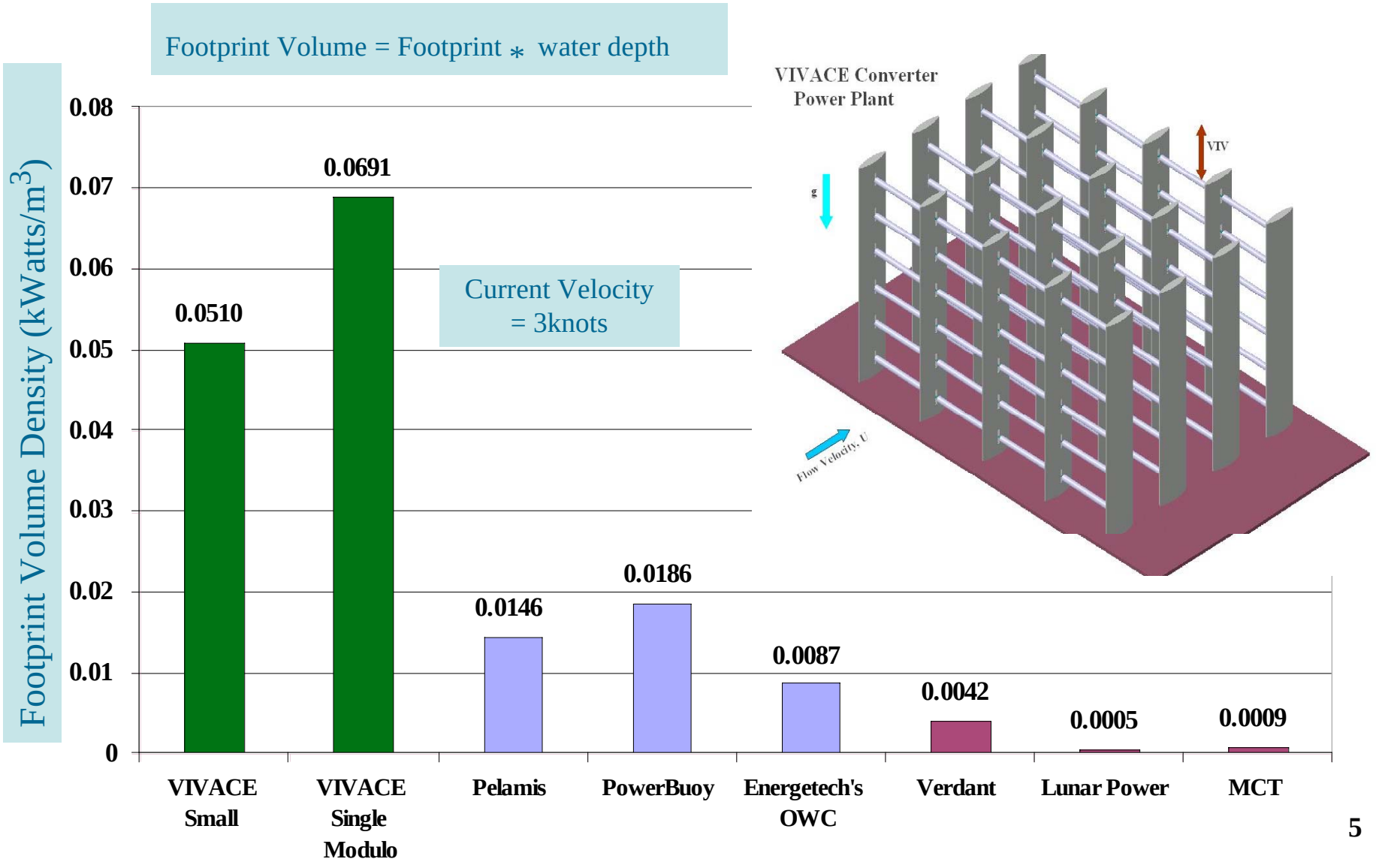
- Untapped energy source
  - –Most currents: $V_{current}$ < 3 knots
  - –Turbines require 6 knots average
- Dispatchable
- Scalable (1kW - 1GW)
- Cost competitive: $0.055/kWh
- Unobtrusive
- Manufacturable





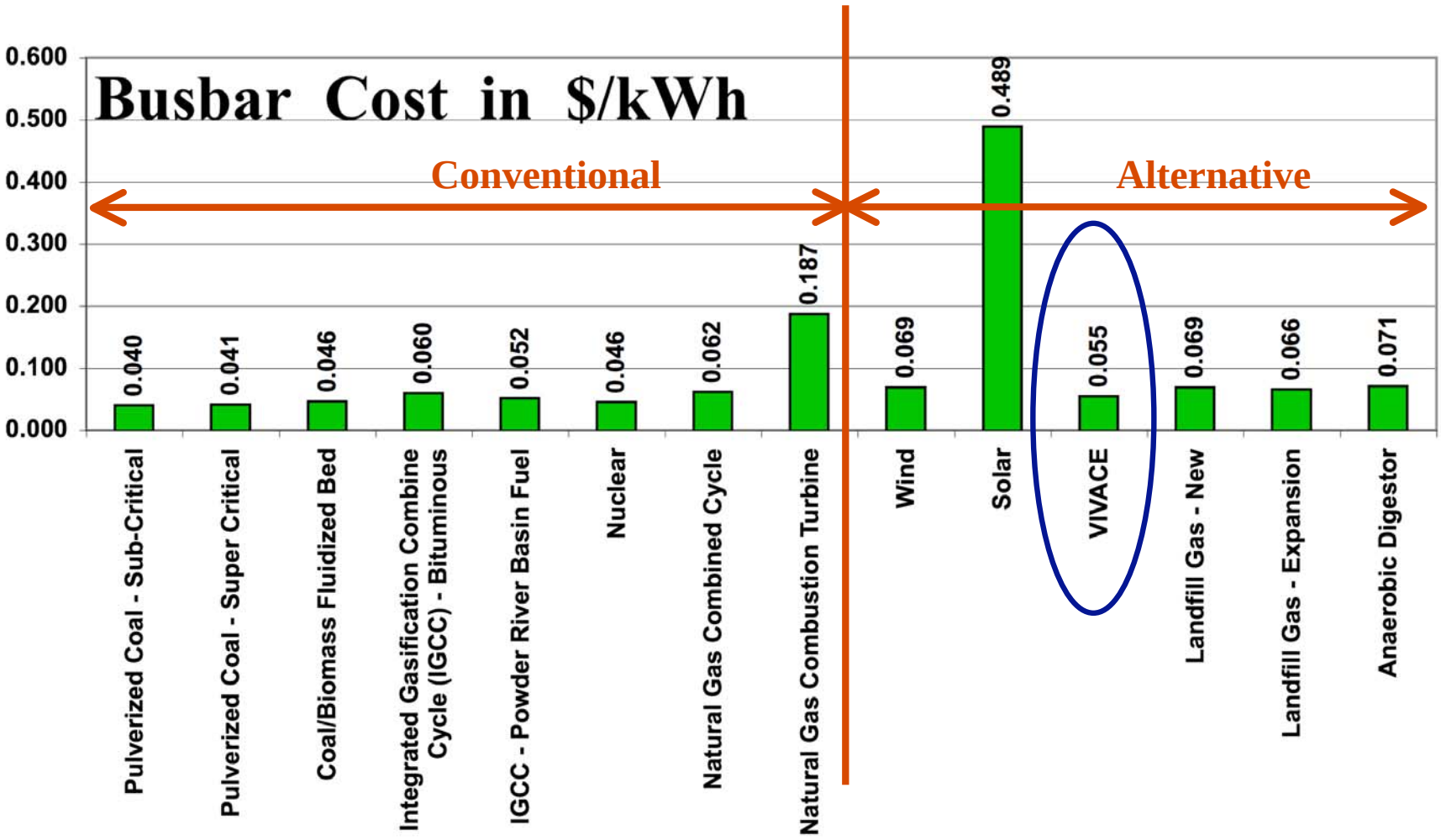
Marine Converters

Footprint Volume = Footprint * water depth



Energy Cost ($/KWh)

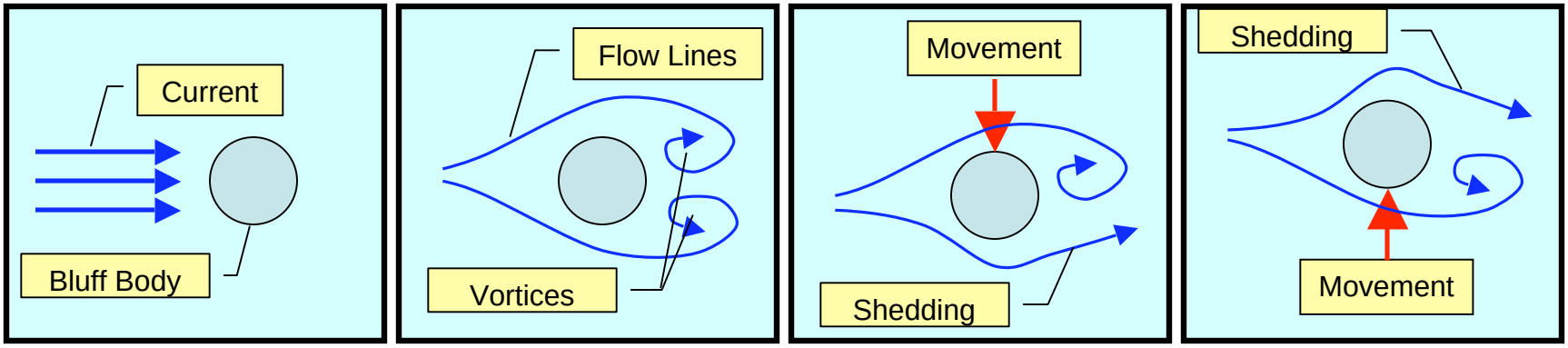
Landscape | Technology | Financial



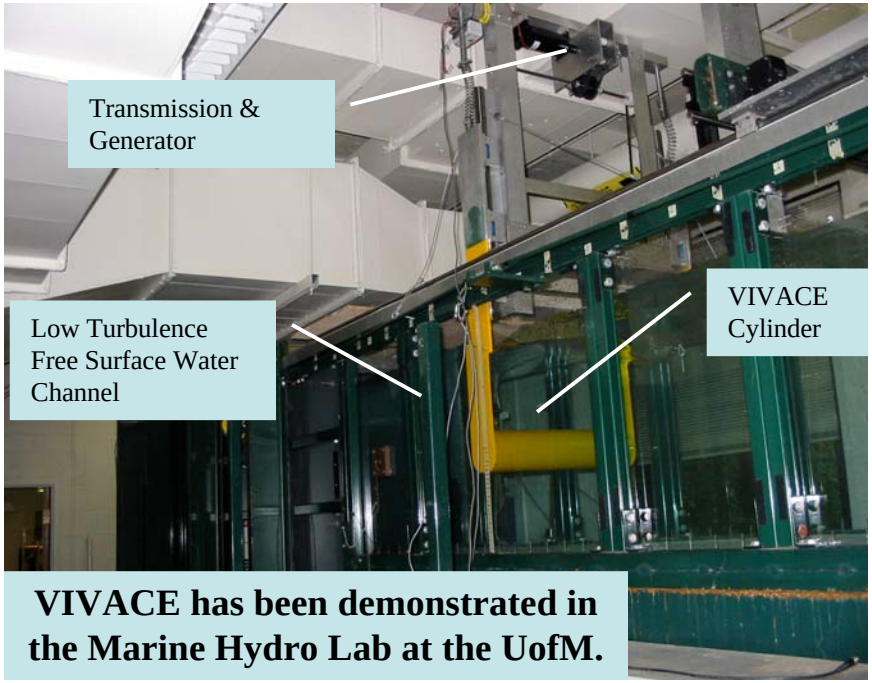
(1) **Oil** at $70/barrel is $0.041/kWh (thermal values only)

(2) **Natural Gas** at $10/10^6 BTU is $0.034/kWh

How it Works



- Vortex Induced Vibration (VIV)
- High energy density
- Operates like fish swim
- Scalable
- Works 24/7
- Unobtrusive to people and fish



VIVACE has been demonstrated in the Marine Hydro Lab at the UofM.

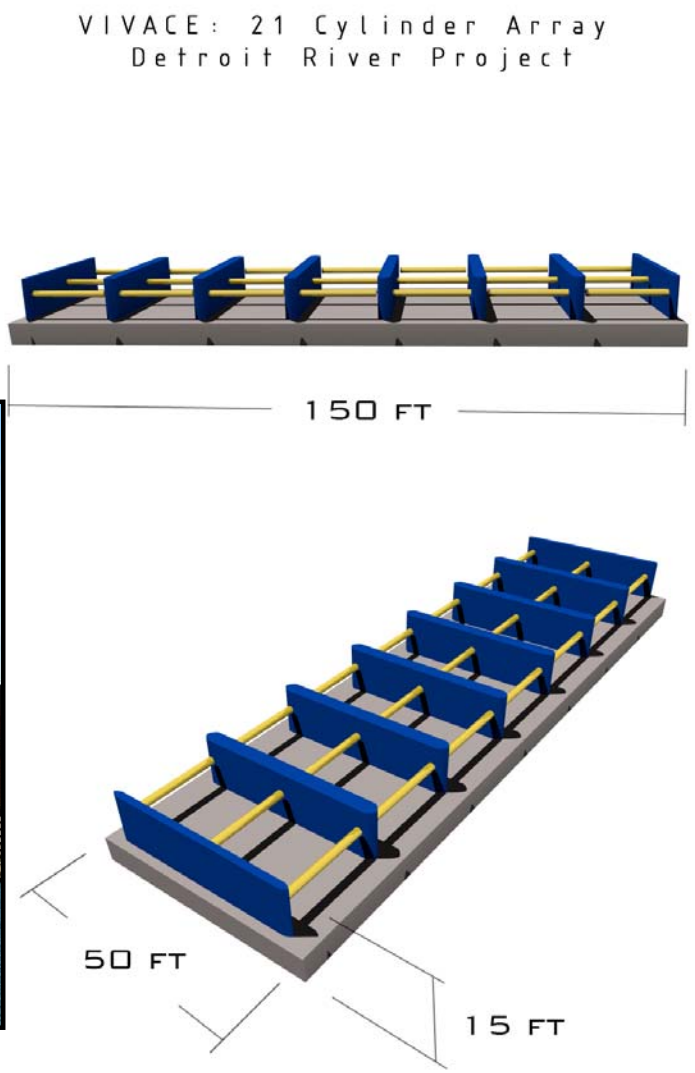
Proof of Concept

Flow Velocity
U=1.6knots
(0.8m/s)

Lab model

Beta Customer

- Detroit/Wayne County Port Authority
  - About $500,000 paid by the Detroit WCPA
  - Design/Install: 12 months (3kW)
- Gamma Customer
  - Ambassador Bridge (50kW)
- Ocean Prototype
  - Off-shore Florida (100kW)



Patent Protected

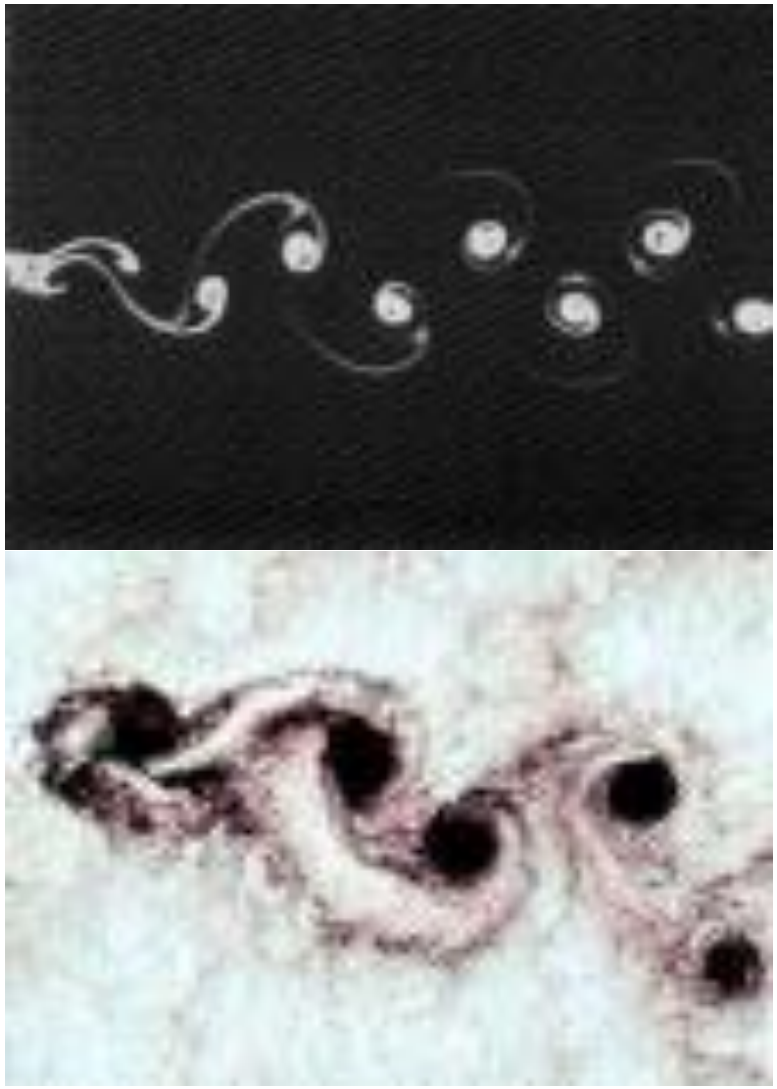
Patents pending:

1st on the VIVACE concept
U.S. on Nov 10, 2005
International on Nov 11, 2005

2nd on turbulence enhancement
U.S. on May 28, 2007

3rd on shape enhancement
Disclosure in Oct 2007

Extensive know-how



Funding

Awarded

- DOD: Office of Naval Research
- DOE: Invention & Innovation
- Detroit WC Port Authority with DTE foundation
- Private
- U of Michigan

Near Future

- DOD: Office of Naval Research
- Detroit WC Port Authority (DTE): Second Phase
- DOE: Marine Energy
- DOC: NIST-TIP
- NextEnergy

Total funding to date: $400,000

Next funding: $3-5 Million

Financial Projections

Year	1	2	3
Customer Type		Beta Customer	Gamma Customer
Customer		Detroit WC Port Auth	Ambassador Bridge
Goal		Prove technology in marine environment	Develop technology of single module
Units Sold	0	1	2
Installed kW	-	3 kW	100 kW
Revenues	$305,000	$750,000	$1,250,000
Net Income	($298,000)	($1,522,000)	($1,060,000)
EBIT Margin	-71%	-189%	-77%
Cost/kW ($kW)	-	$723,133	$22,124

Financial Projections

Year	4	5	6	7
Customer Type	Target Customers			
Customer	Electric Utility			
Goal	Establish functionality of modular installation	Increase scale		
Units Sold	1	4	12	31
Installed kW/yr	500	2,000	6,000	15,600
Revenues	$2,250,000	$7,000,000	$20,000,000	$51,800,000
Net Income	($1,201)	$460,000	$2,860,000	$8,698,000
EBIT Margin	-46%	14%	21%	29%
Cost/kW ($/kW)	$6,568	$3,020	$2,622	$2,360

Management Team

- CTO and Interim CEO
  - **Michael M. Bernitsas**, PhD MIT
  - Prof., University of Michigan
  - Director Marine Renewable Energy Lab
  - Blakely Smith Medal 2003
- President
  - **James C. MacBain,** PhD
  - UofM Government Relations
- Director of Business Development
  - **Gus Simiao**
  - MSE, MBA UofM
- Three part-time engineers

Searching for:

- CEO
- VP Engineering
- Board Members

Summary

vortexhydroenergy.com

Landscape | Technology | Financial

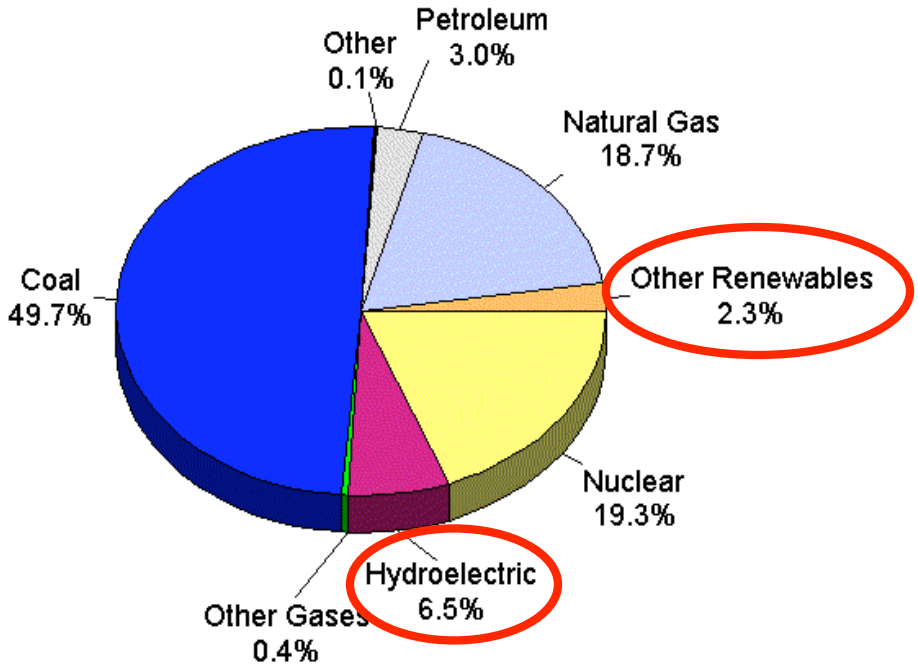
- **Breakthrough technology**
  - Untapped energy source - low speed currents
  - Few/simple moving parts
  - Cost competitive - $2,500/kW - $0.055/kWh
  - Dispatchable
  - Environmentally compatible
  - Scalable and modular
- **Large renewable energy market**
  - Civilian and military applications
  - Target: 500kW modules
  - Potential for assembly line production
- **High Gross Margin**
- **Exit strategy, sell the company in 5-7 years**

BACKUP SLIDES

Size and Growth

U.S. Power Generation

8.8% → Renewable



Energy Information Administration, Form EIA-860, "Annual Electric Generator Report."

Renewable Portfolio Standards

State	Amount	Year
Arizona	15%	2025
California	33%	2020
Colorado	10%	2015
Connecticut	10%	2010
DC	11%	2022
Hawaii	20%	2020
Illinois	25%	2017
New York	24%	2013
Pennsylvania	18%	2020
Texas	5,880 MW	2015

Demand for renewable power is rising

Market Opportunity

Electrical Generation

- Coastal Generation ($7.5 billion/year)

  Ocean current energy estimated as high as 40X existing world electrical generating capacity

- Low-head Hydropower ($3.8 billion/year)

  Undeveloped river energy: 5,400 TWh/yr (World Energy C.)

Pumping

- Desalination ($750 million/year)

  ~2 million gal/day are installed annually, requiring 250 MW

- Irrigation (market value not yet determined)

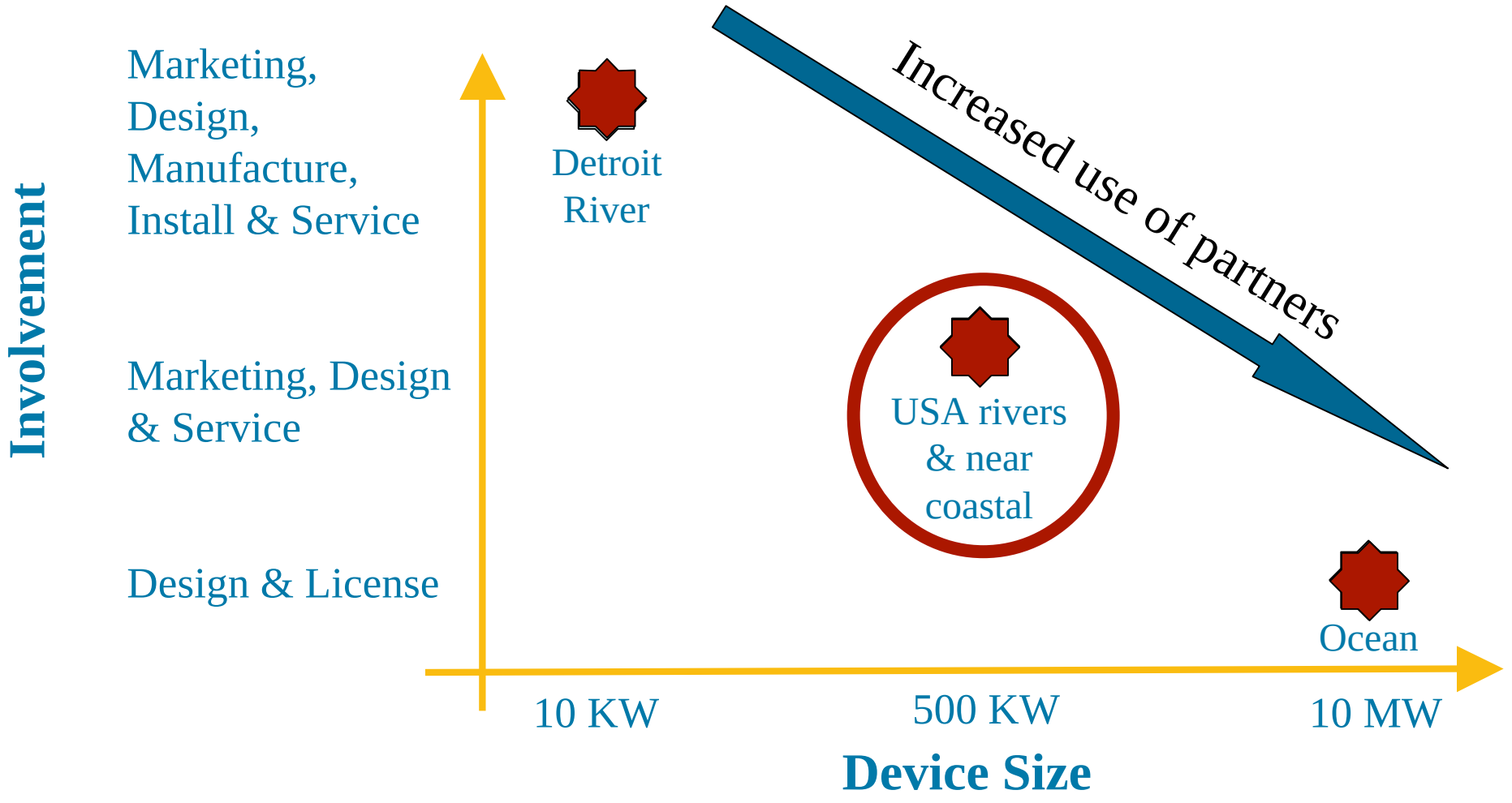
  Raising water out of rivers

Marine Renewable Energy

- **Water:** The largest medium for storing energy
- **0.1% of the ocean energy:**
  - Would cover the energy needs of 15 billion people
  - Clean, renewable, abundant, world-wide available
- **Marine energy:**
  - **Currents**, waves, tides, thermal, salinity
- **Marine currents:**
  - Most currents flow at $V_{current} < 3$ knots
  - Challenge: Turbines, water-mills need $V_{current} > 6$ knots

Technology development is VHE's current focus

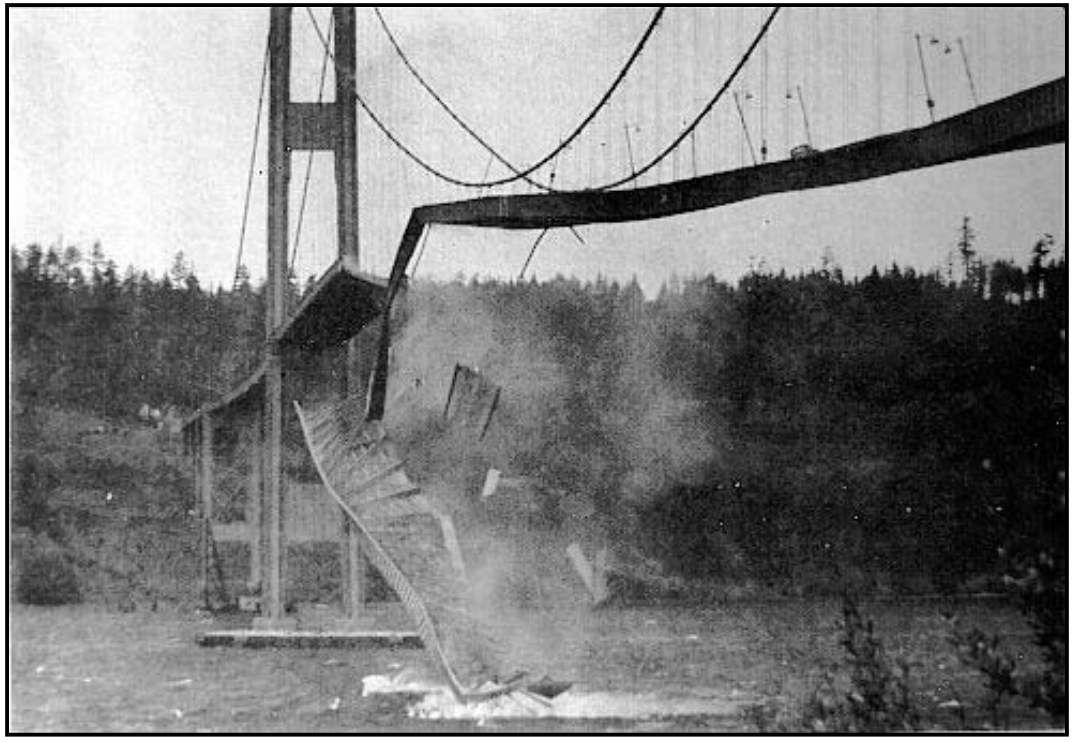
Value Chain



500kW module optimizes market, resources, risk

The Concept

1940: Tacoma Narrows bridge



1965: Ferrybridge, England

VIVACE can control VIV to ***generate energy***!

Three patents pending

Harness a powerful and destructive force in nature

Model & Value Chain

- Business Model: Technology and service provider (GE-Wind)
- Sale of VIVACE to electric utilities: 500 KW units @ $1.5M
- Sale of Services: $250K /device/year

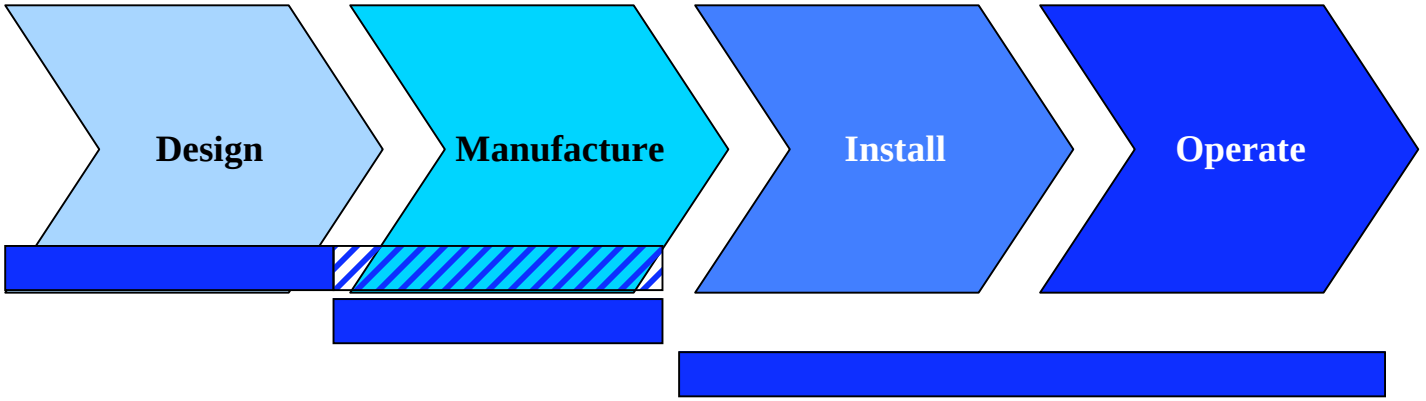
Revenue model similar to GE-Wind

VHE will partner with marine engineering companies

Marketing & Sales Strategy (1/2)

Small-scale Freshwater Installations

- Initial product, target launch is late 2009
- Product: Modular VIVACE units
- Customers: Project developers
- Business Model: Equipment sales (through JV) & support
- Marketing strategy: Push, utilizing existing network of wind/solar developers

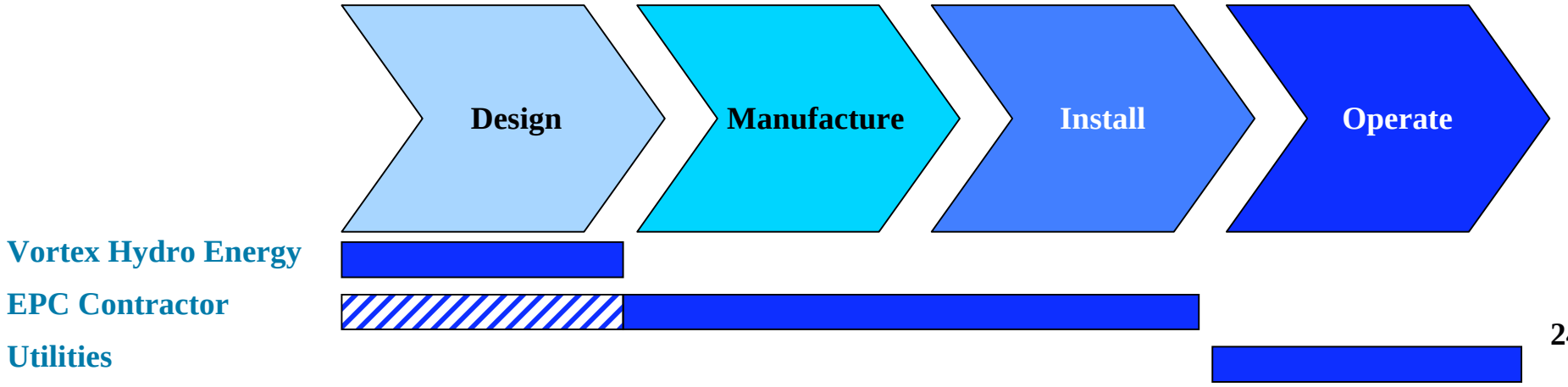


Vortex Hydro Energy
Mfg. Partner
Project Developer

Marketing & Sales Strategy (2/2)

Large-scale Ocean Installations

- Much bigger market opportunity
- Product: Ocean VIVACE power plants
- Customers: Utilities
- Business Model: Technology licensing & engineering support
- Marketing Strategy: Pull, targeted marketing focused on coastal utilities



Risk Mitigation

- **Environment**
  - Study impact of VIVACE on: bottom sediments and fish-food film
  - U of M - School Natural Resources and Environment: Dr. David Allan
- **Market**
  - Cost of energy may go down
  - Environmental responsibility (California)
- **Technology**
  - Technology may not scale as expected
  - Development plan designed to mitigate such risk

Technology development is VHE's current focus

Regulatory

- **Placing device in river – 1.5 to 3 years**
  - Army Core of Engineers
  - Section 404 Clean Water Act & Section 10 of Rivers / Harbors Act
  - River Banks – Owned by local, municipal and county
  - Expedite: Scientific instrument – 6 months
- **Grid Connection – 2+ Years**
  - Federal Energy Regulatory Commission (FERC)
  - Expedite: "Verdant Exception" - 6 Months
    - Cannot sell electricity
- **Environmental**
  - Department of Environmental Quality (Michigan) – 401 Certification
  - Green Credit Certification – Low Impact Hydroelectric Institute

Although cumbersome regulation is not a barrier

FAQ's

Q1. What are the biggest obstacles?

People's perception.

People cannot relate cylinders to lift because we live in air and typically see wings, airplanes, birds; not fish swimming.

Nothing new in hydropower for thousand of years: dams, paddle wheels, sails, propellers.

So, even though VIVACE imitates nature (fish) it appears exotic to people.

How is VHE Financed?

Landscape | Technology | Financial

Year	1	2	3	4
Alpha	375			
Beta	305	500		
Gamma		500	1,000	
Target Customer		1,000	1,000	2,000

- Ambassador Bridge
- Future Grants
- Port Authority
- Awarded Grants
- Funding Rounds

Acknowledgements

Landscape Technology Financial

Hamilton Clark & Co **John McKenna,** 20th Forum Mentor

Office of Technology Transfer: Andrew McColm
Daniel Broderick

Ross School of Business: Gustavo Simiao
Paul Kirsch

Detroit Wayne County Port Authority: John Kerr

Vortex Hydro Energy: Dr. James C. MacBain

Next Energy **DOE** **DOD**

Shepherd Advisors: Loch McCabe

MMPEI

GESI

Great idea … great team … great support