



SOUTHEAST NATIONAL MARINE RENEWABLE ENERGY CENTER

College of Engineering and Computer Science
Florida Atlantic University

SNMREC Program Update

Presented by: Susan H. Skemp

SNMREC Executive Director

<http://snmrec.fau.edu> (May 2012)

US Energy Landscape

Fossil Fuels

- Security - *(Fl. – appx. 75 – 80% imported)*
- Economic - *(Fl. – \$26B in 2006 out of the state)*
- Environmental

Alternative Fuels – Including Nuclear *(Fl. – 16%)*

Renewables – e.g. Solar, Wind, Hydropower, Bio-fuels *(Fl. – <5%)*

*Florida – What about exploring renewables further -
concentrating on local resource availability – the ocean?*

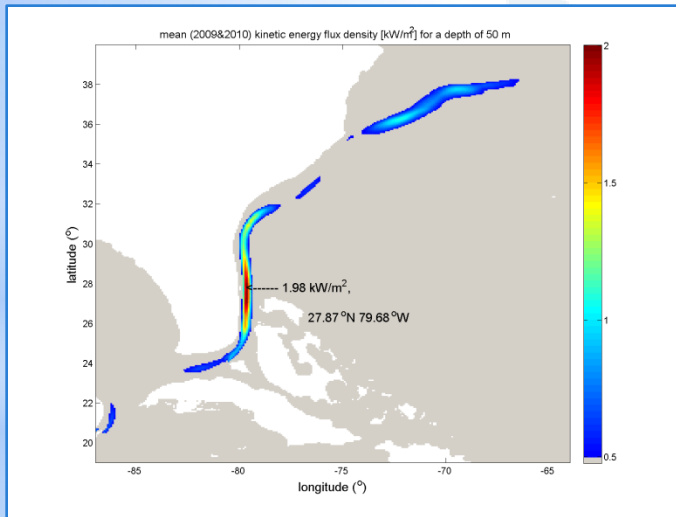
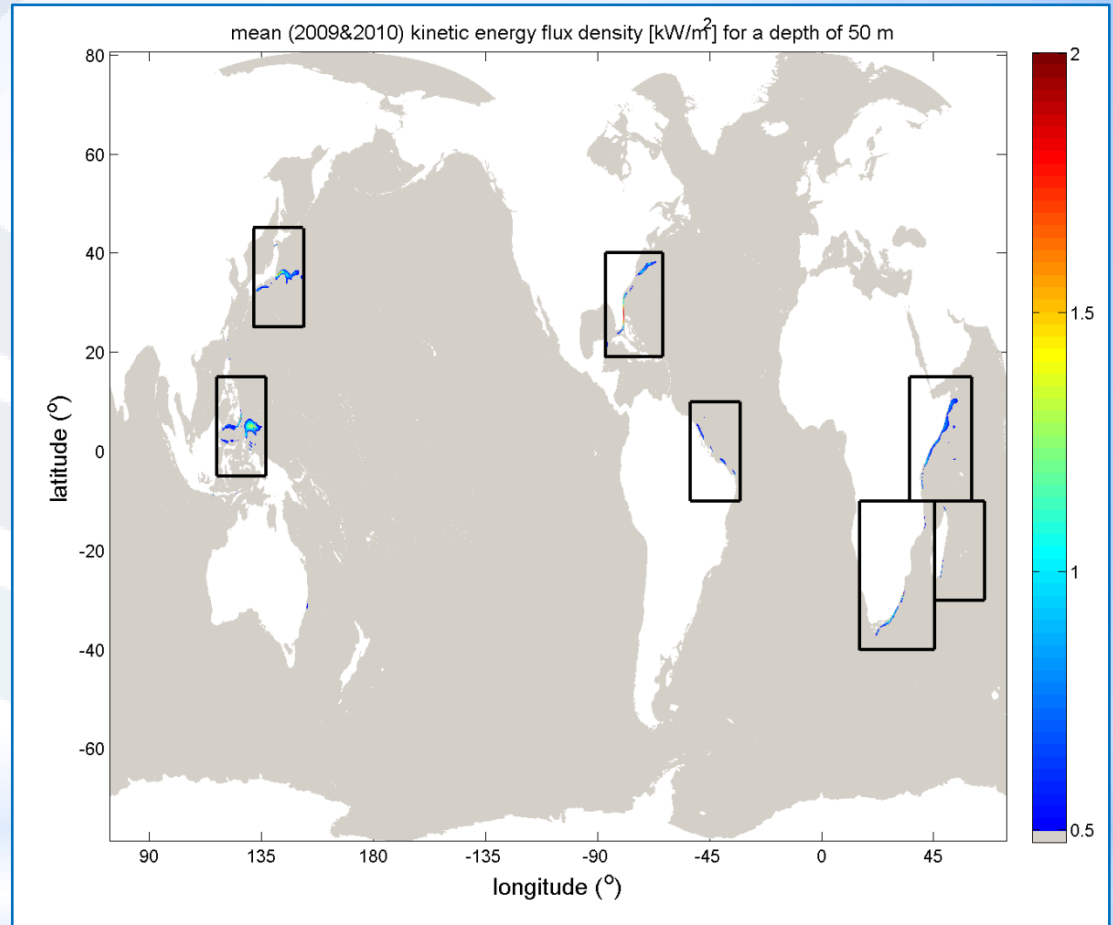
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Ocean Currents - Of Global Interest

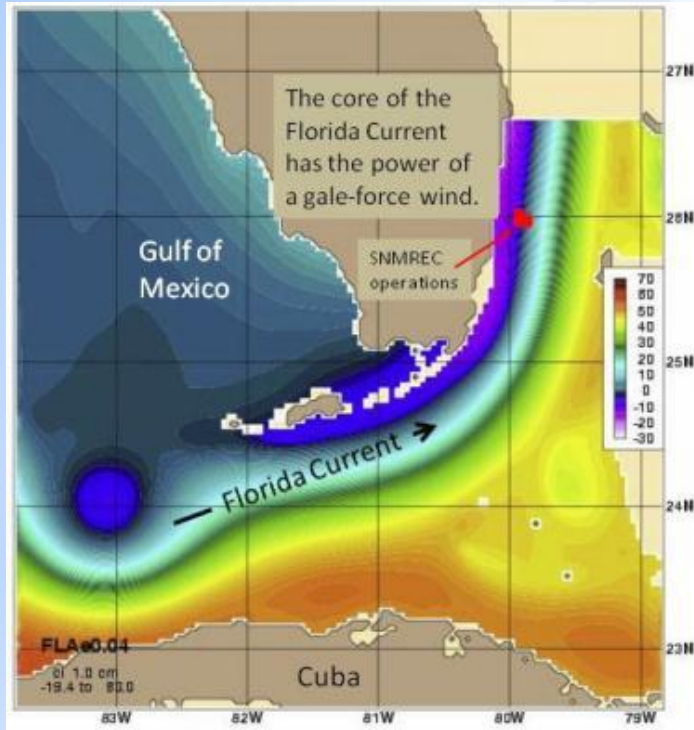
A preliminary study suggests that various areas around the world possess at least 0.5 kW/m^2 of kinetic energy density (flux).

The U.S. (Florida) has the highest with approximately 2 kW/m^2 .



Gulf Stream (1.98 kW/m^2 max)

The Florida Current - What's the Potential?



Oceanographic studies suggest that it should be possible to generate as much power as the Turkey Point power plant, but without fuel or nuclear waste.

The DOE-sponsored resource assessment project at Georgia Tech will further quantify this potential.



Turkey Point is the largest nuclear power plant in Florida and the 6th largest in the U.S.

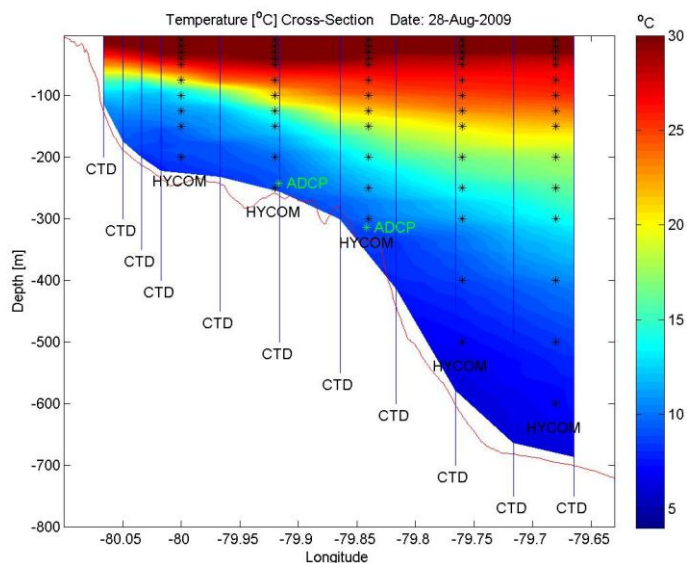
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Ocean Thermal Energy Potential

Ocean thermal energy conversion (OTEC) is possible where the temperature difference between ocean-surface water and water at depth exceeds about 20 °C to be economically efficient. Research shows considerable potential offshore.

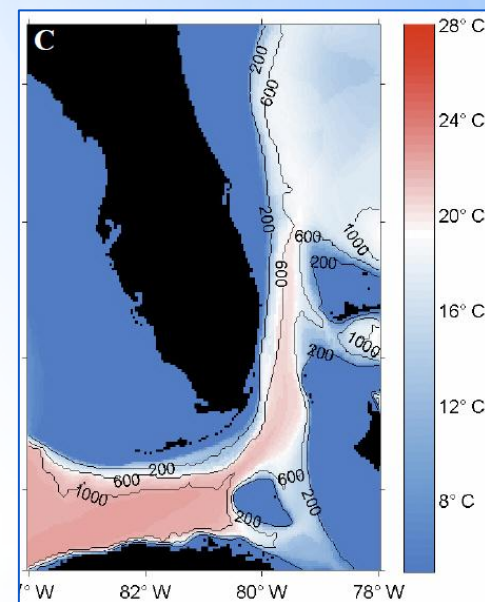
Validated using 85 CTD transects



Thermal potential > 200GW total;
recoverability unknown

Such potential involves much deeper cold water in most locations, in the Florida Straits it is as shallow as 200 m, as shown by the contours.

HYCOM 2010 mean ΔT °C



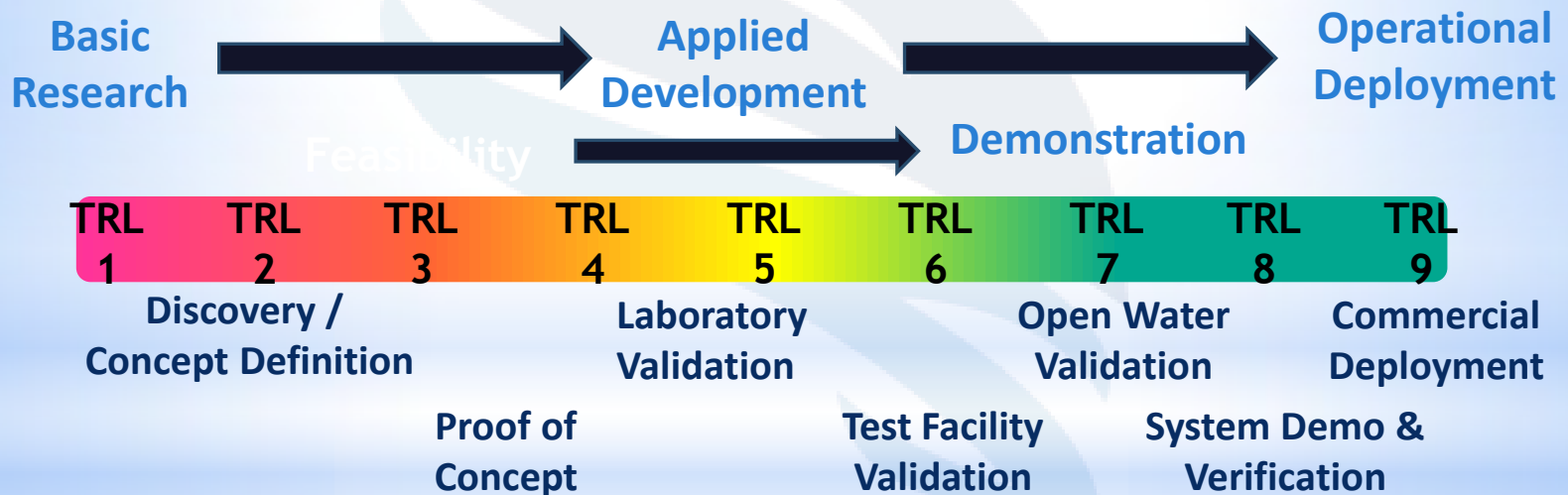
- *A.E. Leland, F.R. Driscoll, J.H. VanZwieten, N.J. Nagurny, and R.J. Howard, (2010) "Ocean Thermal Energy Capacity Estimation and Resource Assessment of Southeast Florida" Proceedings of the Offshore Technology Conference, Houston, Texas, May 3-6, no. OTC-20559-PP
- *L.T. Rauchenstein, J.H. VanZwieten Jr., and H.P. Hanson (2011) "Model-based global assessment of OTEC resources with data validation off Southeast Florida" Proceedings of the IEEE Oceans Conference, Santander, Spain, June 6-9, no. 110115-112
- *J.H. VanZwieten Jr., L.T. Rauchenstein, H.P. Hanson, and M.R. Dhanak (2011) "Assessment of HYCOM as a tool for estimating Florida's OTEC potential" Proceedings of the IEEE Oceans Conference, Kona, Hawaii, September 19-22, no. 110422-145

Ocean Energy Industry - Technology Maturity

OCEAN CURRENT: Projects vary in maturity, but all are TRL 4 or less. No tests at relevant scales in relevant environment as of yet.

OTEC: Technologies are more advanced.

Technology Readiness Levels (TRLs)



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What are we?

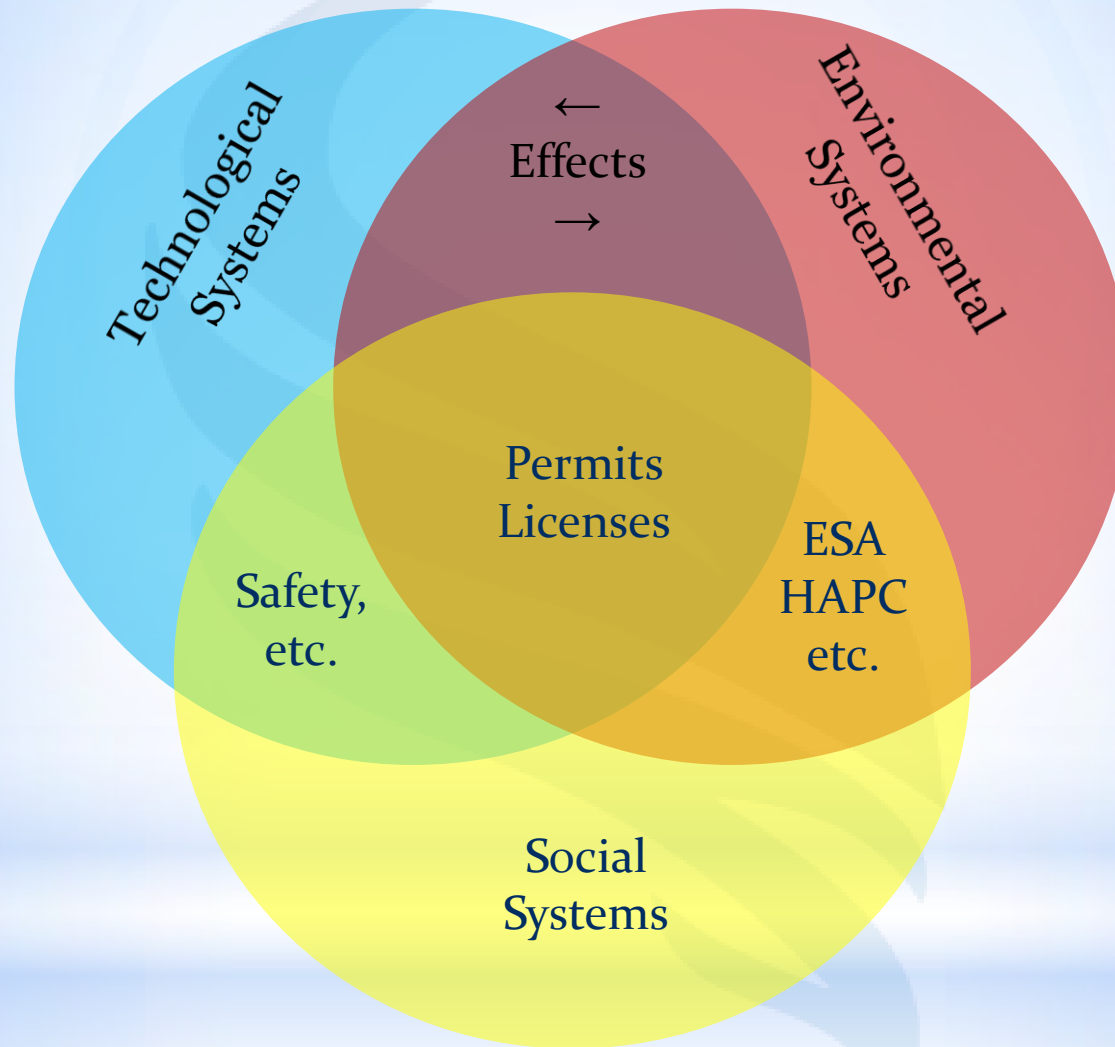
**US Dept. of Energy National Marine Renewable Center at
Florida Atlantic University**

What are we about?

Leveraging research and test capabilities to understand:

- **Power potential of marine resources**
- **Baseline environmental interdependencies**
- **Missing regulatory and permitting information**
- **Early stage technology gaps**
- **Responsible energy extraction**
- **Protocols and standards to increase safety and reliability**
- **Any other outstanding needs to help marine renewables become a commercial reality**

Systems View - Interdependencies



SNMREC Major Programs

Scaled Testing

- ¼ Scale Offshore Turbine Test Berth(s)
- Onshore 25kW Dynamometer
- Experimental Research Turbine

Technology R&D

- Prognostics and Health Monitoring
- Design, Modeling, and Analysis Tools
- Rotor Design, Construction, and Testing
- Standards and Protocol Development

Energy Resource Analysis

- Large-scale Energy Extraction Modeling
- Turbine Inflow Measurement
- Turbulence Characterization and Measurement
- *In situ* Measurement and Analysis

Environmental Assessment

- Sea Turtle and Marine Mammal Population Studies
- Acoustic Noise Measurement and Prediction
- Deepwater Coral Assessment

Regulatory Framework

- 1st OCS BOEM Marine Renewable Lease
- Example Studies (Marine Spatial Planning, NEPA, Deployment Procedures, Bottom Survey)

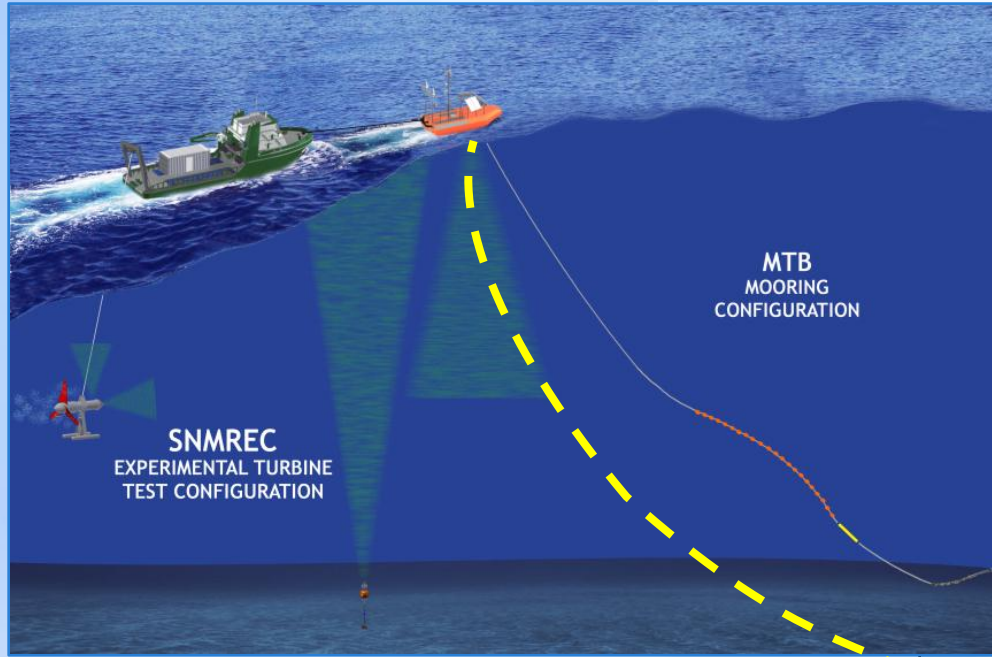
Education and Outreach

- High School Curriculum Development
- Stakeholder Outreach
- Conferences and Workshops
- Industry Collaboration



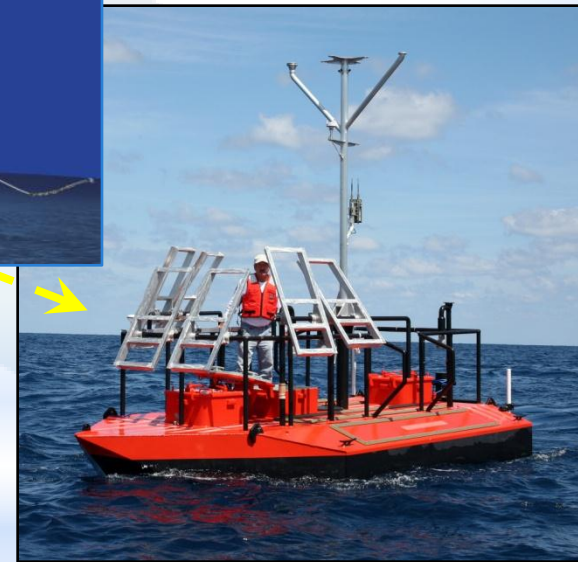
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*We are initially a single anchored deployment with
NO transmission capability*



**Will accommodate
negatively buoyant ocean
current units that produce
less than 100kW max power
and less than 7 meter
diameter rotors.**

**Demonstration and validation of pre-
prototype concepts with 2nd party
certification, in-place regulatory
framework, deployment assistance**

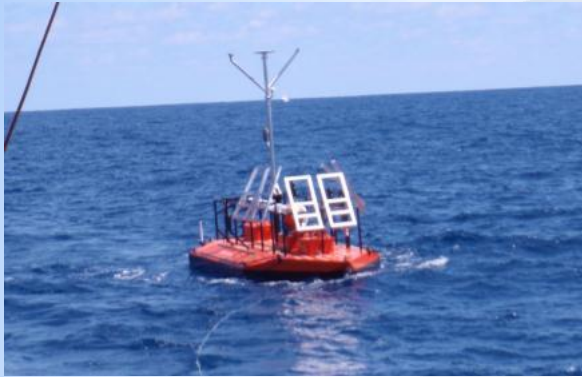


**Mooring &
Telemetry
Buoy during
sea trials.**

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Mooring and Telemetry Buoy (MTB)



Based on sea trial results, increased length, draft, and reserve buoyancy to improve stability and survivability in storms

**SNMREC “Surface Presence”
Replicates NOMAD Buoy Design**



Modified MTB on cradle with ballast weight on stabilizer fin, anodes, and rub rail around deck



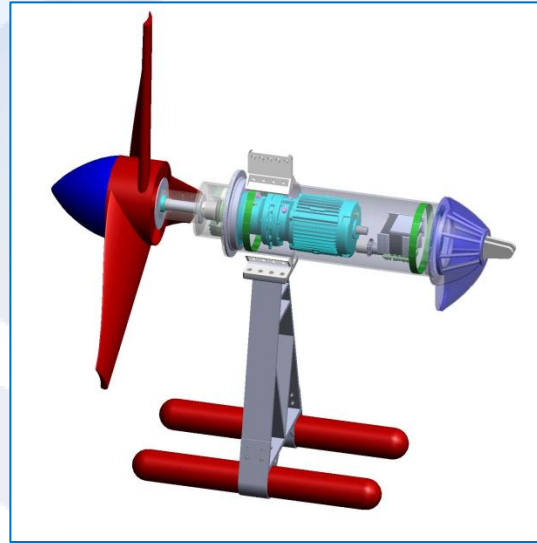
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Ocean Current Research Turbine (OCT)



**Frame and ballast weights
after priming (below)**



**20 kW max power, 10 ft.
diameter rotor,
negatively buoyant**



**Bearing
housing and Drive
Shaft (right)**



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Onshore Test Capabilities

25 kW max power Rotary Dynamometer

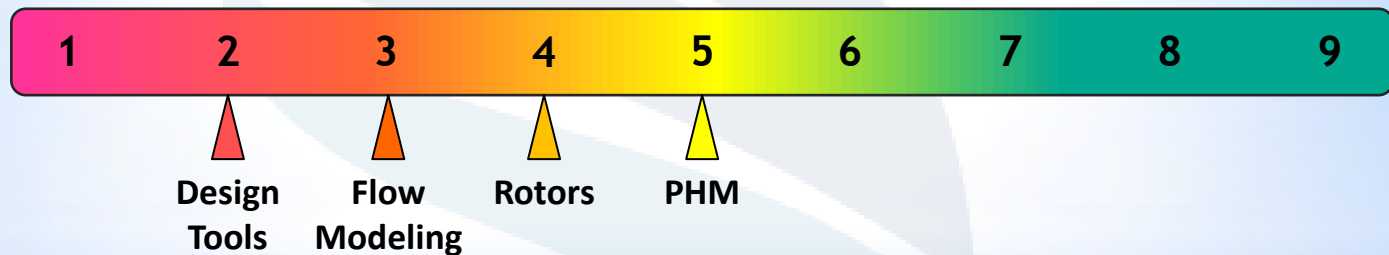
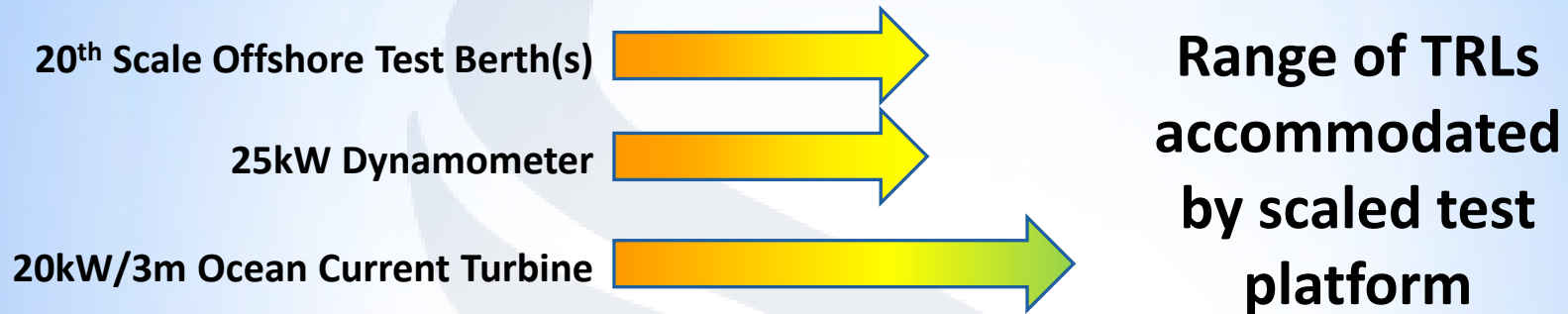


- Closed-loop or grid operation
- Integrated micro dynamometer (3hp)
- Fully controllable drive and generator
- Ocean data used to simulate real-world conditions

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SNMREC Technical Program TRLs



Final project TRL maturity

Stewardship - What and How?



The answer involves two related perspectives:

- *environmental concerns* specific to the Florida Straits;
- *environmental benefits* of implementing renewable energy recovery.

We are concerned about a long list of potential impacts from marine renewable energy implementation.

- Will it change the Florida Current?
- How will it affect marine animals?
- What about shipping, recreational boating, fishing?

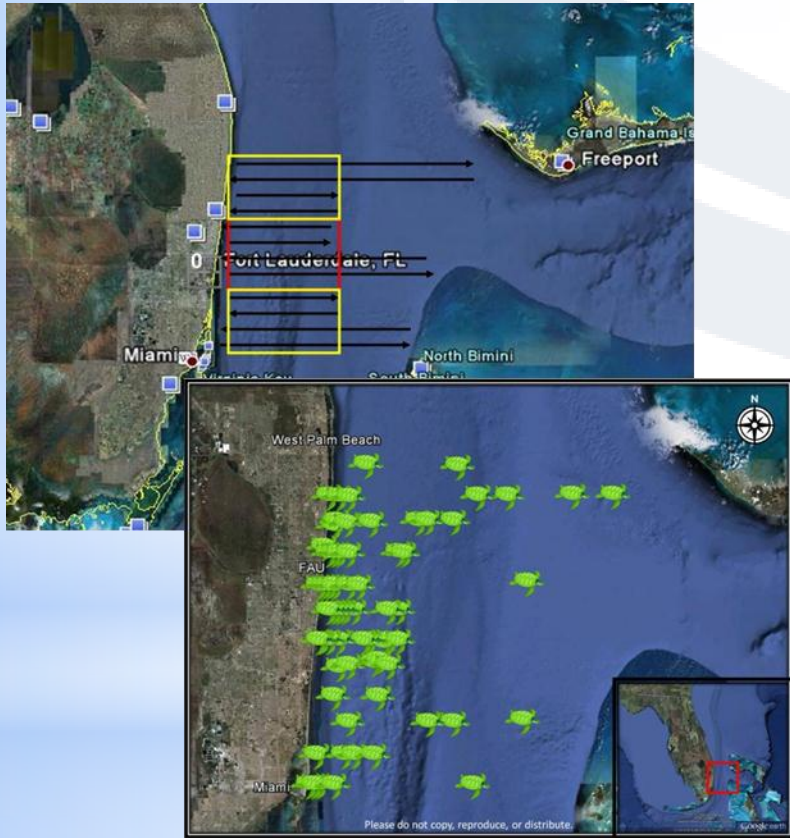
All of these issues are being studied.

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Chelonioidea - *All species are endangered!*

Little is known about their at-sea behavior, and how they might react to energy-system deployments is a complete mystery.



Aerial Surveys

- Assess sea turtle and marine mammal individual and species distribution that might be affected by interaction with devices
- 15 months of cross-channel and 30+ alongshore surveys to date
- Currently accepted protocol is with human observers
- Working on streamlining with technology: video record and post-process

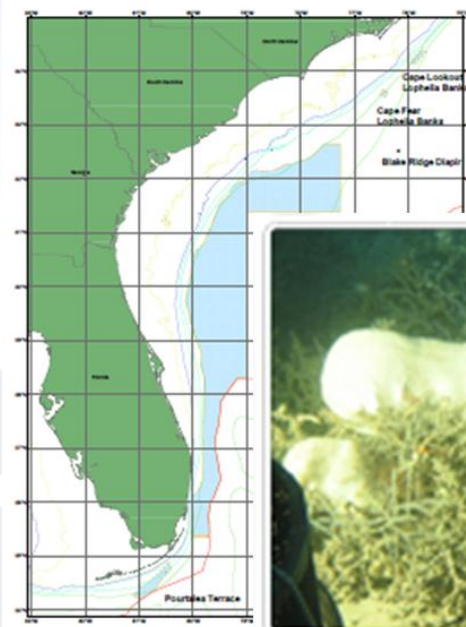
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Lophelia

The existence of these cold/deep-water corals will provide challenges for ocean-bottom activities.

The patchy nature of their distribution throughout the region of interest will require great care with emplacements of anchors and underwater cables.



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Permitting

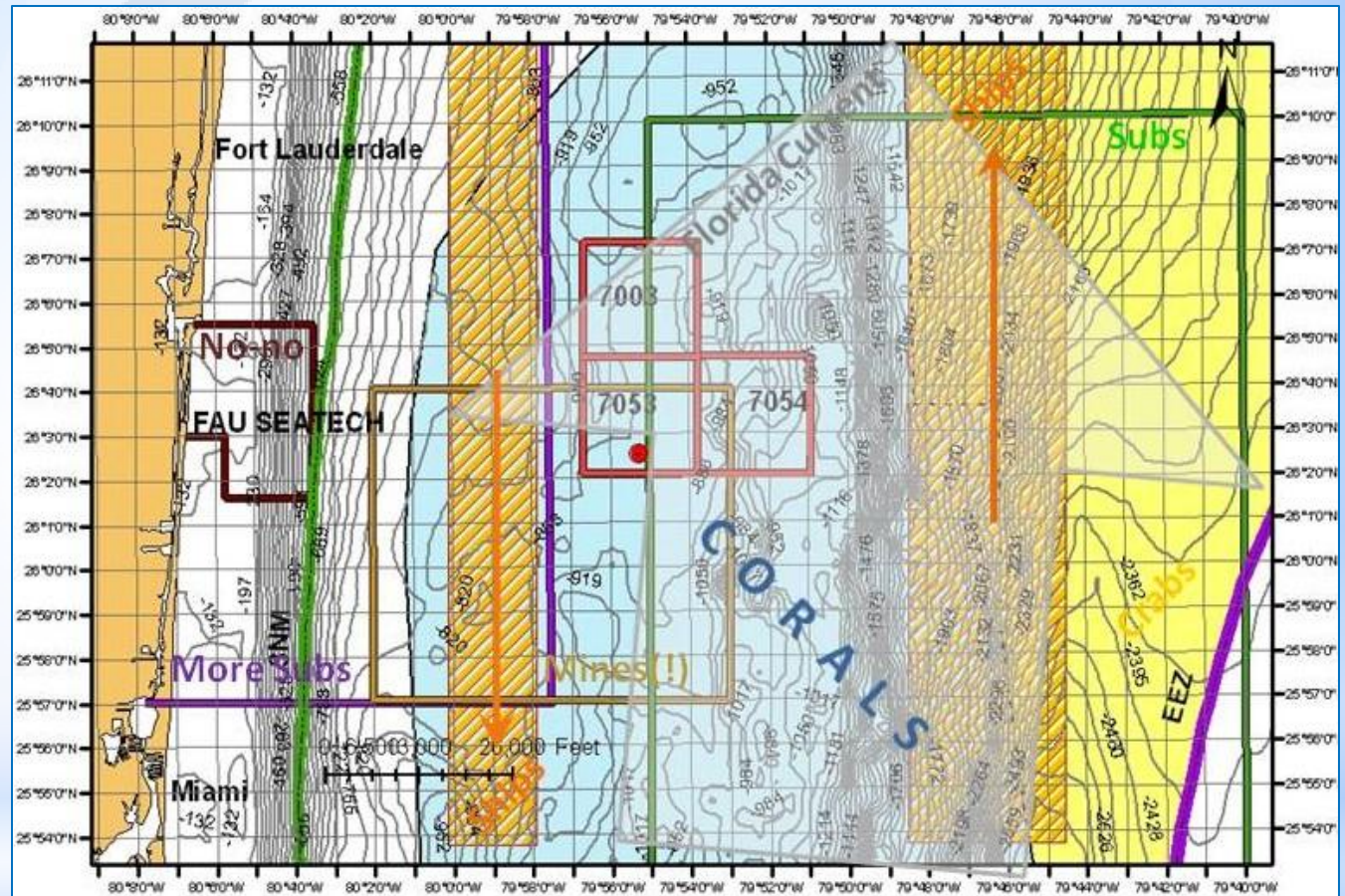
Invoking “Energy” in Scientific and Engineering Oceanographic Research has raised the level of scrutiny and permitting requirements to a higher level of expectation by the regulatory agencies and stakeholders.

Marine & Hydrokinetic (MHK) Lease

Consultancy:

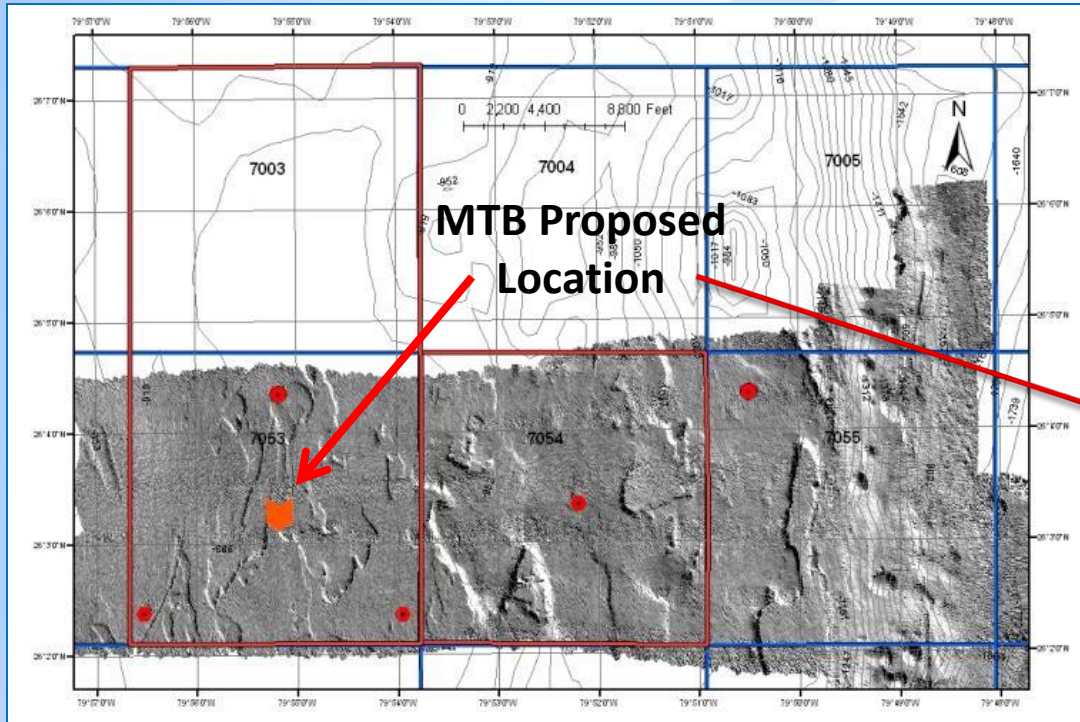
- **DOI/BOEM –
(MHK Lead > 3nm)**
- **FERC
(MHK Lead < 3nm)**
- **DOD/Navy**
- **DoD/Army Corps**
- **DHS/USCG**
- **NOAA/NMFS
(OTEC Lead)**
- **DOE**
- **FL/DEP**
- **FL/FWC**
- **EPA**

and, Other Stakeholders

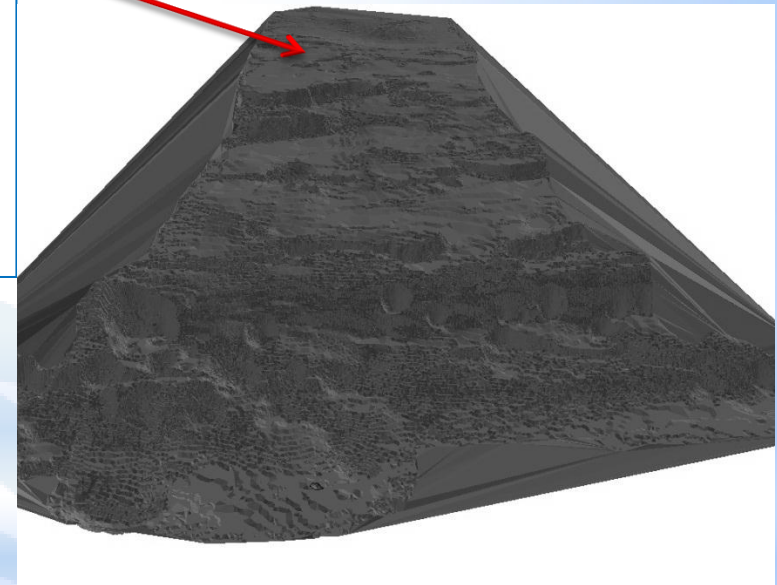


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Proposed Testing Facility Site



**3D Rendered View of
Multibeam Data
Looking West Upslope
of Escarpment**



**Test Areas Located West of Escarpment
to Avoid Potential Coral Habitat and
Site Equipment Over More Suitable
Seafloor for Mooring**

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Regulatory Timeline

November 2007	Initial consultations with regulatory agencies
December 2010	SNMREC Submitted MHK Lease Application to Bureau of Ocean Energy Management (BOEM)
May 2011	BOEM - Notice of Intent to conduct Environmental Assessment (EA)
June 2011	BOEM Initiates Draft EA
January 2012	Public Seminar held at Harbor Branch Oceanographic Institute, Ft. Pierce, 600+ attendees
February 2012	BOEM Consultations complete – Draft EA awaiting Solicitor approval
February 2012	Notification from EPA Regional Office and Florida Dept. of Environmental Protection – Determination of no requirement for Air Quality Permits
★ April 24, 2012	BOEM Released EA Notice in Federal Register (30 - day Public Comment)
April 2012	Public Seminars – Boca Raton, Jupiter and Ft. Lauderdale, FL
★ May 9, 2012	BOEM Public Forum – Broward Downtown Public Library
April 2012	Draft - Lease, Terms and Conditions
Spring 2012	Final EA Release
Summer 2012	Issuance of Lease

Stakeholder Engagement

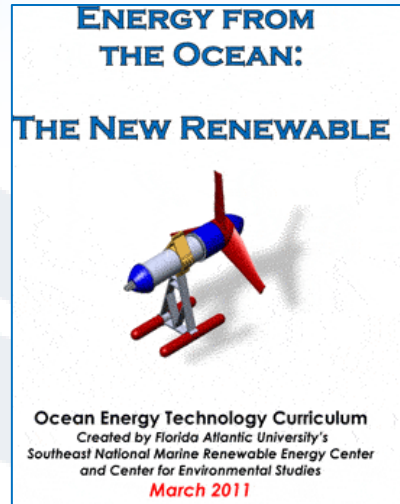
- Federal and State agency and legislative briefings
- Educational tours/briefings
- “Renewable Ocean Energy & the Marine Environment” Workshop – Nov. 3-5, 2010
- Industry Dialogue and Standards Development
- Graduate student and researcher support
- Participation in national and global conferences
- Publications
- Public Stakeholder Forums – Ft. Pierce (Feb. 2012); Boca Raton, Davie and Jupiter, FL (April 2012)



Education - Curriculum Development & Teacher Training Workshops

6 detailed curriculum lessons :

- Why do we need renewable energy?
- How is electricity generated?
- How do we identify ocean currents with the best potential for producing energy?
- Harnessing energy from ocean currents: the new renewable
- What are the environmental impacts of ocean energy?
- The future of ocean energy



Teachers attending workshops:

- Learned the latest developments in Ocean Energy Technology
- Received curriculum materials
- Piloted the new Ocean Energy Curriculum with 9th-12th grade students
- Earned in-service credit



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Diversified and Sustainable Energy Future

We're here to accelerate the commercial implementation of marine renewable energy as one of several renewable energy sources in our Nation's energy portfolio, along with solar energy, biomass conversion, and wind.



Questions