

U.S. DEPARTMENT OF
ENERGY

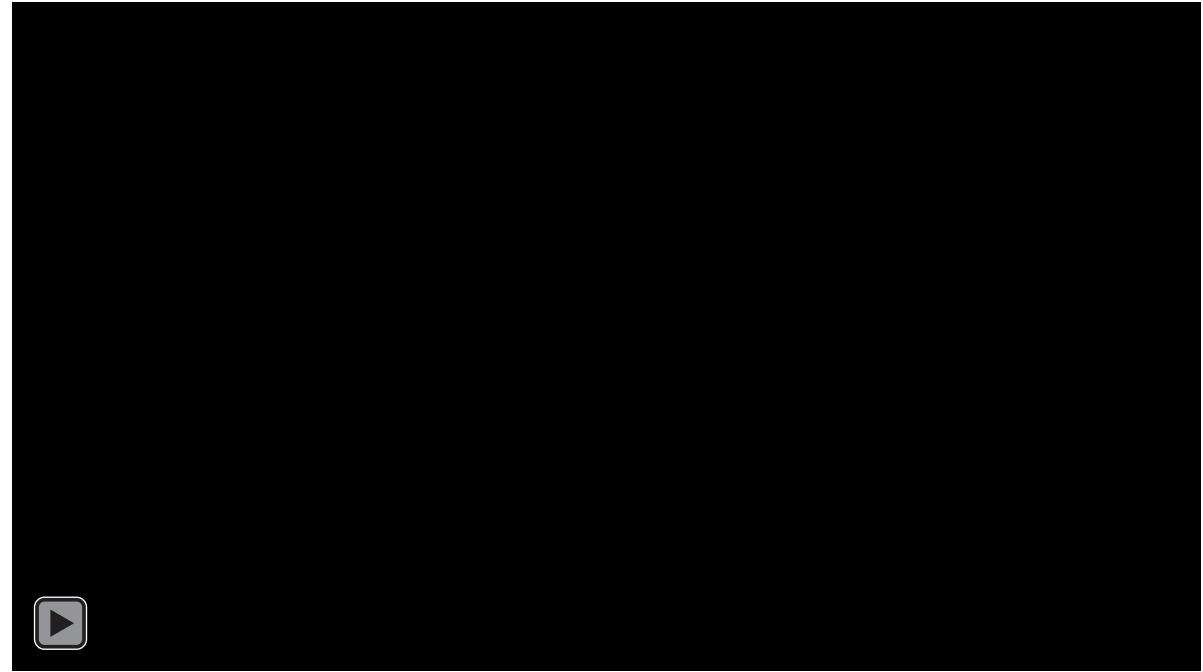
Office of
ENERGY EFFICIENCY &
RENEWABLE ENERGY

Marine Energy to Hydrogen Working Meeting

Marine Energy Overview – Bill McShane – Technology Manager – Water Power Technology Office

February 17th, 2021





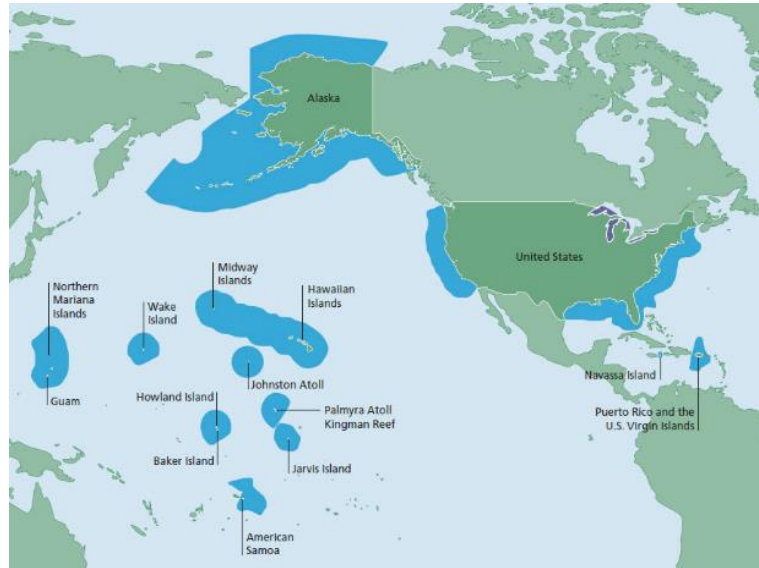
<https://svs.gsfc.nasa.gov/10841>

<https://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=3639>

Should we be Excited about Marine Energy?

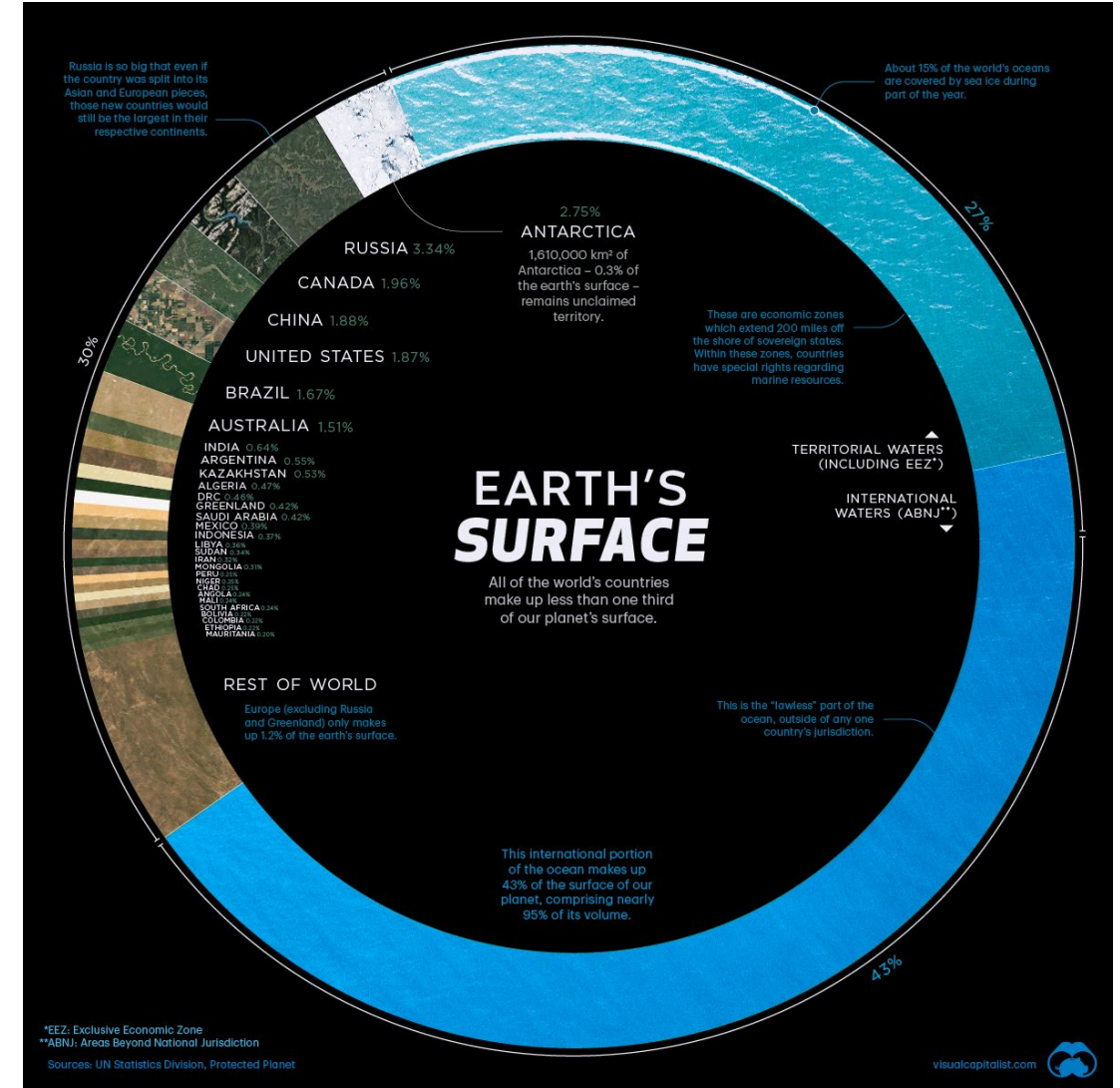
Energy from free-flowing rivers, ocean waves, tides, currents, temperature gradients, and salinity gradients

The Ocean is Vast – Room for Growth



US Area (USDA 2006)	Sq km
Total Land Area	9,158,022
Grassland	2,370,000
Forestry	2,640,000
Cropland	1,786,000
Exclusive Economic Zone (offshore)	11,351,000

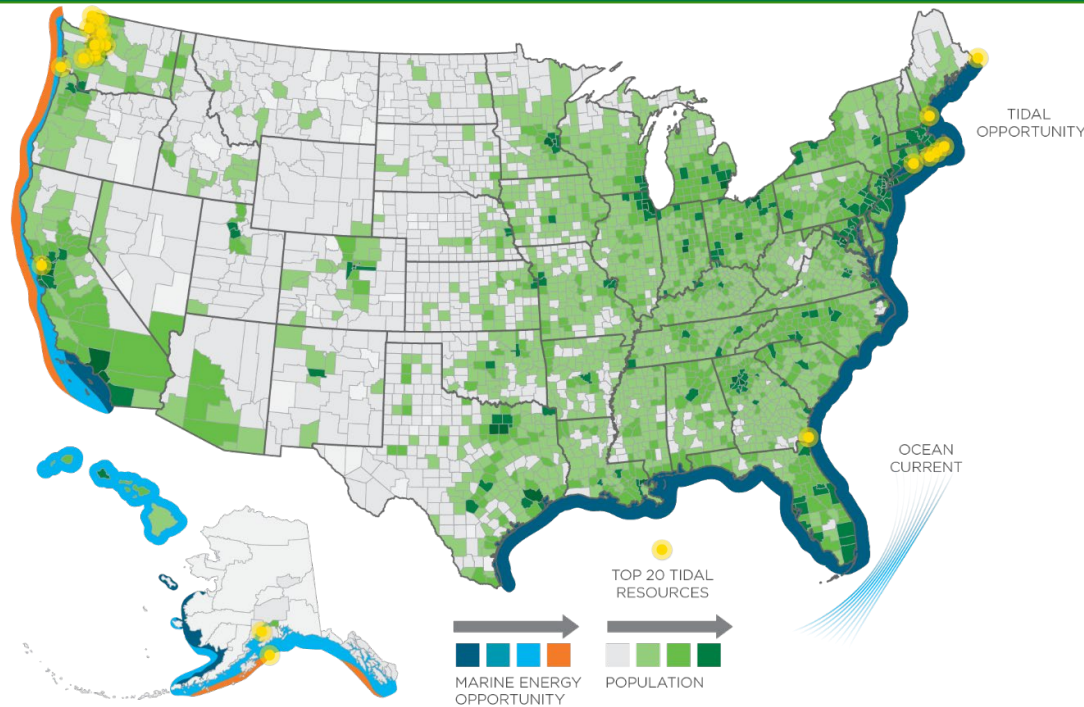
Diverse siting opportunities



<https://www.visualcapitalist.com/countries-by-share-of-earths-surface/>

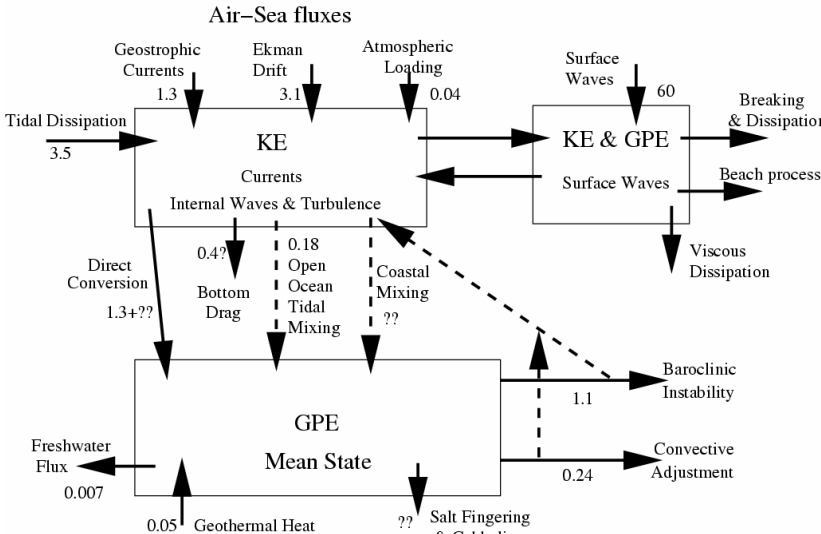
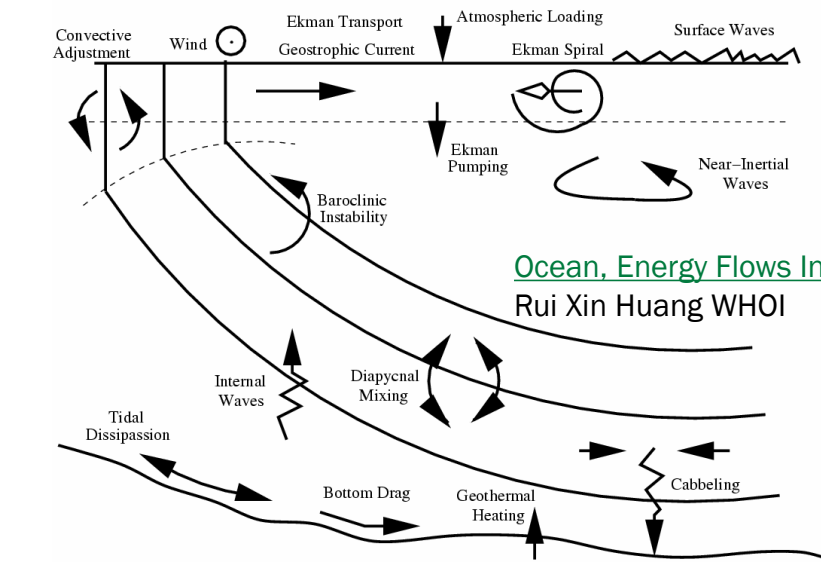
The Marine Energy Resource is Significant and Close to US Population Centers

50%
of the
POPULATION
lives within
50 MILES
of the
COASTLINE



Resource	Total US Theoretical Resource		Total US Technical Resource		CONUS Technical Resource	
	TWh/year	% 2012 U.S. Net Electricity Generation	TWh/year	% 2012 U.S. Net Electricity Generation	TWh/year	% 2012 U.S. Net Electricity Generation
Wave Energy (2,3)	1594-2640	39-65	898-1229	22-30	378-472	9-12
Tidal Current Energy (4)	445	11	222-334	5.5-8.2	15-22	0.4-0.5
Ocean Current Energy (5)	200	49	45-163	1.1-4.0	45-163	1.1-4.0
River Current Energy	1381	34.1	120	3	100	2.5
Total	3620-4666	89-115	1285-1846	31.6-45.2	538-757	13-19

Mechanical energy diagram for the ocean circulation



Mechanical energy balance for the world oceans, units in TW

Marine Energy Has A Value Proposition Beyond A Kilowatt-Hour to Both Grid and Non-Grid Market Opportunities

1. **Locational value** – can be in proximity to large load with no existing or potential transmission access
2. **Predictability** – marine energy's relative predictability reduces integration costs; better foresight than other renewable profiles
3. **Generating profile** – negative correlation with wind and solar at very high penetrations (e.g. winter peak)
4. **Resiliency** – may be one of few solutions available to coastal electric service providers; islanded micro-grids have an energy security value proposition
5. **Integration** – storage, microgrids, interconnection
6. **Distribution** - local effects and investment deferral, electric loads
7. **Transmission** - ancillary services, timing, spatial distribution

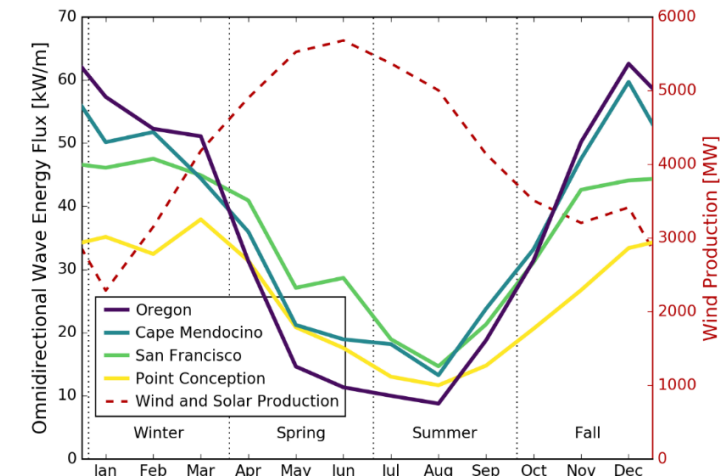


Value of the Kilowatt-Hour

	Excludable	Non-Excludable
Rivalrous	Private Goods Food, clothes, cars and other consumer goods	Common Goods Fish, timber, coal
Non-Rivalrous	Club Goods Cinemas, private parks, satellite TV	Public Goods air, national defence

- Non-rivalry means that more than one person can use the good without diminishing other's ability to use it
- non-excludability means customers cannot be directly charged

Value Beyond the Kilowatt-Hour



Why is the Marine Energy to Hydrogen Energy Vector Worth Investigating?

Promising Opportunities

- The initial fact finding opens the door for opportunities that

- Leverage the strengths of both technologies (synergies)
 - Geographic Colocation
 - Power Variability and Predictability
 - Purifying Water for Hydrogen Production
 - Valuable Coproducts
- Ameliorate challenges of marine energy technologies (strength of working together)
- Have potential of opening unexplored market opportunities
- Look at energy challenges in a creative new way
 - Compression
 - Round Trip Efficiency
 - Hydrogen Storage – a spectrum of options
 - Near-term and long-term Electrolysis Technologies opportunities

- Make two different technical communities more aware of each other
- Safety and versatility

