THE GEORGE WASHINGTON UNIVERSITY
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A Systems engineering approach to site selection and an optimization model for sustainable harvesting of electricity from shallow water tidal currents

Authors: John Domenech*, T. Eveleigh, PhD**, B. Tanju, PhD**

*In partial fulfillment of PhD program: Systems Engineering
**Faculty: School of Engineering & Applied Science, George Washington University

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Situation: anticipated electricity shortage of about ~13-15,000 MW in five Southeastern states (South Carolina, Georgia, Florida, Alabama, and Mississippi) in 2040.

Contributors: to the future problem

- Carbon emission reductions
- Retirement of aging power plants
- Population increase of ~15M to 56M
- Nuclear not likely

Question: Do shallow water tidal currents represent possible considerations for closing the expected shortfall?

- Complexity of site selection?
- Plant optimization?
- Sustainable harvest of electricity from tidal currents?

Systems Engineering approach: provides a tool for decision makers

- Considering other ways to help close the gap
- Social, economic and environmental costs
- Reduce carbon-based emissions

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-DATA MANIPULATION-

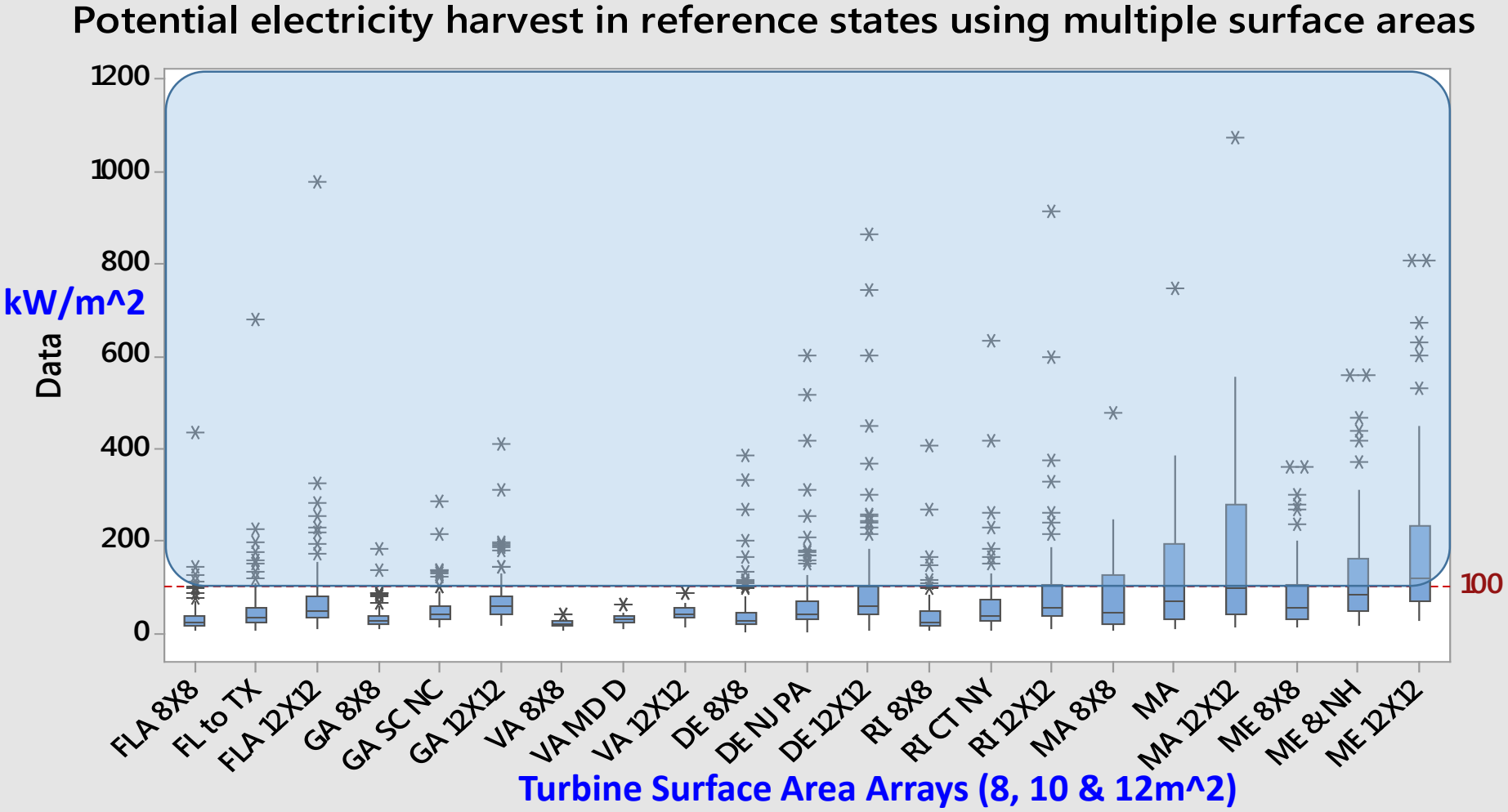
SOUTH CAROLINA COAST-cont.

Average Speed and Direction

				Min Before Flood		Flood		Min Before Ebb		Ebb
Station	Depth	Latitude	Longitude	Spd	Dir	Spd	Dir	Spd	Dir	Ebb
Deveaux Banks, off North Edisto River entrance	12	32° 32.7'	80° 09.4'	0.1	042	1.4	306	0.1	072	2.0
North Edisto River entrance	-	32° 33.7'	80° 11.2'	-	-	2.9	332	-	-	3.7
Wadmalaw Island, Wadmalaw River entrance	12	32° 39.9'	80° 14.1'	-	-	1.1	355	-	-	0.7
Goshen Point, SE of, Wadmalaw River	12	32° 42.6'	80° 10.3'	-	-	0.8	059	-	-	0.7
Goshen Point, south of, Wadmalaw River	12	32° 42.8'	80° 11.2'	-	-	0.6	048	-	-	1.0
White Point, south of, Dawho River	12	32° 37.5'	80° 16.9'	-	-	0.8	234	-	-	0.8
Whooping Island, Dawho River	12	32° 38.2'	80° 20.4'	-	-	0.8	246	-	-	0.6
South Edisto River entrance	-	32° 29.3'	80° 20.9'	-	-	1.8	350	-	-	2.2
Pine Island, South Edisto River	15	32° 30.4'	80° 21.7'	-	-	1.2	345	-	-	1.0
Fenwick Island Cut, South Edisto River	15	32° 32.1'	80° 24.8'	-	-	0.8	220	-	-	0.8
Sampson Island, S end, South Edisto River	15	32° 33.8'	80° 23.5'	-	-	1.4	037	-	-	1.5
Sampson Island, NE end, South Edisto River	15	32° 37.0'	80° 23.2'	-	-	1.4	334	-	-	1.5

Screen shot of typical available data on NOAA website

Boxplots of NOAA data showing # of locations above the minimum threshold of approximately 100kW/m^2 necessary for harvesting electricity.



The minimum potential harvest to cost effectively generate electricity is ~100kW/m^2
A 100kW/m^2 potential harvest powers 40 homes

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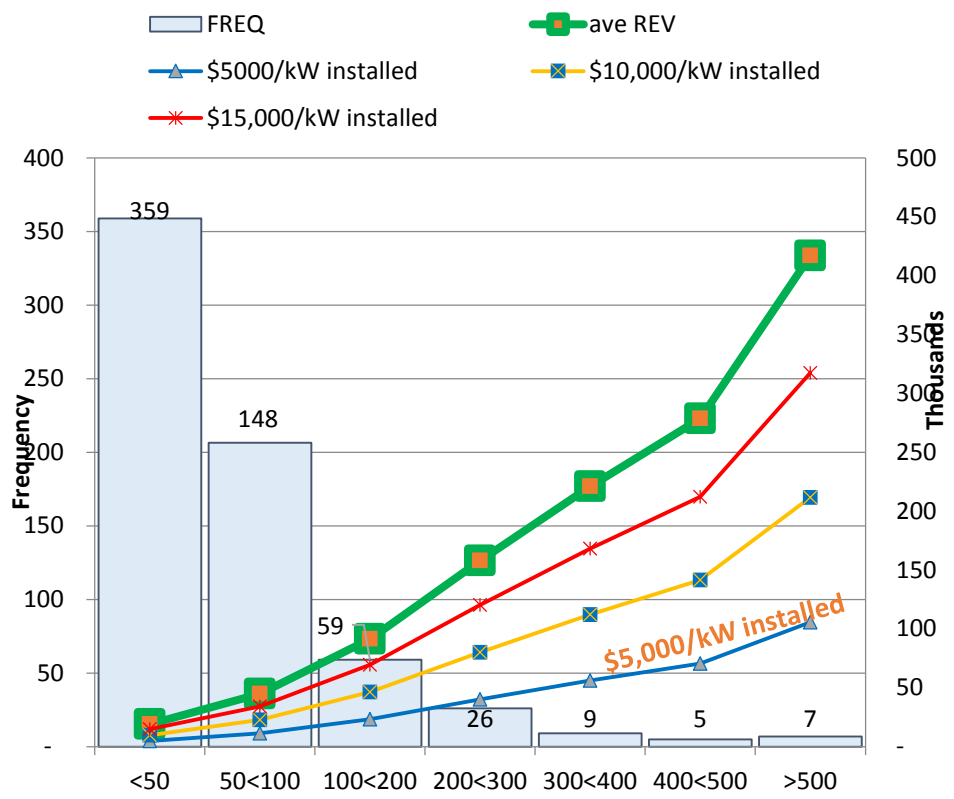
-Revenue and Installed Costs by Array-

For the 10m^2 array seven locations have a potential harvest of >500kW/m^2 (current speed of >2.1m/s each direction) and power about 1,775 homes.

For the 12m^2 array 17 locations have a potential harvest of >500kW/m^2 (current speed of >1.8m/s each direction) and power about 5,150 homes.

10m^2 array: average revenue and average costs/kW at 30 year depreciation at $.015/kWhr



12m^2 array: average revenue and average costs/kW at 30 year depreciation at $.015/kWhr