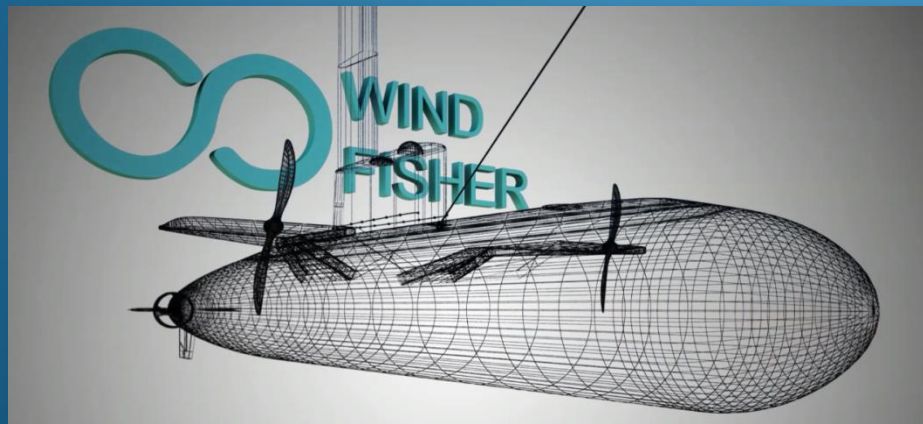


Wind to Ammonia on the High Seas at \$200 per ton

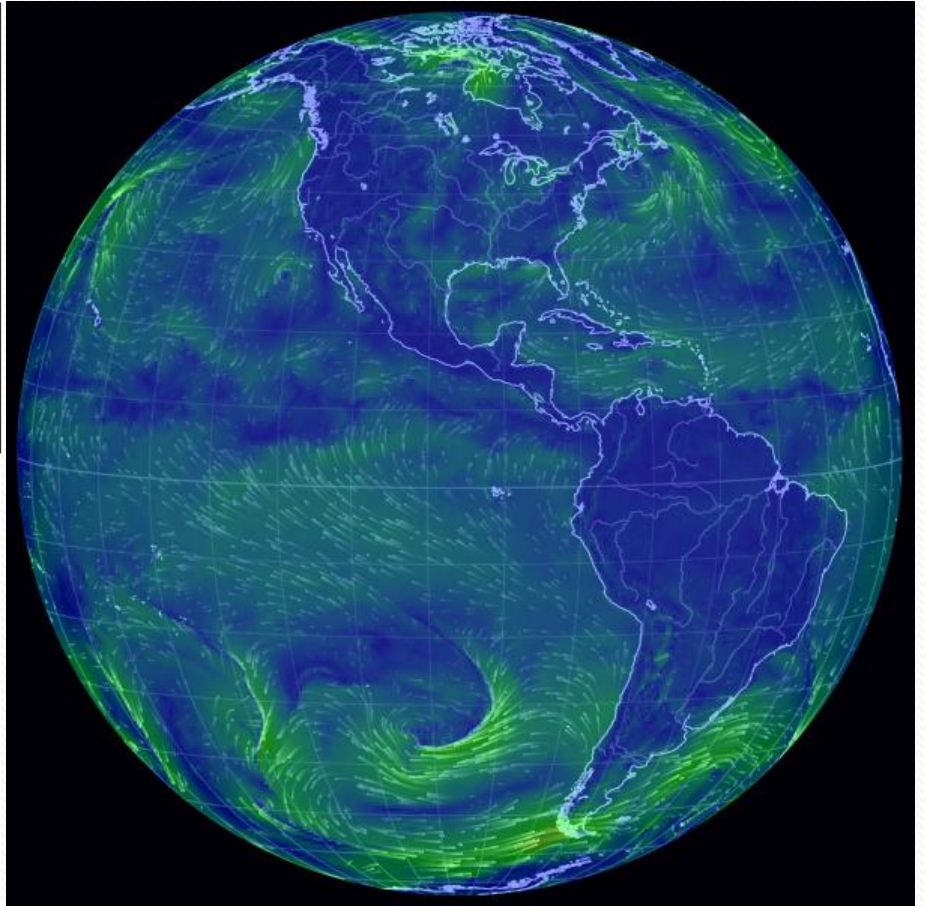
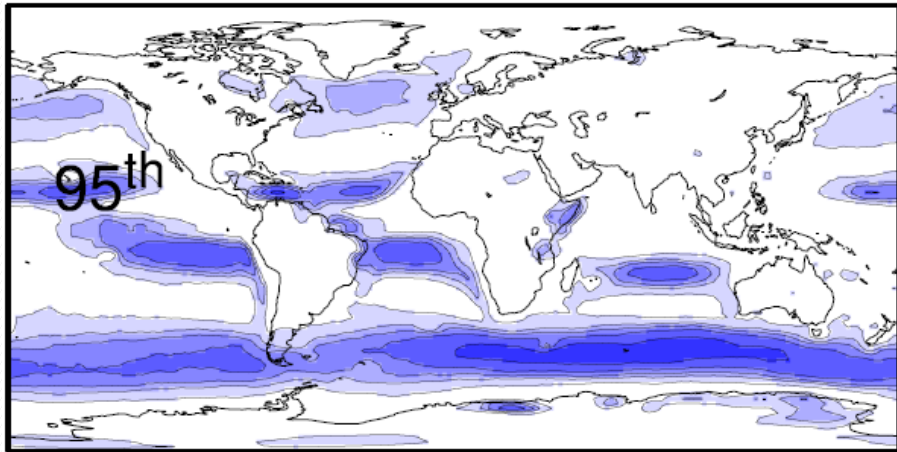
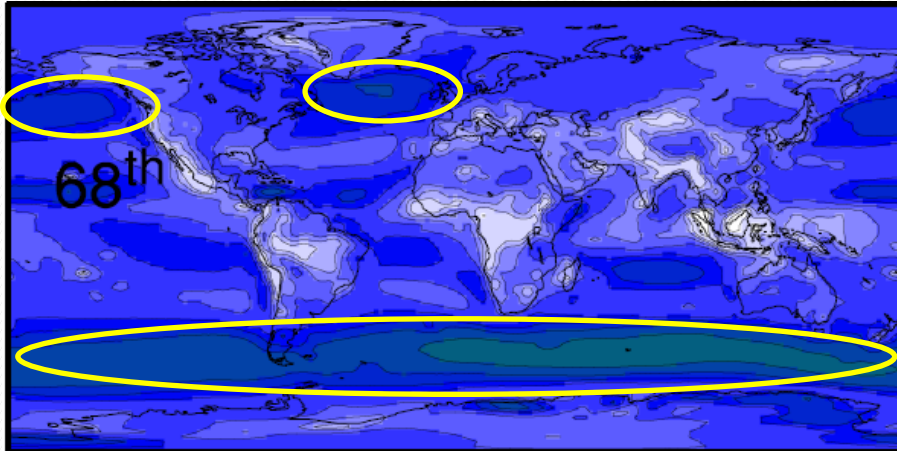
Renewable Ammonia for the Food & Agriculture, Chemical and Energy Industries



Garrett Smith
Founder & CEO



Wind + Water = Energy (NH3)



500m annual – High Altitude Wind Atlas – Archer & Caldeira

earth.nullschool.net



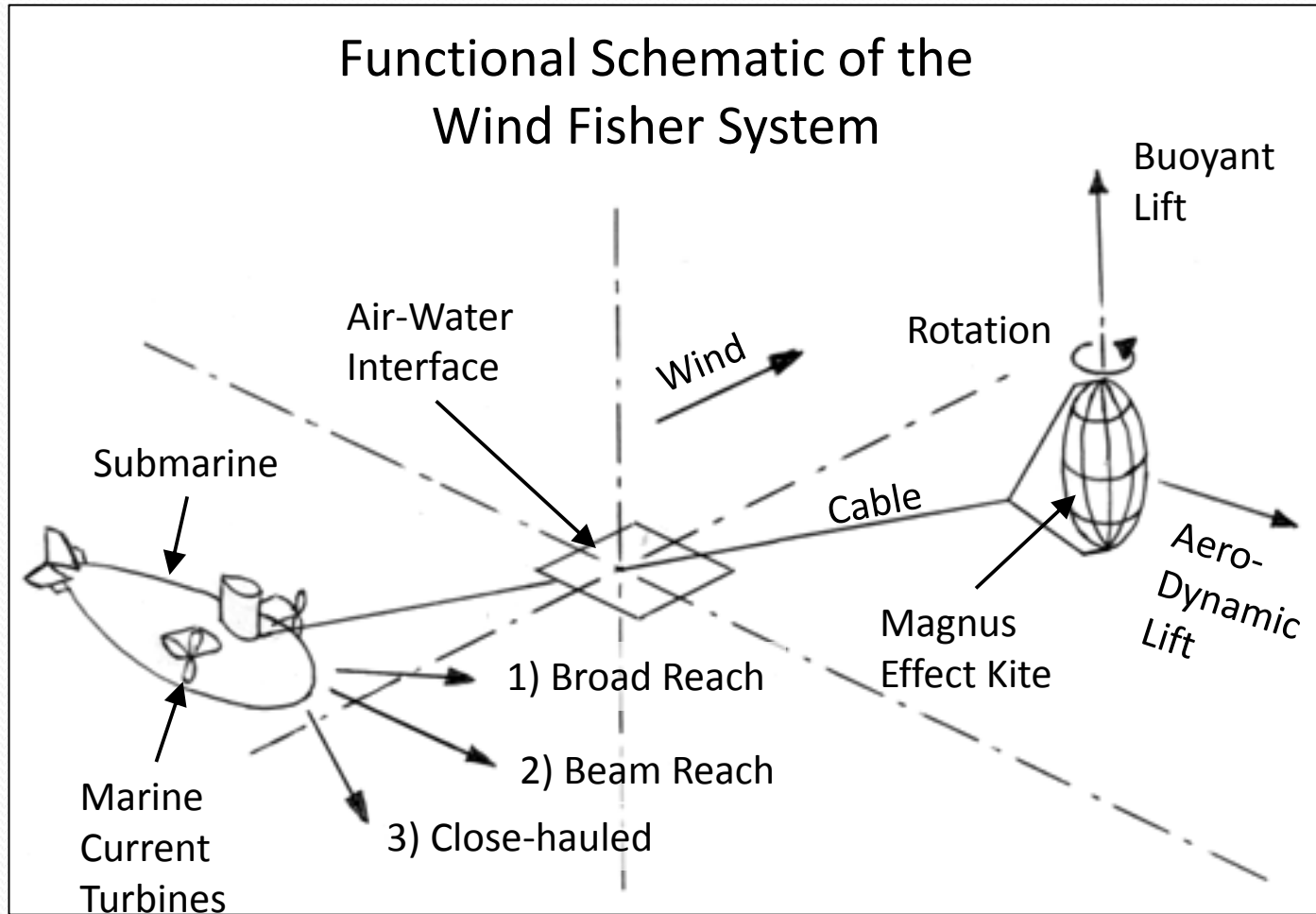
kW/m²

Garrett SMITH, garrett.smith@wind-fisher.com, +33 6 14 90 47

20/09/2015

20

The Wind Fisher Innovation



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Benefits of Magnus Effect

- Excellent gust response : reduced magnitude changes
- Lighter-than-air : limited launch & landing
- Natural stability : kite bridle corrects disturbances

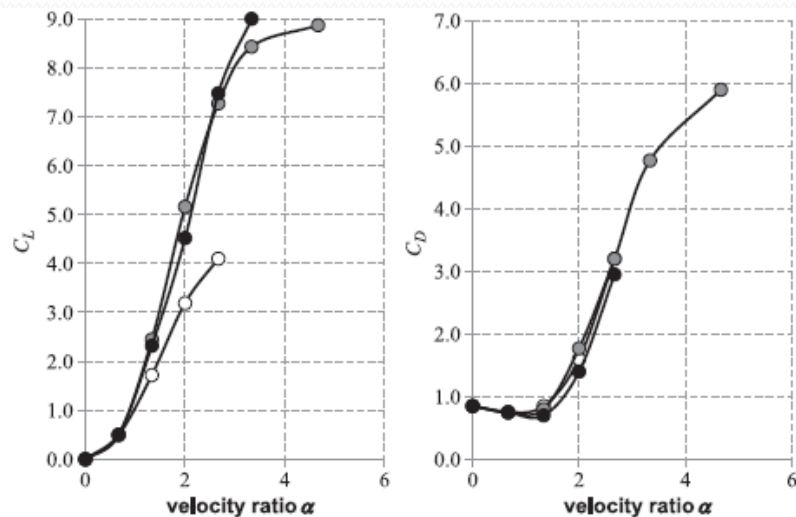
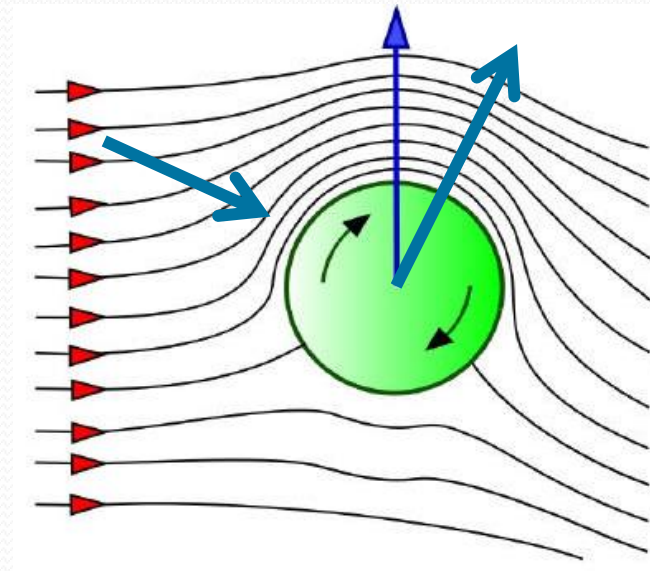


Fig. 27. Lift and drag coefficients of a Flettner-rotor, data according to Ackeret [65].

J. Seifert/ProgressinAerospaceSciences55(2012)17–45

Garrett SMITH, garrett.smith@wind-fisher.com, +33 6 14 90 47



Airborne Wind Energy

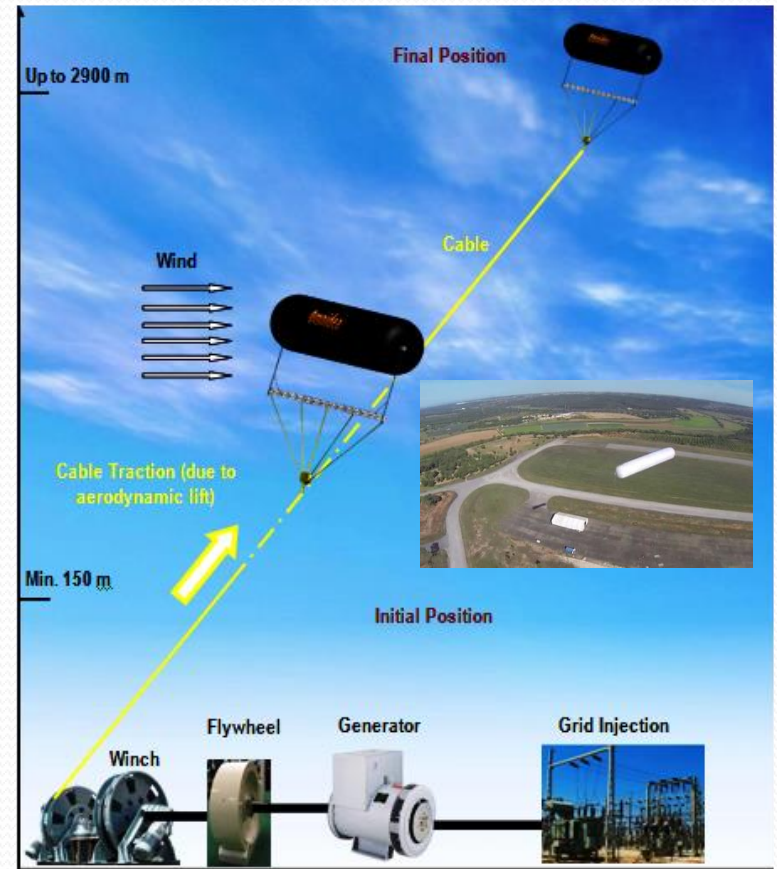
ENERKITE



MAKANI



OMNIDEA



Capacity Factor vs. Fixed Costs

Ammonia Factory CapEx													
	\$ 200 k/ton/day			\$ 400 k/ton/day			\$ 600 k/ton/day			\$ 800 k/ton/day			
Fixed Costs	3%	6%	9%	3%	6%	9%	3%	6%	9%	3%	6%	9%	
Capacity Factor													
20%	\$ 82	\$ 164	\$ 247	\$ 164	\$ 329	\$ 493	\$ 247	\$ 493	\$ 740	\$ 329	\$ 658	\$ 986	
35%	\$ 47	\$ 94	\$ 141	\$ 94	\$ 188	\$ 282	\$ 141	\$ 282	\$ 423	\$ 188	\$ 376	\$ 564	
50%	\$ 33	\$ 66	\$ 99	\$ 66	\$ 132	\$ 197	\$ 99	\$ 197	\$ 296	\$ 132	\$ 263	\$ 395	
70%	\$ 23	\$ 47	\$ 70	\$ 47	\$ 94	\$ 141	\$ 70	\$ 141	\$ 211	\$ 94	\$ 188	\$ 282	
90%	\$ 18	\$ 37	\$ 55	\$ 37	\$ 73	\$ 110	\$ 55	\$ 110	\$ 164	\$ 73	\$ 146	\$ 219	
Renewable Power CapEx contribution to NH3 price (7500kWh/ton SSAS)													
	\$ 0,2 /Watt			\$ 0,5 /Watt			\$ 1,5 /Watt			\$ 3,0 /Watt			
Fixed Costs	3%	6%	9%	3%	6%	9%	3%	6%	9%	3%	6%	9%	
Capacity Factor													
20%	\$ 26	\$ 51	\$ 77	\$ 64	\$ 128	\$ 193	\$ 193	\$ 385	\$ 578	\$ 385	\$ 771	\$1 156	
35%	\$ 15	\$ 29	\$ 44	\$ 37	\$ 73	\$ 110	\$ 110	\$ 220	\$ 330	\$ 220	\$ 440	\$ 660	
50%	\$ 10	\$ 21	\$ 31	\$ 26	\$ 51	\$ 77	\$ 77	\$ 154	\$ 231	\$ 154	\$ 308	\$ 462	
70%	\$ 7	\$ 15	\$ 22	\$ 18	\$ 37	\$ 55	\$ 55	\$ 110	\$ 165	\$ 110	\$ 220	\$ 330	
90%	\$ 6	\$ 11	\$ 17	\$ 14	\$ 29	\$ 43	\$ 43	\$ 86	\$ 128	\$ 86	\$ 171	\$ 257	

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Capacity Factor vs. Fixed Costs

		Ammonia Factory CapEx												
		\$ 200 k/ton/day			\$ 400 k/ton/day			TW \$314			\$ 800 k/ton/day			OW \$659
Fixed Costs		3%	6%	9%	3%	6%	9%	6%	9%	3%	6%	9%	3%	
Capacity Factor														
20%		\$ 82	\$ 164	\$ 247	\$ 164	\$ 329	\$ 493	\$ 247	\$ 493	\$ 740	\$ 329	\$ 658	\$ 986	
35%		\$ 47	\$ 94	\$ 141	\$ 94	\$ 188	\$ 282	\$ 141	\$ 282	\$ 423	\$ 188	\$ 376	\$ 564	
50%		\$ 33	\$ 66	\$ 99	\$ 66	\$ 132	\$ 197	\$ 99	\$ 197	\$ 296	\$ 132	\$ 263	\$ 395	
70%		\$ 23	\$ 47	\$ 70	\$ 47	\$ 94	\$ 141	\$ 70	\$ 141	\$ 211	\$ 94	\$ 188	\$ 282	
90%		\$ 18	\$ 37	\$ 55	\$ 37	\$ 73	\$ 110	\$ 55	\$ 110	\$ 164	\$ 73	\$ 146	\$ 219	
		Renewable Power CapEx contribution to NH3 price (7500kWh/ton SSAS)												
		\$ 0,2 /Watt			\$ 0,5 /Watt			\$ 1,5 /Watt			\$ 3,0 /Watt			
Fixed Costs		3%	6%	9%	3%	6%	9%	3%	6%	9%	3%	6%	9%	
Capacity Factor														
20%		\$ 26	\$ 51	\$ 77	\$ 64	\$ 128	\$ 193	\$ 193	\$ 385	\$ 578	\$ 385	\$ 771	\$ 1156	
35%		\$ 15	\$ 29	\$ 44	\$ 37	\$ 73	\$ 110	\$ 110	\$ 220	\$ 330	\$ 220	\$ 440	\$ 660	
50%		\$ 10	\$ 21	\$ 31	\$ 26	\$ 51	\$ 77	\$ 77	\$ 154	\$ 231	\$ 154	\$ 308	\$ 462	
70%		\$ 7	\$ 15	\$ 22	\$ 18	\$ 37	\$ 55	\$ 55	\$ 110	\$ 165	\$ 110	\$ 220	\$ 330	
90%		\$ 6	\$ 11	\$ 17	\$ 14	\$ 29	\$ 43	\$ 43	\$ 86	\$ 128	\$ 86	\$ 171	\$ 257	

PV
\$380

TW
\$314

OW
\$659

AW
\$314

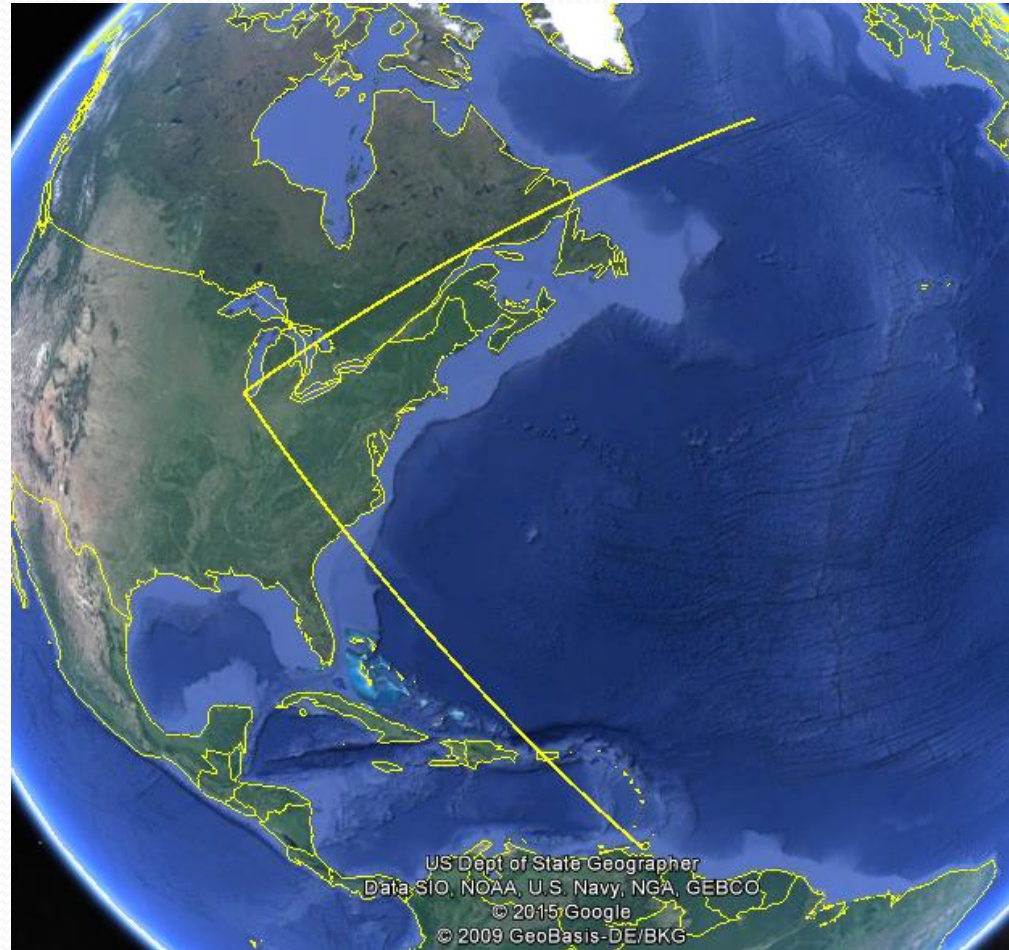
5MW Cost Assumptions

Cost	Sub-System	Cost Metric
\$2200k	Submarine (2700t)	\$800/GT
\$1500k	Generators (7.5MW)	\$0.20/W
\$4000k	SSAS (16t/d)	\$250k/t/d
\$ 900k	NH3 Storage (900t)	\$1000/t
\$2500k	Magnus Kite (100m)	Expert estimate
\$ 400k	ASU & Other systems	
\$11.5M	Total CapEx	
\$197	Cost per ton (5250t/y)	90% CF, 9% cost



NH3 Logistics

- Trinidad vs. North Atlantic, ~4200km each to Chicago
- St. Lawrence Seaway vs. Mississippi
- Direct delivery to France, Ireland, Spain
- Southern Ocean ports in South America, South Africa & Australia/NZ



Island Energy Independence

- Hawaii
 - 42.4M Barrels of oil imports per year
 - 14Mt NH3 fuel equivalent
 - 2700 5MW submarines
- Japan
 - 1300M Barrels of oil imports per year
 - 430Mt NH3 fuel equivalent
 - 82000 5MW submarines
- Alliance of Small Islands
 - 220M Barrels of oil imports per year
 - 72Mt NH3 fuel equivalent
 - 14000 5MW submarines
- World
 - 27B Barrels of oil production per year
 - 8.9Bt NH3 fuel equivalent
 - 1.8M 5MW submarines

Development Status

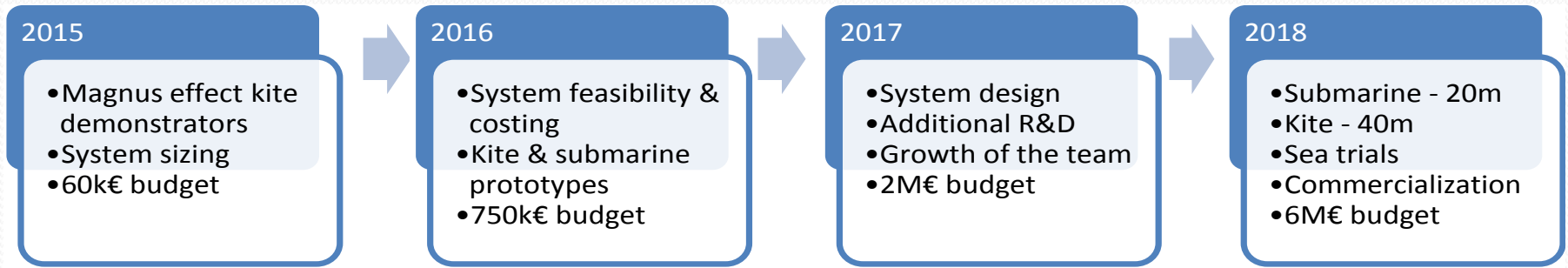
- Incubated by Impulse Partners in Paris
- Patent application for kite in process
- 1.5m span demonstrator kite ready by end October manufactured by Airstar
- Technical feasibility study ready by early 2016 prepared by GIPSA-Lab



Development Needs

- Financing:
 - Investors, Subsidies
- Promotion:
 - NH3 video clips, press articles, crowd funding
- Clients:
 - Farm Coops, Fertilizer & Chem. Corp., Sponsors
- Partners:
 - Engine/Turbine Conversions, Storage, Maritime

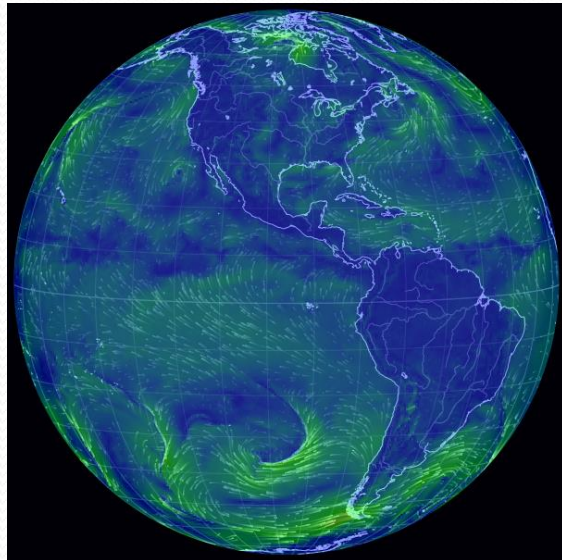
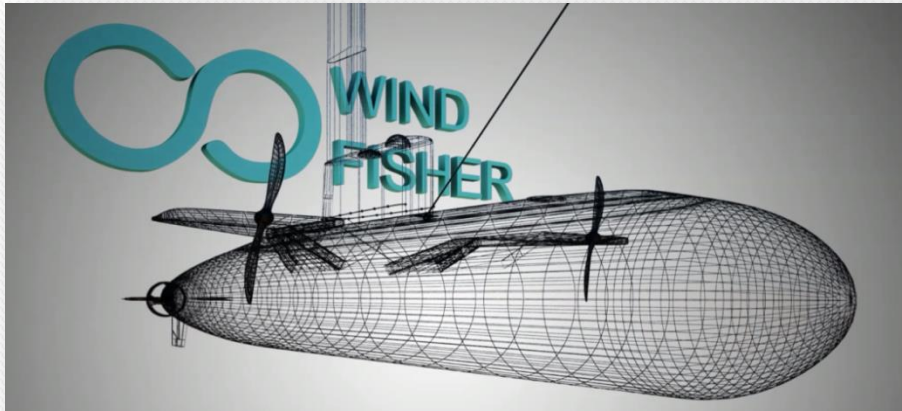
Future Development



Questions to you

- Why hasn't SSAS been funded by VCs yet?
- Why hasn't NH₃ been adopted as a fuel on a larger scale?
- What is the feasibility to convert existing power plants, gas turbines & diesel motors to NH₃?
- Can NH₃ safely power consumer transportation?

Thank you



Functional Schematic of the Wind Fisher System

