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Advancing Training Pathways for the Renewable Energy Workforce

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Abstract: Renewable energy careers are emerging at an unprecedented pace and skill sets associated with energy technology cut across both traditional and emerging industries. Energy production, distribution, infrastructure support, and consumption are significant components of Northwest Washington's economic and workforce development. Given these trends, Bellingham Technical College (BTC), Western Washington University (WWU), and the Pacific Northwest Center of Excellence for Clean Energy have developed career training pathways in renewable energy that advance the capabilities of students, increase employability of graduates, and provide industry with a highly skilled workforce.

Through this project, BTC has developed a new Associate of Applied Science – Transfer (AAS-T) degree model with strong academic foundation that focuses on contextualized advanced math and sciences. This foundation of contextualized academics and advanced technology competencies and skills is coupled with specialized certificate options that focus on renewable energy. Contextualization of coursework allows faculty to easily modify curriculum to keep up with industry trends in the rapidly changing field of renewable energy technology.

Upon completion of both core and specialized coursework at BTC, students are prepared to enter the workforce as a skilled technician ***or*** can choose to directly articulate to the Institute of Energy Studies at Western Washington University. Having options to enter into the renewable energy industry at a variety of technical levels is powerful for students and is important to industry. Furthermore, since the AAS-T degree consists of a strong foundation of transferable academic coursework, students have the option to return to school after working in the field to earn a Bachelor's degree in Energy Studies at WWU at junior level standing.

The partners for this project each bring unique perspectives and strengths, making is a mutually beneficial collaboration. Bellingham Technical College provides expertise and facilities for effective and innovative technological education. Western Washington University participation fosters academic rigor and provides undergraduate research opportunities at the technician training level. Linking the two academic institutions with industry, the Pacific Northwest Center of Excellence for Clean Energy is a nationally recognized institution that provides strategic coordination for the energy industry's skilled workforce. Together these three partners have worked closely with the renewable energy industry to ensure the program meets current industry demands.

1.0 Introduction & Rationale

According to the US Energy Information Administration, global energy consumption has significantly increased and is expected to continue rising through 2035[1]. The energy industry is working to increase energy efficiency and looking toward innovative technologies to meet the growing demand. Prominent energy companies like BP and Phillips 66 are starting new departments focused on alternative energy and investing in technology development and production.

New energy technology career categories are emerging at an unprecedented pace, and skill sets

associated with energy technology cut across both traditional and emerging industries. The number of green jobs in Washington rose 32% in the last few years, and these trends are expected to continue as the demand for energy increases and resources decrease. In Whatcom County alone, there are over 3,600 green jobs[9]. Many emerging green energy jobs will be technical jobs that require more than a high school diploma but less than a bachelor's degree. It is estimated that new green occupations will be modifications of existing jobs, requiring a redefinition of skills, methods and occupational profiles. Some emerging green occupations will require the creation of new industry-recognized credentials and training programs, and many will require modifications to existing programs and courses to integrate green skills[5,6].

A 2008-2009 survey of Washington State employers gathered data about the number and nature of green jobs in their firms. The results are shown in Table 1[9]. The green economy is composed of industries and businesses engaged in four core areas: increasing energy efficiency, producing renewable energy, preventing and reducing environmental pollution, and providing mitigation or cleanup up of environmental pollution.

Table 1:

Industry core area	**Estimated green jobs**	**Percent of core area**
Preventing and reducing pollution	59,288	49.3%
Increasing energy efficiency	38,920	32.4%
Providing mitigation or cleanup of environmental pollution	16,887	14.0%
Producing renewable energy	5,210	4.3%
Total*	**120,305**	**100.0%**

Source: Employment Security Department, 2011 Washington State Green-Jobs Survey

Given these trends, Bellingham Technical College (BTC), in partnership with Western Washington University (WWU) and the Pacific Northwest Center of Excellence for Clean Energy (Center), has developed a career-training pathway in Clean Energy that advances the academic capabilities of students and increases employability of regional graduates. This includes the development of an Associate in Applied Science-Transfer degree with specialized certificates in the areas power electronics and clean energy.

2.0 Partnerships: Bellingham Technical College, Western Washington University and the Center of Excellence for Clean Energy

The partners for this project each bring unique perspectives and strengths, making this collaboration mutually beneficial. BTC provides expertise and facilities for effective and innovative technological education. BTC is a leader in professional technical education, employing highly skilled and industry-recognized faculty and maintaining cutting-edge, high-tech labs. As the only technical college in Northwest Washington State, 73% of BTC students

are enrolled in a professional technical program[2]. BTC has over 350 industry representatives on advisory committees and has an outstanding average graduate employment rate of 86%, with graduates making a median wage of $50,826[2]. BTC offers high- quality education in training programs where the training is high- tech, hands-on and student centered. BTC's vision to be a recognized leader in providing innovative and effective technical education, maximizing student potential and supporting the regional economy through development of a competitive workforce directly aligns with the purpose of the ATE grant competition.

WWU participation fosters the project's academic rigor and will provide undergraduate research opportunities. The Institute for Energy Studies at WWU combines the fields of science, technology and engineering with economics, business management, public policy, and sustainability to meet the demand for education and training related to the production and use of energy[10]. As a newly established college, the Institute is working to develop new undergraduate degrees that combine the science, policy, and technology of energy. Graduates of the Institute for Energy Studies will receive a Bachelor of Arts degree with the option to minor in policy and economics or science and technology.[10]

The Pacific Northwest Center of Excellence for Clean Energy is a nationally recognized institution providing strategic coordination for the energy industry's skilled workforce in the Pacific Northwest (Oregon, Washington, Idaho, Montana, and Utah). The Center represents a wide network of industry professionals and educational institutions working to improve the workforce economy. The Center is led by a broad-based consortium comprised of industry and labor leaders. Their goals are to: a) develop and nurture industry and labor partnerships to better understand the changing workforce issues facing electric utilities and independent power producers; b) translate energy industry research into "Best Practices" training and education to ensure programs meet industry's workforce needs; c) provide clear education and career pathways for students and job seekers for entry into high-skills, high-wage energy jobs; and d) create a competitive workforce pipeline to meet increasing energy demands and support the economic future of the Pacific Northwest.[7]

The career outlook for the AAS-T in Clean Energy with a specialized certificate in the area of power electronics shows growth in both national short-term and long-term projections[3] is in demand in the Northwest Region and/or Washington State[9]. This field represents the clean energy industry areas that are present in our region. Northwest Washington companies such as Whole Energy Fuels Corp, Mercurius Biofuels, OutBack Power, EcoTech Energy Systems, Alpha Technologies Inc., Chinook Wind, Puget Sound Energy, Western Solar and Itek Energy are committed to regional production and talent acquisition in order to be ecologically and financially sustainable.

Power electronics can convert power generated by distributed energy systems into usable power for the grid. This technology can have a significant impact on the environment: with widespread implementation, the United States would be able to reduce electrical energy consumption by replacing traditional energy generation with renewable energy. That energy savings, by today's measure, is equivalent to the total output of 840 fossil fuel-based generating plants. This would result in enormous economic, environmental, and social benefits.[4]

3.0 Industry Analysis – Guiding the Degree Development and Determining Areas of Focus

The Center of Excellence for Clean Energy brought together a group of subject matter experts from the renewable energy sector to govern the development of the AAS-T degree. The overarching goal of this work, from an industry perspective, is to create a degree that will strengthen the labor pool in the Pacific Northwest and elsewhere of qualified applicants who seek long-term career options in various aspects of renewable and clean energy systems. This group consisted of local industry representatives from the renewable energy field including solar technology, wind generation, bioenergy, public utilities, and energy consulting. These industry experts spent two days over the course of a 6 month period performing industry analysis in the area of clean energy in order to identify and codify the necessary knowledge, skills and abilities to support the curriculum development of the Associates degree to allow for both workplace entry and baccalaureate transfer.

The outcome of the industry forums informed the work of the Center of Excellence for Clean Energy, Bellingham Technical College (BTC), and Western Washington University (WWU) on industry trends related to sustainable energy practices, technologies and developments. BTC and WWU used the information gathered from the industry forums to develop the coursework and focus for the AAS-T degree at BTC.

3.1 Questions posed to Industry Partners

Prior to developing the degree in clean energy, two industry forums were convened to gather information from local employers. These industry forums consisted of a group of clean energy industry representatives whom worked closely with BTC and WWU to ensure that the future degree program would adequately meet the needs of industry. The industry forums were well attended and included representatives from the following industries: Tacoma Power and Light, Eco Tech Solar, Chinook Wind, Itek Solar, Puget Sound Energy, Convivium Renewable Energy, Western Solar, Snohomish PUD, and the Washington State Labor Council.

To guide the discussion, the following list of questions was discussed with the industry partners.

1. Describe your company in regards to services, products and markets.
2. How does your company think about the descriptors: CLEAN, RENEWABLE, and SUSTAINABLE when considering energy systems, technologies or business practices?
3. In what ways does the area of clean energy intersect with engineering? Do you see a need for people trained in engineering with a focus on clean energy?
4. What are the short and long-term initiatives in Clean Energy specific to our region (Pacific Northwest)?
5. What key industry technology areas (solar, biofuels, power electronics, sustainable building, etc) are of focus in our region? How do you anticipate this changing in the future?
6. What are the key attributes required for working in this industry?
7. What are the key skill sets required for working in this industry?
8. What is the recommended knowledge base for a graduate of a 2-year and 4-year program with a focus on clean energy and sustainability technologies?

9. How do you see sustainable energy systems, the related positions, and the associated KSAs evolving in the next 5-10 years? What training will workers need to keep pace with evolution in the field?
10. What types of jobs would be available to graduates of a program in clean energy and sustainable technologies? What is the job outlook into the future? Is there demand for this skillset?
11. What positions in your company have major responsibilities related to sustainable systems, services, and products?
12. As we seek to design a program to train workers, and specifically engineering technicians, for careers in sustainable/renewable energy, what advice or recommendations do you have for us?

3.2 Summary of the Key Findings from the Industry Forums

<u>General Program Design (key Knowledge, Skills & Abilities):</u>

- Trends in the Clean Energy industry change too quickly for education to respond effectively.
    - Education needs to recognize this and should focus on creating an adaptable program that focuses on developing problem solving skills and providing students with appropriate subject matter content by incorporating relevant clean energy curriculum/instructional material into the foundational (general education) coursework.
    - Define and focus the program on the basic and core skills that will serve the needs of most employers. These skills include technical skills such as mathematics, problem solving, and clean energy fundamentals as well as soft skills such as communication and teamwork.
    - Provide a broad based general education that incorporates research, class projects, labs, and online learning modules related to clean energy that reflects industry trends. This will allow faculty to easily modify curriculum to keep up with industry trends in the rapidly changing field of renewable energy technology.
    - Provide students with a core technical knowledge base (suggestions included electronics, HVAC, or Instrumentation)
    - The curriculum should be dynamic in its forms and modalities to enable adaptations as the industry and its technologies change
- Provide education and training to help students develop "soft skills" such as communication, teamwork, adaptability, and problem solving. These skills are important to have in any industry sector.
- Include a strong foundation in general education courses including math, physics, and economics so students have a firm understanding of the fundamentals.
- Include content related energy policy, politics, and energy physics (heat & energy).
- Cover the basic fundamentals of all clean energy technologies and conservation strategies.

Focus Area, Technical Knowledge Base

- Focus on providing students with a core technical knowledge base that are not only needed in the clean energy industry but in other industries as well. The aim here is to increase student job prospects upon graduation from the technical training (AAS-T) program.
- Choose one area of focus for the core technical knowledge base and expand on that as resources and program growth allows.
- Suggestions for focus area: HVAC, Electronics, Instrumentation

Industry Partnerships

- Continue to develop industry partnerships with local companies to support student projects, material donations, and collaborative ventures.
- Consider creating an online forum of industry participants to continue providing ideas and suggestions going forward.
- Continue to work with industry via advisory committees to help direct the program and to stay abreast of industry trends in clean energy

Employment & Career Pathways:

- Provide students with accurate and realistic employment prospects up front. This should include estimates on salaries and wages
- Prepare students with a broad base of relevant knowledge, skills and aptitudes (KSAs) that apply to a wide variety of technical areas so students have multiple job prospects when they graduate.
- Define and focus the program on the basic and core skills that will serve the needs of most employers.
- Jobs in the clean energy sector are diverse and, although students would benefit from knowledge of clean energy politics and policy, most of that is currently completed as part of on the job training. An applicant with knowledge of clean energy would be desirable.
- Job titles include: Engineering Technician, Renewable Energy Technician, Solar Installer, Electronics Technician, Project Manager

3.3 Incorporating Industry Feedback: A Focus on Power Electronics

After continuing discussion with industry partners and analyzing career profiles put together by the Center of Excellence for Clean Energy, BTC and WWU chose power electronics as the focus for the core technical knowledge base of the AAS-T degree in Clean Energy. The core technical base will consist of a series of electronics courses that will provide students with the foundational technical training skills that enhance job placement after graduation. Power electronics is a good fit for both BTC and the local economy because the college already has a robust and well-respected Electronics Engineering Technology degree program and a large number of jobs in the Clean Energy sector in the region require knowledge and skillsets related to electronics.

Although the core technical knowledge base consists of classes in power electronics, additional courses will be included to cover topics in clean energy including policy, politics, economics, energy conservation, and power as well as general education courses in math, science and engineering to enhance transferability of coursework.

4.0 Student Pathways: Increasing Options for the Technical Student through the AAS-T Degree

The follow sections discuss the state requirements of the AAS-T degree and how it serves as the basis for the AAS-T in Clean Energy. Details regarding the development of the AAS-T degree in Clean Energy are also discussed in relation to how courses were chosen so that students have adequate training for industry while also satisfying requirements for transfer.

4.1 The Associate of Applied Science - Transfer Degree

The Washington State Associate of Applied Science – Transfer (AAS-T) degree is two-year technical training degree that includes transfer level general education courses. This degree consists of technical courses required for job preparation as well as a college-level general education component. Courses listed as part of an AAS-T degree are designed to prepare the graduate for immediate employment as well as preparation for transfer.[8]

All courses in the AAS-T general education component must be transferable courses and must assure that the student have a foundation in communication and quantitative skills as well as an introduction in science, social science and humanities. [8]

A minimum of 20 general education credits must include the following:[8]

- 5 credits in Communication — ENGL 101-English Composition.
- 5 credits in math — Any generally transferable math course with Intermediate Algebra as a prerequisite.
- 10 credits in Science, Social Science or Humanities

A well-designed AAS-T degree will include additional transfer level courses that also meet industry requirements for job preparation. This allows students to transfer into programs with a significant amount of coursework completed, thus reducing the amount of time it takes to earn an advanced degree.

The AAS-T degree is a relatively new degree model for institutions in Washington State. Most technical colleges, like BTC, have been offering Associate of Applied Science (AAS) degrees for many years. While most AAS degrees include academic math and English courses, these courses are often not transferable because they are “applied” and the content is dependent on the coordinating program coursework. Unlike the AAS, the AAS-T degree includes transferable (rather than applied) academic coursework as the foundation for the degree. In order to provide the students with context, the academic coursework is contextualized to include content related to a technical area, such as renewable energy. Contextualization of coursework is the process of relating subject matter content to meaningful situations and applications that are relevant to a particular subject area, in this case, clean energy.

4.2 General Framework for a Successful AAS-T Degree

The AAS-T degree is a powerful degree option for students because it provides them with the option to enter the workforce as a skilled technician or directly articulate to a 4-year university following graduation. Furthermore, since a well-designed AAS-T degree consists of a strong foundation of transferable academic coursework, students have the option to return to school after working in the field to earn a Bachelor's degree.

The key to creating a successful AAS-T degree is to find a balance between transfer level academic coursework and technical training coursework. The SBCTC requires each AAS-T degree to include a minimum of 20 general education requirements. Although 20 credits is a good start to any degree, it benefits the students far more if they can transfer into a 4-year program with at least a year of coursework completed. In order to include more transferable coursework into a technical degree, the focus should be on choosing courses that are dual purposed to meet transfer requirements as well as prepare students for industry.

Figure 1 illustrates the general foundation of the AAS-T degree and how it works to both prepare students for industry and well as for transfer. It is important to note that by including general education courses in math and science, we are not only preparing students for transfer but are helping them to build a strong foundation in problem solving and communication, skills that are important in industry as well.

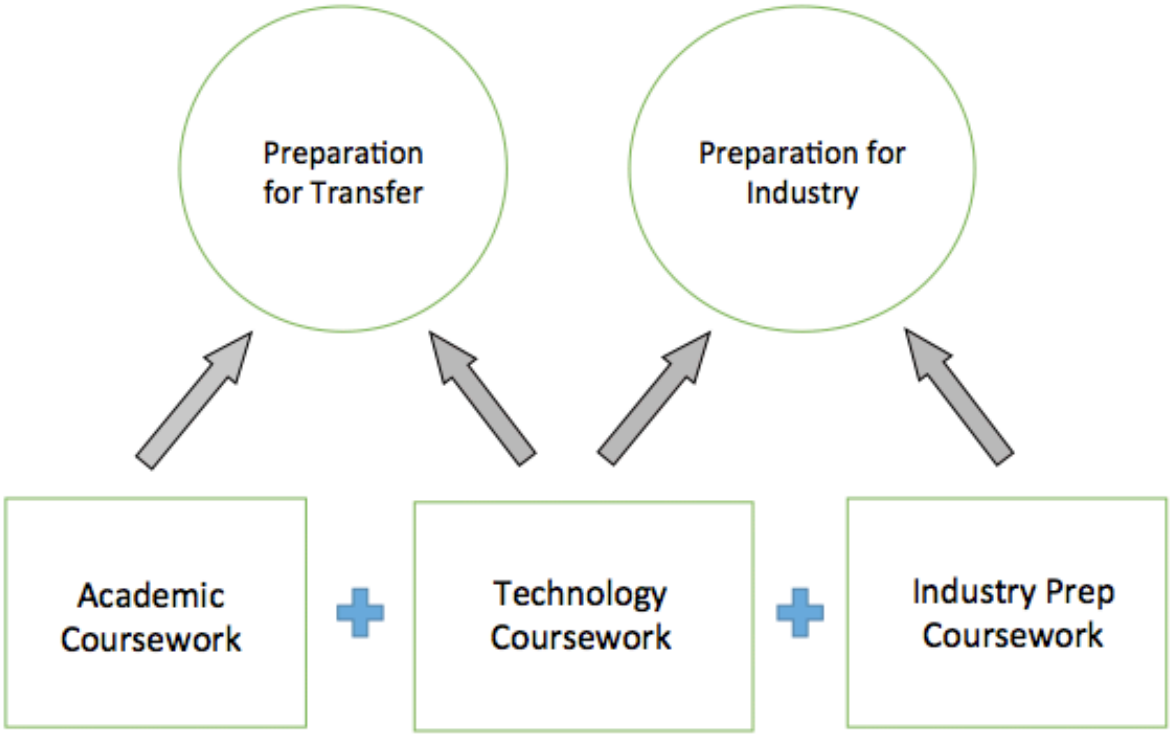

Figure 1: Framework for a successful AAS-T degree

- The academic courses are chosen primarily to satisfy transfer requirements however, these courses also meet industry needs since they develop strong problem solving skills and communication skills.
- The technology coursework is dual purposed. These courses transfer directly into a 4-year program and they also provide core technical knowledge and skillsets for students entering industry.
- The industry prep coursework trains students for a career in industry. These courses do not transfer but will be valuable to transfer students as it gives them technical, hands-on skills they might find useful as they further their education.

4.3 The AAS-T in Clean Energy at Bellingham Technical College

Through this project, BTC and WWU have developed an Associate of Applied Science – Transfer (AAS-T) degree in Clean Energy based on the Washington State AAS-T model described in Section 4.1 and using the framework outlines in Section 4.2. Courses were chosen after careful consideration of transfer requirements and the knowledge, skills, and abilities necessary to be successful and gain employment in the clean energy industry.

As shown in Figure 2, the AAS-T degree in Clean Energy consists academic, technology, and industry prep coursework. The majority of the academic and technology based coursework transfers to the WWU Institute for Energy Studies while providing a solid foundation in problem solving and communication for students planning to enter the workforce directly after graduation. The academic courses include math, science (physics and chemistry), English, and economics. These academic courses are contextualized to include content related to clean energy in order to increase students exposure to key topics related to the renewable energy industry.

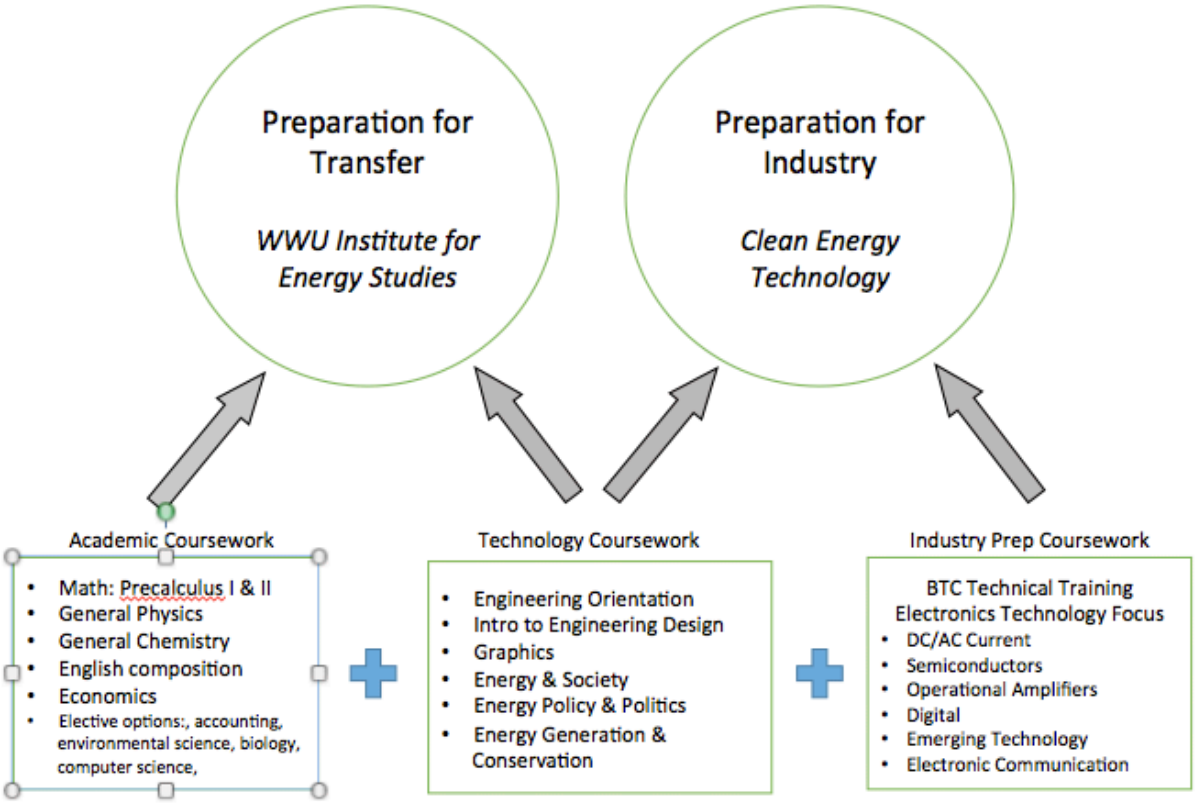

Figure 2: BTC AAS-T Degree in Clean Energy

The industry prep coursework consists of a series of electronics technology courses including AC/DC Current, Semi Conductors, Operational Amplifiers, Digital Applications, Electronics Communication, and Emerging Technologies. The electronics technology coursework prepares the student for jobs related to Clean Energy, specifically in the area of power electronics. Knowledge of this technology is useful a wide variety of clean energy sectors including wind, solar, and utilities. It is important to note that these technical (industry prep) courses do not transfer but serve the purpose of preparing the student for employment. This is the cornerstone employable skillset that students receive as part of the AAS-T in Clean Energy. Note that these courses are also contextualized to include content related to clean energy.

In addition to the academic, technology and industry prep coursework, the degree includes three elective courses. Having electives as part of the degree allows students the ability to build on their technical knowledge base (with classes such as Green Energy, Biofuels, Mechatronics, PLC, etc.) or to satisfy additional transfer requirements (accounting, environmental science, biology, computer science, etc.).

In order to provide students with enough content related to clean energy, it is essential to contextualize as many courses as possible. This involves including homework sets, projects, research papers, laboratories, etc. related to clean energy into the academic, technology, and industry prep courses. Course contextualization is a key to enabling instructors to keep course content relevant and to allow for a broad base of education related to the clean energy industry. It

also allows for the inclusion of a more diverse set of coursework since less courses need to be dedicated solely to clean energy topics. This increases the flexibility of the program and allows for adaptability, most importantly related to technological changes in industry.

Upon completion of both core and specialized coursework and earning an AAS-T degree in Clean Energy, students are prepared to enter the workforce as a skilled technician ***or*** can choose to directly articulate to the Institute of Energy Studies at Western Washington University. Having options to enter into the renewable energy industry at a variety of technical levels is powerful for students and is important to industry. Furthermore, since the AAS-T degree consists of a strong foundation of transferable academic coursework, students have the option to return to school after working in the field to earn a Bachelor's degree in Energy Studies at WWU.

4.4 Certificate Options

There are two certificates embedded into the AAS-T degree: Electronics Technician Certification and Clean Energy Certification. The Electronics Technician Certificate consists of 6 courses covering the fundamentals of electronics. Upon completion of those courses and mastery of the skillset associated with the coursework, the student will be prepared to take the national Electronics Technician Certification exam sponsored by the Electronics Technicians Association.

The Clean Energy Certification consists of three courses that cover content directly related to the clean energy industry: Energy & Society, Energy Policy & Politics, Energy Generation and Conservation. This certificate is also useful for people who are already working in the clean energy industry but may not have adequate background in the clean energy arena.

4.5 Industry Preparation

Students graduating with the AAS-T degree in clean energy will be well prepared for industry. Through the general education courses in math, physics, chemistry and economics, students will gain a firm understanding of the fundamentals and will develop strong problem solving skills. The content related to energy policy, policy and energy conservation will provide the students with a clear picture of the clean energy industry and a solid understanding of the physics behind energy conservation and generation. The electronics curriculum will give students a skillset that is not only useful to the clean energy industry but extends to many other industries as well, further increasing job prospects. In addition, classes in English, economics, and engineering design help to build strong communication and teamwork skills.

All of the general education courses included as part of this degree will include contextualized content related to renewable/clean energy technology. The aim is to deepen student awareness and knowledge of renewable energy through homework assignments, research papers, lab activities and/or projects. Contextualization of coursework allows faculty to easily modify curriculum to keep up with industry trends in the rapidly changing field of renewable energy technology. This will further prepare students for jobs in the dynamic and exciting clean energy industry. Graduates of this program will be prepared to enter the workforce as engineering technicians, electronics technicians, solar installers, and more.

4.6 Transfer Preparation

Although the state requires only 20 transferable credits, the BTC AAS-T degree in Clean Energy consists of a minimum of 45 transferable credits. The additional transferable credits allow students to transfer into the WWU Institute for Energy Studies with at least a year of coursework completed. Furthermore, much of the transferable coursework also meets industry training needs so many of the required courses meet both the needs of industry training and transfer. This is ideal for the student because it increases options after graduation. No longer is the student only prepared for one pathway (job placement *or* transfer), but they have the option to continue their studies or to head out into the clean energy workforce.

5.0 Next steps: Undergraduate Research Opportunities and Collaborative Teaching Opportunities

Faculty at BTC and WWU have begun collaborating to create undergraduate research opportunities focused on current trends in renewable energy. This would allow WWU students access to BTC's faculty of industry experts and state-of-the-art technical labs, providing a practical component to their education. In turn, WWU will assist in the development of undergraduate research opportunities for BTC students, and facilitate applied research opportunities for BTC faculty. At technical colleges, traditional research is not typically an expectation in faculty contracts. This project would allow technical faculty to perform applied research to enhance their curriculum and to advance industry practices. In addition to undergraduate research opportunities, faculty at both institutions have begun collaborating to find ways for WWU and BTC students to share instructors and resources, work on projects together, and learn from on another. This would provide the technical student the opportunity to learn through academic research and apply theory to practice while providing traditional college student with valuable hands-on technical skills.

6.0 Conclusions & Recommendations:

Working closely with industry, BTC and WWU developed an AAS-T degree in Clean Energy that prepares students to enter the workforce as a skilled technician or transfer to the Institute of Energy Studies at WWU. Embedded in this degree are two certificate options: Electronics Technician and Clean Energy. This stackable degree allows students multiple options as they progress through their academic careers.

The key to creating a successful degree that both meets industry needs and prepares students for transfer is identifying the skill sets that are inherent to both industry and academia. Once that is determined, appropriate coursework can be chosen so that industry needs and transfer requirements are met. For example, the industry representatives indicated that it is essential for students to have a firm understanding of math and physics. Energy Studies majors at WWU are required to take Pre-calculus 1 and General Physics 1. By choosing those courses as part of the AAS-T degree, both the needs of industry and academia are met.

The other challenge inherent in creating a successful AAS-T degree is ensuring that it meets industry standards and adequately prepares the graduate for the workplace. In this case, course contextualization is the key to enabling the program to keep pace with industry trends.

Contextualizing renewable energy content into existing courses, rather than creating new courses with content that will become outdated before the first graduate enters the workforce, ensures a sustainable degree program that is flexible and adaptable.

The AAS-T degree in Clean Energy is a powerful degree option for students. After completing the degree students are able to find employment in the clean energy industry as electronics technician, solar installer, wind energy specialist, or engineering technician. The student is also prepared to transfer to the Institute of Energy Studies at WWU to continue their education either after graduation or at a late date. Furthermore, graduates of this program will have completed two certificates (Electronics Technician Certificate and Clean Energy Certificate) and will be prepared to take a national electronics certification exam. Having options to enter into the renewable energy industry at a variety of technical levels is powerful for students and is important to industry.

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