Agenda

Renewable Energy Advisory Council
Wednesday, February 8, 2017: 9:00 a.m. – 12:00 p.m.
Please note the early start time of 9:00.

http://www.energytrust.org/about/public-meetings/renewable-energy-advisory-council-meetings/
Energy Trust conference room Kilowatt
421 SW Oak St., Suite 300
Portland, Oregon 97204

9:00 **Welcome, introductions** **Information**

9:05 **PGE's tests of torrefied biomass at the Boardman Power Plant** **Information**

- Staff from Oregon Torrefaction and PGE will provide an update on the test burns recently conducted with torrefied biomass material at Boardman.

9:35 **Energy Trust's work on hydropower and biopower** **Information**

- Staff will discuss 2016's efforts in these two renewable energy areas and what they will be working on in 2017.

10:25 **Break**

10:35 **Preliminary year-end results** **Information**

- Staff will present preliminary figures for Energy Trust's results in renewable energy and energy efficiency for 2016.

10:45 **Discussion and feedback about budget presentations** **Discussion**

- Staff will seek RAC feedback on the effectiveness of the fall budget presentations in gathering meaningful input, and ask for suggestions on things to keep and things to change.

11:15 **Update on wave energy in Oregon and DOE grant** **Information**

- Jason Busch from Oregon Wave Energy Trust will provide an update on progress in ocean energy and the recent announcement of a US DOE grant for a test facility.

11:45 **Public comment**

12:00 **Adjourn**

Our next meeting is Wednesday, March 15, 2017. You can view this agenda and meeting notes at: http://www.energytrust.org/about/public-meetings/renewable-energy-advisory-council-meetings/. If you have comments on meeting notes, please alert Betsy Kauffman at betsy.kauffman@energytrust.org.

Renewable Energy Advisory Council Meeting Notes

February 8, 2017

Attending from the council:
Erik Anderson, Pacific Power
Bruce Barney, Portland General Electric
Jason Busch, Oregon Wave Energy Trust
Suzanne Leta-Liou, SunPower
Les Perkins, Farmers Irrigation District
Frank Vignola, Solar Monitoring, University of Oregon
Dick Wanderscheid, Bonneville Environmental Foundation
Peter Weisberg, The Climate Trust

Attending from Energy Trust:
Michael Colgrove
Jeni Hall
Mia Hart
Jed Jorgensen
Betsy Kauffman
Dave McClelland
Dave Moldal
Joshua Reed
Thad Roth
Lizzie Rubado
Kenji Spielman
Mariet Steenkamp
Peter West
Lily Xu

Others attending:
Caroline Moore, Pacific Power
Jason Zappe, Portland General Electric
Matt Krumenauer, Oregon Torrefaction
John Reynolds, Energy Trust board
Alan Meyer, Energy Trust board

1. Welcome, introductions and updates

Betsy Kauffman convened the meeting at 9:00 a.m. The agenda, notes and presentation materials are available on Energy Trust's website at: https://www.energytrust.org/about/public-meetings/renewable-energy-advisory-council-meetings/.

2. PGE tests of torrefied biomass at the Boardman Power Plant

Matt Krumenauer presented on Oregon Torrefaction's work with Portland General Electric at the Boardman Power Plant to evaluate the economic, environmental and technical feasibility of fueling the coal plant with biomass after its scheduled closure in 2020. Torrefaction is a process that converts plant or woody biomass to a high-grade solid biofuel. The process involves a thermo-chemical treatment of biomass between 200 and 300 degrees Celsius to form a coal-like substance, ground and densified to produce pellets.

Energy produced per pound of biomass depends on the type of material, time and temperature. Longer roasting creates a higher energy density product. Torrefied biomass burns a little better than coal due to its lower moisture content. Over the past year, Oregon Torrefaction has delivered nearly 5,000 tons of torrefied biomass to PGE's Boardman Power Plant and completed four test burns.

Bruce Barney: The biomass used at the Boardman plant is mostly softwoods. Can you use hardwoods?
Matt Krumenauer: Yes, you can use both. Hardwoods have a higher cellulous content, but are not as prominent in our region. Poplars could be an option.

Dave Moldal: Is there a fire risk associated with torrefied biomass?
Matt Krumenauer: There is a risk, but it's manageable. There were a couple instances of smoldering so we created new operational procedures to monitor the temperature profile of the fuel pile.

Peter West: Are nitrogen oxide emissions comparable to coal?
Matt Krumenauer: That's unknown at this time. Any type of combustion will emit nitrogen oxide, but we will need to perform a stack test on a 100 percent biomass burn to monitor emissions.

Betsy Kauffman: What are the next steps for testing at Boardman?
Matt Krumenauer: PGE will conduct a 100 percent biomass test burn, monitor the performance and gather data. In the longer term, additional testing is necessary to fully evaluate viability, examine the economics for fuel procurement, delivery and performance, and perform a life cycle assessment.

Dave Modal: Are there any similar models running outside of Oregon?
Matt Krumenauer: Other companies are watching our test with Portland General Electric. A few other utilities have completed co-firing tests, including Minnesota Power, Capital Power and PacifiCorp in Utah, but nothing at this scale. PGE wants to use 100 percent biomass or nothing.

Erik Anderson: Have you done an analysis on how much local biomass is available?
Matt Krumenauer: Sourcing woody biomass feedstock is the biggest cost and will drive the cost of fuel. We're analyzing this issue now, which is not 100 percent woody biomass. It could be cost effective to transport biomass from other states.

Suzanne Leta-Liou: Is Energy Trust funding any part of this project?
Jed Jorgensen: Energy Trust provided some Project Development Assistance to examine if this technology could have a role in small combined heat and power applications, not for Boardman.

3. Energy Trust's work on hydropower and biopower

Jed summarized 2016 efforts in the Other Renewables program. One 11-kilowatt hydroelectric project reached commercial operation. Energy Trust received seven competitive applications, approved a hydroelectric project and is still reviewing two biogas projects. Staff committed funding for two small wind projects totaling 20 kilowatts. The program also supported 49 projects with Project Development Assistance, including 27 Irrigation Modernization projects and is expecting results from Irrigation Modernization assessments soon. The program's generation forecast in 2017 is expected from small wind, and there's a high demand for Project Development Assistance, especially related to Irrigation Modernization.

Dave Moldal summarized 2016 efforts for biopower and provided an overview of the current biogas market. This year, the value proposition for biogas projects for large breweries is becoming more convincing and the Portland area is exploring how to handle post-commercial food waste with anaerobic digestion or composting. For the first time, staff is performing project evaluations for a hydroelectric and biogas project to examine their performance, above-market costs, and operations and maintenance issues.

Peter West: When do you expect the irrigation projects that received Project Development Assistance to come online?
Jed Jorgensen: We expect applications late this year or 2018. Then we would work with districts on how to phase the opportunities available to them.

Erik Anderson: What are the primary funding sources for irrigation modernization?
Jed Jorgensen: Funding opportunities are subject to the project benefits. Funding support for water savings benefits can come from Bureau of Reclamation and Oregon Watershed Enhancement Board. Funding for the energy-efficiency benefits could come from Energy Trust and USDA Rural Energy for America Program grants. There are additional funding possibilities related to locally sensitive environmental benefits that may be achieved within certain areas.

Alan Meyer: What's the conversion rate from projects that receive Project Development Assistance to installation? And how do funding opportunities fit in that conversion?
Jed Jorgensen: We don't know the conversion rate yet. We're looking at how costs will change over time. We expect the assessment process to become less expensive per district as we learn and implement operational efficiencies. We are also expecting irrigation districts to bring more funding to the table over time, and are looking at how to ramp down our level of assistance while maintaining participation.
Bruce Barney: I'm concerned about the amount of Project Development Assistance Energy Trust is providing, but it sounds like you're actively trying to balance how much support you're providing.
Betsy Kauffman: If we don't provide Project Development Assistance, we won't have project installations. It is also a high-priority performance metric for the Oregon Public Utility Commission. We believe this is the right time to be providing this support, and these multi-benefit projects bring multiple possibilities for additional funding sources that can produce a better result.

Erik Anderson: Can Energy Trust participate in pipeline injections for biogas?
Betsy Kauffman: No, we can fund only projects that generate electricity.

Bruce Barney: Why did the Tillamook project come offline?
Dave Moldal: This was not an Energy Trust project; they received federal funds. The project collapsed due to manure transport costs.
Peter Weisberg: Some have said it's still economically feasible and that they're looking at other options.

John Reynolds: Can you provide an update on JC-Biomethane?
Dave Moldal: They are consistently generating electricity at about 800 megawatt hours per month. The challenges with processing post-commercial food waste feedstock have been reduced, but there are still some challenges.

4. Preliminary 2016 results

Betsy Kauffman provided an overview of 2016 preliminary annual results for renewable energy programs and energy efficiency programs. Results reflect the best available data at this time, and may shift after the release of the annual report to the Oregon Public Utility Commission in April.

Suzanne Leta-Liou: Why were the two custom solar projects delayed?
Dave McClelland: SolarCity is the owner of one of the projects and during the acquisition by Tesla, all projects were delayed. The second project completed installation and is working through final contracting items that are expected to clear up this quarter.

Suzanne Leta-Liou: Did standard solar exceed goal for both residential and commercial?
Dave McClelland: There was a drop in third-party owned residential systems in the second half of the year. Sunrun and SolarCity stopped offering the third-party model, part of a trend seen across the US. There was a 30 percent increase in customer-owned systems following the

fallout, which was able to fill the market gap. 2016 was also a big year for commercial projects with 8-9 megawatts of new generation.

John Reynolds: Were we under goal for renewables in 2015?
Betsy Kauffman: No, we exceeded goal in 2015. Our annual goals are a forecast of potential generation within a given year, based on budget available. Annual goals are separate from our 2015-2019 Strategic Plan goals and Oregon Public Utility Commission performance measures.

Alan Meyer: Why was Pacific Power 148 percent of goal in standard solar?
Dave McClelland: We completed more projects than forecasted in residential and commercial standard solar. There were also some commercial projects that shifted from 2015 to 2016.

5. Discussion and feedback about budget presentations
Betsy asked for feedback from members about how they would like to be involved in our annual budget development process. Members split into small groups to discuss and share back.

Erik Anderson: I heard some concern around the potential of above-market costs of different technologies. Energy Trust provides Project Development Assistance early and each of those projects could meet above-market cost requirements. Taking a look at overall above-market costs across technologies would be helpful in shaping the budget.

Bruce Barney: I'd like a better frame of reference for how these decisions are made and to see data on generation by project cost and technology.
John Reynolds: I agree about having decisions more visible, especially those with ancillary benefits.
Betsy Kauffman: We've always had a portfolio approach for renewables. Solar used to be more expensive, but we continued to offer services and incentives for market benefit.

Frank Vignola: There's a lot of input and background that council members can't see from Energy Trust staff. I'd like clarity around the type of feedback you're seeking and the role of council members in budget decisions. The council can provide advice on specific projects, but we can't advise on the bigger picture because we don't have the information and background into what goes into making those decisions.

Jason Busch: I'd like clarification around expectations of members. I don't need to understand all aspects of the budget as the board of directors fills that role and approves the budget.

Dick Wanderscheid: The budget process is transparent and has been improved greatly in the last five years. It would be nice to see a larger range than one or two years to see if there are long-term trends, such as a rolling average.

Peter Weisberg: I'd like staff to present more information on strategic decisions related to budget allocation and ask council members for feedback on the approach.

Alan Meyer: I like when there's explanation and context around the external factors considered in decisions. We're doing that already, but I'd like to see it more consistently.
Jed Jorgensen: We currently present the budget in an annual context, but it might be better to show that in the larger context of the Strategic Plan.

Bruce Barney: In the budget presentations, it would be nice to see tables with other graphical interpretations of the data to show the same information differently. I like the current level of exposure we have to the energy-efficiency budget to show a high-level view.

6. Update on wave energy in Oregon and Department of Energy grant

Jason Busch, Oregon Wave Energy Trust, summarized the types of marine hydrokinetic energy technologies and provided examples of where marine projects were deployed, including wave, tidal, ocean current, river hydrokinetic, ocean thermal exchange and floating wind generation. Oregon's focus is on wave energy due to the state's coastal geography. Wave energy is predictable, inexhaustible, close to populations and has low integration costs relative to solar and wind.

In 2016, the U.S. Department of Energy awarded $40 million for the Pacific Marine Energy Center, a wave energy test facility proposed to be built six miles off the coast of Newport. The facility is supported by Oregon State University and different companies can use the facility to test their technologies. Another $4.2 million is being sought from partners to fulfill needed funding. The Oregon Wave Energy Trust is still trying to understand if there are implications for the Department of Energy award given the new administration. Historically there has been bipartisan support from Congress for Department of Energy research and development.

John Reynolds: Does Energy Trust have a role in wave energy if we're limited to sub-20-megawatt projects?
Jason Busch: Over the next 10 years, we expect wave energy will be accessible beyond commercial projects. These large and innovative technologies take a phased approach. It will need collaboration and support from a variety of players to accept wave energy before commercial viability. Oregon National Guard's Camp Rilea will have a smaller-scale project for shallow water tests.

Dave Moldal: What is the water depth at the test facility and how will you chose which companies get to use or lease the limited testing locations?
Jason Busch: The water is 60-80 meters deep. Selection is first come, first served and the Northwest National Marine Renewable Energy Center will use its discretion if there's a conflict.

7. Public comment

There was no additional public comment.

8. Meeting adjournment

The next scheduled meeting of the Renewable Energy Advisory Council is on Wednesday, March 15, 2017, at 9:30 a.m.

Oregon Torrefaction

Torrefied Biomass Testing at Boardman Power Plant

Energy Trust of Oregon

Renewable Energy Advisory Council

February 8, 2017

Oregon Torrefaction, LLC

Mission: To advance forest health and rural, forest-rich community vitality

As an Oregon Benefit Company a purpose of Oregon Torrefaction includes creating a material positive impact on society and the environment.

BONNEVILLE ENVIRONMENTAL FOUNDATION

U.S. Endowment for Forestry and Communities

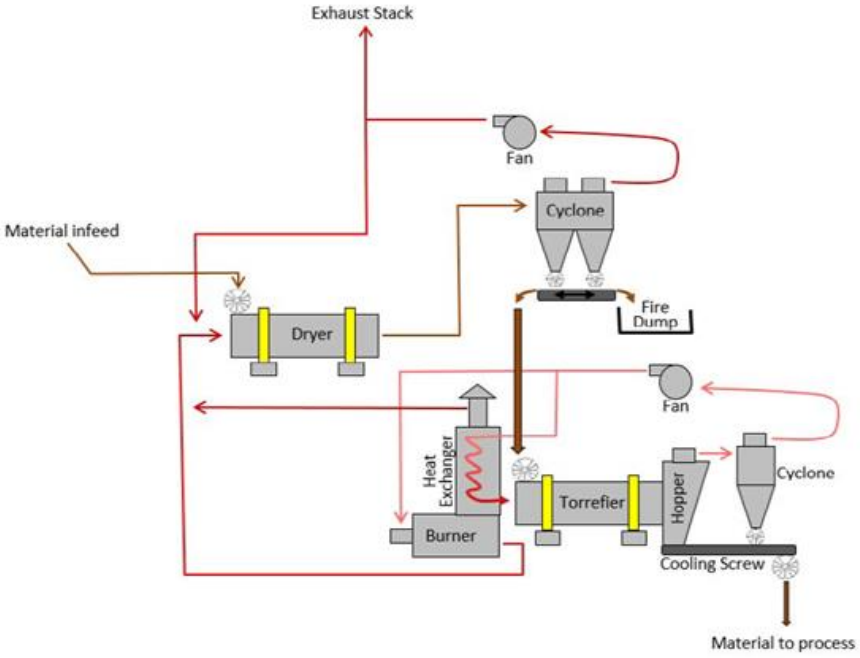
Ochoco Lumber COMPANY

Oregon Torrefaction

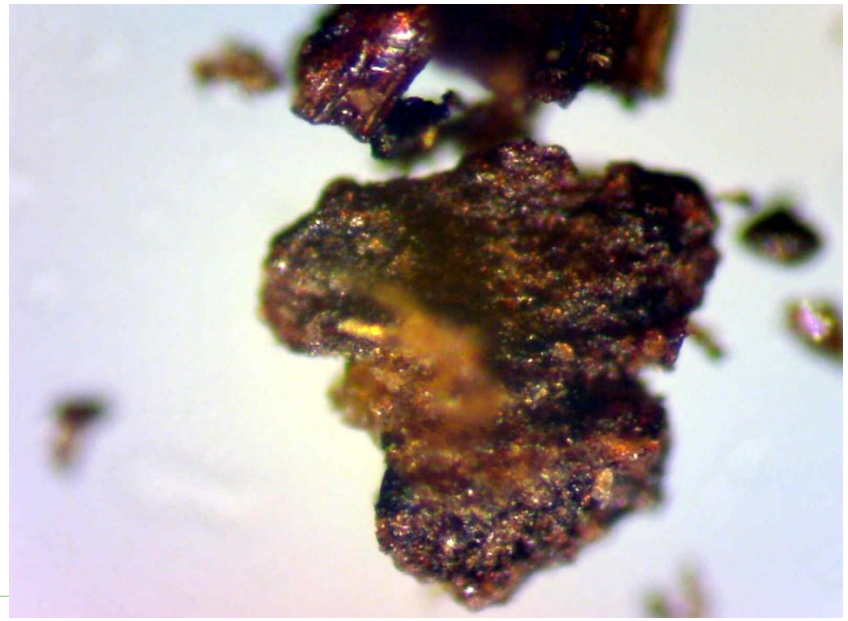
Torrefaction

- Mild form of thermal conversion – biomass is treated between 250° C and 300° C without oxygen and a defined retention time
- Physical properties of biomass are changed resulting in a hydrophobic and brittle material

Oregon Torrefaction



Why Torrefaction?



Oregon Torrefaction

4 facilities produced the ~5,000 tons that was delivered to PGE

Reklaim

New Biomass Energy

Airex

Oregon Torrefaction

INL Unit

Torrefied wood chips from restoration treatments

Oregon Torrefaction

Densified wood chips via Warren Baerg Cuber

Oregon Torrefaction

Torrefaction after densification

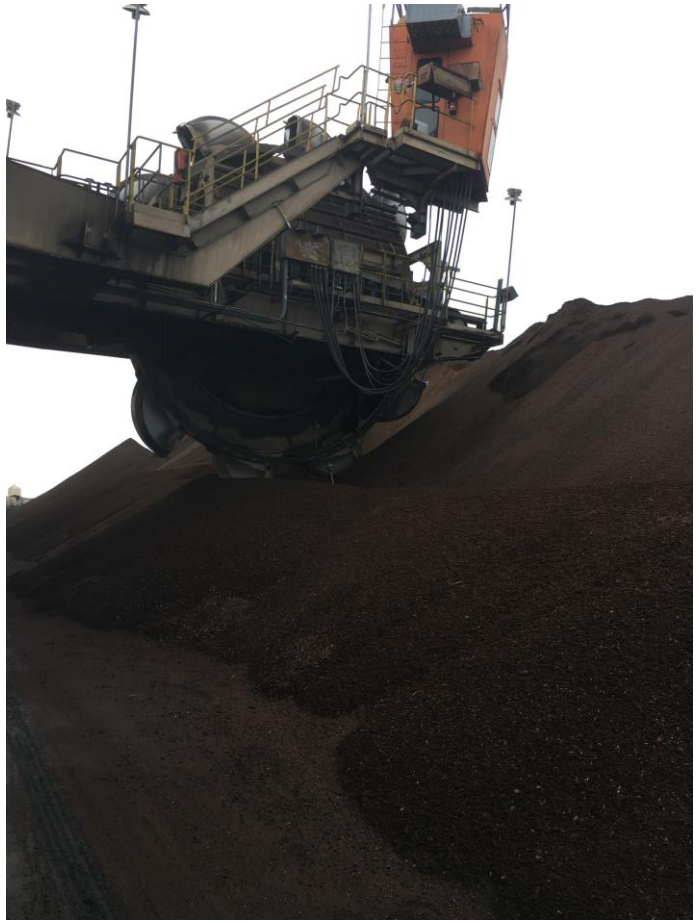
Fuel analysis

Origin	Material	n	Mean (btu/lb)	SD	CV (%)
Airex	Northern softwood	1	8,185		
INL	Pine and fir	11	8,951	721	8.1%
New Biomass Energy	Southern Yellow Pine	6	8,680	204	2.3%
OT Boardman Cuber	Pine and fir	1	8,292		
ReKlaim	Pine and fir	17	8,879	280	3.2%
	Wood	**36**	**8,832**	**469**	**5.3%**
ReKlaim	**Arundo**	**5**	**10,709**	**231**	**2.2%**
	Total		**9,061**		

Origin	Material	n	Mean (btu/lb)	Mass (tons)	fraction	wt mean
Airex	Northern softwood	1	8,185	219.6	0.044	360
INL	Pine and fir	11	8,951	583.9	0.117	1,046
New Biomass Energy	Southern Yellow Pine	6	8,680	3,714.3	0.744	6,454
OT Boardman Cuber	Pine and fir	1	8,292	4.0	0.001	7
ReKlaim	Pine and fir	17	8,879	468.6	0.094	833
ReKlaim	Arundo	5	10,709	5.0	0.001	11
	Total	**41**		**4,995.3**	**1.000**	**8,710**

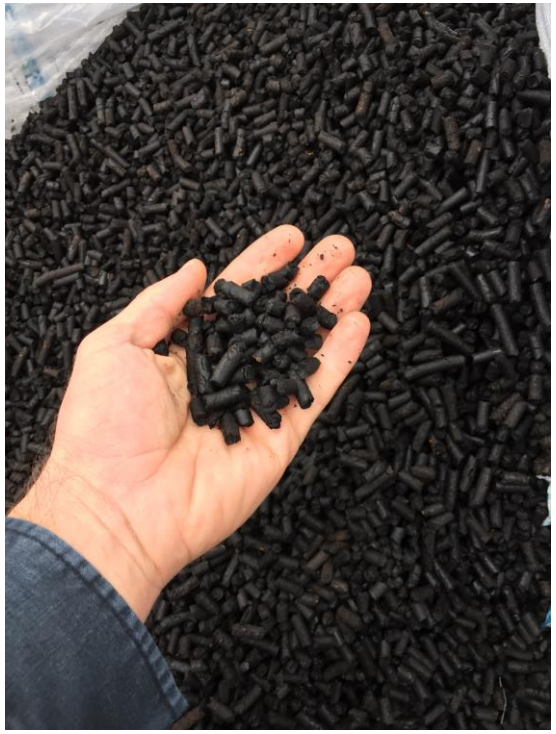
Different delivery methods

Handled with existing equipment in the yard



Oregon Torrefaction

Weather



Oregon Torrefaction

It burned well!

Video>

Oregon Torrefaction

Other Renewables program

2016 Results
2017 Outlook

Feb 8, 2017

EnergyTrust of Oregon

Overview

- Project installations
- Project installation applications & reviews
- Project Development Assistance

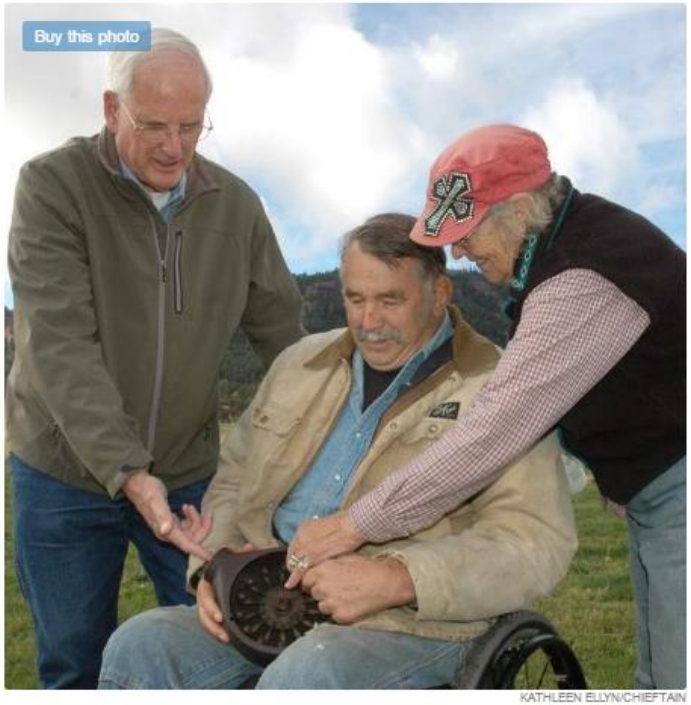

Project Installations
in 2016
SPS Ranch (11kW hydro)

WALLOWA COUNTY'S NEWSPAPER SINCE 1884 • FEBRUARY 7, 2017
209 N.W. FIRST ST., ENTERPRISE OR • (541) 426-4567

Wallowa County
CHIEFTAIN

Wallowa County poised for micro-hydro boom

Kathleen Ellyn • Wallowa County Chieftain
Published on November 1, 2016 3:56PM
Last changed on November 1, 2016 4:06PM



KATHLEEN ELLYN/CHIEFTAIN

Vern Spaur, center, and his wife Marti point out the simplicity of the 1870s technology, the Pelton Wheel, at the heart of their 21st-century micro-hydro pump to State Sen. Bill Hansell.

Project Installation Reviews and Commitments

- Competitive applications: reviewed proposals from two wind, two biogas, three hydro
  - One hydro project selected for funding
  - Biogas projects still under review

- Non-competitive applications: Committed funding for 20kW of small wind

Project Development Assistance*

- Supported 49 projects, (~3x > 2014)
- Committed almost $3 million (30% > 2015)

	Projects Supported	Total funds committed	Total funds spent
Focus Area 1: Biogas	6	$80,930	$89,860
Focus Area 2: Irrigation Hydro	27	$2,250,043	$1,341,206
Outside of focus areas	16	$654,108	$375,953
Total	49	$2,985,081	$1,807,019

*Preliminary results – numbers not final.

PDA in Focus Areas

- Biogas (six projects):
  - four municipal wastewater facilities
  - two breweries

- Irrigation hydro (27 projects):
  - 14 irrigation districts participating in Irrigation Modernization
  - Seven other irrigation district projects
  - Three other agricultural water supplier projects
  - Two on-farm projects

Irrigation Modernization participants:

Deschutes Watershed

Arnold Irrigation District
Central Oregon Irrigation District
Lone Pine Irrigation District
North Unit Irrigation District
Ochoco Irrigation District
Swalley Irrigation District
Three Sisters Irrigation District
Tumalo Irrigation District

Other areas

Alder Slope Ditches
East Fork Irrigation District
Middle Fork Irrigation District
Dee Irrigation District
Hudson Bay Dist. Imprvmnt Co.
North Prairie Creek Ditch
Westside Poley-Allen Ditch

PDA Outside of Focus Areas

- Ten hydro projects
  - One facility upgrade, three municipal water projects, five non-powered dam sites, one natural stream
- Three geothermal projects
  - Two tribes and the air national guard base in K-Falls
- One biomass, one biogas, one community wind

2017 Forecast: More of the same

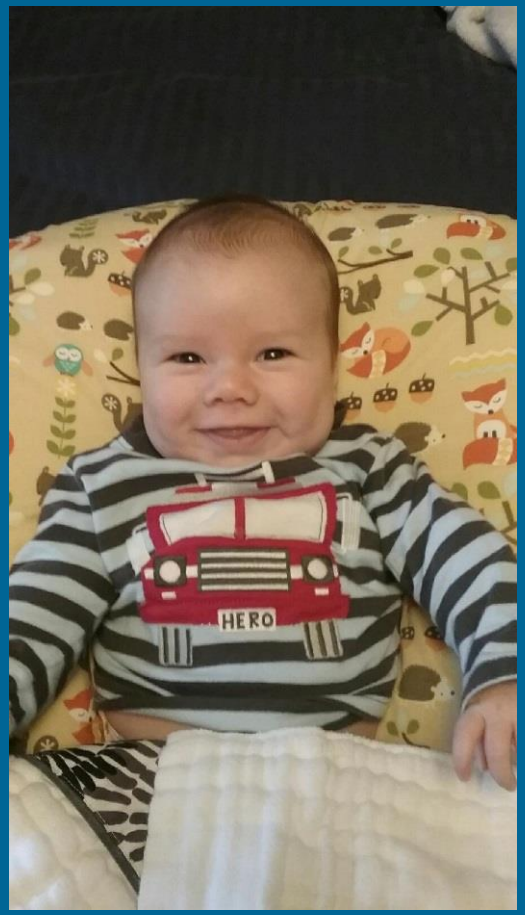
- Few project installations (small wind only)
- Focus areas remain the same
- High demand for Project Development Assistance
  - 12 additional irrigation districts in Modernization
  - Additional interest in irrigation hydro PDA from other developers (~6-8 more projects)

Renewables market update – biogas generation

Renewable Advisory Committee - February 8, 2017

Energy Trust of Oregon

The ‘Henrik’ digester



Biogas RE market scope

Extracting energy from organic waste streams as part of improved waste management practices

- Water Resource Recovery Facilities
- CAFOs
- Food processing facilities / breweries
- Post commercial food waste

Biogas energy projects in Oregon
(excluding landfill)

Water Resource Recovery Facilities (9)

~ 7 MW

26 kW for every MGD – USEPA 2011

Dairy Digesters (6)

~ 6 MW

Food Waste (2)

~ 3 MW

Water Resource Recovery Facilities

- Ideal for EE & RE

  → *permanent, low cost of capital, municipally owned, heat and electric load*

  →Net-metered: off-setting retail power price

- Key ingredient for project success: ***energy champion****!*

Evolution of WRRF Services

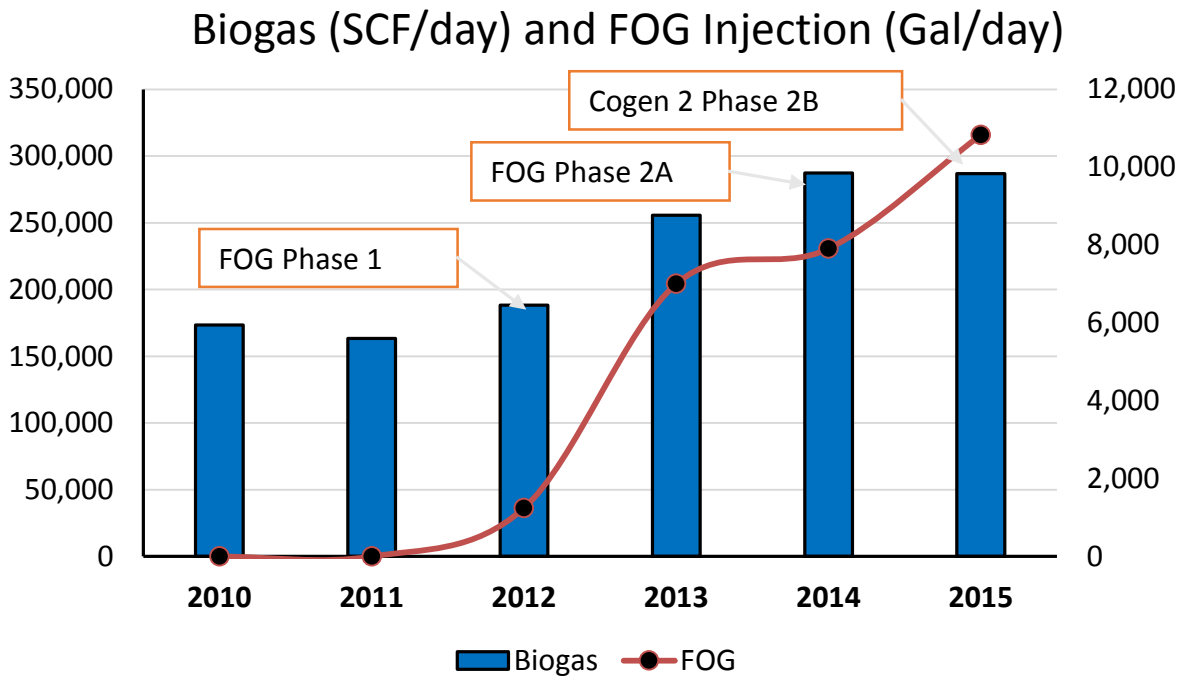
- 1st Generation – protect public health
  - Clean water
  - Biosolids treatment
- 2nd Generation – value-added products
  - Recycled water
  - Soil amendments
  - Renewable energy generation (biogas, solar)
- 3rd Generation – greenhouse gas reduction / sustainably goals
  - Use existing infrastructure to achieve goals
  - Efficiency upgrades / Strategic Energy Management / Solar / biogas energy

The Gresham story

Ten-year journey to net-zero energy demand

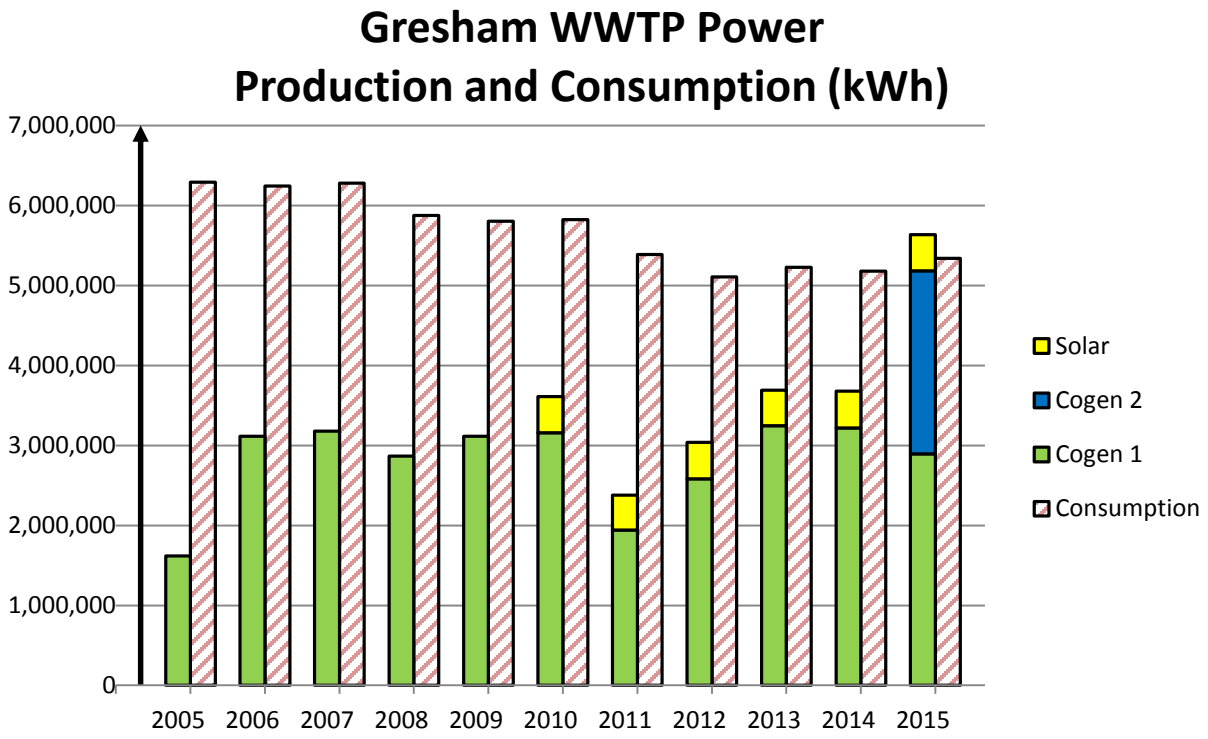
- Cogen #1 – 2005 (395 kW)
- City Sustainability Plan – 2009 (100% RE by 2030)
- Solar array – 2009 (420 kW)
- FOG Feasibility Study – 2009
- Energy Mngt. Team – 2010 (net-zero by 2015)
- **Master Plan update - 2011**
- Energy efficiency measures
- FOG phase 1 (2012) & phase 2 (2014)
- Cogen #2 – 2015 (395 kW)

Biogas Production Trends



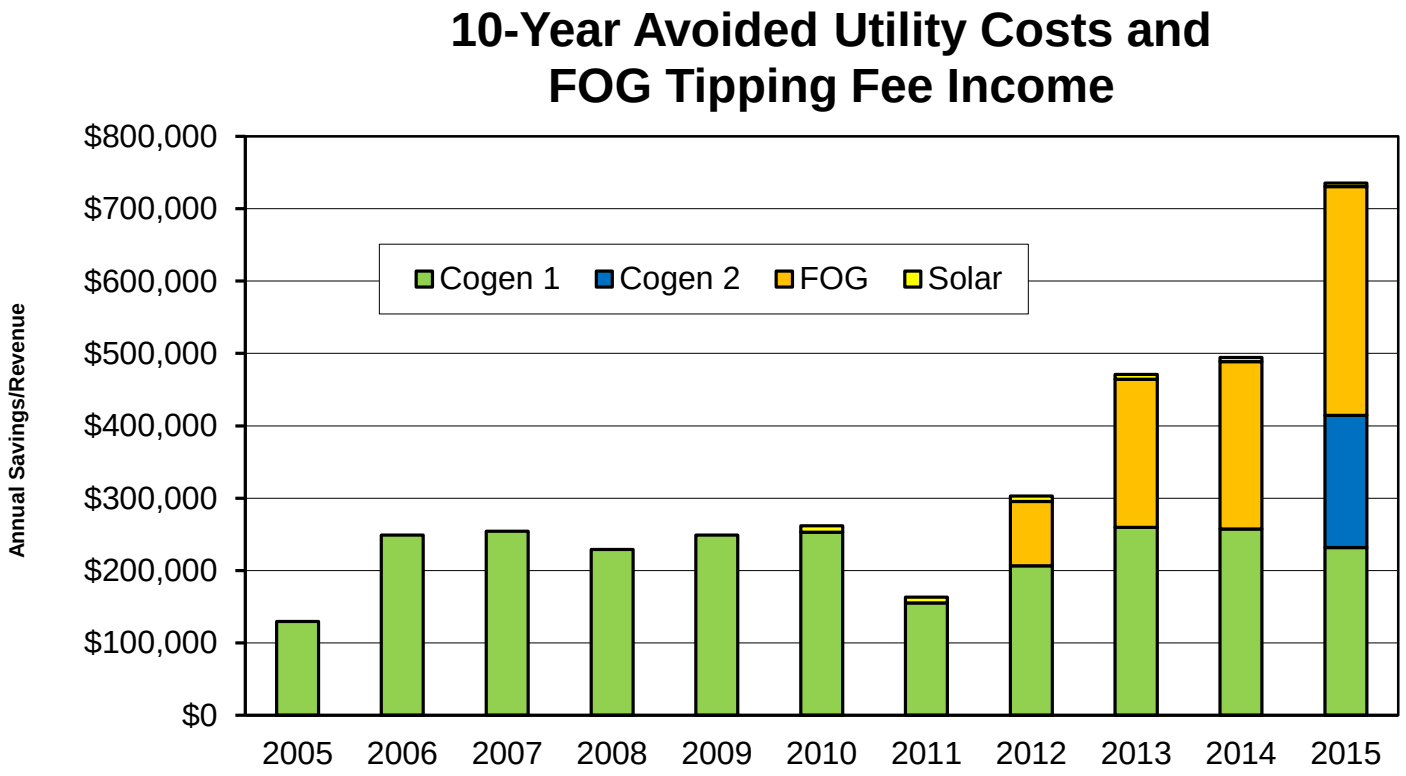
- 2014 Gas production up 60%+ from baseline
- Produced more energy than we consumed in 2015
- Flared 20% of biogas production in 2015 (Future project?)

Annual Energy Trends Since 2005



- **17% reduction in Power Consumption**
- **One Year of Energy Net-Export in March, 2016**
- **0 kWh PGE Utility Bill each month for a Year**
- **595,000 kWh of Net-Exported power donated to PGE**

Annual Savings



- **Approximately $750,000 per year ongoing savings**
- **$3,500,000 in savings since 2005**

Food & Food Processing & Brewery waste

Are there ponies in these biomass piles?

Biogas energy: food waste policy drivers

- Metro 2030 Regional Waste Plan (Solid Waste Roadmap)
  - Request for Proposal (RFP) → April 2017
    - ❖ 50,000-60,000 tons of post commercial food waste from Portland for AD or composting

- Oregon DEQ – Food Waste Recovery Strategic Plan

Technology trends: biogas

1. Smaller scale portable / lower cost AD systems for food processing

2. High pressure boiler with noncondensing (“back pressure”) steam turbine

3. Nutrient recovery technology → monetize N/P/K from digestate

Biogas initiatives

Bio/Hydro project evaluations:

- Performance and costs
- Above market cost
- O&M issues and best practices

Power Usage Effectiveness (PUE) metric – for WRRFs

- With PacNW Pollution Prevention Resource Center & OrACWA

Tailwinds

- Significant benefits of net metering / CHP
- Utility incentives: Blue Sky & Renewable Development Fund
- Corporate & municipal sustainability goals
- Regional food waste recovery policies
- New projects at existing WRRFs

Headwinds

- Higher return on investment for biogas?
  - Vehicle fueling / pipeline gas
- Low avoided power prices
  → QFs difficult to pencil
  → no small manure projects
- Loss of key biopower incentives:
  → Oregon's EIP-CHP Tax Credit
  →Federal ITC
- **Higher** capital costs with strong economy

Uncertainty creates challenges in the biogas energy market….

Thank You!

Questions?

EnergyTrust of Oregon

2016 Preliminary Annual Results

February 8, 2017

Energy Trust of Oregon

2016 Preliminary Results - RE

- ✓ **Big year for standard solar program – 2.3 aMW**
  - 107% of PGE goal
  - 148% of Pacific Power goal

- ✓ **Record pipeline development in Other RE PDA program**
  - 14 irrigation districts in Irrigation Modernization Program

- ✓ One large solar project completed. Two shifted to 2017, resulting in RE generation of 2.78 aMW - 67% of overall forecasted goal.
- ✓ On track to achieve 2015-2019 Strategic Plan goals


EnergyTrust
July 12, 2016
Ireland Trucking
$32,701.00
Thirty-Two Thousand Seven Hundred One Dollars and 00 Cents

2016 Preliminary Efficiency Results

Saved 60.0 aMW—**109%** of electric savings goal

Saved 6.7 MMTh—**117%** of gas savings goal

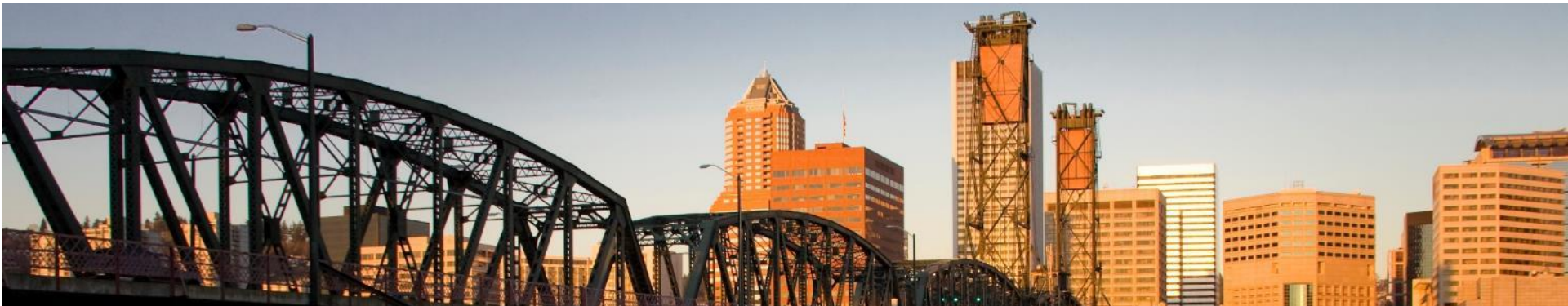
Exceeded goals for all 5 utilities

- ✓ **108%** of PGE goal
- ✓ **110%** of Pacific Power goal
- ✓ **117%** of NW Natural OR goal (125% of WA)
- ✓ **111%** of Cascade Natural Gas goal
- ✓ **110%** of Avista goal

On track to achieve 2015-2019 Strategic Plan goals

A Few of Our Biggest Achievements

- Successful portfolio approach
- Shining year for LEDs
- Construction boom
- Targeted efforts to serve renters, moderate-income customers
- Strong standard solar installations
- Pipeline of irrigation district hydropower projects



Preliminary Generation Results: Standard Solar

	Generation	Goal	% Achieved
PGE	1.11 aMW	1.04 aMW	107%
Pacific Power	1.20 aMW	0.81 aMW	148%
Total	2.31 aMW	1.85 aMW	125%

Preliminary Generation Results by Program

	Generation	Goal	% Achieved
Solar Electric	2.78 aMW	4.13 aMW	67%
Other Renewables	0.01 aMW	0.01 aMW	100%
Total	2.78 aMW	4.13 aMW	67%

CAC Backup Slides

2016 Preliminary Results by Utility

	Savings	Goal	% Goal Achieved	IRP target	% IRP Achieved
PGE	36.46 aMW	33.66 aMW	108%	27.23 aMW	134%
Pacific Power	23.56 aMW	21.42 aMW	110%	16.84 aMW	140%
NW Natural (OR)	6,165,930 annual therms	5,254,568 annual therms	117%	3,920,239 annual thm	157%
Cascade Natural Gas	516,885 annual therms	466,577 annual therms	111%	447,071 annual thm	116%
Avista	34,708 annual therms	31,574 annual therms	110%	N/A	N/A

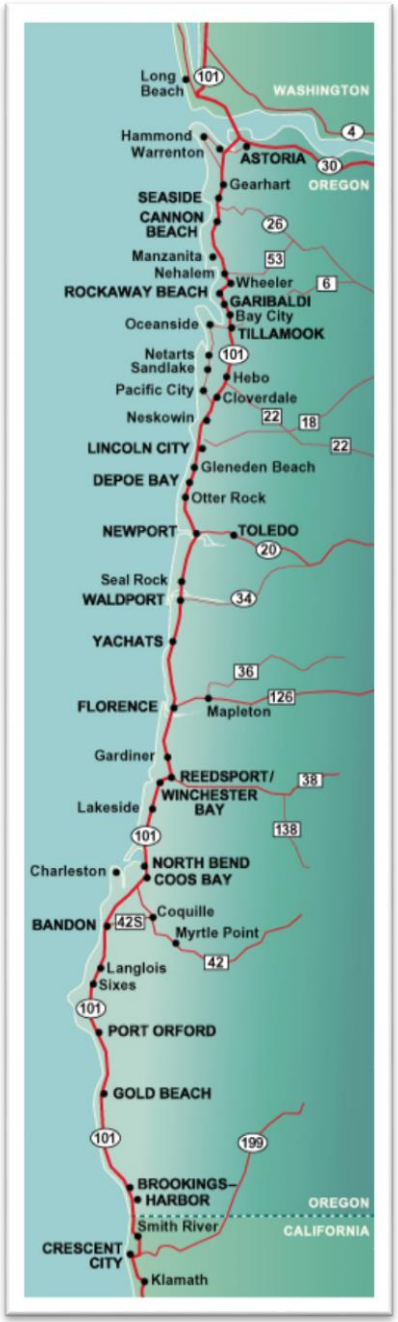
Preliminary Efficiency Results By Sector

	Electric savings	% Achieved	Gas savings	% Achieved
Commercial sector	24.30 aMW	111%	2,873,446 annual therms	111%
Industrial and agricultural sector	11.88 aMW	87%	1,332,696 annual therms	129%
Residential sector	23.85 aMW	121%	2,511,381 annual therms	120%
Total	60.02 aMW	109%	6,717,523 annual therms	117%

Ocean Renewable Energy

Shifting the Energy Paradigm Away from Fossil Fuels

OregonWaveEnergy TRUST



4 Goals:

1. Provide short background on OWET's work to date.
2. Update on the state of the industry for both wave and floating wind.
    1. 1st, 2nd, and 3rd generation technologies
3. Discuss the opportunity of the new grid connected test site and the uncertainty of the new administration.
4. Introduce the Pacific Ocean Energy Trust.

OWET - Paving the Path to Commercialization

- $14,000,000 invested in Oregon to date - leveraged about $30,000,000
- Adopted the nation's first comprehensive ocean plan for integrating marine energy – Territorial Sea Plan
  - Established a coherent and predictable permitting process
  - Established areas where development is encouraged
- Built familiarity with the technologies for both public and private sectors
- Set up essentially a one-stop permitting process
- National conference
- Environmental research
- Funded and encouraged technology R&D in Oregon
- Helping to establish the nation's first grid connected test site
- Supply chain development for permitting, manufacturing, and operations

OregonWaveEnergy TRUST

Oregon is a National Leader

- Best wave resource in the continental U.S.
- Sub-stations along the coast with the capacity to absorb ~500 megawatts of new power generation without major upgrades to the grid
- OSU's Northwest National Marine Renewable Energy Center (NNMREC) – one of only three national ocean energy centers funded by the U.S. Department of Energy
- Experienced and established supply chain
- Transportation infrastructure and deep water ports for ease of deployment
- Able workforce and sophisticated workforce development networks
- Strong planning and supportive policies and the Oregon Way

OregonWaveEnergy TRUST

Types of Ocean Energy Technology

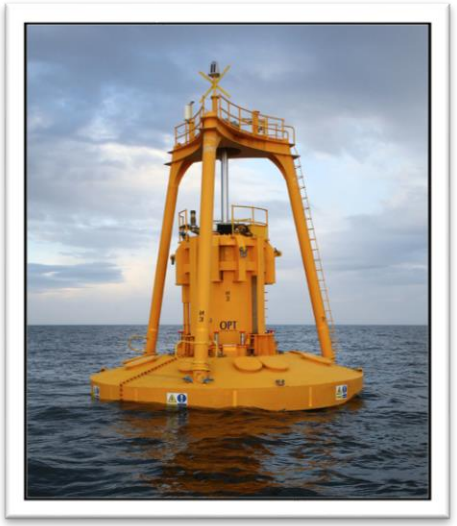
- Marine Hydrokinetic (MHK)– motion of the ocean
  - Wave Energy – West Coast
  - Tidal Energy – requires the right geography
  - Ocean Current Energy – e.g., California Current
    - Riverine hydrokinetic – non-impoundment
- Ocean Thermal Exchange – OTEC – Equatorial
- Offshore Wind – probably floating wind only

Why wave energy?

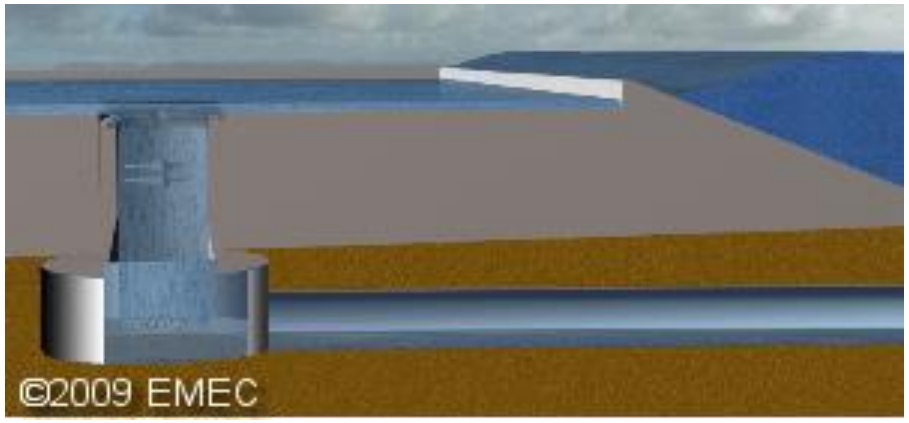
- Tremendous Resource
- Inexhaustible
- Highly Predictable
- Close to populations
- Lower integration costs relative to wind and solar
- West side generation – balancing the grid
- Winter peaking

The Technologies

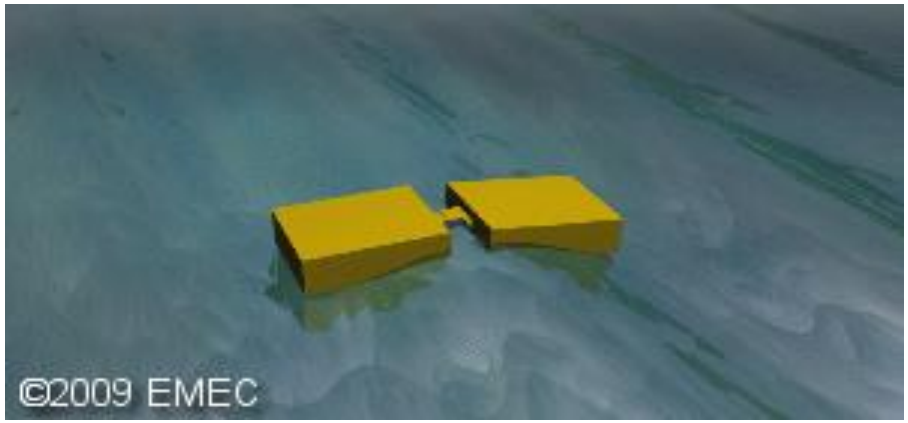
Diversity: power take off, siting, size



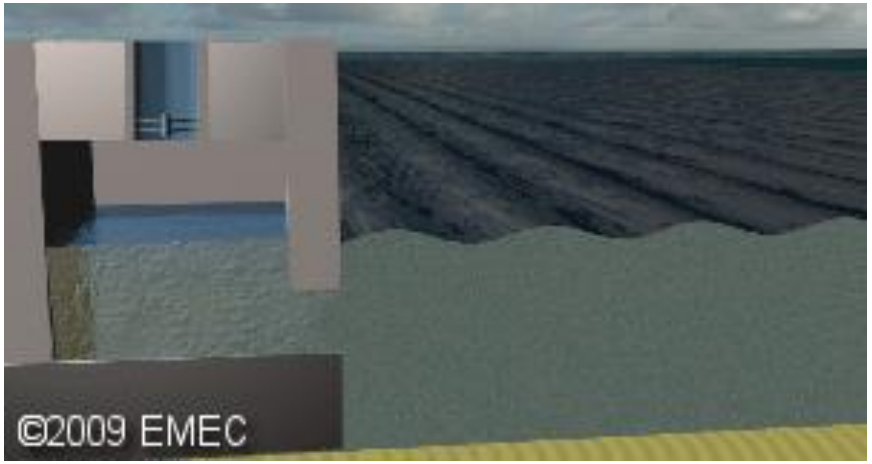
OregonWaveEnergy TRUST



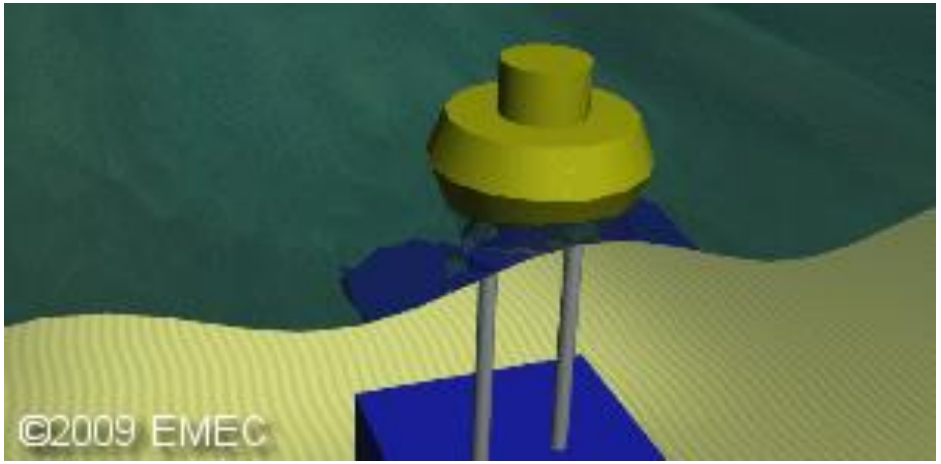
Overtopping



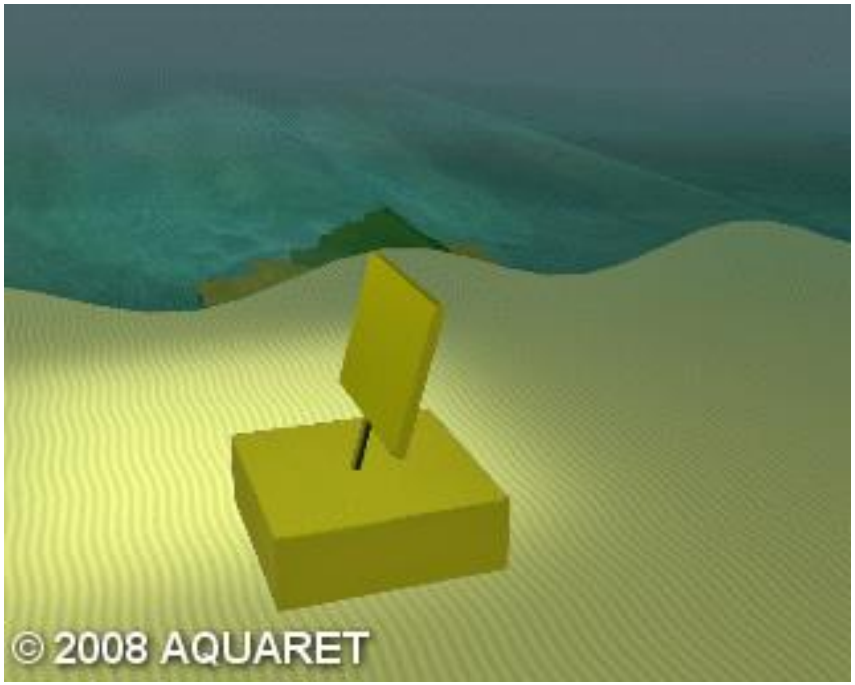
SNAKE / ATTENUATOR



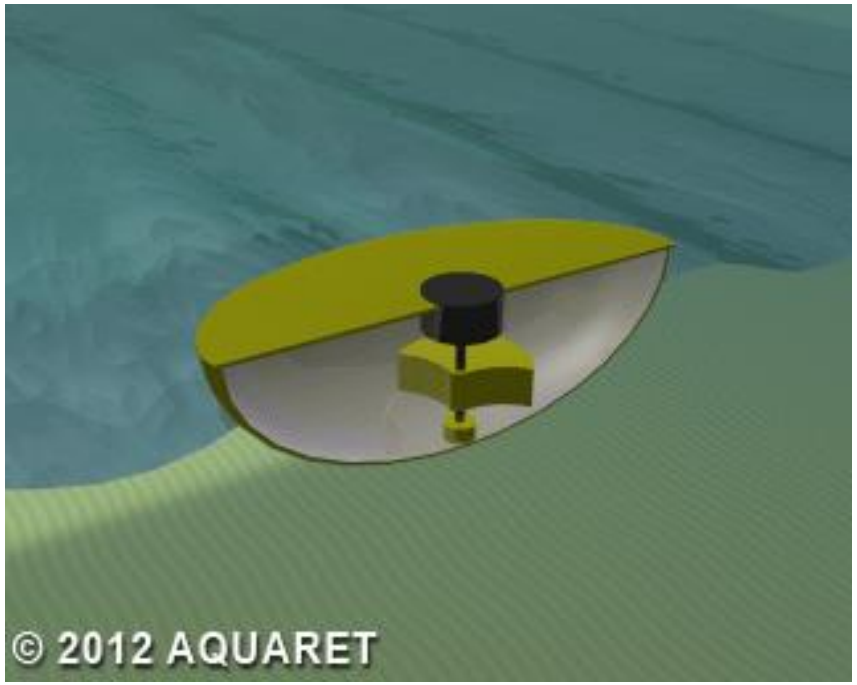
Oscillating Water Column



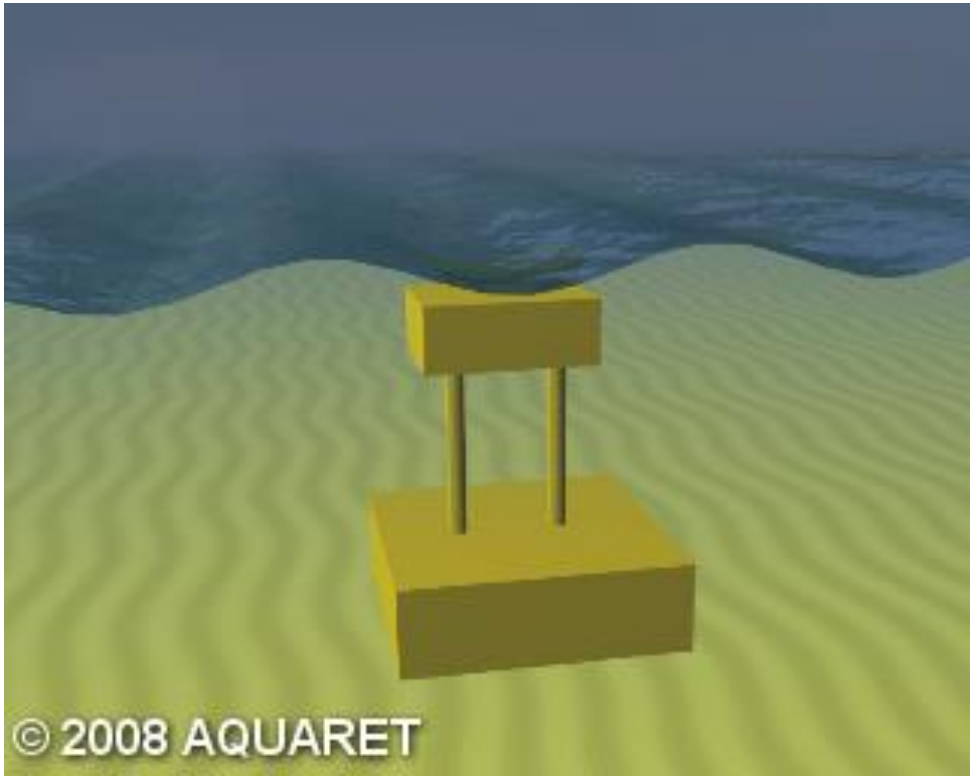
Heaving Buoy/Point Absorber



Oscillating Wave Surge Converter



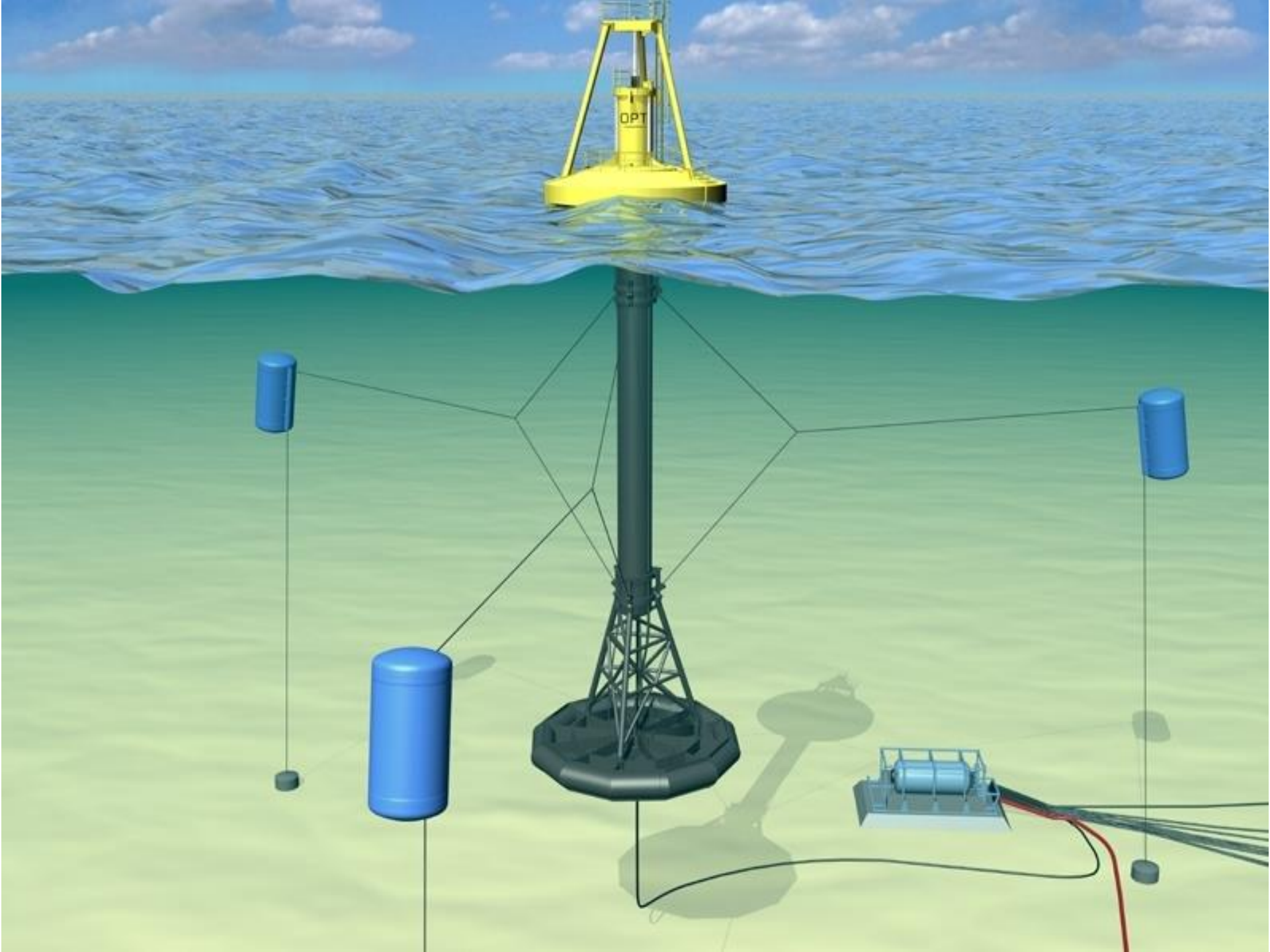
Rotating Mass



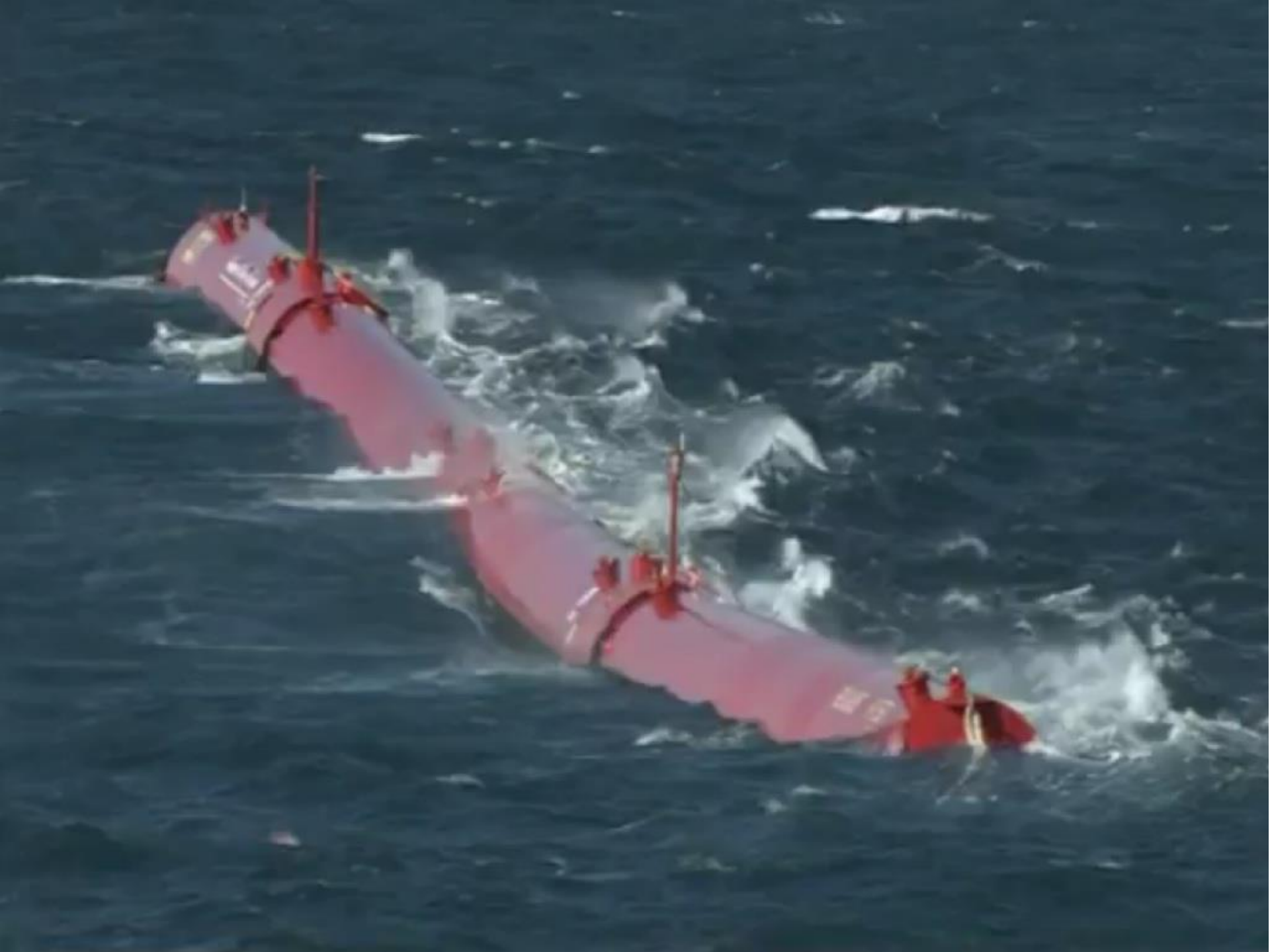
Submerged Pressure Differential

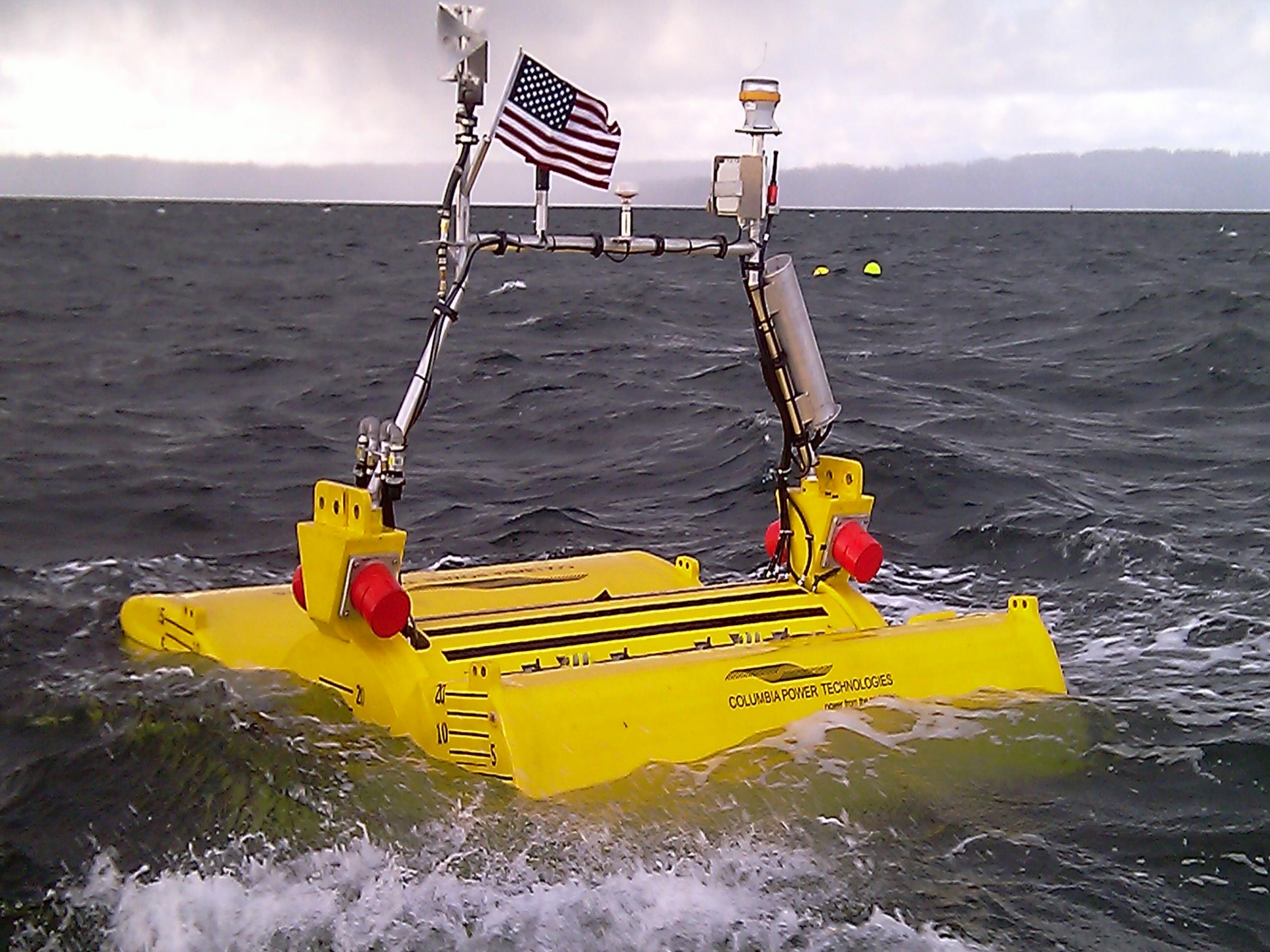
OregonWaveEnergy TRUST


M
3
M
3
OPT

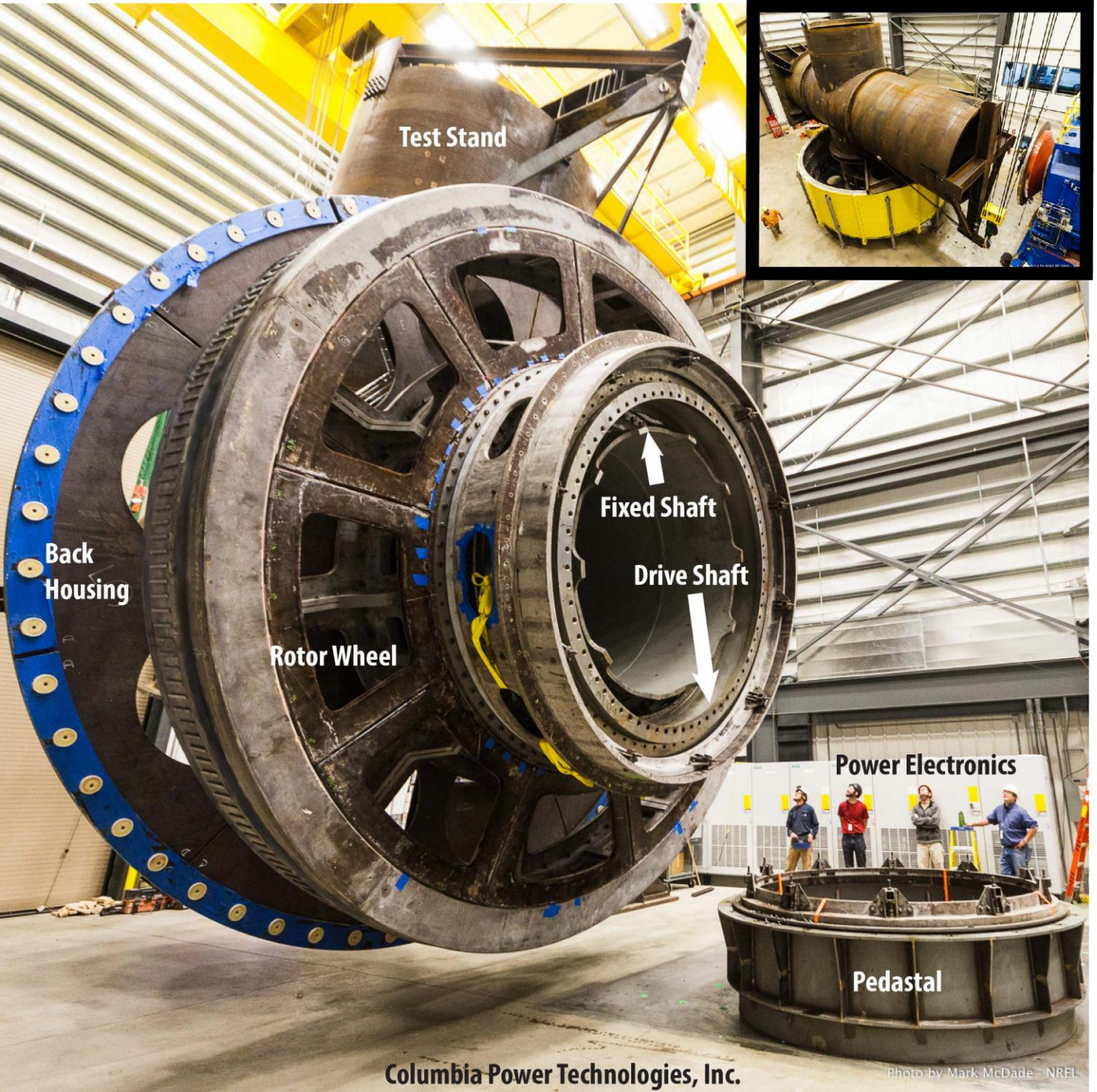

OPT

OregonWaveEnergy TRUST




COLUMBIA POWER TECHNOLOGIES


ANCHOR


Test Stand
Back Housing
Rotor Wheel
Fixed Shaft
Drive Shaft
Power Electronics
Pedastal
Columbia Power Technologies, Inc.
Photo by Mark McDade - NREL

Fred. Olson Renewables
Lifesaver Technology
Wave Hub testing facility, U.K.


sei
sei
www.oceanenergy.ie


ENTERPRISE


ENTERPRISE


ENTERPRISE


Northwest Energy Innovations
Azura Technology
Wave Energy Test Site - Hawaii


Europcar


29/JUN/2012

OregonWaveEnergy TRUST


M3 Wave Energy – Oregon Grown

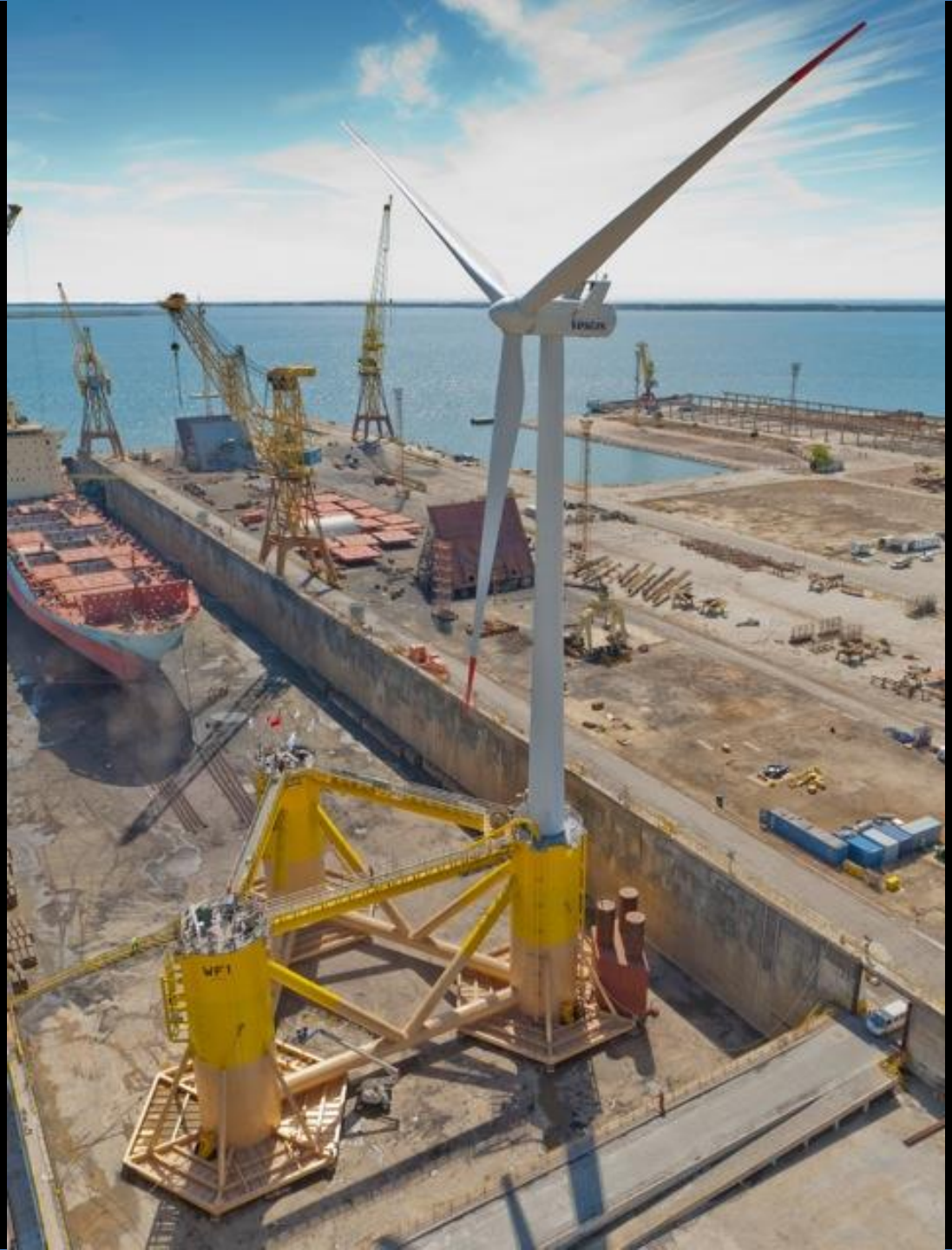

Contingency marker buoy
Recovery Lift Line Can
Acoustic pinger

U.S. Deployments

- Ocean Renewable Energy Company – tidal – multiple – Maine and Alaska, additional deployments in 2017
- NWEI – Azura – Wave Energy Test Site – Hawaii - current
- Fred. Olson Renewables – Wave Energy Test Site - current
- Ocean Energy LTD – Wave Energy Test Site - 2017
- Oscilla Energy – NETS test site Oregon - 2017
- Columbia Power Technologies – Wave Energy Test Site – 2018
- NWEI – full scale Azura – Wave Energy Test Site –

DOE Wave Prize: The Third Generation

- M3 Wave Energy LLC
- CalWave Power Technologies
- Oscilla Power
- Sea Potential
- RTI Wave Power
- SEWEC
- Waveswing America
- Harvest Wave Energy
- **AquaHarmonics - $1.5 million winner**
- Wave Energy Conversion Corporation of America
- Mocean Energy



Northwest National Marine Renewable Energy Center

- Pacific Marine Energy Center
  - OH Hinsdale Wave Research Lab
    - Linear Generator
    - Large Wave Flume
    - Tsunami Basin
  - PMEC – North Energy Test Site
  - PMEC – South Energy Test Site

Linear Generator

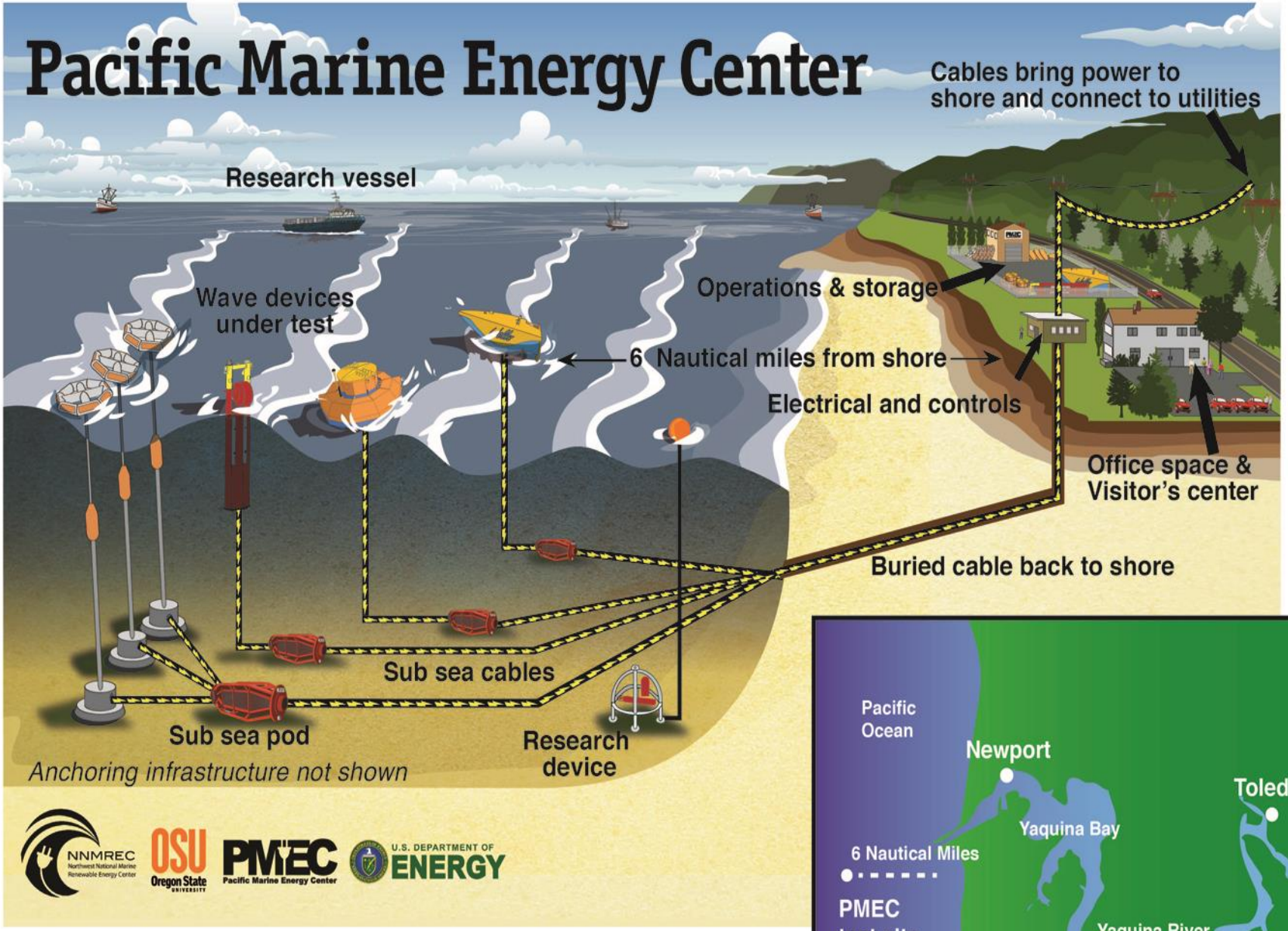
Large Wave Flume

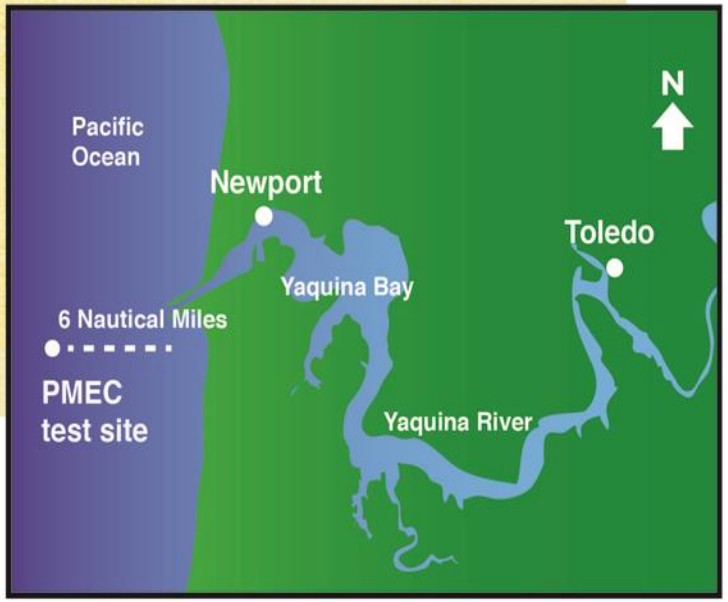
OregonWaveEnergy TRUST

Tsunami Wave Basin

OregonWaveEnergy TRUST

Pacific Marine Energy Center





NNMREC Northwest National Marine Renewable Energy Center
OSU Oregon State University
PMEC Pacific Marine Energy Center
U.S. DEPARTMENT OF ENERGY

The Opportunity of PMEC SETS

- $40,000,000 federal money from DOE
- Requires 20% match…about $9,000,000
- Already got $800,000 from state legislature in 2015
- Asking for $4,200,000 from 2017 legislature
- Leaves $4,200,000 delta
- Anchor asset will bring companies to Oregon for 20 years.
- Multiple companies writing PMEC SETS into DOE proposals

Sea of Uncertainty

- Highly dependent on Rick Perry's DOE
- Early indicators not good, but…
- Congress has been supportive
- New Water Power Technologies Office – New Director – Alejandro Moreno
- Opportunity for Regulatory Reform – ease the 5-7 year process
- GRAC

Pacific Ocean Energy Trust

- OWET with longer legs –
  - Entire West Coast, plus Hawaii and Alaska
  - All forms of marine renewables
- Most active in California – the giant has awoken
- 2017 California Offshore Wind Industry Symposium – March 2
- Block Island project – 30 MW – first in nation
- Statoil won most recent NY lease at $42.5 million!
- Vestas – 8 MW marinized turbine! 10 MW under development
- Create a regional body that unites key stakeholders to advance policy priorities, promote targeted research, and expedite development

Questions?

www.oregonwave.org

OWET Executive Director Jason Busch

jbusch@oregonwave.org

OregonWaveEnergy TRUST