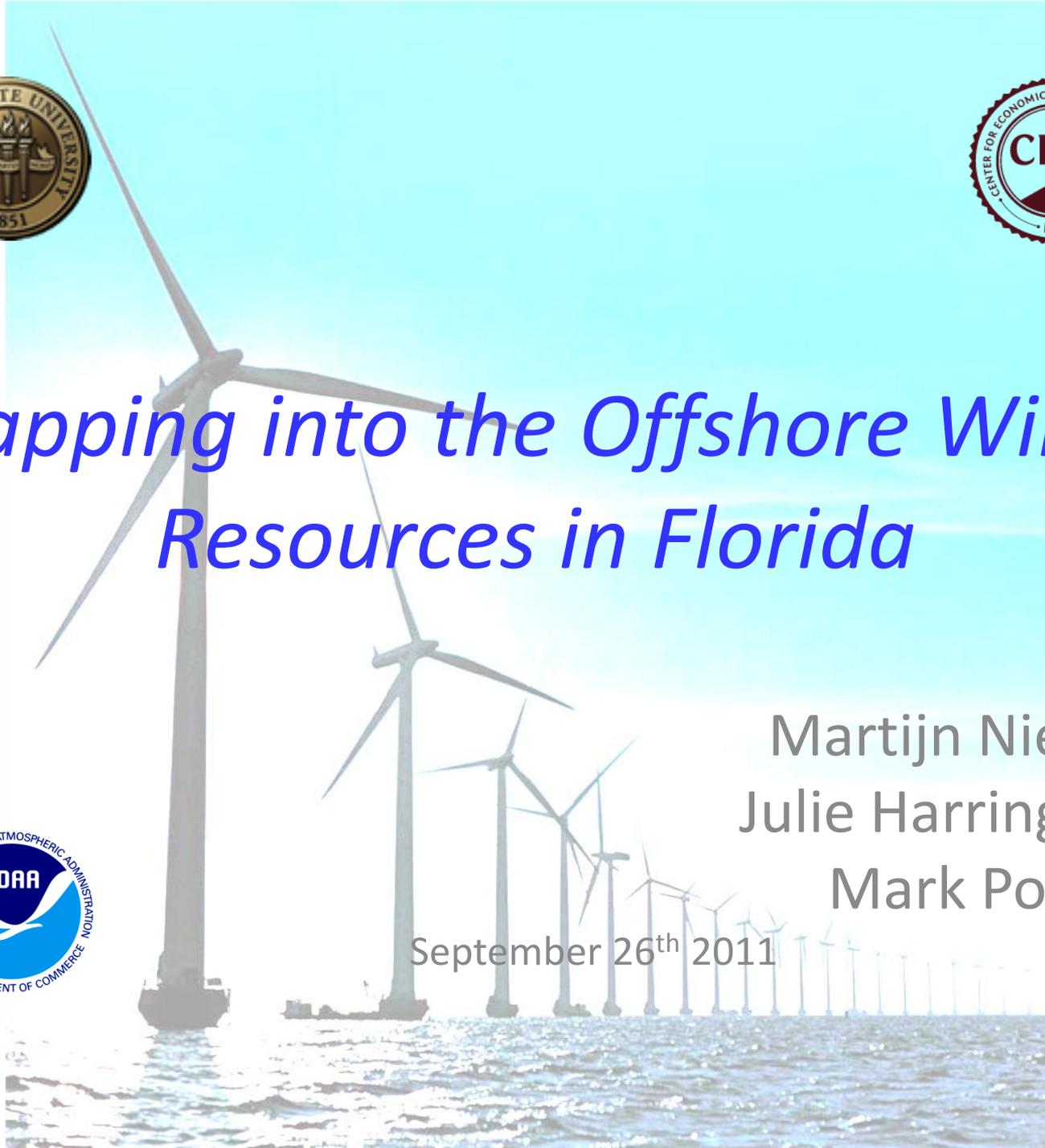




# *Tapping into the Offshore Wind Resources in Florida*

Martijn Niekus  
Julie Harrington  
Mark Powell

September 26<sup>th</sup> 2011

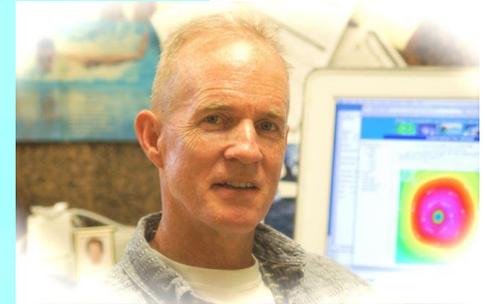




# Florida State University



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Ocean-Atmospheric  
Prediction Studies



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AOML



**NOAA** NATIONAL OCEANIC AND  
ATMOSPHERIC ADMINISTRATION  
UNITED STATES DEPARTMENT OF COMMERCE



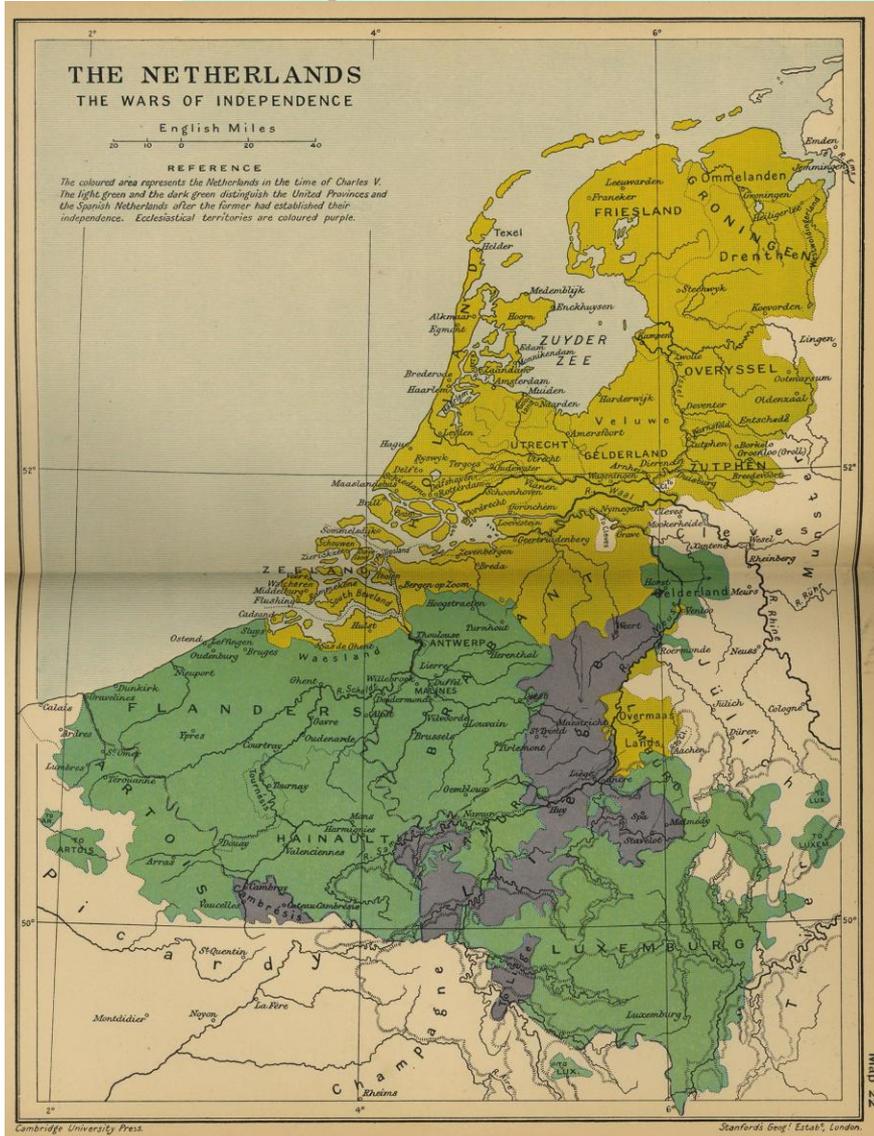
**Center for Economic Forecasting  
and Analysis (CEFA)**



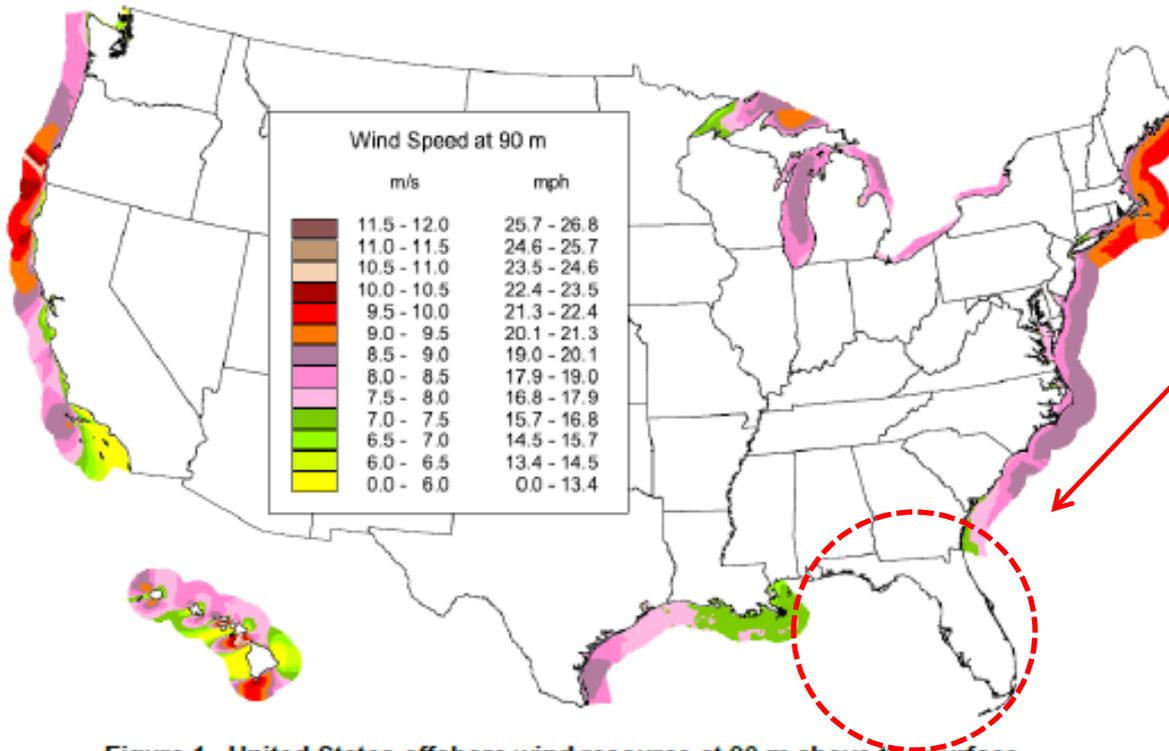
**Institute for Energy Systems,  
Economics and Sustainability**

# “Windmills keep the Netherlands Afloat”

## The Power of Wind



# US and Florida Offshore Wind Resources



The lack of shading off FL, AL, MS is being misinterpreted as no wind resource

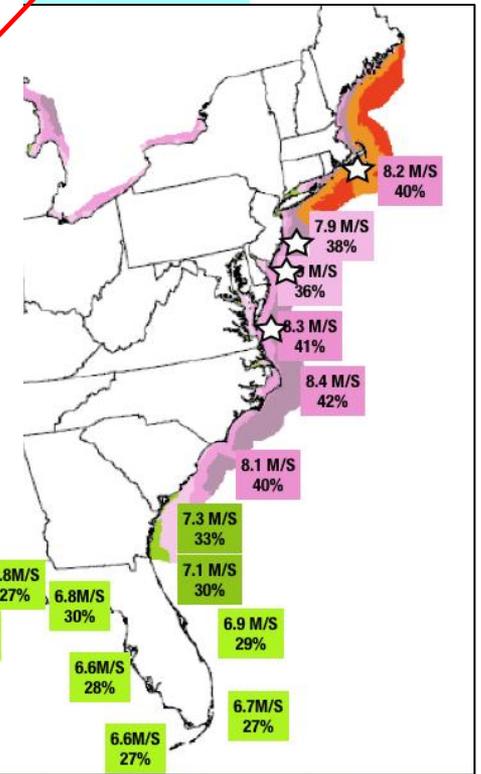


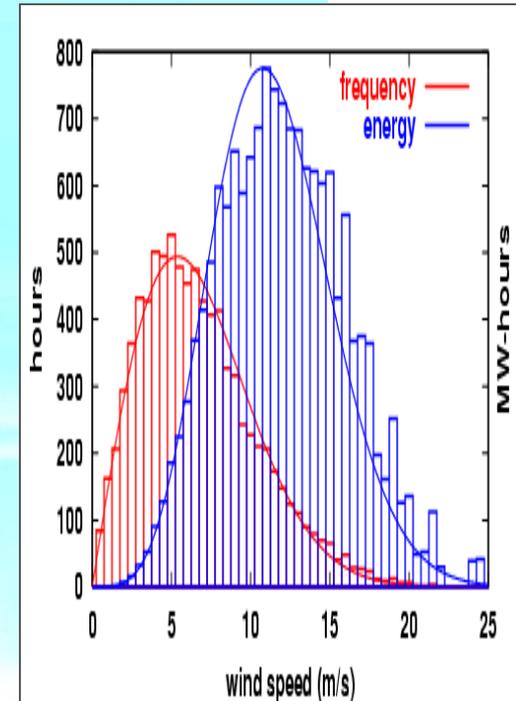
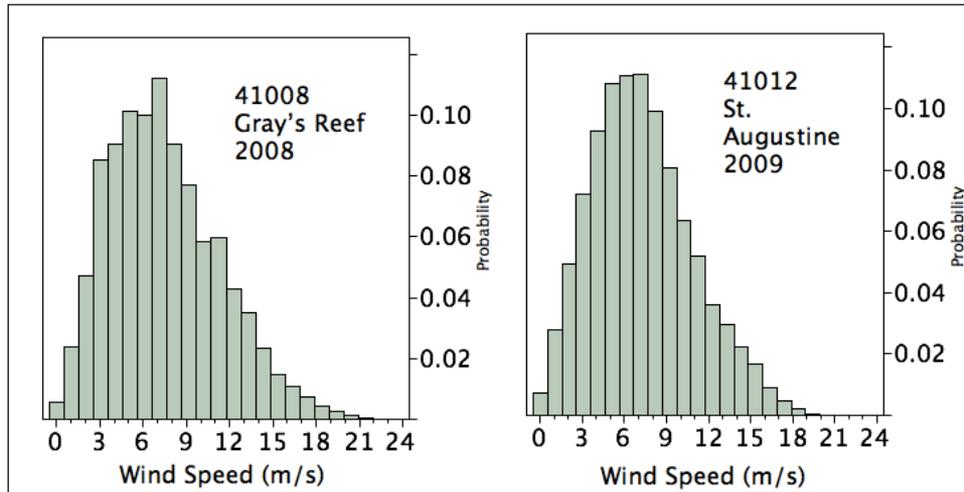
Figure 1. United States offshore wind resource at 90 m above the surface.

Figure 2. blanked-out Florida areas filled in and additional validation boxes added based on extrapolation of buoy and CMAN observations to 90 m. Stars show locations of offshore wind farm leases. On 100 m the wind speeds and capacity factors are higher.



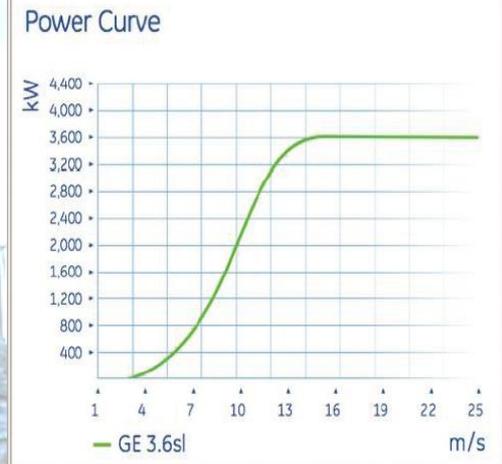
# Offshore Wind Speed to Energy

Wind speed distributions at Gray's Reef and St. Augustine.

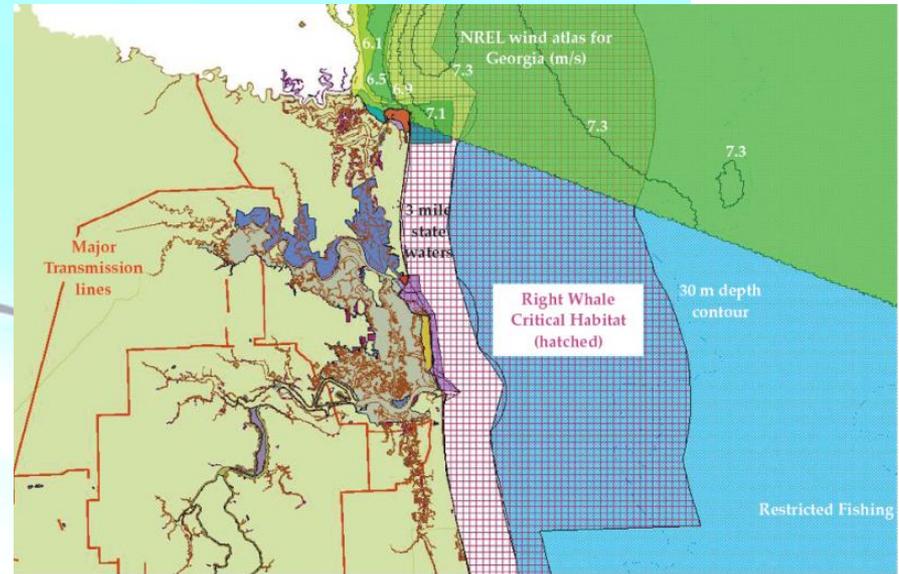
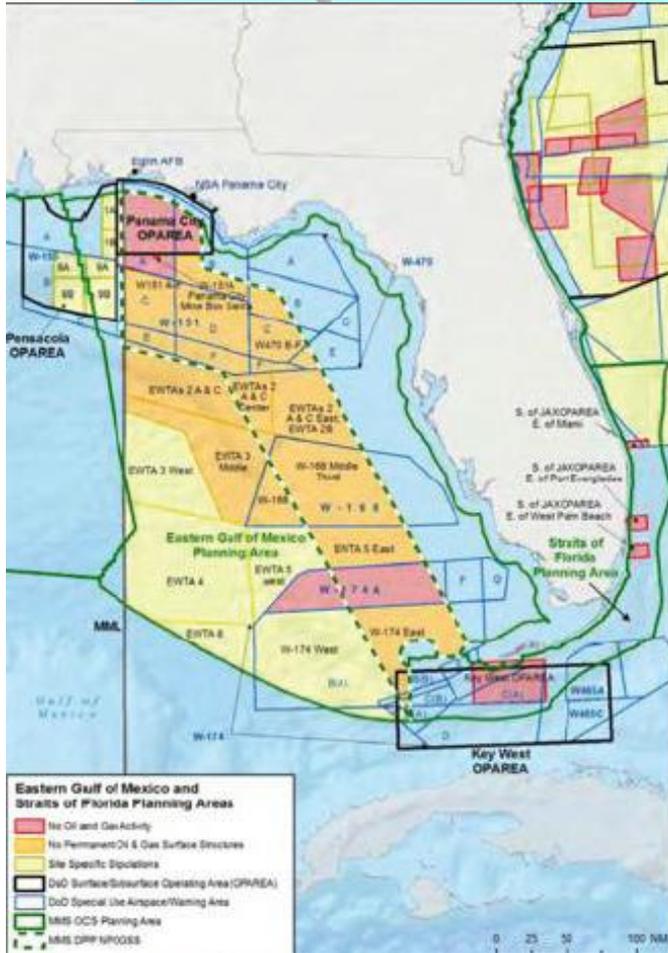


Winds are extrapolated from 5 m buoy measurements to 100 m turbine hub height.

**Conclusion:** Florida offshore wind capacity resources are there. Estimates so far are on the conservative side.



# Coastal and Marine and Spatial Planning



Florida has 1,350 miles of coastline, close to populated coastal area's.



# Florida Offshore Wind Energy Potential in MW and GWh

DRAFT

Executive Summary » Step 3 » Wind Technical Potential

Offshore wind has a large technical potential. A high resolution wind map is needed to confirm the potential onshore Class 2 wind.

Technology	Focus of This Study	Methodology	Technical Potential by 2020 [MW]	Technical Potential by 2020 [GWh]
Onshore Wind	Coastal wind	For areas within 300 meters of the coast identified by a previous report as having the potential for utility-scale Class 2 wind <sup>1</sup> , conducted a GIS analysis to screen out land use types not suitable for wind development, and applied a wind farm density factor to available land.	186 <sup>1</sup>	293 <sup>1</sup>
Offshore Wind	Wind projects that could be installed in water <60 meters in depth	Conducted a GIS assessment to screen down NREL data on Florida offshore wind potential based on shipping lanes, local opposition to projects within sight of shore, marine sanctuaries, and coral reefs.	40,311	125,230

Notes:

- The analysis assumes the areas identified in the Florida Wind Initiative: Wind Powering America: Project Report, which was completed by AdvanTek on November 18, 2005, contain Class 2 wind. To date, there are no high resolution wind maps that are publicly available. A high resolution wind mapping study is needed to confirm the availability of the resource in these areas and pinpoint any areas with a wind resource that might be outside the areas identified in the Florida Wind Initiative report.

## Potential Path to Reduce Cost of Offshore Wind Energy in Class 6 Wind (\$2009 USD) (NREL 2010)

Component	2010	2020	2030	2010 -Land
Installed Capital Cost (\$/kW)	\$ 4,259	\$ 2,900	\$ 2,600	\$ 2,120
Discount Rate Factor (DRF)	20%	14%	8%	12%
Turbine Rating (MW)	<u>3.6</u>	<u>8.0</u>	<u>10.0</u>	1.5
Rotor Diameter (m)	107	156	175	77
Annual Energy Production / Turbine (MWh)	12,276	31,040	39,381	4684
Capacity Factor	39%	44%	45%	36%
Array Losses	10%	7%	7%	15%
Availability	95%	97%	97%	98%
Rotor Coefficient of Power	0.45	0.49	0.49	0.47
Drivetrain Efficiency	0.9	0.95	0.95	0.9
Rated Windspeed (m/s)	12.03	12.03	12.03	10.97
Average Wind Speed at Hub Heights (m/s)	8.8	9.09	9.17	7.75
Wind Shear	0.1	0.1	0.1	0.143
Hub Height (m)	80	110	120	80
Cost of Energy (\$/kWh)	0.27	0.10	0.07	0.09
Cost of Energy (\$/kWh) at constant 7% DR	0.12	0.08	0.07	0.08

- *Wait for developments to come and the lower cost of offshore wind energy?*



# Principles Cost Calculus

- Offshore Wind Cost of Energy Calculations
- The general formula for calculating the cost of offshore wind energy can be represented as:

$$\text{Cost of Energy} = \frac{(\text{Discount Rate Factor} \times \text{Productive Capital}) + (\text{O\&M} + \text{LRC} + \text{Fees})}{\text{Annual Energy Production}}$$

O&M = Operations & Maintenance costs

LRC = Levelized Replacement Costs

Fees = permitting, licensing, annual insurance, warranties, etc.

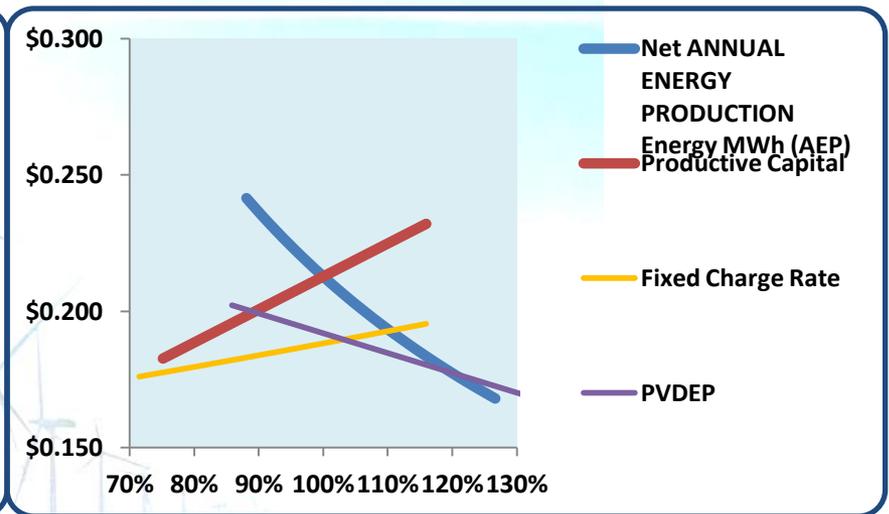
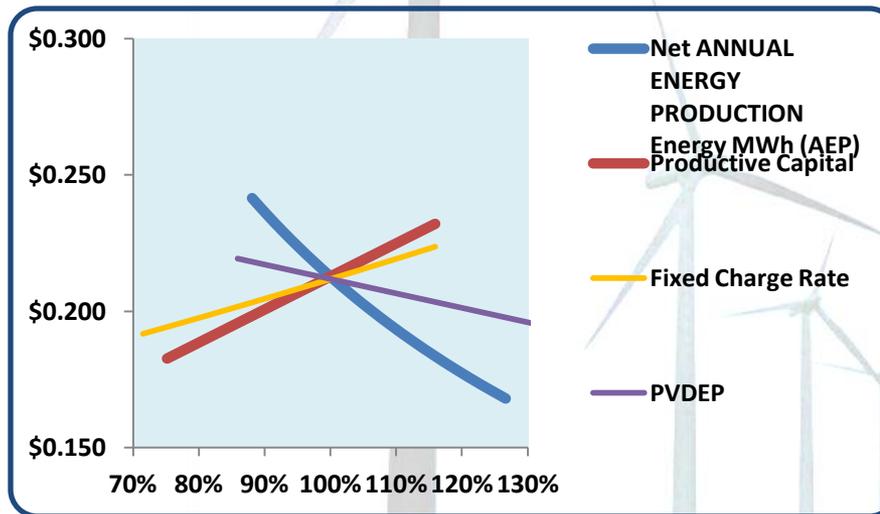
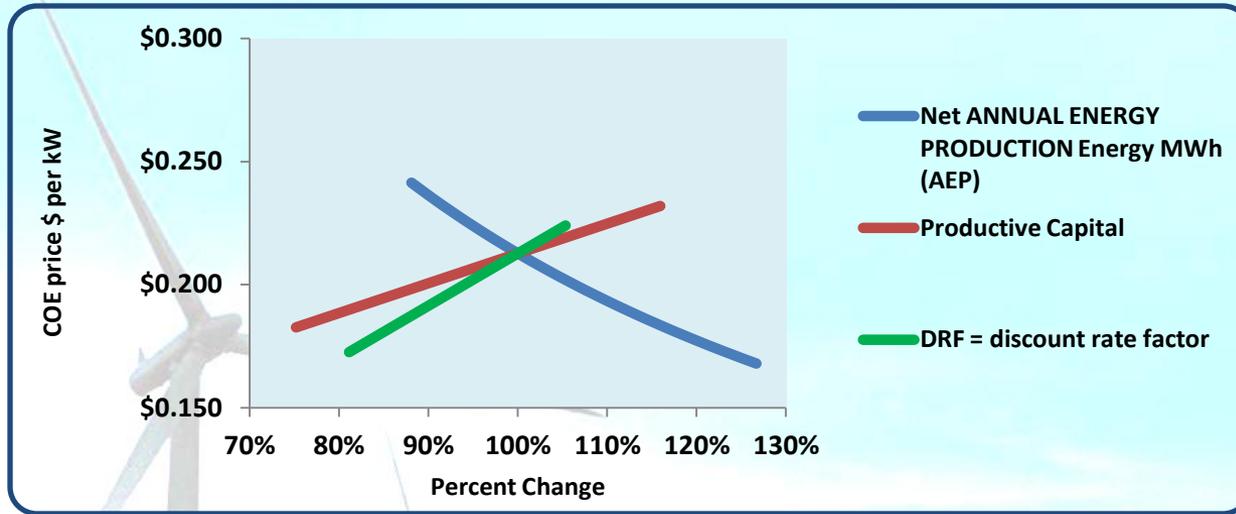
$$\text{Discount Rate Factor} = \frac{\text{Fixed Charge Rate}}{1 - 1/(1 + \text{Fixed Charge Rate})^N} \times \frac{(1 - T \times \text{Present Value of Depreciation})}{1 - T}$$

N = analysis period

T = marginal income tax rate

Fixed Charge Rate	8.3%
PVDEP = present value of depreciation	0.8723
T = Effective tax rate	37.6%
<b>DRF = discount rate factor</b>	<b>11.1%</b>
Productive Capital	\$ 715.8 M
Levelized Replacement Cost	\$ 5.1 M
Operation and Maintenance Cost	\$ 19.8 M
Fees	\$ 1.1 M
<b>Current Cost of Energy per kWh</b>	<b>\$ 0.212</b>

# Sensitivity Analyses Cost of Offshore Wind Energy



- A concerted effort in both lowering the risk factor and raising depreciation allowances could reduce the offshore wind Cost of Energy significantly.
- Likewise a “Florida Power Authority” could reduce the offshore wind Cost of Energy significantly.

# Florida Employment and Output Opportunities on Offshore Wind Energy

- **Florida** offshore wind power could supply in excess of 10 GW by 2030, as an additional source of energy.
- Offshore wind energy could add 13,000 permanent Florida jobs annually by 2030.
- Offshore wind energy could add \$9.5-\$14.5B to Florida GDP by 2030.
- 10 GW of offshore wind energy is enough to power app. 3.1 million average residential homes annually, which is about half the number of residential homes in **Florida**.
- 10 GW of offshore wind energy could offset:  
about 5,000 tons of coal or 81 million Cubic Ft of NG and omit 8 million tons of carbon dioxide (CO<sub>2</sub>) emissions in Florida.

# Conclusions

- Florida has an offshore wind resource capacity of up to 40 GW.
- Cost can be brought down significantly by a concerted effort in both reducing the risk factor and raising depreciation allowances.
- Likewise a “Florida Power Authority” could reduce the offshore wind cost.
- Reduce the timeline for deploying offshore wind energy (presently 7-10yrs).
- In application there is a bounded storage capability / (Atlantic Wind Interconnection).
- **Therefore Florida has the opportunity to:**
  - add 13,000 permanent jobs annually by 2030,
  - add \$9.5-\$14.5B to its’ GDP by 2030,
  - power about half of the number of residential homes,
  - and replace about 8 million metric tons of carbon emissions,
  - **by utilizing its’ off shore wind resources as an added option to provide for the energy needs.**



*Thank You*  
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