Pacific NorthWest Economic Region

Energy Solutions: Marine Renewable Energy

1. Systems Approach: Begin with the end in mind
2. Marine Renewable Energy: is a “Big Tent” endeavor
3. Marine Renewable Energy: “Marine & Hydrokinetic Energy” (MHK)
    - Tidal
    - Ocean Current
    - River Current
    - Offshore Wind (Fixed and Floating)
    - Ocean Thermal Energy Conversion (OTEC)
    - Others…
4. “It takes a village”: Many skill sets needed
5. More to MHK than “Levelized Cost of Energy (LCOE)”
    - Cost + Pricing + Value
    - System Benefits
    - Public Benefits = Disaster Resilience

Energy Solutions: Marine Renewable Energy

- When we talk about MHK…

  Most of us think about Marine Energy Converters (MECs):

  Wave, Tidal, Ocean Current, River Current, OTEC, Offshore Wind, etc

  Lot's of technologies… in wave energy alone there are:

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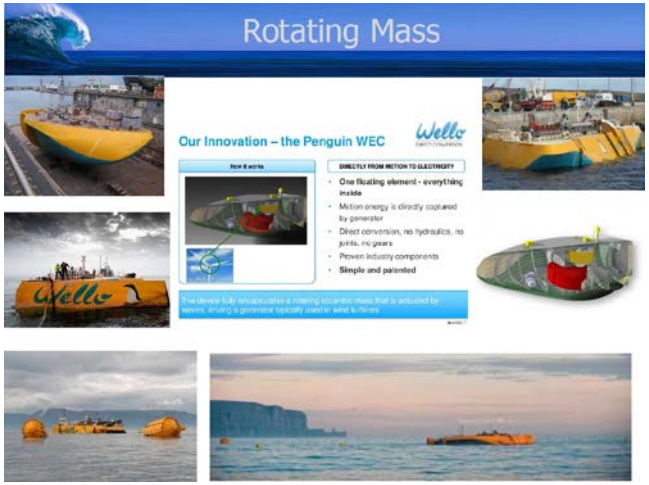

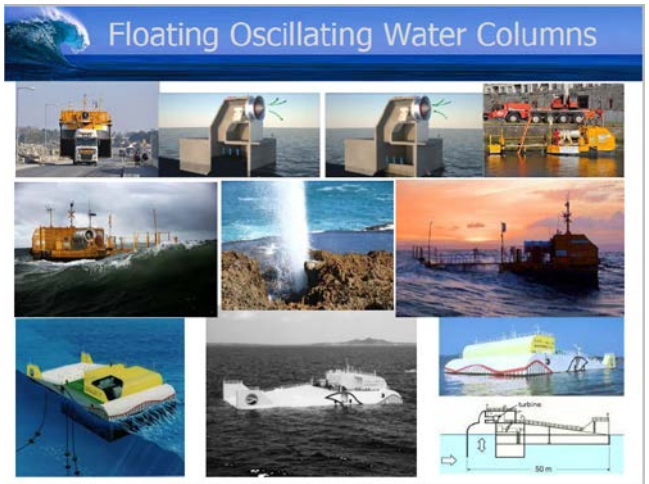

Energy Solutions: Marine Renewable Energy

- And, while MECs are cool technologies…

  An integrated system solution is required so that the MECs can be deployed, maintained, operated, recovered...

  and can provide a useful output to the utility…

  (generate electricity or make water)…

  and generate revenue!

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- From a Systems Approach…

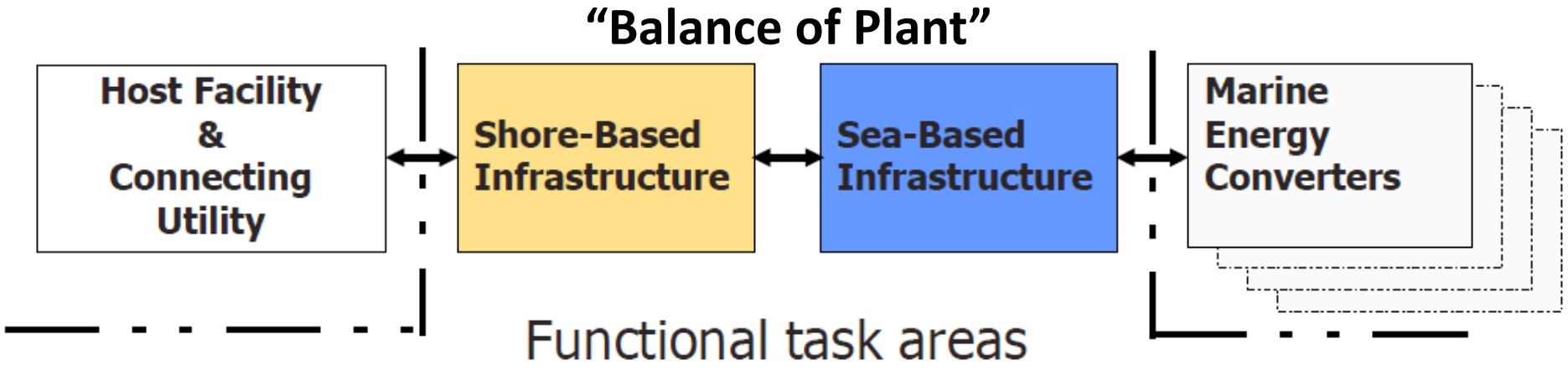
  the grid is called a "Boundary System"

- In Conventional Hydro parlance…

  The connection to the grid is the *"Balance of Plant"*.

CalWave℠ System Block Diagram

And, from a Project Developers Grid-Centric perspective:



Host Facility	**Boundary System: Mature** Base infrastructure and procedures. Connecting utility infrastructure and procedures. O&M
Design & Planning	Resource adaptation, conceptual design/preliminary/detailed design, program planning
Regulatory & Permitting	Site evaluation and selection, environmental analysis, outreach, and agency interaction
Implementation, Operations & Maintenance	Procurement, fabrication, logistics, installation, commissioning, project operations, maintenance, monitoring, adaptive management, and decommissioning
Financial & Business Management	Financial & Business Models, Planning, Acquisition Program & Project Management, Program & Grant Administration, Contingency/Configuration/Change Control, Cost Controls
Marine Energy Converters (MECs)	**Boundary System: New Product Development** Technology invention, prototyping, progressive test, planning, and demonstration. O&M

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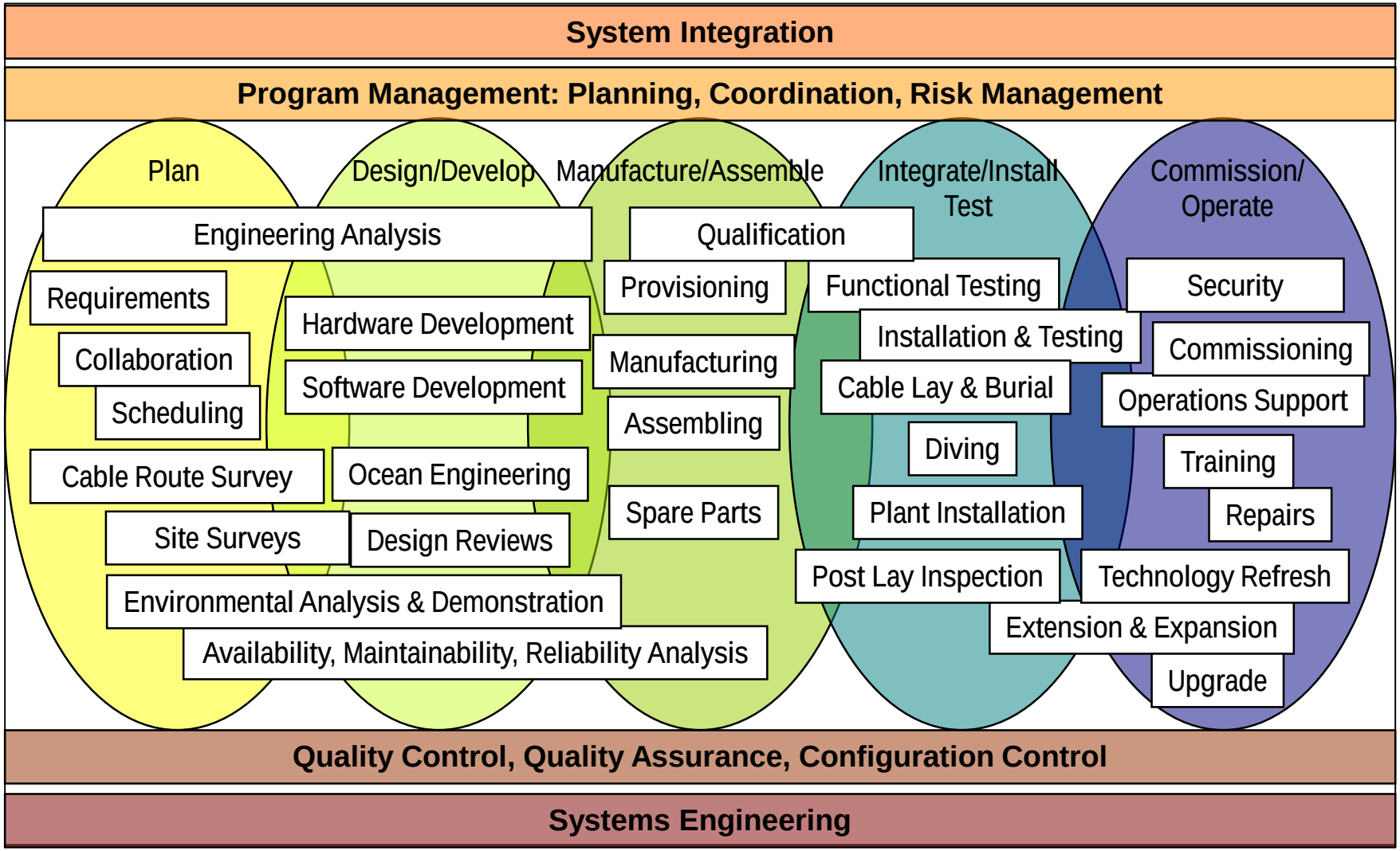
Pacific NorthWest Economic Region

Maritime Industry Value Chain



Slide provided by: leidos

Maritime means: Related to the sea and inland waters including water-side & upland activities

Maritime Sector Clusters and Activities:

- Port Operations
  - Cargo Loading and Unloading
    - Longshoreman
    - Stevedores
  - Passenger Loading and Unloading
  - Distribution of Cargo (Arrival/Departure)
  - Multimodal Distribution
  - Homeland/Maritime Security
  - Marine Logistics (Cargo Distribution)
  - Spill Response
- Transportation
  - Cargo (dry and liquid)
  - Passenger (ferry and cruise)
  - Tug/Towboats (ship assist, tow, bunkering)
  - Recreational
- Maritime-Related Professions
  - Marine Engineering
  - Naval Architects
  - Admiralty Lawyers and Staff
  - Risk Managers/Insurers/Surveyors
  - Marine Chemists
  - Merchants Exchange Members

- Shipbuilding and Repair
  - Ship Repair Operations
  - Tug and Barge Construction
  - New Vessel Construction
  - Recreational Boat Construction and Repair
  - Ship Engineering and Design
- Offshore Exploration and Support
  - Scientific and Oceanographic Research
  - Commercial
  - Academia
- Marine Manufacturing & "Blue Technology"
- Tourism
- Academia
- Wave Energy Industry
- Not-for-Profit/Non-Governmental Organizations

- Fishing and Crabbing
  - Commercial Fishers
  - Commercial Crabbers
  - Sport & Charter
  - Recreational
  - Operations/Engineering/Logistics Support
  - Catch Operations
  - Processing
  - Marine Hardware and Chandlery
  - Distant Waters Operations
- Maritime Workforce Deployed around the Globe
  - US Commercial Mariners on ships of many flags
  - US Merchant Marine & Military Sealift Command
  - Tug & Tow Mariners
  - Local Fishers and Crabbers
  - Distant Waters Fishing and Crabbing Fleet
  - Oil & Gas Operations Fleet
  - Research Vessel Fleet and US NOAA
  - US Coast Guard
  - US Navy & Marine Corps
  - Ocean and River Pilots

Note: ~9,000 distinct USCG licenses are domiciled in Oregon

Maritime careers span a wide range of opportunities from deep sea to shoreside positions.

Energy Solutions: Marine Renewable Energy

Industry, Government and Academia Working Together

- Maritime Economic Sector Initiative
- Oregon Senate Bill 867 – Maritime Industry Task Force
- Maritime Industry Workforce Solutions Group

Oregon State Legislature
Oregon Legislative Information
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Session

2017 Regular Session

SB 867 Enrolled
Follow this Bill: e-Subs

Overview | Text | Analysis | Meeting Material/Exhibits | Amendments

Overview

At the request of:	(at the request of Oregon Coastal Zone Management Association (OCZMA))
Chief Sponsors:	Senator Kruse, Roblan, Representative Gomberg, Smith DB
Regular Sponsors:	Senator Johnson, Representative McKeown
Bill Title:	Relating to maritime sector workforce development; and prescribing an effective date.
Catchline/Summary:	Creates Task Force on Maritime Sector Workforce Development.
7-18 (S)	President signed.
7-18 (H)	Speaker signed.
Current Location:	Governors Office - Awaiting Signature

SENATE MAJORITY OFFICE
Oregon State Legislature
State Capitol
Salem, OR

NEWS RELEASE

July 1, 2017

CONTACT: Rick Osborn (503) 986-1074
Rick.osborn@oregonlegislature.gov

Maritime industry is vital to coastal Oregon economy

SB 867 creates task force dedicated to training coastal workforce for good jobs

SALEM – The Oregon Senate voted to advanced legislation today designed to help maritime businesses – as well as current and future workers in that industry – by connecting workforce training opportunities with the needs of maritime sector businesses.

Spearheaded by a bipartisan group of legislators that includes Sen. Roblan Roblan (D-Coos Bay), Sen. Jeff Kruse (R-Roseburg), Rep. David Gomberg (D-Otis) and Rep. David Brock Smith (R-Gold Beach), Senate Bill 867 – which passed the Senate floor on a 30-0 vote – creates the Task Force on Maritime Sector Workforce Development.

"The maritime industry is vital to our state's economy; it has been a cornerstone throughout our state's history, and it will continue to create good jobs on the coast," Roblan said. "As a lifelong educator, I have known for years that training opportunities are of little value if they don't prepare our students with the skills they need to be successful in the workforce."

Wave Energy Project Life Cycle = Jobs

Plan/Design/ Develop	Manufacture/ Assemble	Integrate/ Install	Commission/ Test	Operate/ Maintain
Designers	*Schedulers*	*Ocean Engineers*	*Operators*	*Maintenance Techs*
Technologists	*Buyers*	*Technologists*	*Engineers*	*Electricians*
Materials Scientists	*Vendors*	*Boat Operators*	*Technologists*	*Machinists*
Oceanographers	*Transportation*	*Marinas*	*Designers*	*Welders*
Meteorologists	*Welders*	*Materials Techs*	*Materials*	*Boat Operators*
Environmental	*Electricians*	*Oceanographers*	*Oceanographers*	*Marinas*
Surveys	*Machinists*	*Meteorologists*	*Meteorologists*	*Riggers*
Analysis	*Painters*	*Environmental*	*Environmental*	*Painters*
Regulatory	*Quality Assurance*	*Regulatory*	*Communications*	*Ocean Engineers*
Legal	*Riggers*	*Legal*	*Public Relations*	*Designers*
Ocean Engineers	*Ocean Engineers*	*Communications*	*Finance*	*Technologists*
Mooring Engineers	*Mooring & Cables*	*Public Relations*	*Administration*	*Materials*
Cable Engineers	*Integration*	*Finance*	*Boat Operators*	*Oceanographers*
Power Distribution	*Testing*	*Administration*	*Marinas*	*Meteorologists*
Communications	*Communications*	*Anchoring*	*Ocean Engineers*	*Environmental*
Public Relations	*Finance*	*Cable Technicians*	*Moorings*	*Legal/Finance*
Finance	*Administration*	*Power Technicians*	*Cables*	*Administration*
Administration	*Facilities Managers*	*Lodging/Food*	*Distribution*	

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More to MHK than "Levelized Cost of Energy (LCOE)"

- Engineers love precise metrics, and LCOE is precise and inaccurate
- MECs need time in the water, generating power to confirm LCOE
- Power for Oregon Coast is generated east of the Coast Range

Cost + Pricing + Value

- Cost: Will be higher than baseload generation (coal, hydro, gas, nuclear)
- Pricing: "Nodal Pricing of Distributed Generation"
  - Location, Location, Location
- Value: What is that next kWhr worth in different situations?
  - Clean, Renewable Energy
  - System Benefits
  - Public Benefits

Energy Solutions: Marine Renewable Energy

Tale of Two Test Sites: Infrastructure Planning

Oregon National Guard
Courage and Commitment

CalWave SM

Cal Poly San Luis Obispo

U.S. Department of Energy

Energy Solutions: Marine Renewable Energy

Marine Renewable Energy Program

Oregon Military Department
with National Guard Bureau
in collaboration with OWET

California Wave Energy Test Center (CalWave)

initiated by PG&E WaveConnect
CalWave I study led by Cal Poly
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Camp Rilea Armed Forces Training Center

*Energy Independence/Security/Resilience/Net Zero

- Base: 500kW average, ~1MW peak, PacifiCorp
- Community: 50 MW at BPA Lewis & Clark Substation

Vandenberg Air Force Base

*Energy Independence/Security/Resilience/Net Zero

- Base: 10MW min, 20MW ave, 28 MW peak, PG&E
- Community: >100 MW

"A site that will cooperate with testing"	Test Center
Shallow and Mid-Depth WECs	Deep Water >60m
Surface/Floating or Bottom-Mounted	Surface or Bottom-Mounted
Near-term Market: 1MW	Near Term Market: 25MW to 40MW
Waves-to-Wires and Near-Shore Pumpers	Waves-to-Wires
Longer-term testing: deep water "graduates"	Longer-term testing: deep water "graduates"

Common to both: Need for Energy Security, Energy Independence and Disaster Resilience

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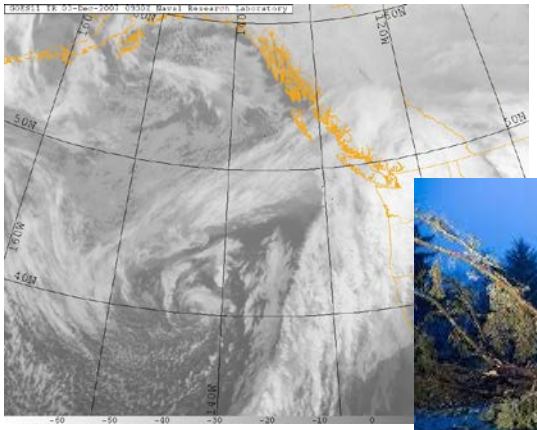
"Great Coastal Gale of 2007!"



Vandenberg Air Force Base
Wildfire! Feb 2017

Requirement: Disaster-Resilient Power

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