ARPA-E's Ocean Emerging Technology Programs

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ARPA-E Program Director

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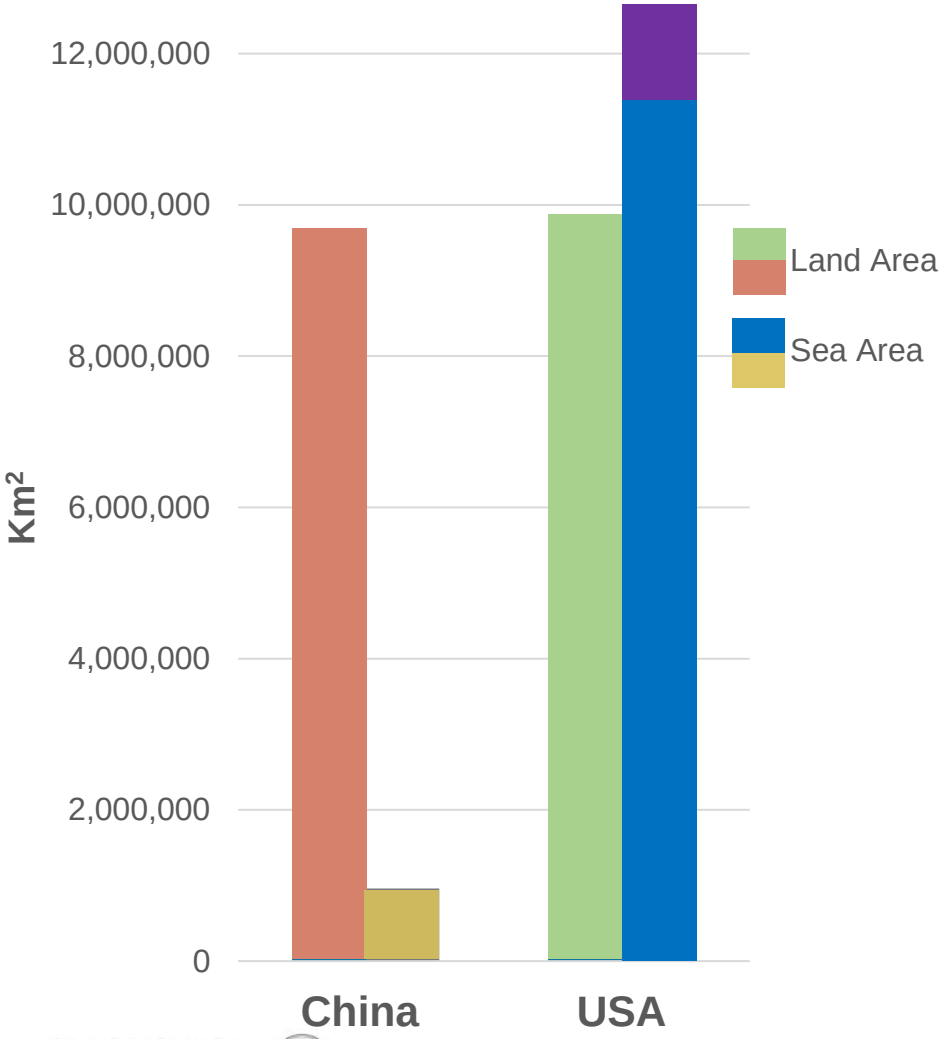
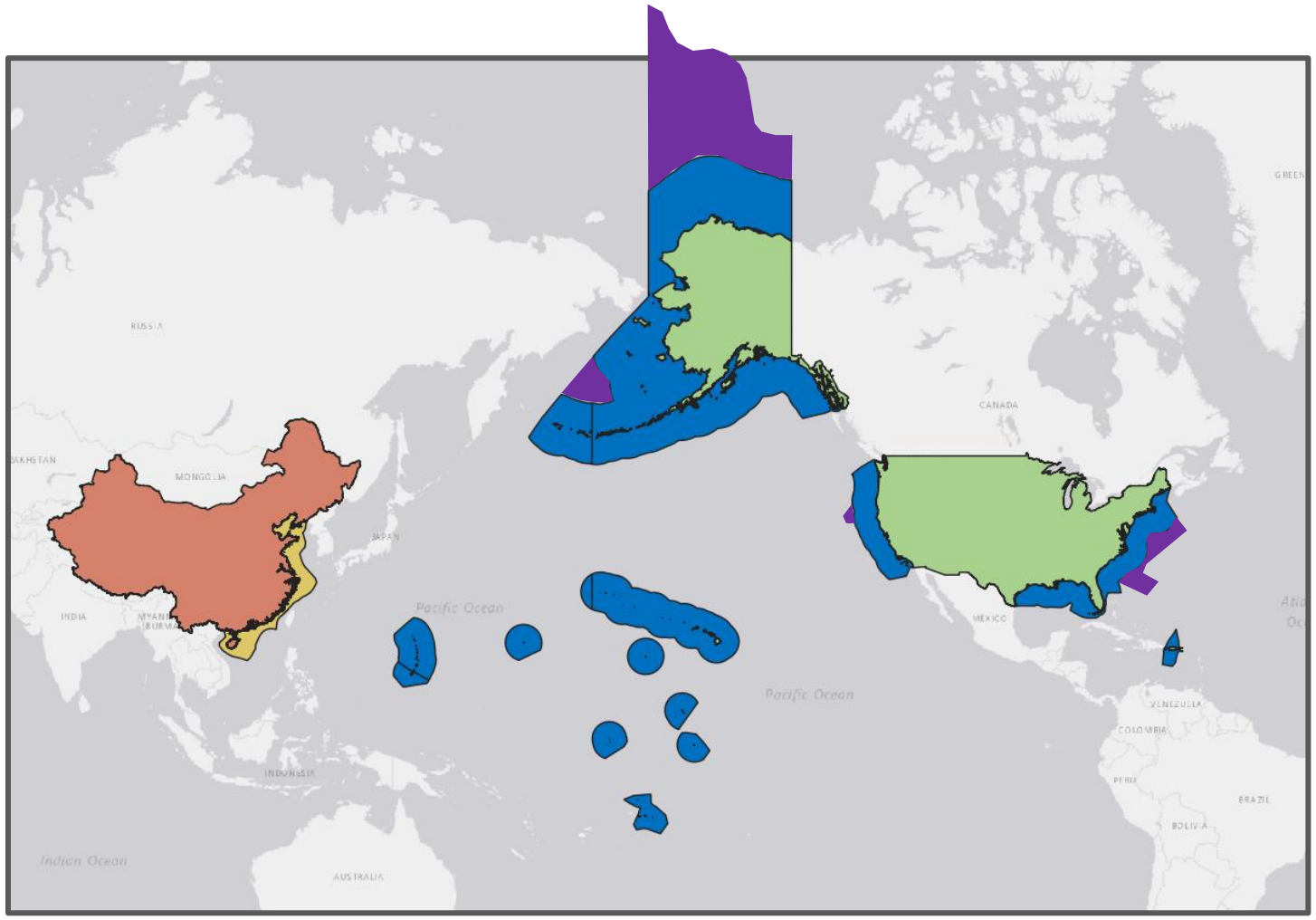
Advanced Research Projects Agency - Energy

- We fund high-risk, potentially high reward technology development in the energy and emissions space
- Part of the Department of Energy
- ~**$450M** of awarded projects per year
- Modeled after the *DARPA* approach to rapid research and development
- Emphasize **impact and scale**: research and development funding is focused towards **commercialization**

How do we think about the ocean?

The U.S. has the world's ~~second~~ largest maritime Exclusive Economic Zone (EEZ)





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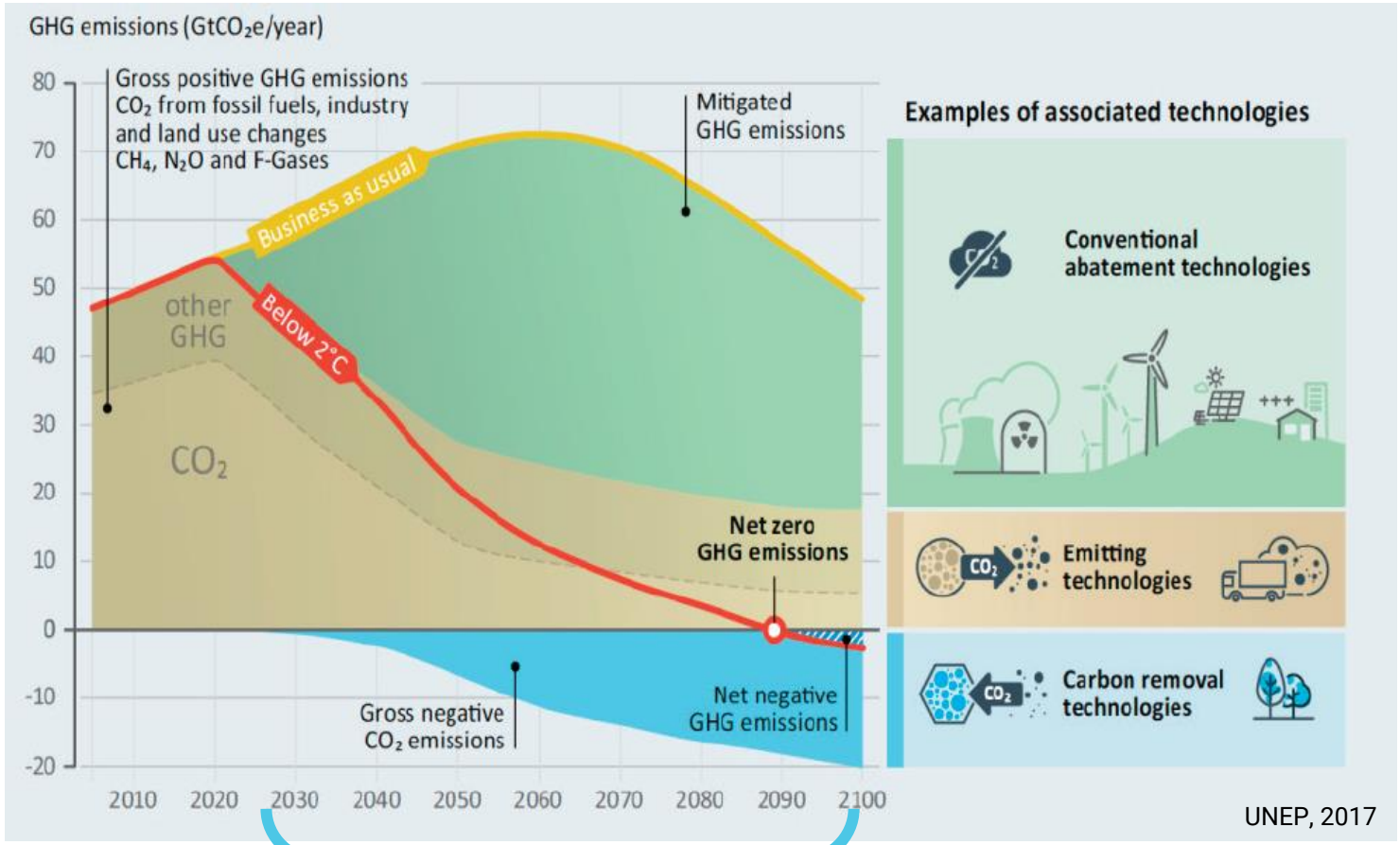
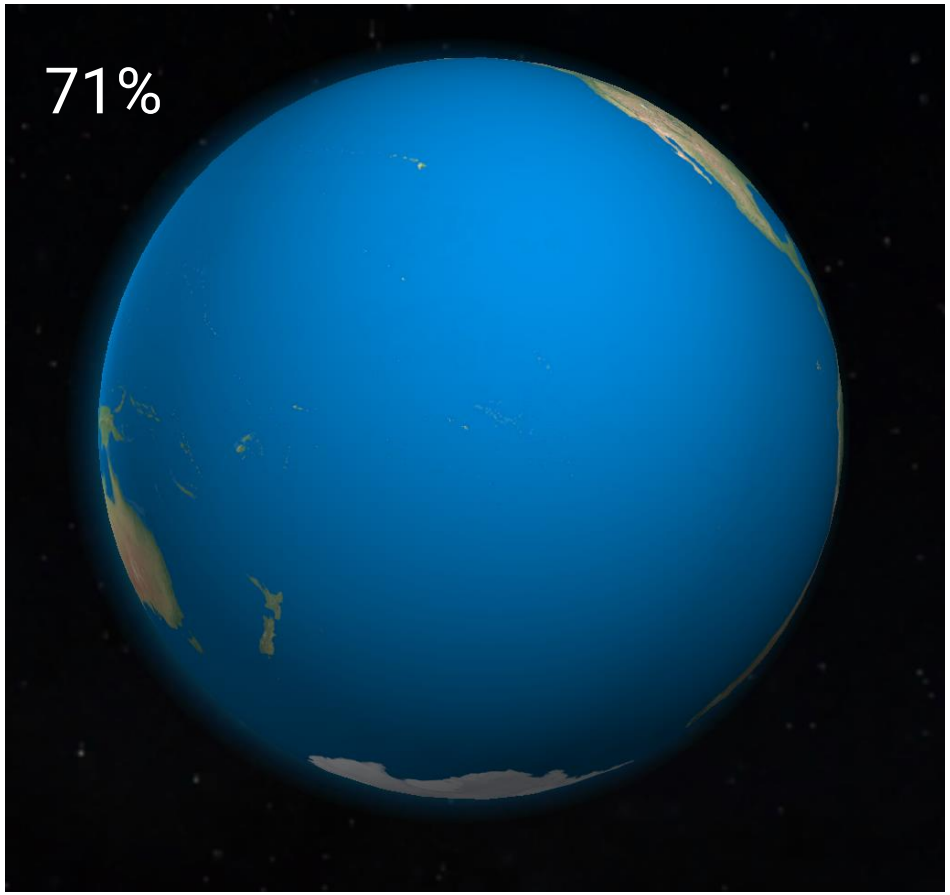


UNEP, 2017



How will we capture this carbon, and where will we store it?

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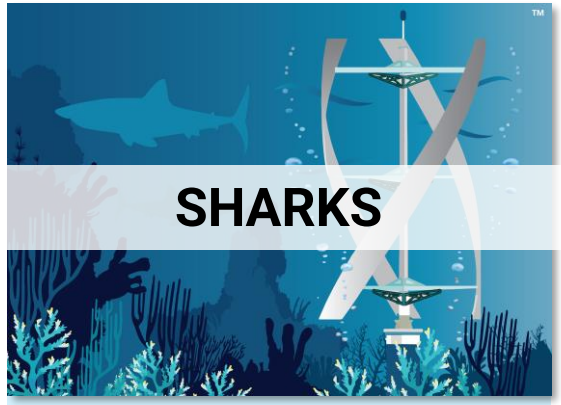
Current ARPA-E Ocean Programs

Building a **Gigaton-Scale Ocean Bioenergy Industry**

Rethinking **Floating Offshore Wind Technologies**



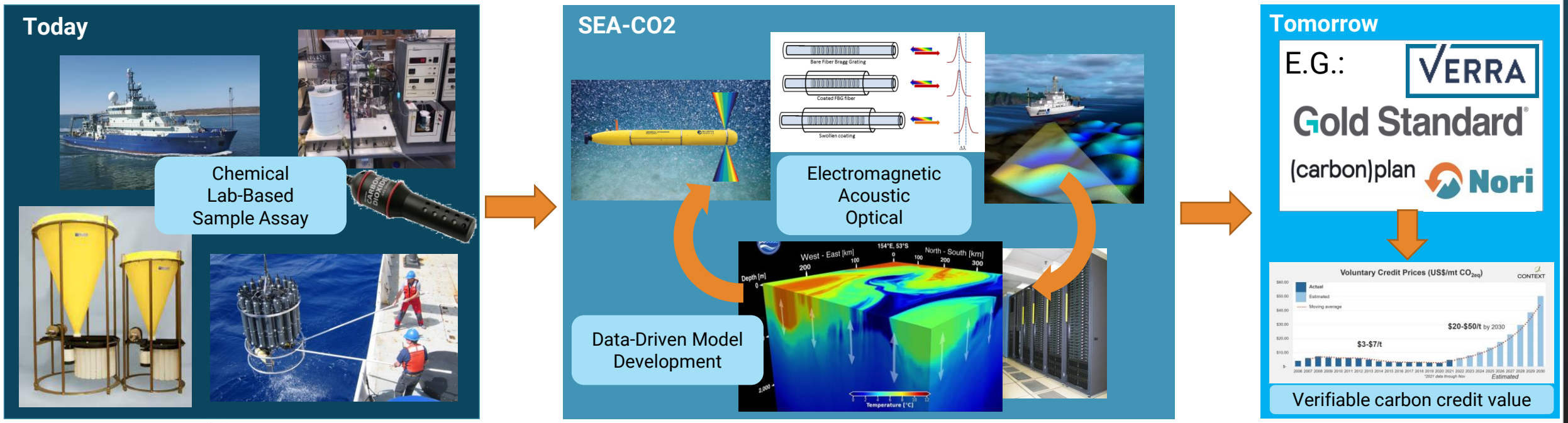
Rethinking **Hydrokinetic Turbines**

Realizing a **Marine Carbon Removal Industry**

Enable a gigaton-scale carbon capture industry, soon.

SEA-CO2: *Sensing Exports of Anthropogenic Carbon through Ocean Observation*

- Accurate quantification defines marine CO2 removal financial value in carbon markets
- Ocean CO2 removal promises the biggest scale with least adverse impact



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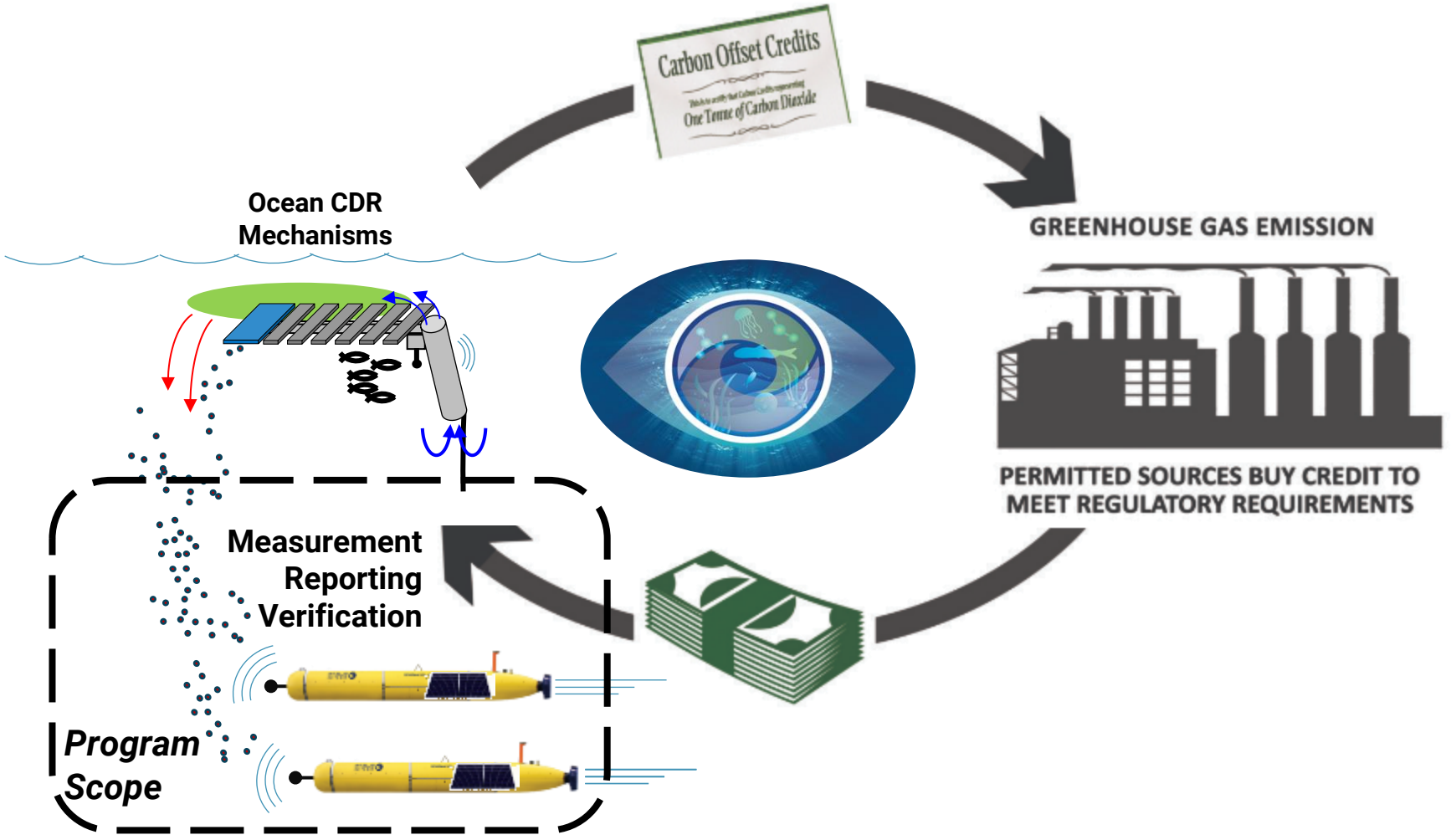
$37.3M, Kickoff January 2024

Accurate Quantification of Efficacy is the Key Enabler of mCDR

What are we trying to do?
Create viable Measurement, Reporting and Validation (MRV) technology for marine Carbon Dioxide Removal (CDR) processes

Technical Areas:
1. *Develop volumetric, scalable **carbon sensing** technology (7 teams)*
2. *Create effective **models** to estimate CDR performance (4 teams)*

Why is this important to you?:
Federal regulatory agencies for climate intervention require data-driven methods of verification



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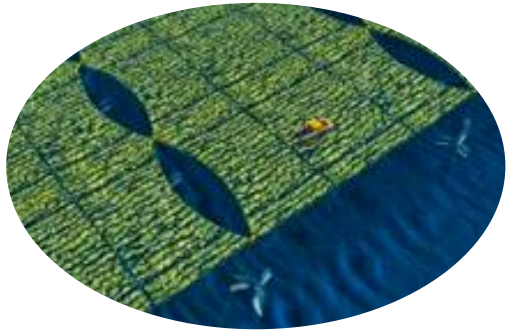
‘Limitless’ space. No fertilizer, no fresh water required

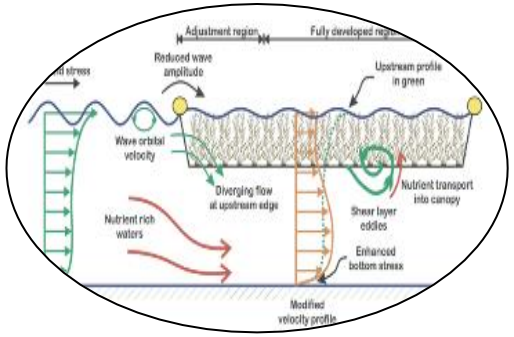
ARPA-E MARINER: Macroalgae Research Inspiring Novel Energy Resources

- ARPA-E is building a U.S. marine biomass industry from *scratch*.
- 9.7B people by 2050: 30% more energy, 50-100% more food.
- Biomass is critical for both and provides flexibility for low-carbon energy
- Let’s use the world’s ~~2nd~~ largest EEZ to our advantage!



U.S. First deepwater offshore farms

Autonomous monitoring and farm control



Unique biogeochemical modeling

>40% yield increase via selective breeding. Invention of sporeless varieties

$66M, 2016-present

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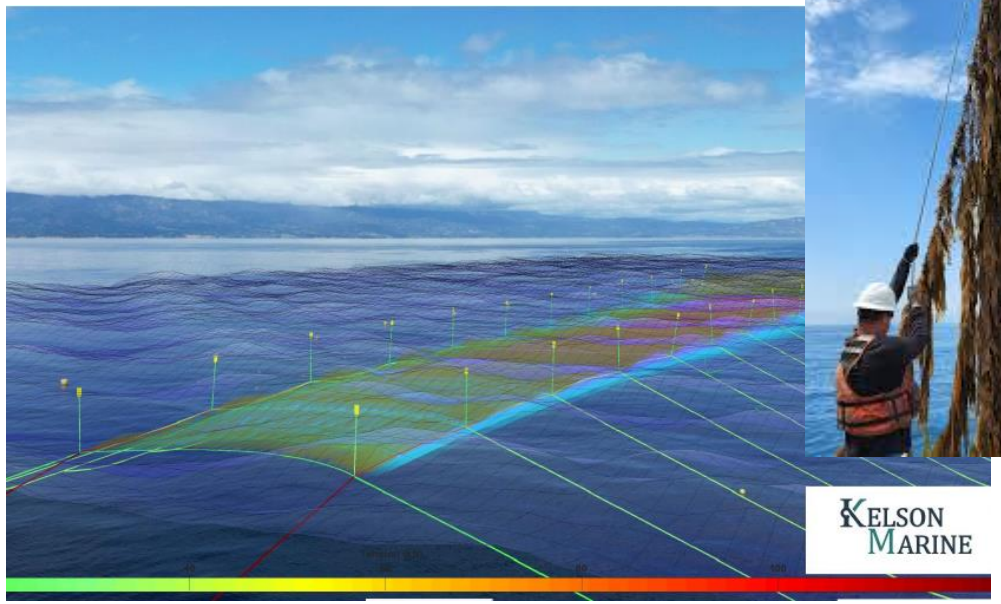
Example of Public-Private Partnership: Ocean Rainforest (ORI) / NOAA

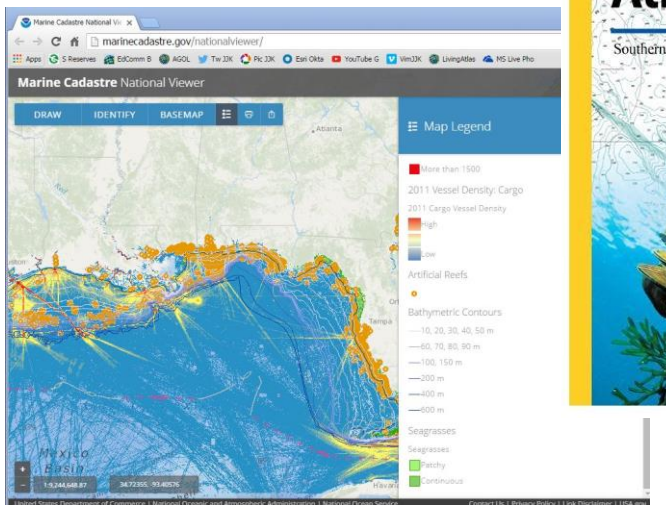
- ORI: Unprecedented deep-water seaweed farm in 80-100m of water, California
- NOAA: Marine spatial planning for aquaculture permitting

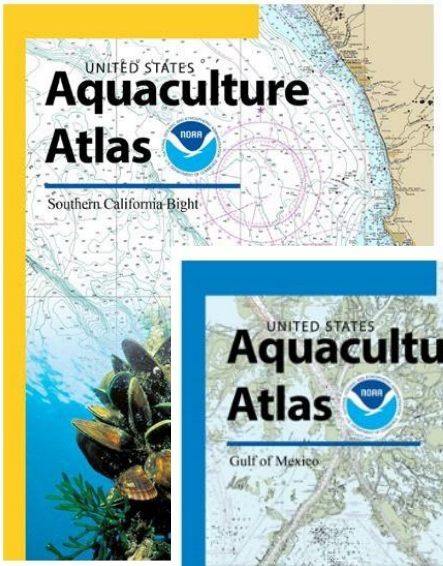
- Initial funding: ORI: $4.05M (2020). NOAA: $2.9M (2017).
- Upon successful permit acquisition in 2022, Plussed up ORI $4.5M (2023). NOAA: $570K (2023)
- ORI applied for 2000-acre commercial permit June 2024.

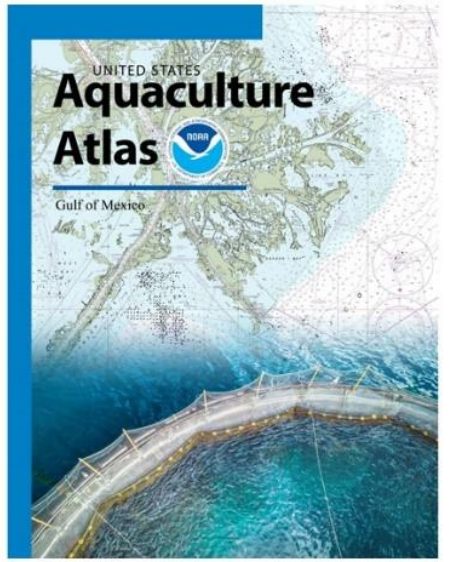


KELSON MARINE

OCEAN RAINFOREST







NCCOS | NATIONAL CENTERS FOR COASTAL OCEAN SCIENCE

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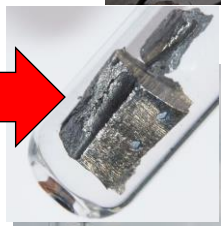
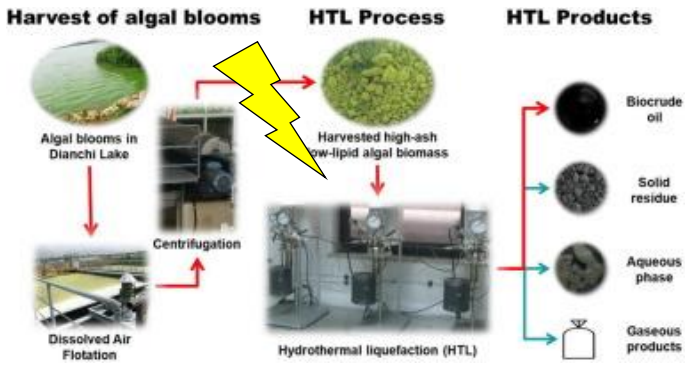
A distributed, independent source of Rare Earth Elements?

Macroalgae hyperaccumulates rare earths. Can these metals add value to biomass?





Tian *et al*. 2015

$5M, 3 teams, Kickoff 2024

A high-risk Exploratory Topic

ARPA-E/KIMST U.S. – Korean Bilateral: Potential New Program

- New methods of farm sensing and deepwater cultivation to enable low-cost, large-scale offshore farming for energy biomass commodities
- Leverage the Republic of Korea's experience gained from building their 1.8 MMT market to accelerate scaling of the nascent U.S. industry

Potential technical focus areas:

1. Persistent crop- and farm-state sensors
2. Offshore farm depth/nutrient/temperature control
3. Efficient de-watering and biomass preservation
4. Understanding the mechanisms of seaweed based agricultural biostimulants
5. Other new uses of seaweed biomass for energy-efficient uses

ARPA-E Webinar on this potential new ocean technology funding opportunity: Tomorrow (Wednesday December 4th) at 16:00 Eastern Time. Register here:

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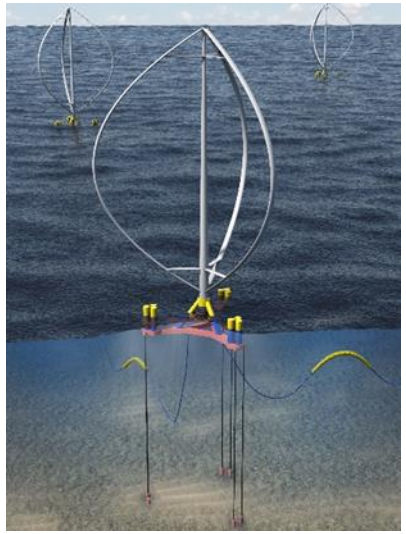
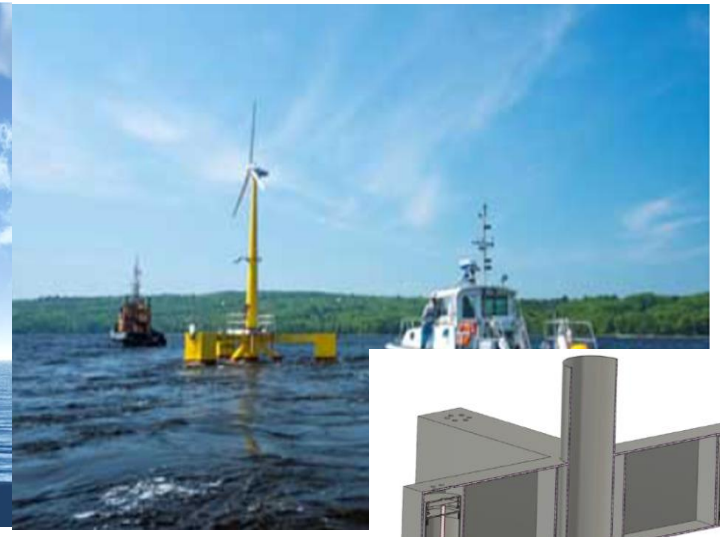
December 2, 2024

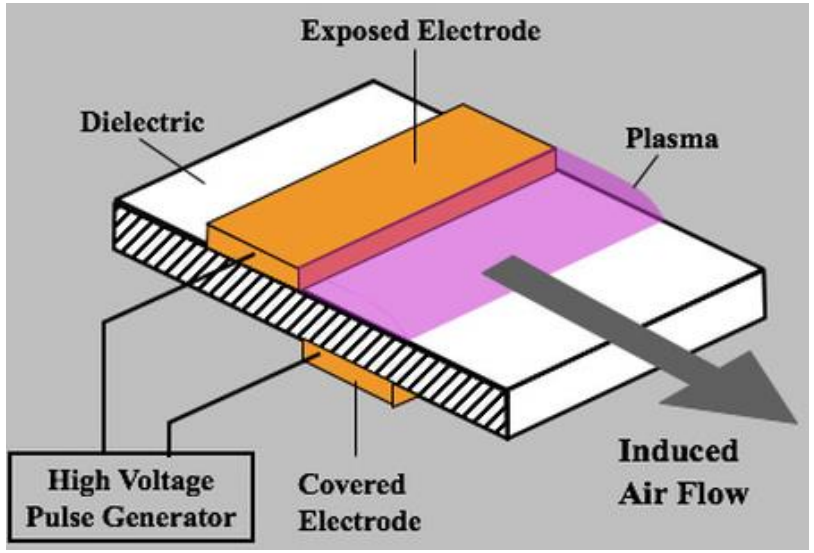
Economic floating offshore wind for deepwater areas

ARPA-E ATLANTIS: Aerodynamic Turbines Lighter and Afloat with Nautical Technologies and Integrated Servo-control

- More energy resources in U.S. deep water than our total electricity consumption.
- ATLANTIS: novel, cost-effective Floating Offshore Wind Turbines (FOWT) using new philosophies incorporating control co-design.
- Inspiration for the DOE FOWT Earthshot







Ionic plasma for dynamic airfoil boundary control

$103M, 2018-present

Dynamic stability through variable ballast water chamber

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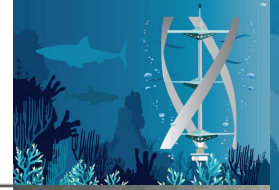
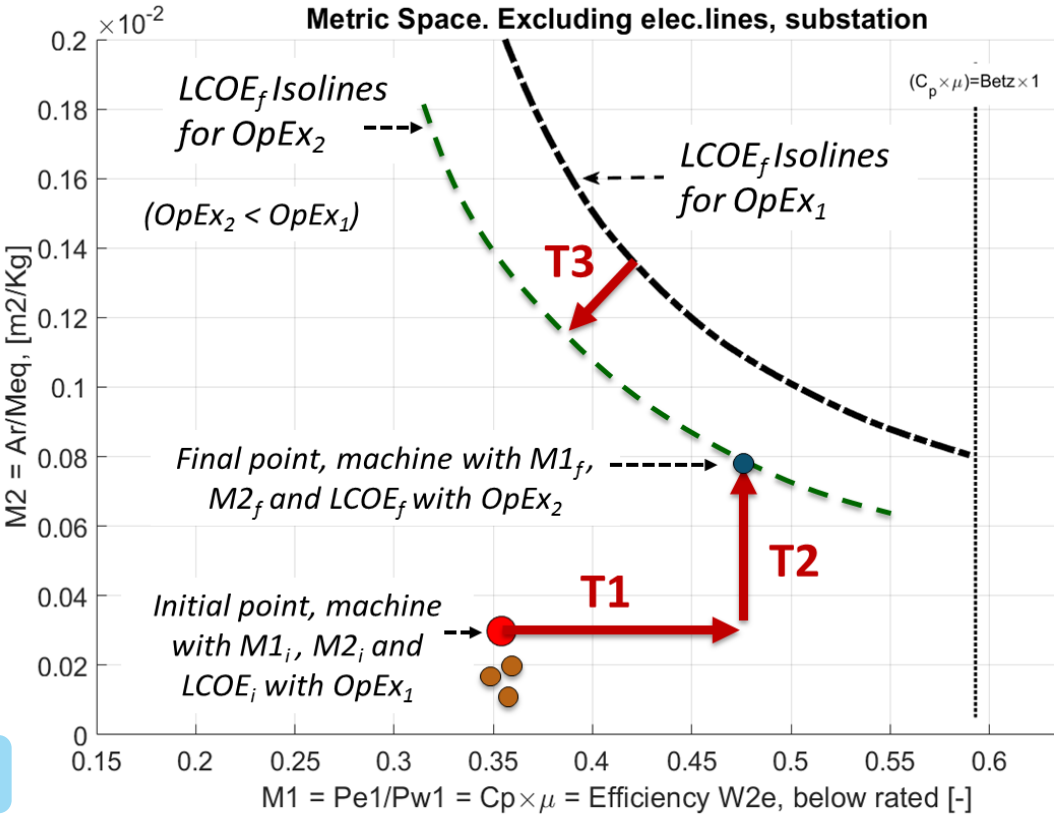
Clean, reliable, tidal and riverine energy converters



ARPA-E SHARKS:
Submarine Hydrokinetic And Riverine Kilo-megawatt Systems

- Energy costs disproportionately impact marginalized groups in remote communities
- SHARKS: River and tidal energy turbine control co-design to reduce the Levelized Cost Of Energy (LCOE)



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$38M, 2020-present

If it works…

will it matter?

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