OREC

Oregon Renewable Energy Center

Oregon TECH

OREC Feasibility Study

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Contents

Executive Summary

The purpose of this study is to determine if there is a niche in the energy and manufacturing markets for the services provided by the Oregon Renewable Energy Center (OREC). The research team researched the needs of industry by conducting interviews with people in the energy and manufacturing fields to gain insights into the needs of these industries. The team also conducted literature reviews of the websites of many different energy research centers to determine if the proposed model for OREC was unique and if it could fill a gap in the applied energy research market.

OREC was established by the Oregon State Legislature in 2001 to promote energy conservation and renewable energy use in Oregon through applied research, educational programs, and practical information. OREC's activities are founded on the principle that wise energy use is the foundation for a sustainable economy, good jobs, and economic prosperity. OREC, its affiliated faculty and students, and its industry partners play a critical role in Oregon and the Northwest as a facilitator, technical advisor, and action-oriented solutions developer to address the Northwest's energy and economic challenges.

Since its inception in 2001, OREC has received approximately $52,132 in state dollars for energy-related contracts, and $2,355,624 through the Engineering Technology Industry Council (ETIC) to enable OREC to support engineering education in the form of renewable energy labs, funding for student projects, and small faculty-led applied research projects. State funds were leveraged with $9,578,357 in other public funds (federal, state, and local), and $750,468 in private investments (sponsored projects, stipends), a 4>3:1 ROI for the state.

To ascertain the future market value of OREC, the team conducted research and organized this report into five analysis areas: industry analysis, research center analysis, current asset analysis, Oregon talent development analysis, and financial analysis.

Industry Analysis: The results of the industry analysis indicate that there is a market for the services of OREC. The companies surveyed indicated that they would certainly benefit from an applied energy research center that could assist with developing prototypes, testing, and advising on manufacturability and material selection, all of which are services OREC can provide. The survey also indicated that these companies feel that grid integration of renewables, energy storage and manufacturability are areas where more research is needed. OREC could potentially focus on these research areas to maintain and cultivate partnerships and meet the needs of industry.

As indicated in the industry analysis, companies would like to see undergraduates gain research experience before entering the workforce. Part of OREC's mission is to provide a venue for undergraduates and graduate students to collaborate with faculty on industry-sponsored and student-initiated projects. This will make Oregon Tech graduates much more attractive to industry and increase OIT's reputation as an applied research university.

Research Center Analysis: The analysis of other national energy research centers indicated some clear trends. The primary areas of focus for the other research centers are development of renewable energy and energy storage. Most of their funding is from sources other than the

university, with the most common source being from private party donations (figure 10). Other funding commonly comes from federal or state grants, or from industry partnerships. All of the research centers involve students in their research, however the involvement is limited to graduate students who have been granted a research fellowship (figures 6, 11, and 12). The research projects are typically chosen by the faculty, or sometimes chosen by industry or private party sponsors (figure 9). Research projects are not usually chosen by the students. Most of the research centers reported that their uniqueness comes from their industry partnerships or specialized labs and equipment (figure 13).

OREC could address these gaps by providing a unique experience for undergraduate researchers in addition to utilizing the talent of graduate students, and providing an opportunity for students to be more involved in deciding which projects to undertake, in collaboration with faculty and industry partners.

A survey of other research centers about their facilities indicates a lack of manufacturing capabilities. This gap can be filled by OREC by promoting collaboration between its manufacturing, mechanical, electrical and renewable energy, computer systems and civil engineering departments at Oregon Tech so that students have the opportunity to work on multi-disciplinary projects. OREC can also offer unique geothermal and solar labs if the current power generation facilities become more accessible as a learning and experimentation environment.

Current Asset Analysis: The current asset analysis indicates that approximately 30 faculty at Oregon Tech with the potential to affiliate with OREC are already engaged in research projects of their own, or at least have ideas for research projects as shown in figures 18 and 19. Most of their research interests are in line with OREC's capabilities, which means that working with the center could be a benefit to the faculty. OREC would also benefit from having the faculty conducting research because it could help build up recognition and credibility for the center, expand professional development opportunities, increase strategic partnerships with industry, and produce additional revenue for the university.

There is a significant amount of interest in working with OREC from the faculty as demonstrated by figures 14, 20, and 21. However, figure 21 also shows that the faculty would not be able to dedicate very much time to working with OREC if they became OREC-affiliated faculty. The number of hours that the faculty are willing to commit to applied research may change as they see OREC evolve into a well-established and recognized entity. The current bottom line seems to be that the research center needs paid research positions in order to be well staffed and support consistent faculty engagement.

Talent Development Analysis: The Oregon talent development analysis addresses some of the issues facing the manufacturing and energy industries in Oregon. First, there is an identified need to develop the talent necessary to fill the positions created by the emerging advanced manufacturing sector. Next, industry partners indicated a need to produce graduates with experience in smart technologies in the energy and utility sectors which could be accomplished through OREC projects. Finally, there is a need to replace the mass of power engineers and utility workers that will be retiring over the next decade.

With its unique resources in manufacturing, power engineering, smart grid technology, OREC can play a major role in preparing the next generation of Oregon's engineers and technical talent needed to fill the critical gap.

Financial Support Analysis: The financial support analysis section explains the proposed funding model for OREC. It is a hybrid financial model based on funding sources from the state and university (hard money), grants and industry partnerships (soft money). In this model there are state-funded positions and grant-funded positions. The state-funded positions are the director, administrative assistant and a sponsored projects and grants administrator. These staff members are responsible for the administrative requirements of the research center. Student research positions could be made available as volunteer positions with the benefit of students gaining academic credit, work experience and industry connections, or through undergraduate or graduate research assistantships or stipends. It is anticipated that there will be at least 30 OREC-affiliated faculty from Oregon Tech with the expertise to participate with companies on applied research or grant-funded projects. OREC-affiliated faculty who could be given release time from teaching, on a permanent or rotating basis, with compensation from state support, grant or industry sponsorships, based on the expertise needed for specific projects. Current faculty or new faculty could be hired into these teaching and applied research positions.

In order to reach its full potential as a research center OREC will need three key components: a reliable funding source for consistent administration of the center, industry and academic partners to consult with and support faculty and students to conduct the research, and cutting-edge technical projects with the potential to solve energy challenges and provide project-related revenue.

The survey of other research centers shows that their primary sources of funding come from federal and state government grants. It is unusual for a research center to be supported by the parent university as a primary funding source. Based on the survey examples, the proposed budget for OREC will initially consist mostly of federal and state funds, with a transition to more industry-supported projects. Having consistent funding, especially for the administrative functions to support the grants and sponsored projects, would give the research center financial stability.

The surveys of energy industry companies, Oregon Tech faculty, and other research centers, as well as the Oregon Talent Plan, indicate that there are many benefits to OREC from having partners in industry and academia. During the survey of other research centers, when asked what makes them unique to other centers, a common response was their industry partners.

Cutting-edge research projects will play a large role in the feasibility of OREC, as the research projects will further define OREC's purpose, direction, and areas of expertise. The survey of other research centers showed that many energy-related research centers are actively researching energy storage and micro-grids. If OREC were to take a similar approach it may be difficult to distinguish itself from other research centers. The study also showed that there aren't many energy research centers working on prototyping and manufacturability of clean energy technologies. Since Oregon Tech has excellent manufacturing engineering programs and facilities that complement its expertise in renewable energy generation, power and controls, and clean energy innovation, pursuing this type of research could help set OREC apart.

Introduction

Scope

The scope of this feasibility study is to determine whether there is a unique niche in the market for the Oregon Renewable Energy Center (OREC), as an approach-specific, energy applied research center that supports Oregon Tech's applied education programs and faculty professional development, and meets the product-development needs of small and medium-sized companies.

History of OREC

The Oregon Renewable Energy Center (OREC) was established by the Oregon State Legislature in 2001 to promote energy conservation and renewable energy use in Oregon through applied research, educational programs, and practical information. OREC's activities are founded on the principle that wise energy use is the foundation for a sustainable economy, good jobs, and economic prosperity. OREC and its affiliated faculty and students play a critical role in Oregon and the Northwest as a facilitator, advisor, and action-oriented solutions developer to address the Northwest's energy and economic challenges. http://www.oregonlaws.org/ors/352.221

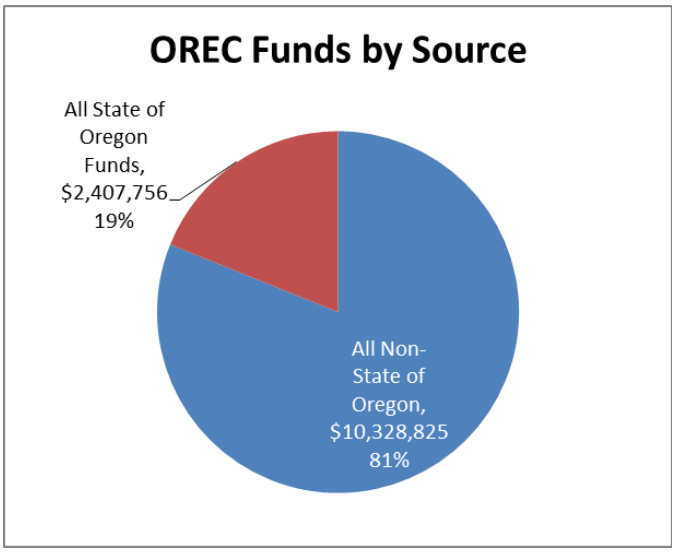
Oregon's elected leaders had the vision to establish an energy research center at OIT in 2001, prior to the dawn of the "green revolution." They based the center at Oregon Tech due to its history of advancing renewable energy solutions in Oregon for over 30 years. While the legislation did not authorize a budget allocation to pursue OREC's mission, it authorized the university system to accept grants and gifts on OREC's behalf, and provided a leadership role for Oregon Tech in its pursuit of renewable energy engineering and applied research.

ORS 352.221 states: (1) Pursuant to ORS 351.870 (Findings and policy for ORS 351.865 to 351.890), there is created within the Oregon University System the Oregon Renewable Energy Center. The Oregon Renewable Energy Center shall be administered by the Oregon Institute of Technology.

(2) The purpose of the Oregon Renewable Energy Center is to engage in renewable energy system engineering and applied research.

(3) The Oregon University System may receive moneys from any public or private source to support the Oregon Renewable Energy Center. Gifts and grants received to support the Oregon Renewable Energy Center shall be credited to the appropriate fund at the Oregon Institute of Technology by the Oregon University System. [2001 c.818 §2; 2009 c.762 §80]

Since its inception in 2001, OREC has received approximately $52,132 in state dollars for energy-related contracts, and $2,355,624 through the Engineering Technology Industry Council (ETIC) to enable OREC to support engineering education in the form of renewable energy labs, funding for student projects, and small faculty-led applied research projects.



These state dollars have been matched with $9,578,357 in other public funds (federal, state, and local), and $750,468 in private investments (sponsored projects, stipends) for a total of $10,328,825 in other funds. **OREC produced a 10-year ROI for Oregon of 4.3-to-1.**

Oregon Tech, the host of the Oregon Renewable Energy Center, is the first ABET-accredited institution with Renewable Energy Engineering in the world. Oregon Tech delivers extensive programs and start-of-the-art facilities in geothermal power, energy storage, energy testing and power electronics along with unique major programs to educate and train the next generation of energy and power engineers.

In addition to OREC, Oregon Tech is home to the Geo-Heat Center, an internationally renowned repository of information and technical advice on geothermal energy development, and two geothermal power plants and testing sites including the 280kW Geothermal power plant and the 1750kW geothermal plant. The campus has been entirely heated by geothermal water for several decades, and now the geothermal resource is being utilized in a 1.75-megawatt combined heat and power plant to provide electricity.

Oregon Tech also has an installed 7,800 ground-mounted solar electric panels on 9 acres of hillside at its Klamath Falls campus, with a total capacity of just under 2 megawatts. The panels are tilted at 35 degrees with different orientations ranging from 180 to 210 degrees south to capture the sun's rays and convert the energy into electricity to power approximately 35% of the Oregon Tech campus.

With the completion of the 1.75 MW geothermal power plant and the 2.0 MW solar array project, Oregon Tech became the **first university** in North America to reach a major goal to generate most of the electrical power needed for the campus.

OREC is currently at a crossroads. Its previous funding sources are no longer viable, and the renewable energy research market has considerable competition from global-renowned universities and research labs. OREC's future is envisioned as a multi-disciplinary, approach-specific research center, supported with sustaining public funds and complemented by industry-sponsored research projects that will help small and medium-sized companies prove their concepts

in the technology-readiness level 3 – 7 stages of development. This study is intended to gauge the market potential of this approach.

Industry Analysis

This is an analysis of the renewable energy-related industry in Oregon. The team researched eight different Oregon-based energy companies and trade associations, then surveyed them to indicate how they could benefit from an energy research center at Oregon Tech.

List of companies and trade associations surveyed:

- Portland General Electric
- Oregon Solar Energy Industry Association
- Smart Grid Northwest
- Sunset Manufacturing
- Ryno Motors
- Neil Kelly
- Ewind Solutions
- Powin Corp

These are the responses from the survey questions given to the industry partners.

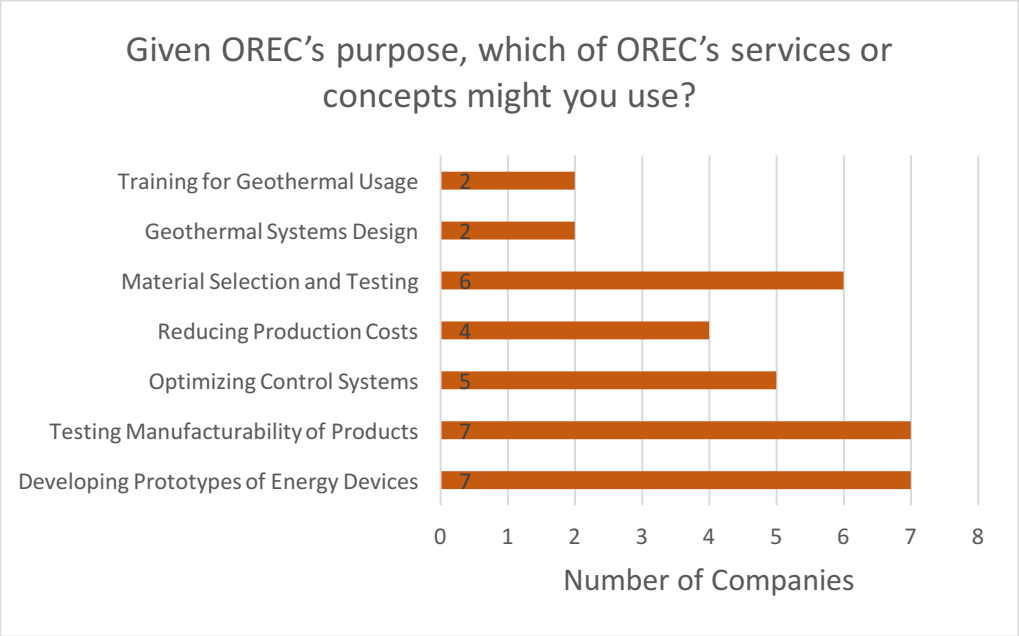


Figure 1. Industry Survey Question 1.

The results of the industry survey show that there are companies that are struggling to bridge the gap from product idea to producing a marketable product. Figure 1 indicates that companies could benefit from a facility or center designed to help companies with developing prototypes, testing, manufacturability and material selection.

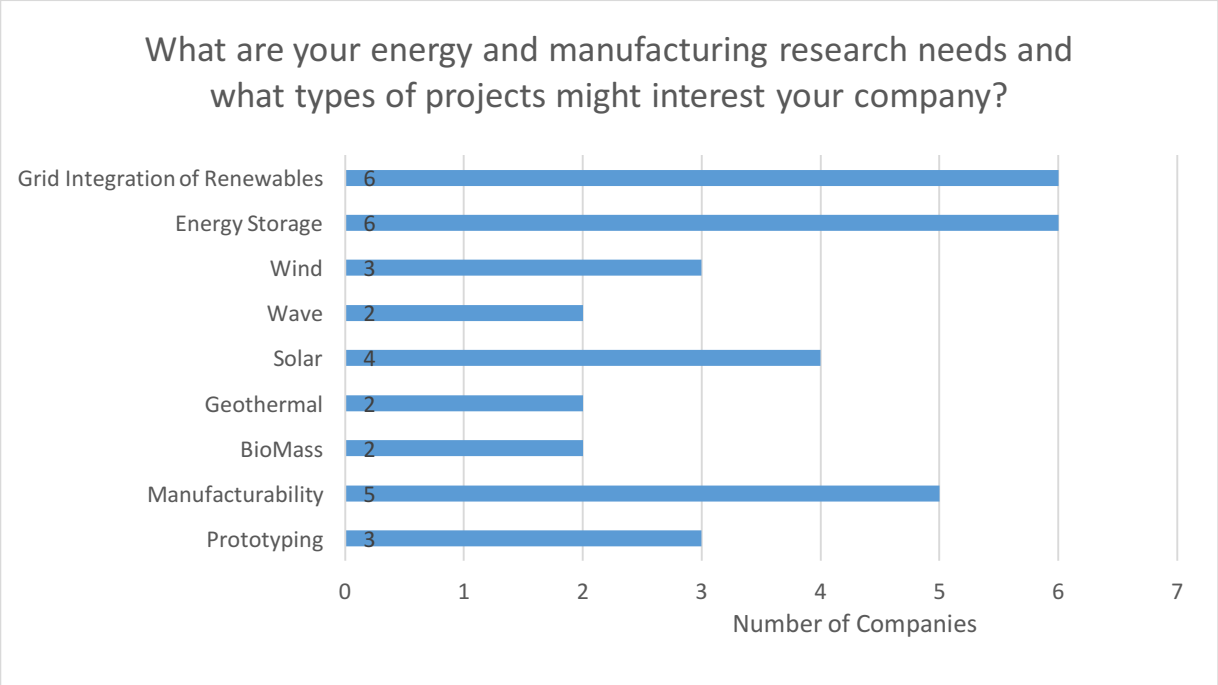


Figure 2. Industry Survey Question 4.

Figure 2 shows that industry has energy and manufacturing research needs that are currently not being met. Grid integration of renewables, energy storage and manufacturability were among the top need of the companies surveyed. Because the renewable energy industry is still in its infancy, this industry will continue to grow, creating more companies and new technologies that will need to be tested for viability.

Figure 3 indicated that employers highly value research experience. The companies surveyed made it clear that undergraduates and graduate students entering the workforce have very little research experience and these students would greatly benefit from research experience before graduation. At most universities, it is very difficult for undergraduates to gain this research experience before graduating.

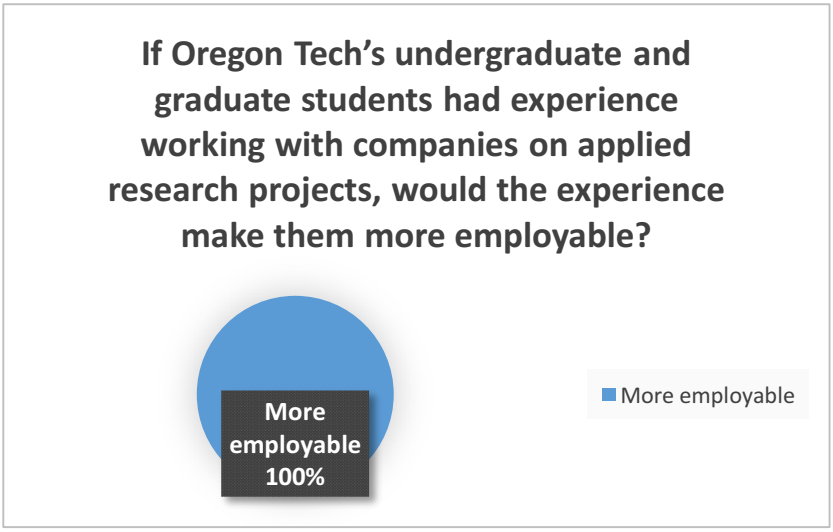


Figure 3. Industry Survey Question 6a.

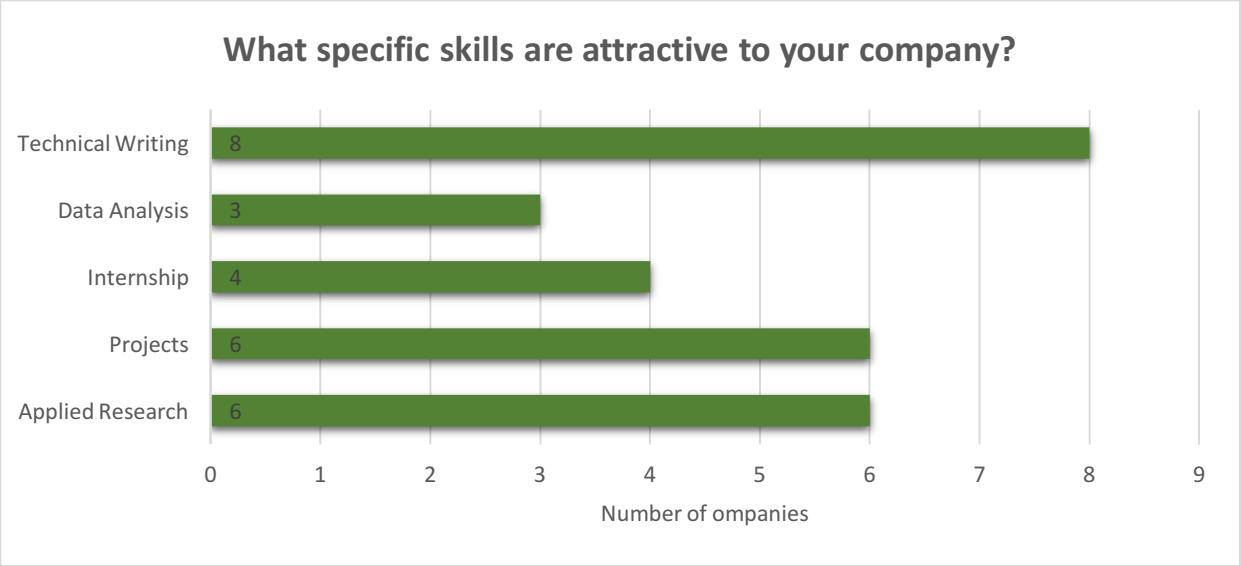
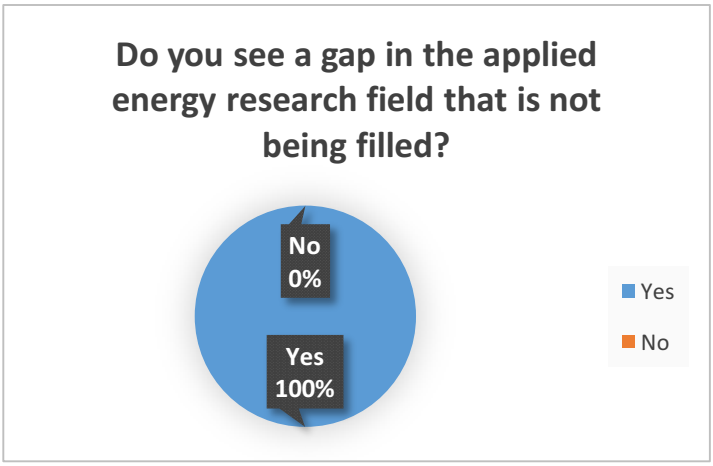


Figure 4. Industry Survey Question 6b.

Figure 4 shows the specific skills that are attractive to the companies that we researched. Looking at the data, technical writing skills are the most important, however all of them are valuable skills. Again, survey respondents made it clear that they would like to see recent graduates gain research experience before entering the workforce.



The results of the last question in the industry survey make it clear that these companies feel there is a gap in the applied energy research field. These results are illustrated in Figure 5. These companies would like to see an effort made to fill the gap and have a venue to use for their own research ideas.

Figure 5. Industry Survey Question 10.

Results

The results of the industry analysis indicate that there is a market for the services of OREC. The companies surveyed indicated that they would certainly benefit from an applied energy research center that could assist with developing prototypes, testing, manufacturability and material selection, all of which are services OREC can provide. The survey also indicated that these companies feel that grid integration of renewables, energy storage and manufacturability are areas

where much more research is need. These are areas that OREC could potentially focus on to maintain partnerships and meet the needs of industry.

As indicated in the analysis, companies would like to see undergraduate and graduate students gain research experience before entering the workforce. Part of OREC's mission is to provide a venue for undergraduates and graduate students to collaborate with faculty on industry and capstone or graduate research projects. This will make Oregon Tech graduates much more attractive to industry and increase OIT's reputation as an applied research university.

Figure 1 indicates that companies could benefit from our services in developing prototypes, testing, manufacturability and material selection. Figure 2 shows that industry has energy and manufacturing research needs that OREC could help with. OREC can provide students with a venue to gain the kind of research experience that employers are looking for. Oregon Tech equips students with all these skills and prepares them for the work force. There is huge potential for OREC-affiliated faculty and students to fill this gap and provide industry with a venue to conduct the practical research that helps them validate their energy products or concepts and advance them to market-readiness.

Research Center Analysis

The research team conducted a survey of national and regional energy research centers to gain an understanding of the best practices operation. The research team looked at the websites of over thirty applied research centers in an effort to determine if there is a gap in the industry that could be filled by OREC. The list of research centers to investigate further was narrowed down to ten based on the highest scoring in the rubric, which can be found in the appendix. The main criteria used to choose which energy centers to research were:

- University-affiliated
- Interdisciplinary research (EE, CE, ME, CSET, Business, Economics, medical)
- Business relationships
- Student-faculty collaboration
- Based in the United States

Next, the team developed a survey to send to the top ten centers with questions that could not be answered from a literature review of their website. The main areas of interest that the survey covered were research topics, funding, student involvement, industry and private sector involvement, facilities and other resources available. This information summarizes how the research centers operate, what their assets are, and how they are an asset to others. The model for OREC can be built upon the successful models of other research centers. The results have been compiled in order to make final recommendations in this report; the graphs can be seen in the following pages.

The list of centers included in the survey:

- Schatz Energy Research Center (Humboldt State University)
- Northwest National Marine Renewable Energy Center (Oregon State University)
- Clean Energy Institute (University of Washington)
- Wanger Institute for Sustainable Energy Research (Illinois Institute of Technology)
- Hawaii Natural Energy Institute (University of Hawaii)
- Carnegie Mellon Electricity Industry Center (Carnegie Mellon University)
- University of Maryland Energy Research Center (University of Maryland)
- Center for Energy and Environmental Resources (University of Texas at Austin)
- Center for Environmental Research and Technology (University of California Riverside)
- Center for Sustainable Electrical Energy Systems (UW Milwaukee)

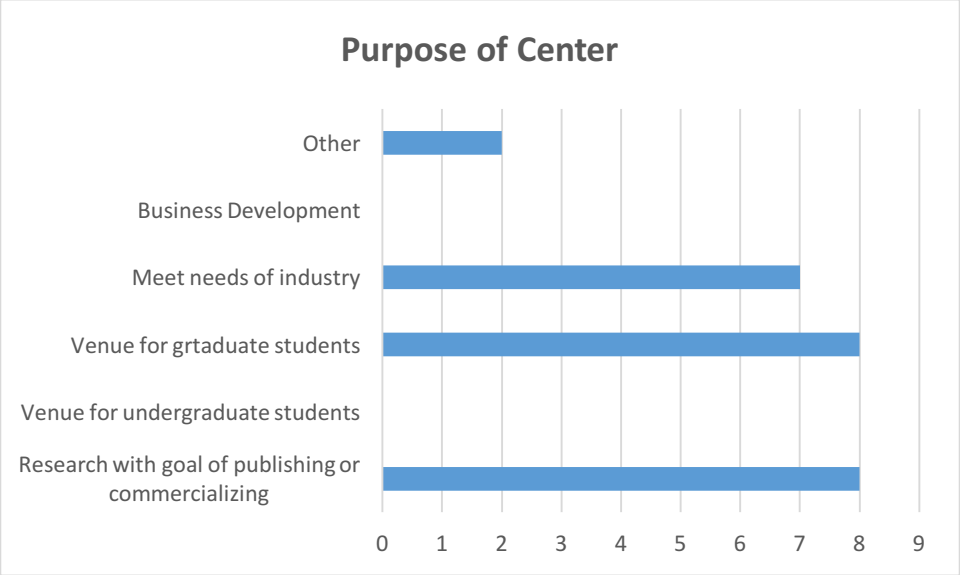


Figure 6. Research Center Survey Question 1.

Figure 6 shows that the other research centers studied provide research opportunities for graduate students, but do not provide many opportunities for undergraduates to participate in research. The other centers are also focused on publishing and commercialization, which is typical for research vs teaching universities.

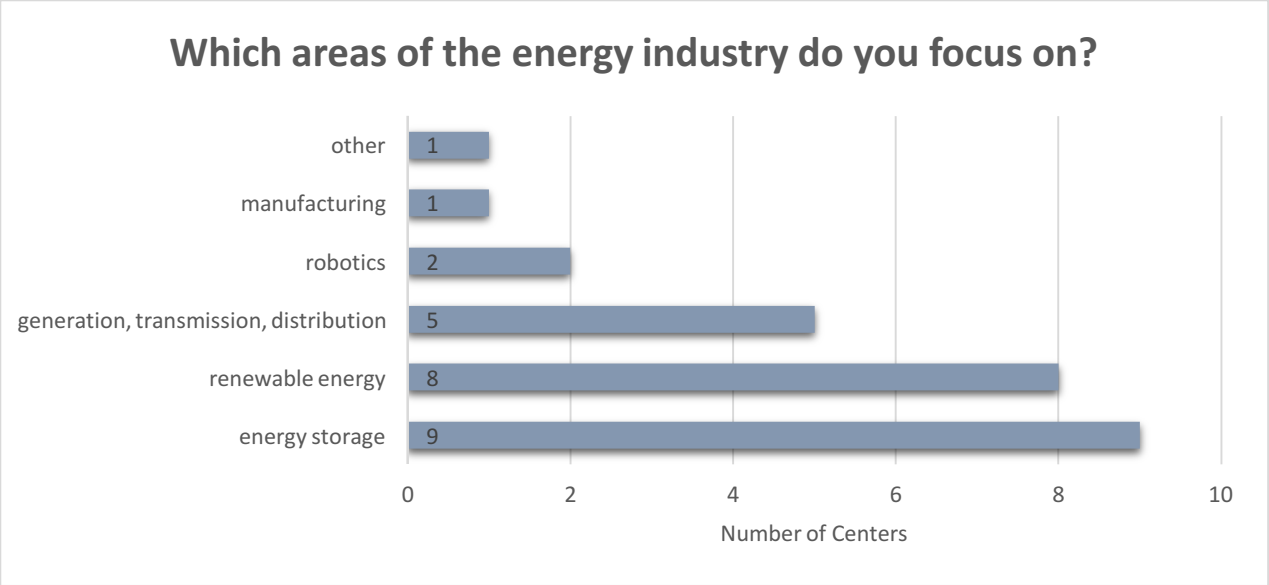


Figure 7. Research Center Survey Question 2.

Figure 7 indicates that most of the other research centers focus on renewable energy or energy storage and generation, leaving a gap in the manufacturing sector. OREC's approach-specific focus, that combines expertise in energy and manufacturing, seems to be have some market potential.

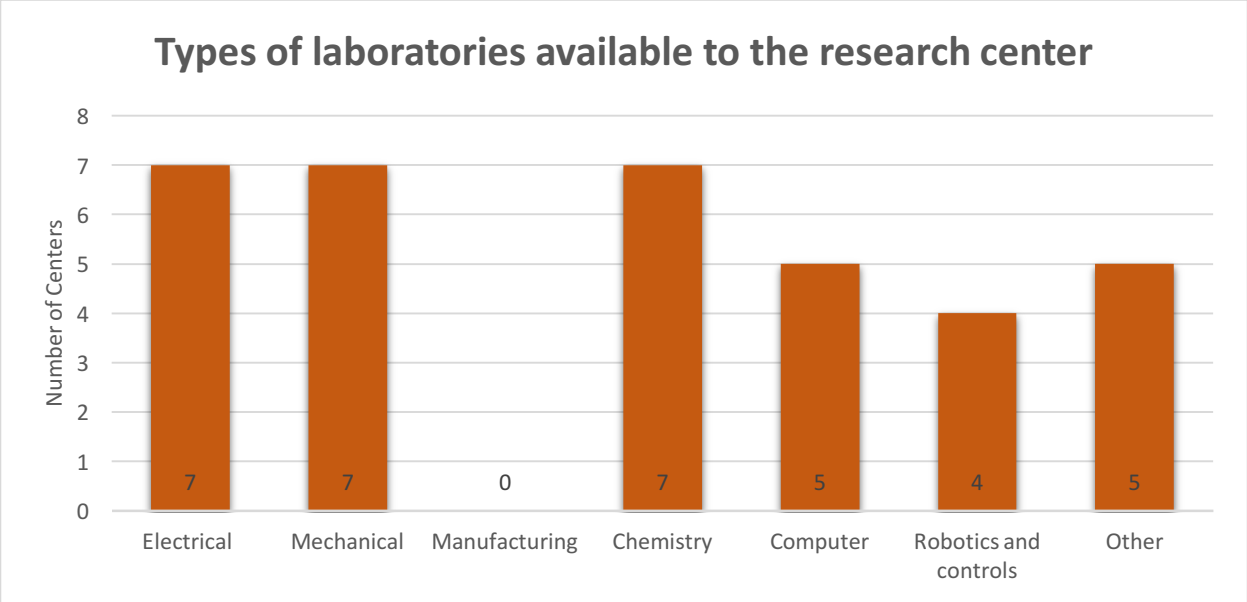


Figure 8. Research Center Laboratories.

Figure 8 shows the lack of manufacturing laboratories at the other research centers.

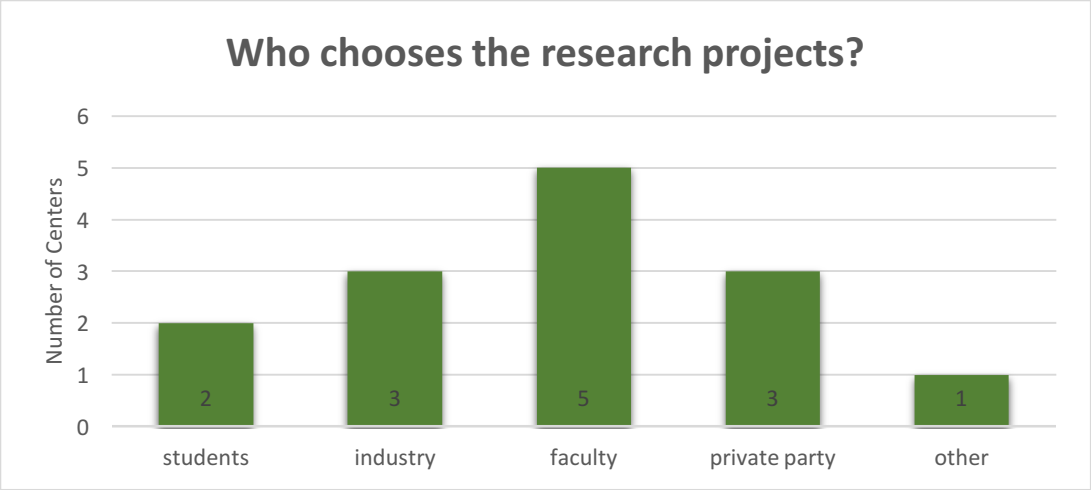


Figure 9. Research Center survey Question 3.

Figure 9 shows that most of the research projects at the other research centers are selected by faculty, industry, or private parties which is expected for traditional research centers. Student involvement in research decisions is limited at these centers, and provides an opportunity for OREC to support research collaborations between students and industry partners on capstones or graduate projects, or between faculty and industry partners.

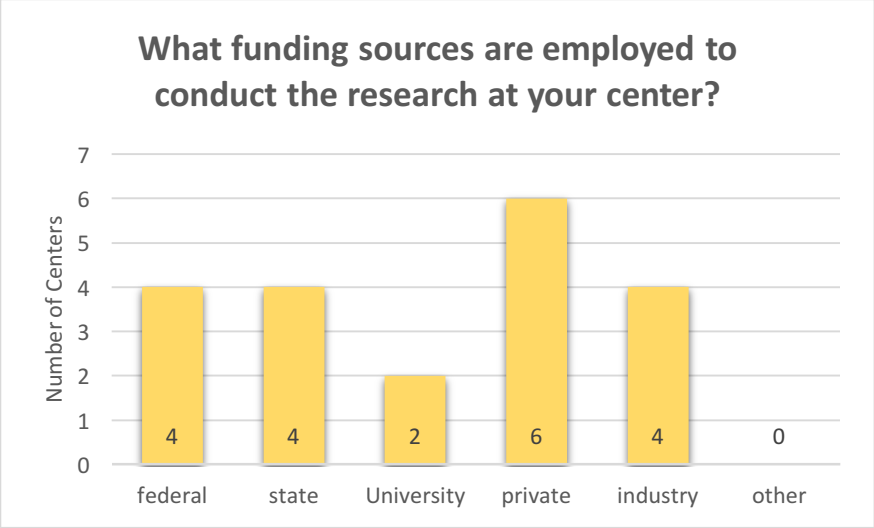


Figure 10. Research Center Survey Question 4.

Figure 10 shows that the other research centers receive a mixture of funding sources, with private party donations from foundations and corporate sponsors being the greatest source of funding. This graphs also indicates that, while the research centers are affiliated with universities, their primary sources of funding do not come from the universities.

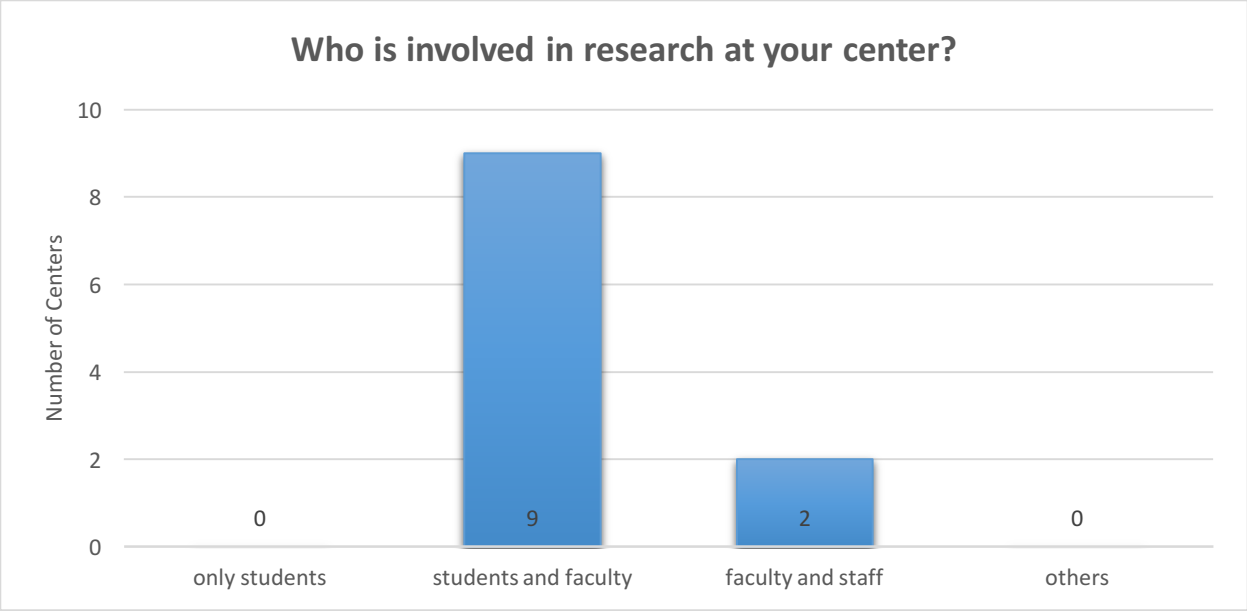


Figure 11. Research Center Survey Question 5.

According to Figure 11, most of the research is conducted by students and faculty working together, because most of the centers studied are affiliated with a university. However, some of the centers do have full time research faculty employed.

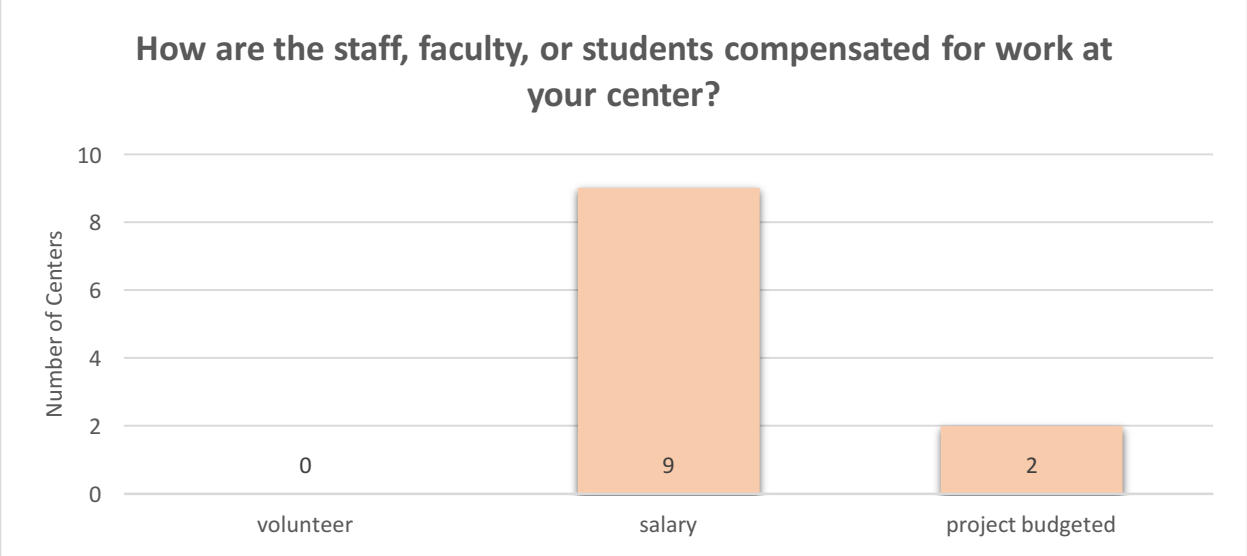


Figure 12. Research Center Survey Question 6.

Figure 12 shows that all of the research positions are paid positions for both faculty and students. Most of the compensation is from faculty salaries and graduate research fellowship. The salaries and project budgets are derived from a combination of federal, state and industry funds.

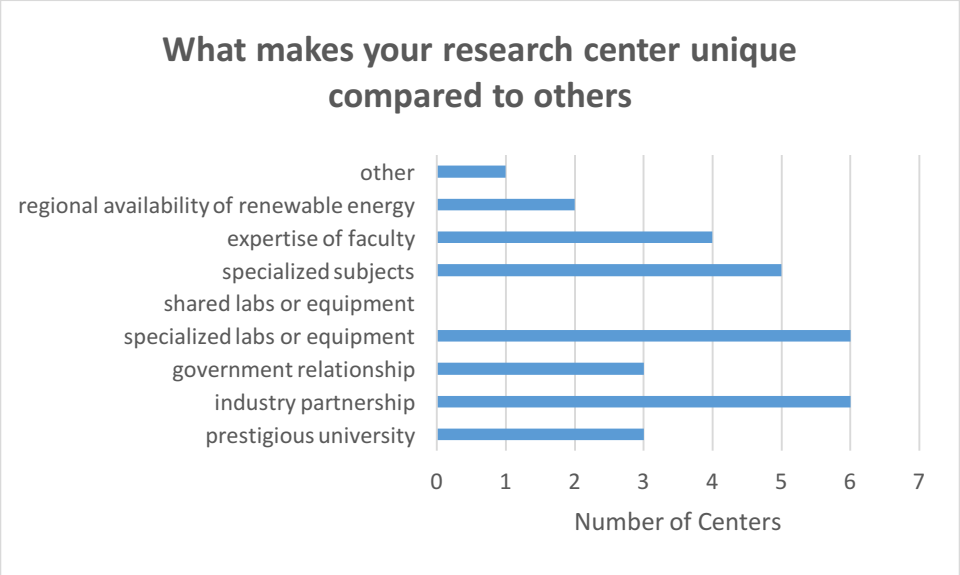


Figure 13. Research Center Survey Question 7.

Figure 13 demonstrates the unique characteristics of the other research centers in our study. OREC seems to be unique in its regional availability of renewable energy sources, its use of shared labs and equipment among multiple departments, and its multi-disciplinary approach to renewable energy education and research. OREC has access to talent and labs from Oregon Tech's Manufacturing & Mechanical Engineering, Civil Engineering, Software and Embedded Systems, and Electrical & Renewable Energy Engineering Departments.

Results

The literature review and survey of ten university-affiliated applied research centers indicates some clear trends. The primary areas of focus for the research centers are renewable energy and energy storage. Most of their funding is from sources other than the university, with the most common source being from private party donations (figure 10), such as foundations and corporate sponsors. Other funding commonly comes from federal or state grants, or industry partnerships. All of the research centers involve students in their research, however, the involvement is limited to graduate students who have been granted a research fellowship (figures 6, 11, and 12). The research projects are typically chosen by the faculty, or sometimes chosen by industry or private party sponsors (figure 9). Research projects are not usually chosen by the students. Most of the research centers feel that their uniqueness comes from their industry partnerships or specialized labs and equipment (figure 13).

OREC could fill the need for undergraduate and graduate talent development through access to research projects earlier in a student's academic career. OREC has an advantage in its access to energy and manufacturing labs, with some very unique assets in geothermal energy and multi-

disciplinary labs. As OREC's focus is further refined, it will increase opportunities for the university to solicit private donations, industry partnerships, and state and federal grants.

Current Asset Analysis

An inventory of ORECs current assets was conducted to include the faculty, technology and equipment, and partnerships with universities, industry and the community.

Faculty Interest

20 members of the faculty at Oregon Tech were surveyed to gauge their level of interest in participating with OREC, how working with OREC could be beneficial for them, as well as how they could be an asset to OREC. The faculty members included in the survey range from assistant professors to department chairs.

Figure 14. Faculty Survey Question 1a.

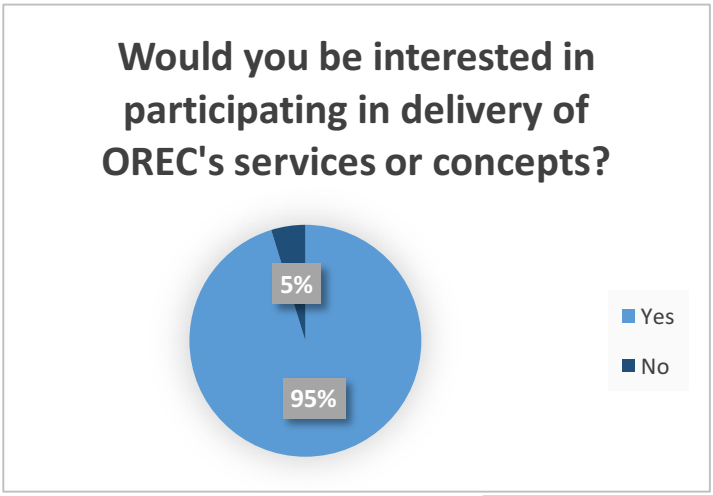


Figure 14 shows that most of the 20 faculty respondents would be interested in working with OREC.

According to figure 15, faculty would rely on a wide variety of funding sources. Most funding would be expected to come from state or federal sources or from the university.

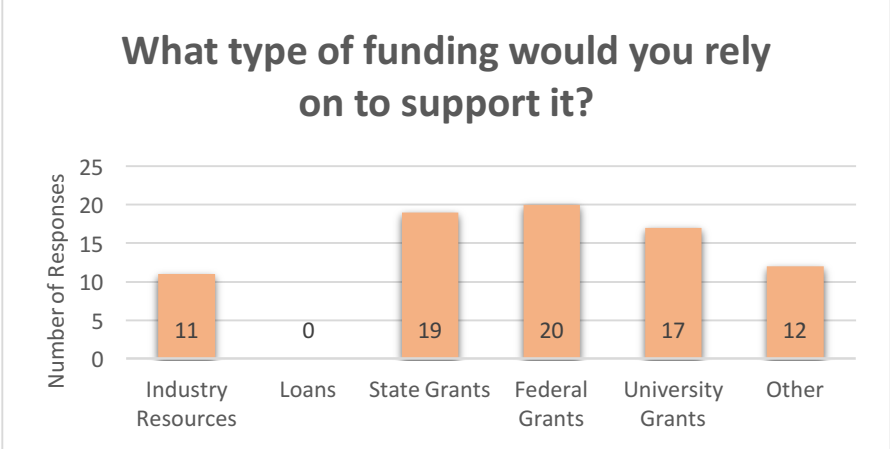


Figure 15. Faculty Survey Question 1b.

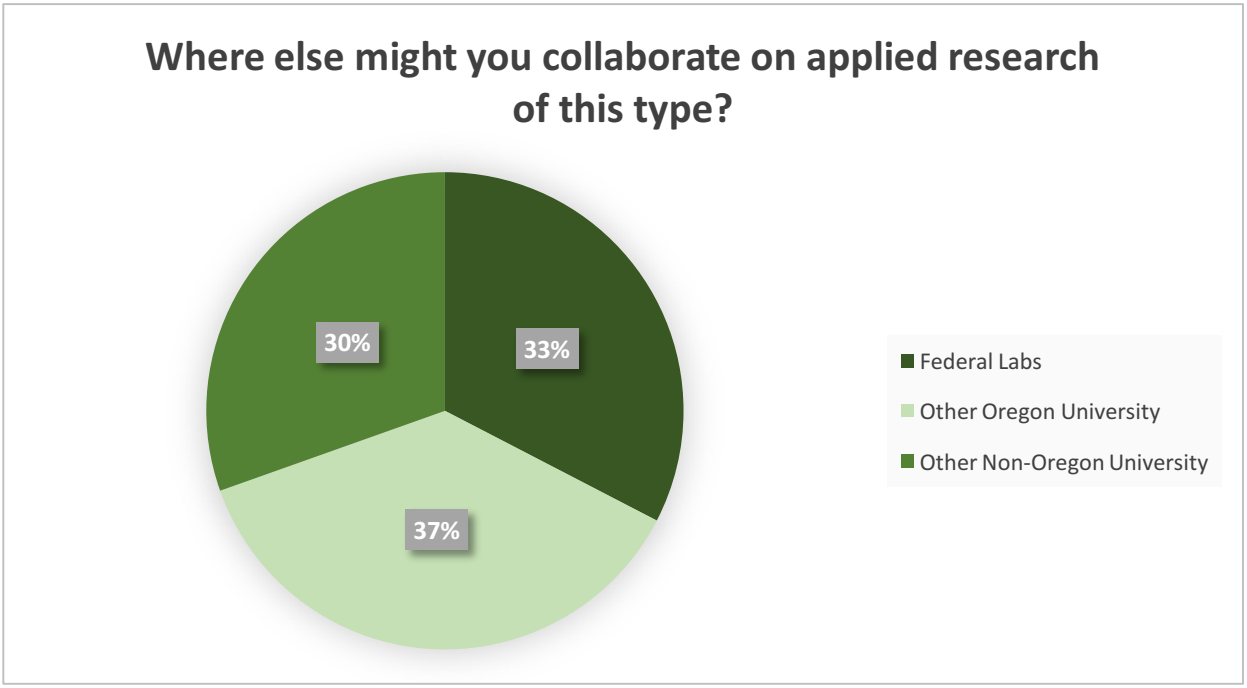


Figure 16. Faculty Survey Question 2.

Figure 16 shows that there are a variety of other research facilities where faculty could collaborate on applied research, though there is not one specific lab which takes the most preference. Other Oregon universities mentioned were Portland State University or Oregon State University.

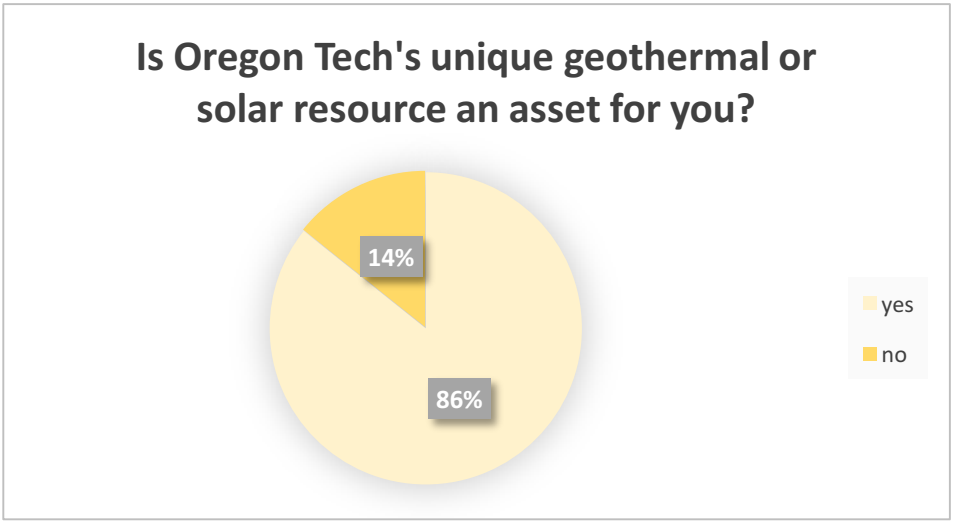


Figure 17. Faculty Survey Question 3.

According to Figure 17, most faculty find Oregon Tech's unique renewable energy resources to be an asset.

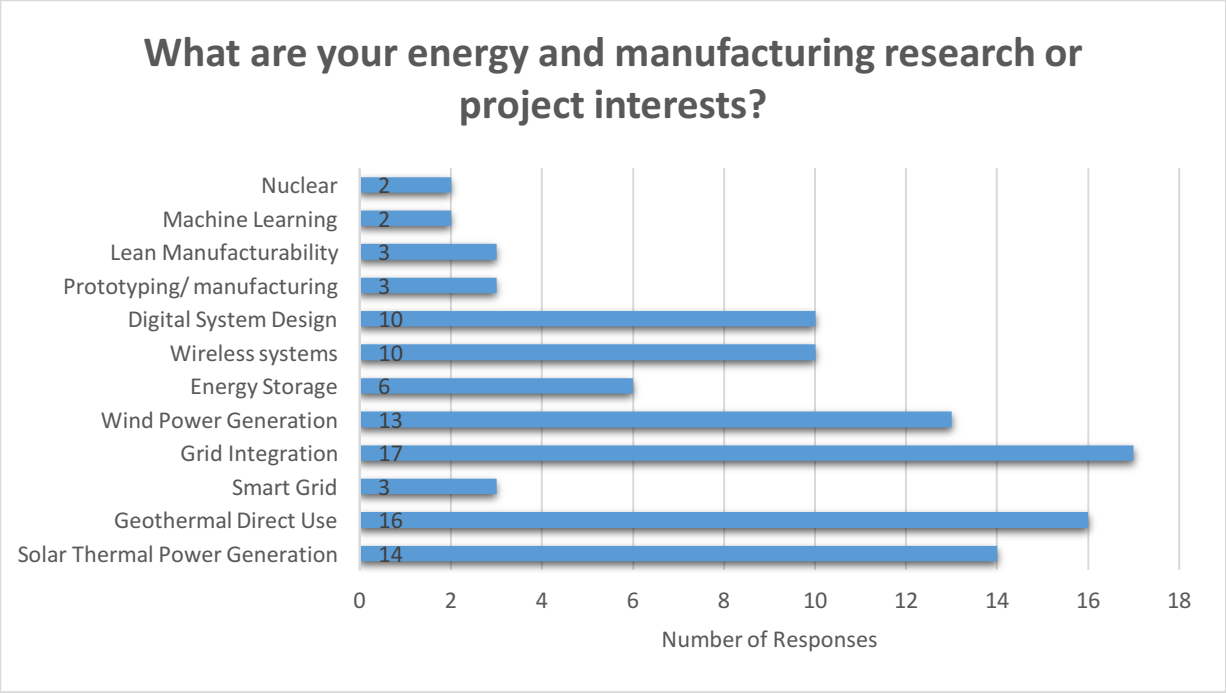


Figure 18. Faculty Survey Question 4.

Figure 18 shows that the faculty are most interested in grid integration, geothermal direct use, solar thermal power generation, and wind power generation; though there is a large variety of energy and manufacturing-related research topics that the faculty are interested in.

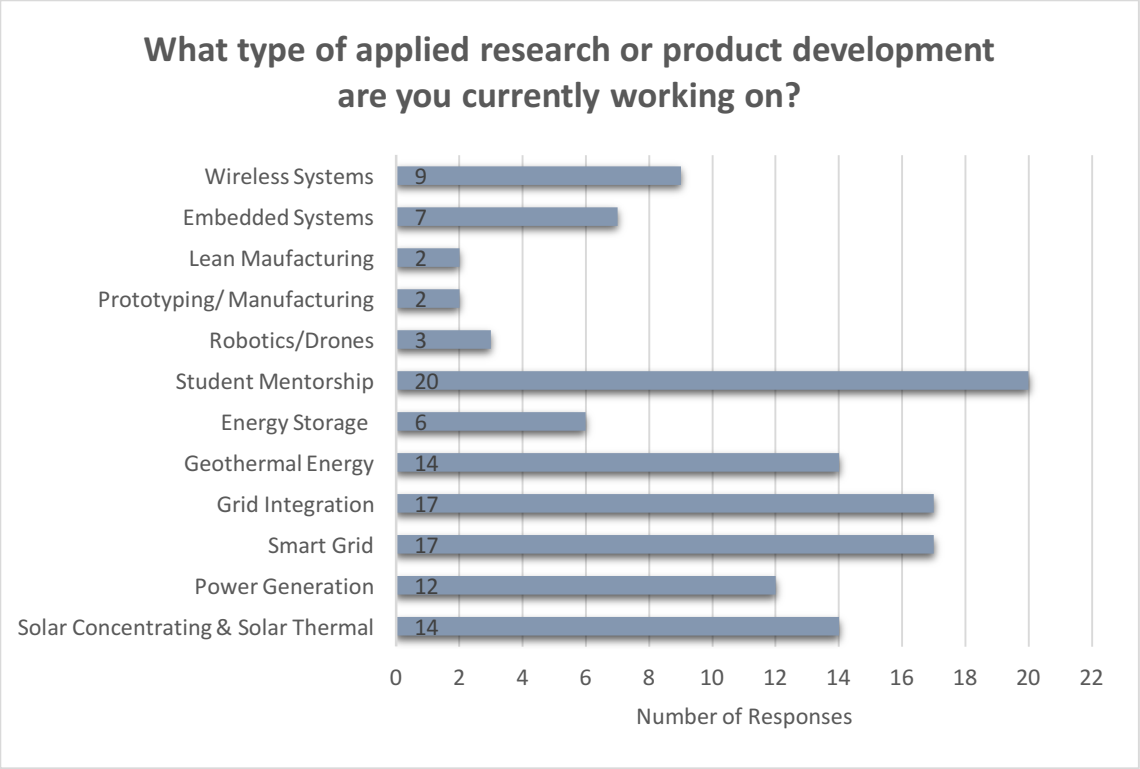


Figure 19. Faculty Survey Question 5.

According to figure 19 the faculty are already very involved in student mentorship. They are also highly involved with grid integration, smart grid, geothermal energy, and solar thermal energy.

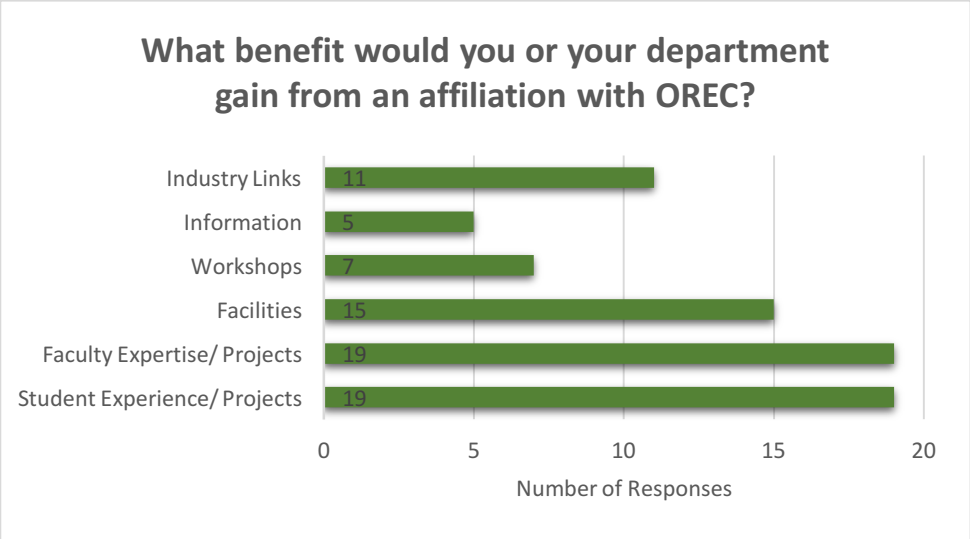


Figure 20. Faculty Survey Question 7.

Figure 20 shows that the largest benefit from an affiliation with OREC for faculty and their departments would be the opportunity to work on collaborative applied research projects with faculty and students.

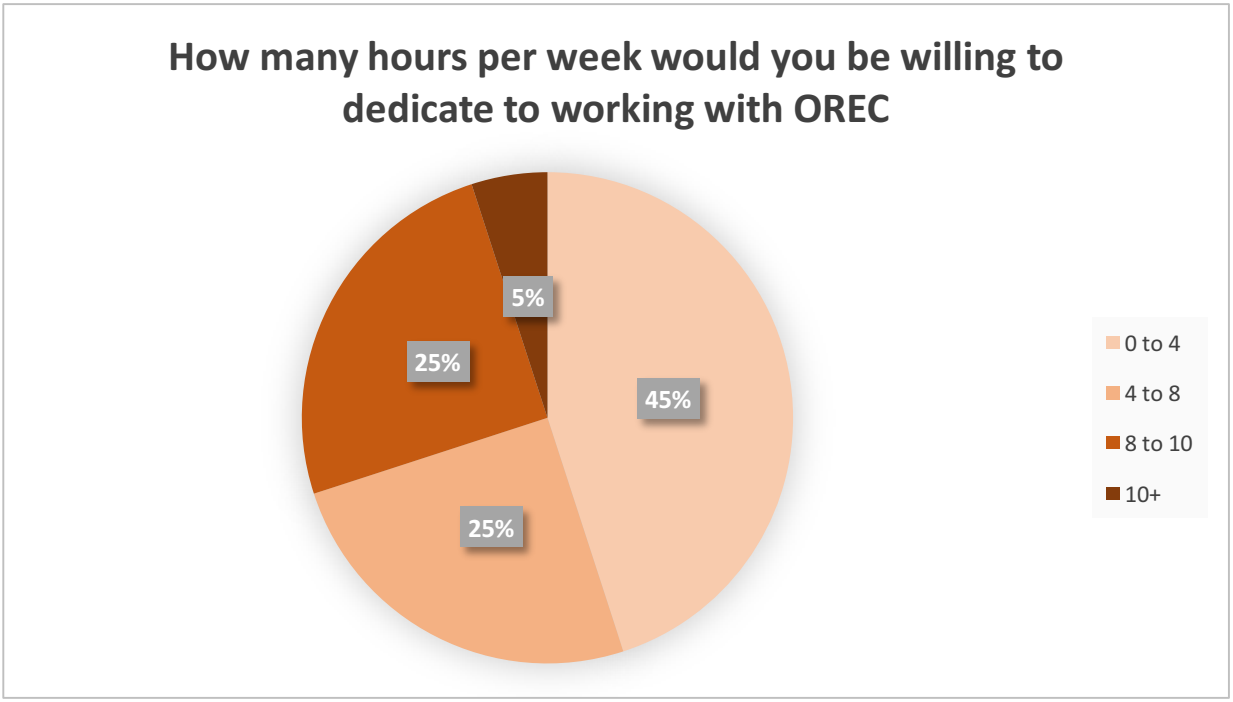


Figure 21. Faculty Survey Question 8.

According to figure 21, a large proportion of faculty would be willing to dedicate between 4 to 10 hours per week to working with OREC. Most of the faculty would only be willing to dedicate no more than 4 hours per week, due to teaching loads. Very few of the faculty would be willing to dedicate more than 10 hours per week.

Results

Most of the faculty at Oregon Tech are already engaged in research projects of their own, or at least have ideas for research projects as shown in figures 18 and 19. Most of their research interests are in line with OREC's capabilities, which means that working with the center could be a benefit to the faculty. OREC would also benefit from having the faculty conducting research because it could help build up recognition and credibility for the center.

There is a significant amount of interest in working with OREC from the faculty as demonstrated by figures 14, 20, and 21. However, figure 21 also shows that the faculty would not be able to dedicate very much time to working with OREC if they became affiliated faculty members. The number of hours that the faculty are willing to put in may change as they see OREC evolve into a well-established and recognized entity, but the bottom line seems to be that the research center needs paid research positions in order to compensate faculty and provide release time from teaching.

Technology and Equipment

This section is an inventory of the current assets and capabilities of OREC broken into three categories: Integrated Energy Systems and Laboratories, Capabilities for Development of Energy Technology, and Educational Programming and Outreach.

Integrated Energy Systems and Laboratories

The following is a list of the equipment and laboratories available to OREC to integrate renewable energy systems into the current technology.

- Labs within Cornett Hall (senior design lab, welding area, composite lab, 3D printers, civil engineering labs, manufacturing technology labs, SAE lab, fluids lab, robotics lab)
- Algae bioreactor
- Biodiesel equipment
- String Inverter PVP 5200 watt
- Energy auditing equipment
- Evacuated tubes
- Solar panels (2)
- Solar tracer
- 1/3 HP 115V water/oil pump
- DC motors
- DC motor controllers
- Smaller concentrator (7" radius)
- Laser engraver
- Hydrogen and nitrogen storage tanks
- Thermal camera

Capabilities for Development of Energy Technology

This section gives an account of the resources OREC has that enable it to assist in the development of new energy technology.

- Dedicated work space in Cornett Hall
- Klamath Falls campus and Wilsonville campus (plus others) of OIT
- College of Engineering, Technology, and Management (ETM) at Oregon Tech
    - Includes all engineering, technology, and management programs
- Engineering and technology related clubs (IEEE, SAE, ASME, ASCE, Engineering Honors Society, Mars Reach, Solar Hope, Engineers Without Boarders, Inventors Club etc.)
- MECOP/CECOP internship programs
- Association with Oregon Tech name and branding
- Geo-Heat Center Archives (OIT Library)

- Geothermal Power Plant (K Falls campus)
- Solar Farm (K Falls campus)
- Solar concentrator
- Solar Tracker
- Res Hall/The Village [Net zero building] (K Falls campus)
- Ac Motor Drive ABB ACS 400 Application macro
- Industry funding (PGE, Pacific Power, BEST)

Educational Programming and Outreach

This section provides an overview of resources OREC has to provide students with an opportunity to engage in real world energy research. The resources in this section range from incomplete student projects to fully developed and implemented equipment.

- Electric motors
- PEPE (electric car)
- Striped down car for conversion to electric
- Energy auditing equipment
- Smart grid
- Hardware and software labs within the Computer Systems and Engineering Technology (CSET) labs
- Renewable Energy Lab in Wilsonville (versatile computer workstation, lab benches, fume extractor, dry box for metal-air batteries)
- Work shop in Wilsonville (drill press, saws, hand tools, Tormach CNC Mill)
- Micro grid lab in Wilsonville (two motor/generator set, power management controllers, resistive bank, and monitoring station)
- 3-D Printer (Wilsonville and Klamath)
- Flow Limiter Instrument Controller trainer (FLIC) at Wilsonville control systems lab
- Electrochemical lab in Wilsonville (batteries, galvanic cells, fuel cells and photovoltaics)
- Biological Potentiostat in Wilsonville (characterize electrochemical cells)
- Fluids and Thermodynamics Lab in Wilsonville (the concentric heat exchanger, plate heat exchanger, flow measurement H10, and galvanic hydraulic bench)
- HVAC Green Building Lab in Wilsonville (design and build air handler, a refrigeration trainer, building diagnostic tools)
- Optics Lab (Photodetector, radiometer, spectroradiometers, microscopes, interferometers)

Partners

OREC and Oregon Tech currently work with a multitude of partner industry organizations, universities, and community-based economic development entities. The partnerships help OREC expand its reach to small and medium-sized companies, fulfill its mission for public service in energy systems and applied research, and engage undergraduate and graduate students in relevant experiential learning to prepare the next-generation workforce.

Industry Partners

- Gorge Technology Alliance
- Manufacturing 21 Coalition (M21)
- NW Collaboratory for Sustainable Manufacturing and Oregon Manufacturing Innovation Center (OMIC)
- Oregon Manufacturing Extension Partnership (OMEP)
- Oregon Solar Energy Industry Association (OSEIA)
- Oregon Aviation Industries
- Pacific Northwest Defense Coalition (PNDC)
- Pacific Power, Avista, PGE, BPA and other utilities
- Renewable Northwest Project
- Smart Grid Oregon
- Sustainable Valley Technology Group
- Technology Association of Oregon

University Partners

- PSU: Oregon Transportation Research and Education Consortium (OTREC)
- PSU Power Engineering Lab
- UO:
    - Center for Advanced Materials Characterization in Oregon (CAMCOR) talk about what these are
    - Support Network for Research and Innovation in Solar Energy (SuNRISE)
- UO 4+1 Industrial Internship Program
- Great Basin Center for Geothermal Energy

Possible Future Partners

- OSU Extension Service
- OSU Energy Efficiency Center (EEC)
- OSU:
    - Energy integration motor lab

  - Northwest *National Marine* Renewable *Energy Center* (NNMREC)
  - Microproducts Breakthrough Institute (MBI)
  - Wallace Energy Systems and Renewable Facility
  - Center for Sustainable Materials Chemistry (jointly with UO)
  - Advanced Thermal Hydraulic Research Laboratory
  - O.H. Hinsdale Wave Laboratory
- UO:
  - Photovoltaic laboratory
  - Solar radiation monitoring laboratory
- Schatz Energy Research Center (Humboldt State University)
- National Energy Technology Lab (NETL)

Community Based Partners

- Business Oregon
- Chambers of Commerce for Klamath, Tualatin, Wilsonville
- Drive Oregon
- Governor's Regional Solutions Team – Central Oregon
- Higher Education Coordinating Commission (HECC)
- Klamath County Economic Development Association
- Klamath IDEA
- Oregon BEST
- Oregon Employment Dept.
- Oregon Innovation Council
- Oregon Metals Initiative
- Oregon Talent Council
- Oregon Wave Energy Trust
- Oregon Workforce Investment Board and local workforce boards: WSI, WICCO, East Cascades, Rogue
- South Metro-Salem STEM Hub
- Southern Central Oregon Economic Development District (SCOEDD)

In summary, OREC has an abundance of resources in the form of faculty expertise, unique energy-generation systems, teaching and applied research labs, and industry and community partnerships. OREC currently lacks the systems to support faculty who wish to offer their expertise in the applied research area. With dedicated staff to garner university and state sustaining support, and build deeper industry and academic collaborations, OREC could exponentially broaden the number and scope of its projects, expand faculty and student engagement, and potentially secure more donations and grants.

Oregon Talent Analysis

This section describes the need for talent development to meet the needs for industries throughout Oregon.

Manufacturing

An analysis of the Oregon Talent Plan indicates that manufacturing has shifted from a traditionally unskilled industry to one which requires a higher level of education. According to the Oregon Talent Plan, "Modern manufacturing is becoming more and more complex, inter-weaving computers, electronics, software, firmware, hardware and artificial intelligence" [1]. Given this new paradigm within the manufacturing industry, Oregon would benefit from an educational institution that can provide students with exposure to advance manufacturing processes.

Manufacturing accounts for a significant part of Oregon's economy employing 180,791 workers at 5,868 facilities [1]. According to the Oregon Talent Plan, in 2014 manufacturing accounted for 85% of Oregon exports, which was worth approximately $17.8 billion [1]. The advance manufacturing sector of the Oregon economy is expected to grow over the next decade, which will provide Oregon employees with high paying jobs. According to the Oregon Talent Plan, the sector is expected to grow by 19% by the year 2022, which translates to an increase of 16,900 jobs [1].

Oregon has extensive manufacturing companies and facilities, but lacks a facility with engineering staff to support prototyping required to enable rapid design iterations that are necessary to develop stable and robust manufacturing processes. There is a need for a facility to support rapid prototyping that bridges the gap between concept and manufacturing. The absence of cost-effective prototyping has created a situation that makes Oregon industry less competitive with other states and results in lost opportunities. OREC's faculty and lab assets, coupled with its unique energy resources, could provide essential teaching/learning and applied research capabilities.

Energy Technology & Utilities

Continued advances in smart technology and computing power are projected to increase the Smart Grid market significantly. Oregon's 10-year energy plan calls for meeting 100% of new growth load through energy efficiency and conservation which will require the use of technology in addition to consumer conservation. Smart grid advancements are expected in an array of energy related applications including substation automation, communications, asset management and condition monitoring, as well as demand response. Smart grids are projected to be two of the most significant advancements in energy, reducing demand through more effective smart grid management, saving money for utilities and customers, and lowering greenhouse emissions [1].

The energy sector is facing a significant rate of retirement among professionals and technical positions. Findings indicate that more than 60% of the electric power workforce in the Pacific Northwest is age 45 or older with 17% of the current workforce expected to retire by 2018. Additionally, employers reported having to work much harder than in the past to fill available positions [1].

Results

The Oregon talent development analysis highlights some of the issues facing the manufacturing and energy industries in Oregon. First, there is an identified need to develop the talent necessary to fill the positions created by the emerging advanced manufacturing sector. Next, industry partners in energy conservation and power indicated a need to produce graduates with experience in smart technologies in the energy and utility sectors which could be accomplished through OREC projects. Finally, there is a need to replace the mass of power engineers and utility workers that will be retiring over the next decade.

With its unique resources in manufacturing, power engineering, smart grid technology, OREC can play a major role in preparing the next generation of Oregon's engineers and technicians needed to fill the critical gap.

Financial Support Analysis

In an effort to determine the best financial model for OREC, an analysis of the ten energy research centers' sources of funds was conducted. Although all ten energy research centers studied are university affiliated, not all of the funding for the research is derived from university sources. There were a few different financial models observed at the other centers. All of the energy research centers studied are funded in part by federal and state funds and all of the centers benefited from the availability of university resources such as faculty, facilities, equipment and students. However, they all had different combinations of funding sources.

The Clean Energy Institute (CEI) at the University of Washington derives funds directly from the state budget. They are unique in that they are the only energy research center studied that has a dedicated annual budget from the state, which was a mandate from the governor.

Another financial model observed in the research is that of the energy research center offering memberships to the community in which companies, individuals, and government agencies can purchase and benefit from the research being conducted at the centers. The membership allows the members to present research topics or projects to be conducted at the center. The consortium-type model is also well supported at the federal level through the National Science Foundation I-UCRC program, but primarily supports prestigious research universities.

The financial model for the Carnegie Mellon Electricity Industry Center (CMEIC) is a mixture of various federal agencies and private foundations. Also, the center brings in 50 PhD students every year that are funded through various fellowships. CMEIC also consults with many government agencies with respect to energy policy which is another strong source of funding for the center.

The Winston Chung Global Energy Center at the University of California Riverside (WCGEC) is a good example of an energy research center that operates on private donation funding. Winston Chung, who is an entrepreneur and Fellow of the Bourns College of Engineering, gave a gift of $600,000 in research funds and $2.5 million worth of rare earth lithium ion batteries for the research center. While that gift was very generous and a great benefit to the research center, it was a one-time gift that the research center cannot rely on into the extended future. In order to maintain stability, the research center will need to seek out additional funding so that they can continue to operate once the $600,000 gift is spent.

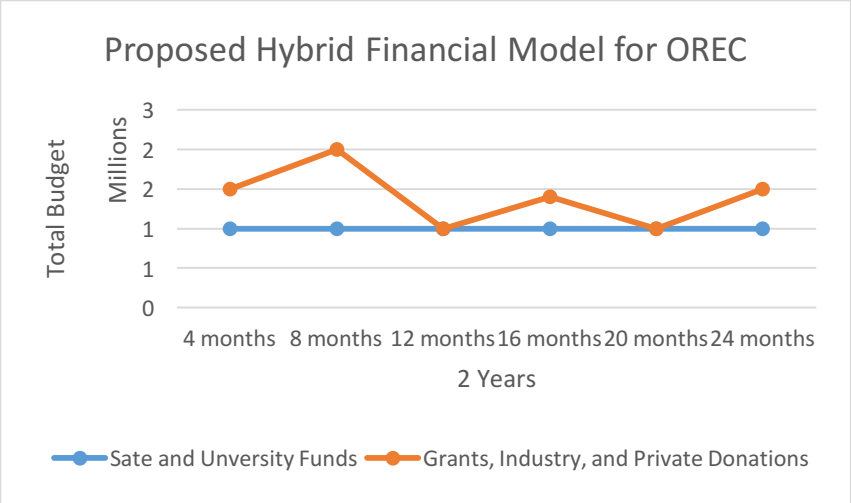
A common practice for all the centers studied was that of seeking donations from the public. Most of the centers have a section of their websites dedicated to asking the public to donate to the center to fund new research. This funding stream was not as significant to the operations as the other funding sources, but is certainly something that Oregon Tech and OREC could consider.

Proposed Model

The proposed model for OREC is a hybrid financial model based on funding sources from the state and university (hard money), grants and industry partners (soft money). In this model there are state-funded positions and grant-funded positions. The state-funded positions are the director, administrative assistant and a sponsored projects and grants administrator. These staff members are responsible for the administrative requirements of the research center. Student research positions could be made available as volunteer positions with the benefit of students gaining work experience and industry connections or through undergraduate or graduate research assistantships or stipends.

The grant-funded positions are for research faculty and a grant writer. These positions are responsible for the research and project generation aspect of the facility. The grant generation will be directed toward the National Science Foundation (NSF), the Department of Energy (DOE), the Department of Defense (DOD), the Oregon Talent Council (OTC) and so on.

It is anticipated that there will be at least 30 OREC-affiliated faculty from Oregon Tech with the expertise to participate with companies on applied research or grant-funded projects, who could be given periodic release time from teaching, with compensation from state support, grant or industry sponsorships, based on the expertise needed for specific projects.



The goal is for OREC to be able to remain viable and continue to conduct research during times when soft money is unavailable. This requires that hard money be dedicated to the annual budget for OREC as can be seen in figure 22.

Figure 22. Proposed Hybrid Financial Model for OREC.

Feasibility Evaluation

There are a few key areas which must be considered in the feasibility study and plan for OREC. The necessary components are budget, partnerships, and projects. In order to reach its full potential as a research center OREC will need a reliable funding source, industry and academic partners to consult with, and cutting edge technical projects to research and develop.

The survey of other research centers shows that their primary sources of funding come from federal and state government grants. It is unusual for a research center to be supported by the parent university as a primary funding source. Based on the survey examples, the proposed budget for OREC will consist mostly of federal and state funds. Having consistent funding, especially for the administrative functions to support the grants and sponsored projects, would give the research center financial stability.

The survey of other research center also showed that private party donations and industry grants can be a very significant funding source. These sources can be included in the model for OREC as supplementary funds, however, since this type of funding is less reliable it should not be the only funding source in the budget for the sake of stability.

The surveys of energy industry companies, Oregon Tech faculty, and other research centers, as well as the Oregon Talent Plan, indicate that there are many benefits to OREC from having partners in industry and academia. During the survey of other research centers, when asked what makes them unique to other centers, a common response was their industry partners. Their industry partners are so significant because they are either providing financial support, specialized labs or equipment, or technical expertise.

The Wilsonville and Seattle campuses are good resources for generating industry partners because of their proximity to many energy, utility, transportation and manufacturing companies. The range of campuses provides OREC an opportunity to create partnerships with many companies seeking assistance with evaluating, testing, prototyping and manufacturing. The Klamath Falls campus is

a good resource for conducting general research and giving undergraduates research experience, as well as accessing the unique geothermal and solar energy generation facilities.

The Oregon Talent Plan indicated that technology and engineering related jobs are hard to fill, with the primary reason being not enough qualified applicants. The survey of energy industry revealed that if Oregon Tech graduates had experience working with OREC they would be more employable at those companies. A partnership between OREC and a specific company means that the company may be able to provide equipment, funding, or knowledge, while in exchange students could be preparing for the workforce while they are working with OREC. This type of situation could be beneficial to both parties as OREC would be supplying excellent future employees.

Having academic partners is important to OREC so that the research center can gain credibility and recognition, as well as to provide faculty or student researchers. The survey of Oregon Tech faculty showed that there is a high degree of interest in working directly with OREC, and that most faculty are interested in working with students on research projects. The survey also showed that the faculty have many research interests of their own, with a large proportion of the projects falling under the energy category. Having Oregon Tech faculty and students working together with OREC would be a good way for the research center to gain more recognition and credibility. The academic partnerships could also be extended beyond Oregon Tech to other universities.

Cutting-edge research projects will play a large role in the feasibility of OREC, as the research projects will further define OREC's purpose, direction, and areas of expertise. The survey of other research centers showed that many energy-related research centers are actively researching energy storage and micro-grids. If OREC were to take a similar approach it may be difficult to distinguish itself from other research centers. The study also showed that there aren't many energy research centers working on prototyping and manufacturability of clean energy technologies. Since Oregon Tech has excellent manufacturing engineering programs and facilities that complement its expertise in renewable energy generation, power and controls, and clean energy innovation, pursuing this type of research could help set OREC apart.

References

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https://www.oregon.gov/EMPLOY/OTC/Documents/OTC_TalentPlanDraft_11-5-15.pdf

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Appendix

A1 - Questions for Industry Interviews

Oregon Tech is conducting interviews with energy industry partners to ascertain the value to companies and communities of its applied research center, the Oregon Renewable Energy Center (OREC).

We want to hear your opinions on whether or not your company would utilize the services of OREC as well as the value you might find in hiring graduates from Oregon Tech's degree programs if the students had experience working on applied research projects through OREC.

First, I'd like to describe OREC and its purpose, and then ask you nine questions that should not take more than 15 minutes to answer.

As a public purpose, applied research center created by the Oregon State Legislature, the Oregon Renewable Energy Center (OREC) speeds the integration and optimization of renewable energy resources with current power generation systems, and accelerates clean energy technologies in collaboration with industry partners.

OREC is designed to meet a critical gap in technology development for small and medium-sized companies. OREC enables Oregon's smaller players to invent and produce solutions to the nation's larger energy and manufacturing challenges, by providing access to expertise and equipment that is beyond reach otherwise.

OREC has a focus on prototyping, validating, testing, and manufacturability. OREC is designed to bridge that gap in collaboration with companies who are evaluating the feasibility and manufacturing of more competitive or lower cost solutions. Collaborations with Oregon Tech include the use of unique labs and facilities, distinguished industry-aware faculty, and a focus on applied research.

What OREC can do:

- Developing prototypes for solar, wave and other energy devices
- Testing the manufacturability of new products
- Battery characterization and testing; expanding storage capabilities
- Optimization of hybrid vehicle control systems
- Building and testing customized components to reduce production costs
- Selecting materials, assessing strength of materials, especially composites and metals
- Manufacturing product or process improvements; manufacturing controls and robotics
- Product development and remote monitoring of solar energy systems
- Utilizing geothermal energy to accelerate food and agricultural products
- Geothermal combined with solar for boosting solar output in hybridized systems
- Training on the use of Oregon Tech's unique geothermal resource

Questions:

1. Given OREC's purpose, as described above, which of OREC's services for prototyping, validating, testing or manufacturability of clean tech or energy-related products or concepts might you use?

1b. If you would use any, what kind of resources do have to support such a project, or would you need to rely on outside funding to support it?

- Company resources
- Loans
- State Grants
- Federal Grants

2. Where else might your company seek research assistance of this type?

- Federal lab
- Other Oregon university, name _____
- Other university outside of Oregon, Name _____

3. To what degree do you find Oregon Tech's unique geothermal resource an asset for your company in terms of the optimization of current power sources with clean energy systems?
    - How so?
4. What are your energy and manufacturing research needs and what types of projects might interest your company?
5. What kind of applied research or product development is your company currently conducting (in general terms) and how is the research funded?
6. If Oregon Tech's undergraduate and graduate students had experience working with companies on applied research projects, would the experience make them more employable? What specific skills and degrees are attractive to your company?
7. To what degree are you able to find the talent you need for your business?
8. What is currently the most reliable source of that talent, and what's missing?
9. What benefits would your company gain from an affiliation with Oregon Tech, OREC and its students and faculty?
10. Do you see a gap in the applied energy research field that is not being filled?
11. What are the most under-researched areas in your industry?

Thank you for your time. May I use your company name and answers, with or without attribution, in a research paper about the value of OREC?

OK to use name?

OK to use answers without company name?

A2 - Research Center Questionnaire

Introduction:

Oregon Tech is engaged in an analysis of the market opportunities and industry needs that could be addressed by the Oregon Renewable Energy Center (OREC), a university-based applied research center, authorized in statute by the Oregon Legislature in 2001.

The purpose of our research is to determine if there is a market niche for an approach-specific applied energy research center that employs the multi-disciplinary capabilities of Oregon Tech. This questionnaire is intended to gauge/understand the current opportunities to conduct applied research tied to the needs of businesses and communities as they relate to regional, state and national energy security, smart grid, storage, energy integration and manufacturing challenges, and coalesce these initiatives at the university.

The goal is to build capacity to support industry outreach, enable the university to conduct research and leverage funding, and enhance teaching, all of which will advance the competitiveness of small and medium-sized business base in Oregon and the Pacific Northwest.

Also, OREC will play a significant role in fulfilling Oregon's energy policy initiatives, including an updated Renewable Portfolio Standard, and other progressive energy policies.

The information you share with us will guide Oregon Tech in an effort to position OREC for future success and sustainability.

The survey should take no more than 10 minutes to complete.

Survey Questions

General:

- Of the following, which best applies to your research center? Check all that apply.
  - The goal of the center is to engage in basic research with the goal of publishing or commercialization of energy-related technologies.
  - The goal of the center is to provide a venue for undergrad projects.
  - The goal of the center is to provide graduate learning experiences for students
  - Other

- What is the main influence behind the goals for the center? Choose one.
  - To meet the demands or needs of an academic program
  - To meet the demands of industry partners
  - To provide research experience for undergraduates
  - To generate external sources of revenue
  - To provide a venue for faculty collaboration or faculty-initiated or inspired research
  - To expand the university's capabilities and reputation in an area of expertise
  - Others

- What is the applied research center's primary area of expertise?
  - Renewable energy
  - Power systems

  - Wave energy
  - Geothermal
  - Robotics/controls
  - Energy storage
  - Policy analysis
  - Other
- What are the applied research center's primary labs and equipment?
  - Electrical Labs
  - Mechanical labs
  - Manufacturing labs
  - Chemistry labs
  - Computer labs
  - Robotics and Controls labs
  - Other
- Which areas of the energy industry do you feel are under-researched?
  - Energy storage
  - Renewable energy
  - Generation/Transmission/Distribution
  - Robotic/Mechatronics
  - Manufacturing
  - Other. Please specify.
- What academic programs are affiliated with or supported by the center?
  - Electrical Engineering
  - Renewable Energy Engineering
  - Civil Engineering
  - Mechanical Engineering
  - Manufacturing Engineering
  - Chemical Engineering
  - Computer Science
  - Information Technology
  - Other

Financial:

- What are the funding sources and amounts of contribution for the applied research center?

%	Federal	State	University	Industry	Private	Other
0-25						
25-50						
50-75						
75 +						
Total						

- Is the applied research Center organized as a?
  - Non-Profit organization
  - Self-supporting research center inside the university
  - Self-supporting auxiliary
  - Multi-university collaborative
  - Industry-University consortium
  - Other

- Does the applied research center generate income outside of the public funding? If yes, what are the sector in which they are earning and what are the amount?

%	Providing Training	Conference & Symposium	Prototyping & Testing	Consultation	Construction & Development	Feasibility Study & Technical Report
0-25						
25-50						
50-75						
75 +						
Total						

Return on investment:

- Approximately how many jobs have been created or retained through new and improved product development or manufacturing production as a result of the applied research center over the past 5 years?
  - 0-10
  - 10-20
  - 20-30
  - > 30

- Approximately how many startup companies have been created through partnership with the applied research center over the past 5 years?
  - 0-5
  - 5-10
  - 10-15
  - >15
- If the applied research center is affiliated with an educational institution, how many BS-level degrees are awarded every year in energy and related fields?
  - 0-10
  - 10-20
  - 30-40
  - >40
  - N/A
- If the applied research center is affiliated with an educational institution, how many MS-level degrees are awarded every year in energy and related fields?
  - 0-5
  - 5-10
  - 10-15
  - >15
  - N/A
- If the applied research center is affiliated with an educational institution, what percentage of students receive research experience with the center in the last 5 years?
  - 0-5
  - 5-10
  - 10-15
  - >15
  - N/A

- Approximately how many undergraduate and graduate research or teaching assistantship does the applied research center support each year?
  - 0-5
  - 5-10
  - 10-15
  - >15
- Approximately how many industry-supported undergraduate and graduate projects are conducted at the applied research center each year?
  - 0-5
  - 5-10
  - 10-15
  - >15
- Does the university, through the research center, claim any patents or have any licensing revenue?
  - Yes
  - No

- If so, what is the number of patents?
  - 0-5
  - 5-10
  - 10-15
  - >15
- If so, approximate licensing revenue (in thousands of dollars)?
  - 0-10
  - 10-30
  - 30-50
  - >50
- What is the expected timeline for a return on investment (ROI) for most of your research center's investments (grants, sponsored research)?
  - Less than one year
  - 1-5 years
  - 5-10 years
  - More than 10 years
  - unknown
- Approximately how many students are employed or conducting research at the applied research center each year?
  - 0-20
  - 20-50
  - 50-100
  - >100
- Approximately how many faculty and staff are employed or conducting research at the applied research center each year?
  - 0-5
  - 5-10
  - 10-20
  - >20

Leadership and Governance:

- How was the applied research center initially established?
  - Legislated

  - Industry sponsored
  - University sponsored
  - Private sponsored
  - Other
- How is the applied research center governed?
  - Governing Board
  - University Board
  - State Board
  - Other

- What kind of time line is used for academic planning and project identification?
  - One year
  - Two years
  - Three years
  - > three years
- How are the research projects initiated? Choose all that apply.
  - Students
  - Industry
  - Faculty
  - Private party
  - Other
- How are the research projects selected?
  - Approval from director of center
  - Approval from board or committee
  - Approval from academic program or department
  - Other
- Is there a board or committee to guide the center?
  - Yes
  - No
- If yes, how are the members selected or appointed?
  - Expertise
  - Interest
  - Availability
  - Other

Industry:

- What are you doing to meet the needs of industry? Choose all that apply.
  - Preparing students to enter the workforce
  - Developing new technologies which they are interested in
  - Engage in prototyping, testing, validation, simulating, evaluating, feasibility study and technical report
  - Other
- What segment of the energy industries do you most serve? Choose all that apply.
  - Geothermal
  - Solar
  - Wind
  - Biomass/Biofuels
  - Hydro
  - Smart Grid
  - Batteries/grid storage
  - Smart controls

- Low-energy food
- Electric or hybrid vehicles
- Manufacturing
- Robotics
- Utility companies
- Private
- Other

Marketing:

- How does the center promote themselves? Check all that apply.
  - Online website
  - Social media (Facebook page, twitter, etc.)
  - Through publications of research or developing technology
  - Travel to outside conferences, seminars, or workshops
  - Host conferences, seminars, or workshops
  - Invite students to apply for scholarships or internships
  - Maintain a newsletter (online or print)
  - Relationships with industry associations.
  - Relationships with local and national industry partners
  - Other
- What makes your research center unique compared to others?
  - Prestigious university
  - Industry partnership
  - Government relationship
  - Specialized labs or equipment
  - Shared labs or equipment
  - Specialized projects and developing cutting edge technology
  - Expertise of the faculty
  - Regional availability of renewable resources
  - Other

Partnerships:

- Approximately how many industry partnerships does the applied research center have?
  - 0-5
  - 5-10
  - 10-30
  - >30
- What kind of partnership support from the university do you have? Choose all that apply.
  - Graduate research assistants and stipends
  - Undergraduate project experiences
  - Strategic partnership outreach office
  - Industry relationships supported by the university
  - Government relationships supported by the university
  - Private investors or donors
  - Private company support
  - Development office fundraising
  - Marketing material
  - IP or tech transfer office support
  - Grant writing support
  - Development office fundraising
  - University staffing of the center's core function

  - Other
- What kind of private partner support do you have?
  - Private investor
  - Private donors
  - Private company support
  - Pro bono legal or marketing support
  - Donated lab equipment from individual companies
  - Industry associated support with labs, equipment, etc
  - Private foundation support
  - other
- Which is the strongest partnership? Name three of them.

- Is the applied research center interested in working/partnering with OREC?
  - Yes
  - No
- If yes, what are the areas of expertise?
  - Geothermal
  - Solar
  - Robotics and controls
  - Energy storage
  - Smart grid
  - EV/Hybrid car
  - Other
- How are the partnerships usually initiated?
  - The research center actively seeks out potential partnerships
  - The research center is contacted by other parties looking for partnership
  - Other
- How are the partnerships maintained?
  - Ongoing grant writing to support faculty research
  - Sponsored industry projects
  - By having a member of the other party on the board or committee
  - The research center works on projects specifically for the other party
  - The research center has shared equipment that is utilized collaboratively by university and industry partners
  - The partners have formed a consortium to identify shared research needs
  - By preparing students to work as interns or employees for the other party
  - Other

Faculty & staff:

- What type of staff does the center have as paid employees?
  - Director
  - Faculty research positions
  - Graduate student workers or interns
  - Undergraduate Student workers or interns
  - Technicians
  - None
  - Other
- What type of staff does the center have as unpaid or volunteer positions?
  - Director

  - Faculty research positions
  - Student workers or interns
  - Technicians
  - None
  - Other
- On average, how long does a staff member work for the center?
  - 1 year or less
  - 2-5 years
  - 5-10 years
  - More than 10 years
- What is the faculty affiliation with the research center?
  - Faculty are dedicated to research
  - They teach full-time with some release time for research
  - They are full-time researchers with some teaching time
  - They only conduct research when they have an industry or grant-funded project
- How is applied research valued in tenure and promotion policies?
  - 5%
  - 10-15%
  - 30%
  - 40-50%
  - >50%
- Do center-affiliated faculty raise their own salaries through grant or industry-sponsored projects?
  - Yes
  - No
- If yes, how much?
  - 0-5%
  - 5-15%
  - 15-30%
  - >30%

Challenges:

- Has the research center ever been shut down or closed for a period of time?
  - Yes
  - No
- If so, why was it shut down?
  - Loss of funding
  - Loss of faculty and staff
  - Loss of laboratories or space
  - No interest from industry
  - No interest from university
  - Other
  - N/A
- How was it brought back into service/what is the driving force to bring it back?
  - University initiative
  - Government initiative
  - Industry initiative
  - Other
  - N/A

- How did the applied research center become successful? Check all that apply.
  - Working closely with industry or institutional partners
  - Dedicated faculty and staff
  - Involved and dedicated students
  - The center is currently not operating successfully
  - Other
- Do faculty and staff raise their own funding through grant or industry-sponsored projects?
  - Yes
  - No
- Where does the salary of the faculty and staff of the applied research center come from?
  - State/Federal
  - University
  - Tuition
  - Research Grant
  - Other

Contact:

- Can we visit the applied research center and emulate the model?
- Who would be a good contact person?
- Who would be a good person to interview?

A3 – Questions and Names of Faculty for Faculty Interviews

Oregon Tech is conducting interviews with its faculty to ascertain the value to companies and communities of its applied research center, the Oregon Renewable Energy Center (OREC).

We want to hear your opinions on whether or not you or your department would utilize the services of OREC as well as the value you might find in hiring graduates for Oregon Tech's degree programs if the students had experience working on applied research projects through OREC.

First, I'd like to describe OREC and its purpose, and then ask you nine questions that should not take more than 15 minutes to answer.

As a public purpose, applied research center created by the Oregon State Legislature, the Oregon Renewable Energy Center (OREC) speeds the integration and optimization of renewable energy resources with current power generation systems, and accelerates clean energy technologies in collaboration with industry partners.

OREC is designed to meet a critical gap in technology development for small and medium-sized companies. OREC enables Oregon's smaller players to invent and produce solutions to the nation's larger energy and manufacturing challenges, by providing access to expertise and equipment that is beyond reach otherwise.

OREC has a focus on prototyping, validating, testing, and manufacturability. OREC is designed to bridge that gap in collaboration with companies who are evaluating the feasibility and manufacturing of more competitive or lower cost solutions. Collaborations with Oregon Tech include the use of unique labs and facilities, distinguished industry-aware faculty, and a focus on applied research.

What OREC can do:

- Developing prototypes for solar, wave and other energy devices
- Testing the manufacturability of new products
- Battery characterization and testing; expanding storage capabilities
- Optimization of hybrid vehicle control systems
- Building and testing customized components to reduce production costs
- Selecting materials, assessing strength of materials, especially composites and metals
- Manufacturing product or process improvements; manufacturing controls and robotics
- Product development and remote monitoring of solar energy systems
- Utilizing geothermal energy to accelerate food and agricultural products
- Geothermal combined with solar for boosting solar output in hybridized systems
- Training on the use of Oregon Tech's unique geothermal resource
- Aid in new design
- Design in new materials for improved quality and cost reduction
- Aid in manufacturing process selection
- Help in prototyping

Questions:

1. Given OREC's purpose, as described above, would you be interested in participating in the delivery of OREC's services for prototyping, validating, testing or manufacturability of clean tech or energy-related products or concepts? Yes No

1b. If so, would you have resources to support such a project, or would you need to rely on federal or state grant funding or an industry sponsorship to support it?

- Company resources
- Loans
- State Grants
- Federal Grants
- Industry-sponsored applied research

2. Where else might you collaborate on applied research of this type?

- Federal lab
- Other Oregon university, name _____
- Other university outside of Oregon, Name _____

3. Is Oregon Tech's unique geothermal or solar resource an asset for you in terms of the optimization of current power sources with clean energy systems?

- Yes How so?
- No

4. What are your energy and manufacturing research needs and what types of projects might interest you?
5. What kind of applied research or product development are you currently conducting (in general terms) and how is the research funded?
6. Would you be interested in working with Oregon Tech's undergraduate and graduate students on applied research projects? What specific skills and degrees would you be looking for in your research assistants?
7. What benefits would you or your department gain from an affiliation with OREC and its other interdisciplinary researchers?
8. If you were to be a faculty member affiliated with OREC, how many hours per week would you be able to dedicate, if you had resources to support the work?

   a. 0 to 4
   b. 4 to 8
   c. 8 to 10
   d. More than 10

9. Looking to the future, what would you like to see OREC become?

Thank you for your time.

May I use your name and answers, with or without attribution, in a research paper about the value of OREC?

OK to use name?

OK to use answers without name?

Names of faculty members:

Feng Shi	Jamie Zipay	Paul Dingman	Allen Lowe	Eve Klopf
Seth Anthony	Matt Beekman	Mehmet Vurkac	Don Lee	Calvin Caldwell
Teshome Jiru	Hope Corsair	Allan Douglas	Claudia Torres Garibay	Aaron Scher
Frank Rytkonen	James Eastham	Slobodan Petrovic	Joe Stuart	Eklas Hossain

A4 – Rubric for Choosing Applied Research Centers

Only centers that scored 100 points were interviewed.

Center Name	University Affiliation	Interdisciplinary Research	Business Relationshi	Students involved in research	Based in US	Total Score
Schatz Energy Resrarch Center (Humbolt State)	20	20	20	20	20	100
Northwest National Marine Renewable Energy Center (OSU)	20	20	20	20	20	100
Clean Energy Institute (UW)	20	20	20	20	20	100
Wanger Institute for sustainable Energy Research (IIT)	20	20	20	20	20	100
Hawaii Natural Energy Institute	20	20	20	20	20	100
Carnegie Mellon Electricty Industry Center	20	20	20	20	20	100
University of Maryland Energy Research Center	20	20	20	20	20	100
Center for Energy and Environmental Resources (CEER) U of T Austin	20	20	20	20	20	100
Center for Sustainable Electrical Energy Systems (UWM)	20	20	20	20	20	100
Center for Environmental Research and Technology (UCR)	20	20	20	20	20	100
Michigan Alternative & renewable energy center	20	20	20	10	20	90
Center For Energy Research (UNLV)	20	20	0	20	20	80
Renewable Energy Center (U of N reno)	20	20	20	0	20	80
Electric power and power electronics center	20	0	20	20	20	80
Clean Energy Research Center (USF)	20	0	20	20	20	80
Scott Institute for Energy Innovation CMU	20	20	20	0	20	80
Winston Chung Global Energy Center (UCR)	20	0	20	20	20	80
Energy Efficiency Center (OSU)	20	0	0	20	20	60
Great Basin Center for Geothermal Energy (U of N)	20	0	0	20	20	60
Electric Power research insitute	0	20	20	0	20	60
Pacific Northwest National Laboratory	0	20	20	0	20	60
sustainable energy research center (MSU)	20	20	0	0	20	60
Smart Grid Research Center	0	0	20	20	20	60
center for revolutionary solar photoconversion	0	0	20	0	20	40