Clean Energy Technical Education Task Force Report

June 2014

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Executive Summary

In 2013, the Maryland General Assembly passed HB 226/SB 275, and Governor O'Malley signed into law the Maryland Offshore Wind Energy Act of 2013. Under this law, a Clean Energy Technical Education Task Force ("Technical Task Force") was established. The legislative mandate of the Technical Task Force was to study current clean energy programs and course offerings at Maryland community colleges, with a particular emphasis on wind energy, and to identify areas in which additional associate degree, certificate, continuing education, and training programs and course offerings should be offered at one or more community colleges. Staff support to the Technical Task Force was provided by the Maryland Energy Administration (MEA) and the Maryland Higher Education Commission (MHEC).

In October 2013, the Technical Task Force convened the first of six meetings held between October 2013 and June 2014. During this time Technical Task Force members researched and discussed clean energy technologies, requisite skills and certifications necessary for pursuit of careers in the clean energy sector, and current related course offerings in Maryland and elsewhere. With this knowledge, the Technical Task Force then generated 4 recommendations in accordance with the Technical Task Force's mandate from the Maryland Offshore Wind Energy Act of 2013.

The recommendations are summarized below and explained in detail in the recommendations section of this report:

- **Recommendation 1: Focus on supply chain and logistics management.**
- **Recommendation 2: Develop Partnerships and Programs in Marine Operations and Maintenance, Safety, Seamanship; and explore workforce development at the Port of Baltimore.**
- **Recommendation 3: Develop and fund a Renewable Energy Affinity Group to match industry needs to educational entities that can help meet these needs.**
- **Recommendation 4: Incentivize community-college renewable-energy associate degree, certificate, continuing education, and/or training program development, through a competitive grant program managed jointly by MHEC and MEA.**

Technical Task Force Members and Attendees

Members

Delegate Ben Barnes	Delegate, Maryland House of Representatives
Adam Cohen	Founder and Vice President, Pioneer Green Energy
Gregory S. Farley (Chair)	Associate Professor of Biological Science; Director, Center for Leadership in Environmental Education (CLEEn) at Chesapeake College
Frederick H. Hoover	Maryland Energy Administration Director's Designee
Joe Martinelli	Interim Vice President, Workforce Development and Continuing Education, Prince George's County Community College (PGCC)
Robert Wallace	CEO, Bith Energy

Attendees

Liz Burdock	Managing Director, Business Coalition for Maryland Offshore Wind
Rich Cerkovnik	Director, STEM Program, Anne Arundel Community College
Terry Goolsby	Executive Director, Clozynergy, Inc.
Lance Lucas	Owner, Digit All Systems

Staff

Andrew Gohn	Senior Clean Energy Program Manager, Maryland Energy Administration
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Ross Tyler	Offshore Wind Economic Development Program Manager, Maryland Energy Administration
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Emilee van Norden	Clean Energy Program Manager, Maryland Energy Administration

Technical Task Force Purpose

The Maryland Offshore Wind Energy Act of 2013 mandates that, "The Technical Task Force shall study the programs and course offerings currently being offered in the area of clean energy, with a particular emphasis on wind energy, and identify areas in which additional programs and course offerings should be offered at one or more of the of the following community colleges:

(1) Allegany College of Maryland;
(2) Anne Arundel Community College;
(3) Baltimore City Community College;
(4) Community College of Baltimore County;
(5) Carroll Community College;
(6) Cecil College;
(7) Chesapeake College;
(8) College of Southern Maryland;
(9) Frederick Community College;
(10) Garrett College;
(11) Hagerstown Community College;
(12) Harford Community College;
(13) Howard Community College;
(14) Montgomery College;
(15) Prince George's Community College; and
(16) Wor-Wic Community College."

Introduction

Background

In May 2004, the State of Maryland demonstrated its commitment to support renewable energy by adopting its Renewable Portfolio Standard (RPS). The RPS as it was originally adopted required that Maryland obtain 10% of its electricity from renewable resources; however, in 2008, through the leadership of the O'Malley-Brown Administration and the Maryland General Assembly, Maryland doubled its RPS requirements, thereby working to ensure clean air and water for current and future Marylanders. This bold modification to the RPS now requires 20% of Maryland's electricity must be provided by renewable resources by 2022.

As a result of the RPS adoption, Maryland saw exponential growth in the installation of solar and land-based wind as new investment followed the strong state policy foundation. Further, the RPS was modified to include waste-to-energy and thermal technologies, such as solar water heating and geothermal heat pumps. Despite the notable growth in Maryland's renewable generation capacity,

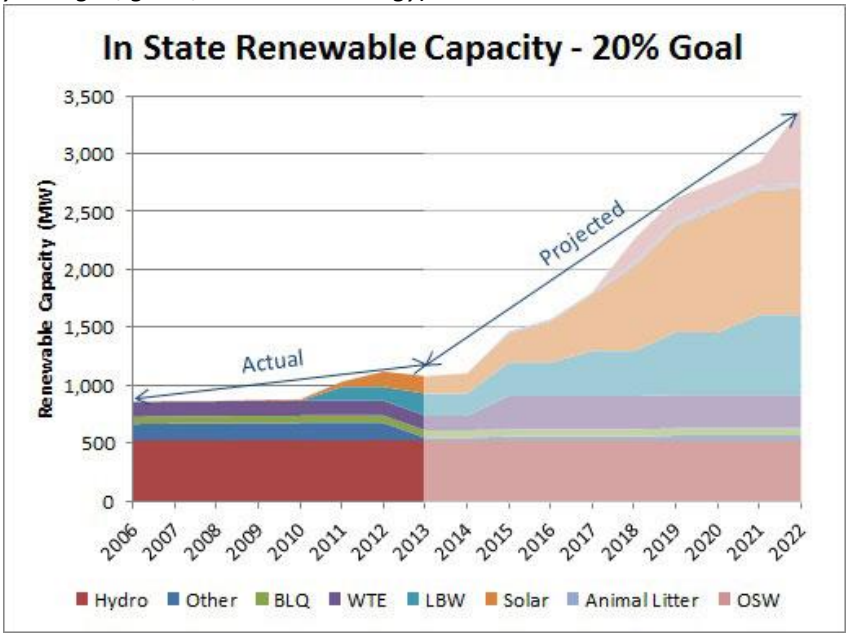
which has seen an 8.2%[1] increase since 2007, Maryland was still projected to fall short of its 2022 goal. In order to meet this goal the O'Malley-Brown administration recognized yet another source of renewable energy generation would need to be developed. Therefore, in 2009, the Maryland Energy Administration (MEA) was asked by the O'Malley-Brown administration to begin looking at the process for developing an offshore wind farm off the coast of Maryland. Such a wind-energy facility would help meet the energy needs of the RPS and spur the clean energy economy: according to the American Wind Energy Association, the wind industry alone has supported $15 billion dollars in private investment annually in U.S. communities over the past five years.

Since that time, numerous stakeholders have been engaged in the effort to bring offshore wind to Maryland. The Maryland Energy Administration has worked closely with the Maryland General Assembly, the Public Service Commission, the U.S. Department of Energy, and U.S. Bureau of Ocean Energy Management to navigate the legal and regulatory path toward deploying offshore wind farms. Throughout this process, the MEA has also involved stakeholders such as the shipping industry, fishermen, the hospitality sector, individual towns and cities, local businesses, and educational institutions. In May 2013, as a result of much work and great cooperation among all of these stakeholders, the Maryland General Assembly passed the Maryland Offshore Wind Energy Act of 2013.

The General Assembly recognized that beyond meeting the requirements of the RPS and providing Marylanders with cleaner, healthier air and water, the Maryland Offshore Wind Energy Act was also an opportunity to develop and diversify Maryland's clean energy sector. Under the new law, the Clean Energy Technical Education Technical Task Force was created to study Maryland's ability to implement clean energy programs at the community college level.

[1] As of 2013; source: https://data.maryland.gov/goals/renewable-energy

Figure 1: Maryland's Renewable Energy Goals and Capacity (actual and projected). Source: https://data.maryland.gov/goals/renewable-energy)



Wind Energy

As Figure 1 above illustrates, almost 2,500 MW of clean energy needs to be deployed for the state to meet its target of 20% (at current consumption rates, 20% is almost 3,500 MW installed). The latter figure represents over a million homes powered by clean energy, representing over 3.5 billion dollars of new investment. For Maryland to meet its targets, a wide array of technologies and sectors must be deployed, corresponding directly to jobs that will be based in the state of Maryland. When clean energy is developed, it directly creates jobs both over the short and long term. **Maryland has set the policy drivers in place; it must now capitalize on the clean energy economy by fostering the right educational degree, certificate, and training programs at the community college level.**

As an example of what Maryland can become is illustrated by two states, Iowa and Texas, that have each leveraged clean energy to drive a new economy around clean energy jobs and the corresponding supply chain. Iowa derives 27.4% of its energy from wind power (U.S. Department of Energy, Iowa State Report) and Texas almost 10% (State of Texas; Economic Development and Tourism Office). Texas ranks first among all states in terms of installed capacity. This development was spurred in both states by legislatively mandated renewable energy goals, workforce development programs, and supportive policy. According to the American Wind Energy Association and the Iowa state summary, total employment in clean energy in 2010 was 30,800 jobs, and 6,000 jobs were directly related to the wind industry. Texas has 102,000 direct and indirect jobs overall in renewable energy employment. The jobs and wages for the Texas example are listed in Table 1.

As Table 1 and the two state examples (IA, TX) demonstrate, strong policy, along with the right training programs, could deliver a significant number of high paying jobs in the state of Maryland. Moreover, the higher-paying jobs in Table 1 are in wind and solar power, which require significant education and

training. Wind power potential in Maryland, including offshore wind, could provide more than 2.8 times the energy needed by the state, while supporting high-paying Maryland-based jobs and training programs.

Many of the jobs experienced in Maryland, particularly in the early phases of offshore wind development, will likely be in the supply chain, helping to manufacture, certify, procure and deliver the wide variety of products and services necessary for the project. An example of the job supply chain created for an onshore wind-energy facility is listed in Table 2. According to a report released in September 2012 by the National Resources Defense Council (NRDC), a typical wind farm of 250 MW creates 1,079 direct jobs over the life of the project. These jobs begin at the pre-construction and development phase of the wind farm; the jobs then move into the permitting phase, increase significantly during construction, and then offer high paying jobs over the life of the wind farm. **With the right training programs in place in Maryland, the state can capitalize on high paying jobs in the same way Iowa and Texas have.**

Solar Energy

Solar is another high growth potential field for which Maryland should begin training the workforce. Solar power generates jobs in manufacturing, skilled trades, sales, supply chains, and affiliated positions. Typical solar employment opportunities, from the January 2014 National Solar Jobs Census of 2013, are listed in Table 3. In Maryland, 133 solar companies employ approximately 2,000 people and growing[2]. These employment figures translate to real, significant investment in Maryland: in 2013, Maryland homeowners, businesses, and utilities invested a collective $113 million invested to install solar energy[3].

To install solar photovoltaic and wind-energy electricity generators, existing trades professionals must seek additional specialty certifications, notably those designed and offered by the North American Board of Certified Energy Practitioners (NABCEP). Community colleges, through continuing education and workforce training departments, are among the best hosts for courses that lead to NABCEP testing and certification. Certification offers a chance for existing professionals to better compete in the marketplace, and to profit from the growing clean-energy economy.

Thermal Energy and Efficiency

Because Maryland has added thermal resources, including solar hot water systems and geothermal HVAC systems, to the RPS, the state can anticipate growth in these sectors as well. Geothermal HVAC, in particular, is a well-developed technology in Maryland, but opportunities remain to educate existing HVAC installers, developers, and builders about the equipment, incentives, and certifications involved.

[2] http://thesolarfoundation.org/solarstates/maryland
[3] http://www.seia.org/state-solar-policy/Maryland

In summary, the work force supply chain around clean energy is tremendous. As Maryland looks to grow its economy and its supply of clean, domestic energy, it must have the appropriate workforce-training coursework in its community colleges to prepare students for this growing field. The RPS and off-shore wind act have served as a springboard; Maryland must now capitalize on the opportunities available.

Marine Industries in Maryland

The design, construction, and operation of an offshore wind-energy facility adds another layer of complexity and need to the proposed offshore wind project. To address these needs, Maryland will need a skilled workforce educated in marine transportation, vessel safety, and offshore operations, as well as a complementary set of jobs at the Port of Baltimore in engineering, rigging/crane operations, transportation, and associated skills. The Technical Task Force advises Maryland community colleges to explore relationships with marine industry partners to capitalize on education, training, and certification needs.

Current Landscape of Clean Energy Technical Programs at Maryland Community Colleges

Maryland's community colleges are subject to program approval and regulatory oversight by the Maryland Higher Education Commission (MHEC), which keeps a current catalog of course and program offerings at community colleges throughout the state. The Technical Task Force used the MHEC database to examine existing degree, certificate, and workforce training programs in renewable energy and supply-chain management, their geographic distribution in Maryland (which is a proxy for accessibility by Maryland students), and opportunities to expand workforce training and credit-bearing (*i.e.,* leading to a degree) education that will help prepare Maryland's workforce in renewable energy.

The Technical Task Force found more opportunity for development than existing credit or training programs, and this was true for both renewable energy and supply chain management.

CONTINUING EDUCATION AND WORKFORCE TRAINING COURSES:

> **RENEWABLE ENERGY:** Maryland's community college have offered few courses, largely in solar energy, and those are not evenly distributed across the state. 32 continuing-education courses in wind energy, solar energy, or "clean energy" have been offered since 2012, and the preponderance of those (25 courses) were in solar energy (Table 4). Moreover, those courses were distributed unevenly: renewable-energy courses were

offered at only 7 of the 16 Maryland community colleges, and the majority of those courses were offered at two community colleges: Hagerstown Community College (10 courses since 2012) and Montgomery College (5 courses since 2012) (Table 4).

SUPPLY-CHAIN MANAGEMENT: The Technical Task Force identified a wide variety of supply-chain management and transportation management courses in continuing education, distributed evenly across the state. 16 courses have been offered since 2012, at 10 different institions, and one course is available via Maryland OnLine to all colleges in the state (Table 4).

DEGREE AND CERTIFICATE COURSES AND PROGRAMS:

RENEWABLE ENERGY: Many opportunities exist to expand Maryland's community college credit offerings in renewable energy. At present, only 2 degree programs exist in renewable energy (Table 5), and 4 certificate programs exist.

SUPPLY-CHAIN MANAGEMENT: In supply-chain and logistics management, opportunities abound: only 3 degree programs exist (at 2 colleges), and 5 certificate programs exist at 3 colleges (Table 6).

Supply chain management is typically taught as a business discipline, yet only two Maryland community colleges (Anne Arundel Community College and Cecil College) offer degrees in supply chain management. A wider geographic distribution of these degree programs, and related certificate programs, would make community-college graduates competitive in the job market, and would, in turn, help Maryland businesses prepare for, and participate in, the growth of the renewable energy economy.

Recommendations

The Technical Task Force offers 4 recommendations to the Legislature to spur development of associate degree, certificate, continuing-education, and workforce-training credentialing programs at Maryland's community colleges. Development of these programs will prepare the State to begin development of the proposed offshore wind project, continue expansion of other renewable-energy and energy-conservation technologies in pursuit of the Renewable Portfolio Standard, and capitalize on the economic opportunities presented by renewable energy.

Recommendation 1: Focus community college educational and training efforts on supply chain and logistics management.

Offshore and Land-Based Wind Energy: Hundreds, if not thousands, of jobs will be created in renewable energy supply chain development, especially for offshore wind. These jobs include manufacturing, procurement, permitting, site preparation at the Port of Baltimore, staging of equipment before installation offshore, and a wide variety of other tasks prior to installation. This represents perhaps the richest resource for Marylanders seeking employment. The Maryland Business Network for Offshore Wind (Biz MD OSW) recently established a supply-chain portal (www.bizmdosw.org) to help prospective business partners identify their supply-chain needs; the State, and its educational institutions, would do well to monitor that database and seek opportunities to help businesses meet their education and training needs.

Although no analogous portal exists for the onshore wind industry, research shows that a large number of jobs is created in the supply chain for any onshore wind energy development. With at least two onshore wind farms planned for the Eastern Shore of Maryland, and strong wind resources in the western portions of the state, educational entities located close to those supply chains will have ample opportunity to help meet the education and training needs of the wind industry.

Solar Photovoltaic Energy: This supply chain is more localized, and therefore more diffuse, reflecting the nature of solar energy installations at the local residential, commercial, and educational scale. However, solar energy is the fastest-growing renewable energy industry in the state, and among the most cost-effective, and the industry can be expected to grow. Therefore, opportunities exist for community colleges to educate and train the workforce for this vital component of the state's renewable energy portfolio.

Geothermal HVAC: This industry is also localized and diffuse. However, strong incentives for the installation of geothermal HVAC systems exist at the state and federal level, and these are among the first energy-efficiency investments to see a return on investment (ROI), so this industry will probably also continue to grow in Maryland. Providing continuing education to existing HVAC installers, and educating the next generation of HVAC workers, should remain a high priority for Maryland community colleges.

Recommendation 2: Develop Programs in Marine Operations & Maintenance, Safety, and Seamanship

The development of an offshore wind project with a proposed 20-year installation window presents a unique set of opportunities, which pay tribute to Maryland's maritime heritage and culture. Transportation of people and goods to offshore wind turbines, both during and after construction, will require pilots and crew with marine skills, licenses, and safety training that will enable them to safely transport crews and equipment.

The Technical Task Force recommends that Maryland community colleges develop partnerships with partners in marine transportation, in order to develop training programs that will enhance the capacity, safety, and reliability of the maritime service fleet in Maryland. Potential partnerships might include:

Partnerships between community colleges and the United States Coast Guard;

- Partnerships between community colleges and maritime educational entities, including:

        - The AFL-CIO Seafarers Harry Lundeberg School of Seamanship, in Piney Point, MD
        - The Calhoon MEBA Engineering School, in Easton, MD
    - Partnerships between community colleges and the Port of Baltimore

Recommendation 3: Develop a Renewable Energy Affinity Group to match industry needs to educational entities that can help meet these needs.

The Technical Task Force recommends the development of a group and a process to facilitate matching the workforce needs of the energy industry to the programs and courses offered by community colleges. We recommend that the Maryland Legislature should establish a Renewable Energy Affinity Group, under the aegis of the Maryland Higher Education Commission (MHEC). MHEC should receive funding from the legislature to pilot the Affinity Group for a 1-year period. Possible funding sources include: funds from the Exelon/Constellation merger fund ($ 1 million to be expended over 3-5 years), state general or special funds appropriation, or external funds as available.

Members of the Affinity Group should include representatives from:

1. industries involved in the renewable energy supply chain, including solar, onshore wind, offshore wind, and other renewable-energy entities,
2. credit academic, workforce-training, and continuing-education programs at Maryland community colleges,
3. the Governor's Workforce Investment Board (GWIB)
4. the Department of Labor, Licensing, and Regulation (DLLR), and
5. policymakers and representatives of education and the renewable energy industry.

The Affinity Group should convene quarterly, under MHEC's guidance, to learn about projected workforce needs based on renewable-energy projects that are proposed or in development. The development of such a group will help reduce project lead times for developers, and will thereby help Maryland achieve the RPS standard more efficiently.

If this Affinity Group shows success, MHEC should find a way to institutionalize the group, and the process, and support it with both leadership and financial support.

Recommendation 4: Incentivize community-college renewable energy associate degree, certificate, continuing education, and/or training program development, through a competitive grant program managed jointly by MHEC and MEA. The new incentive grant could be modeled after successful programs such as the Base Realignment and Closure (BRAC) academic program development grant and the current Employment Advancement Right Now (EARN) grant program. The Request for Proposals (RFP)could be developed by MHEC and MEA with input from the Department of Labor, Licensing and Regulation, BizMD OSW, Maryland Association of Community Colleges, and others as appropriate. The

RFP might specify geographical/regional restrictions such that funds and resulting programs are disbursed across the state, include possible scholarship funds for students, provide for three to five years of funding through three or more annual funding rounds, and require regular progress reports and specific performance metrics. Possible funding sources include: funds from the Exelon/Constellation merger fund ($ 1 million to be expended over 3-5 years), state general or special funds appropriation, or external funds as available.

APPENDIX: TABLES 1-6

Table 1: Numbers of employees, and average wages, for renewable-energy jobs in Texas, 2013. Source: Texas Workforce Commission.

Renewable Energy-Related Employment in Texas
Second Quarter 2013

Sector (Industry Code)	Firms	Employees	Average Annual Wage
Electric Power Generation (22111)	103	12,087	$98,228
-Wind Electric Power Generation (221115)	17	833	$114,920
Electric Power Transmission, Control, & Distribution (22112)	217	31,393	$88,140
Power Line and Related Structures Construction (23713)	689	18,426	$58,760
Turbine & Power Transmission Equipment Mfg. (333611)	23	1,249	$77,220
Semiconductors, Solar Cells, and Related Devices Mfg. (334413)	125	28,775	$114,920
Electrical Equipment, Generator Mfg. (33531)	188	9,595	$66,560
Battery Mfg. (33591)	12	276	$69,004
TOTALS	**1,374**	**102,634**	**$78,257**

Source: Texas Workforce Commission

Table 2: Jobs generated in the supply chain for an onshore wind energy project. Source: NRDC Report, September 2012, "American Wind Farms: Breaking Down the Benefits from Planning to Production"

Supply Chain Job Task	Job Description Includes	Typical number of jobs
Site Identification, Assessment, and Pre-Development	Conducting wind site measurements, evaluating fatal flaws/potential of site, evaluation of infrastructure activities	12
Project Development, Legal, Regulatory, And Finance	Typical wind farm development work including working with local elected officials, stakeholders, landowners and permitting bodies	50
Project Permitting: Regulatory, Environmental, or Wildlife Assessment	Preparing and applying for relevant required permits, documenting compliance with regulations and assessing potential wildlife and environmental impacts	18
Manufacturing of Power Equipment and Electronics	Manufacturing of electrical and power equipment involved in all aspects of the wind farm	21
Nacelle Assembly	Assembly of nacelle--generating unit in a wind tower that holds gears, electronics, and other equipment to harness the power of the wind moving through the blades	91
Blade Manufacturing	Manufacturing of the blades--typically 20-50 meters in length consisting of composites and resins that can be locally sourced	57
Manufacturing of Engineered Structures	Structures that can house nacelles and also wind turbine tower steel and fabrication	91
Manufacturing of Drive Trains	Assembling completed drive train units that include a gearbox and a generator, which is housed in the nacelle	10
Manufacturing of Sub-Components and Materials	Manufacturing goods such as wiring, fasteners, composites, resins, metals and concrete which are sub-components and raw materials for construction of wind farm	162
Distribution or Transport of Wind Energy Products	Movement of the goods from the manufacturing facilities to the construction site	18
On-Site Civil Works	Construction jobs located on project site, include clearing/building roads, preparing and pouring foundations, preparing site for turbine deliveries and assembly	273
On-Site Mechanical Assembly	Assembling all components, erecting towers, and installing nacelles and blades	202

On-Site Electrical Work	Developing electrical collection system to connect turbines to grid. Building of power substation to put power onto electrical grid. Reinforcing electrical infrastructure and communication system	47
Operations and Maintenance	On-going long term jobs on site operating and mainlining the wind farm	27
Total Jobs Created		1,079

Table 3: Jobs generated in the supply chain for solar energy nationwide, 2013-14. Source: National Solar Jobs Census 2013.

Sector	*2010 Jobs*	*2011 Jobs*	*2012 Jobs*	*2013 Jobs*	*2012 - 2013 Growth Rate*	*2014 Projected Employment*	*2013 - 2014 Expected Growth Rate*
Installation	43,934	48,656	57,177	69,658	21.8%	84,331	21.1%
Manufacturing	24,916	37,941	29,742	29,851	0.4%	32,429	8.6%
Sales and Distribution	11,744	13,000	16,005	19,771	23.5%	22,585	14.2%
Project Development	N/A	N/A	7,988	12,169	52.3%	12,529	3.0%
Other*	12,908	5,548	8,105	11,248	38.8%	13,064	16.1%
Total	**93,502**	**105,145**	**119,016**	**142,698**	**19.9%**	**164,938**	**15.6%**

*2013 employment in "Other" includes 625 solar workers at nonprofits, 588 in government, and 241 in academia. Changes in the number of jobs in the "Other" category over the years are not necessarily a reflection of actual increases or decreases in employment, but may instead be due to changes in the types of jobs included in this category.

Table 4: Continuing Education and Workforce Training opportunities at Maryland community colleges, 2012-2014. (Source: Maryland Higher Education Commission)

WIND ENERGY Result: 6 Courses

College	Course No.	Course Title	State Hrs	Method	Year Appr
BALTIMORE COUNTY	**VOA898**	WIND ENERGY PROFESSIONAL PART A	96	DIST ED	2012
BALTIMORE COUNTY	**VOA899**	WIND ENERGY PROFESSIONAL PART B	96	DIST ED	2012
BALTIMORE COUNTY	**VOA900**	WIND ENERGY PROFESSIONAL PART C	96	DIST ED	2012
CHESAPEAKE	**CEX670**	WIND ENERGY	24	CLAS/LAB	2012
HAGERSTOWN	**CNT208**	WIND ENERGY INSTALLATION	50	CLAS/LAB	2012
HAGERSTOWN	**PLC489**	MARYLAND WIND ENERGY INITIATIVES	3	CLAS/LAB	2014

SOLAR Result: 25 Courses

College	Course No.	Course Title	State Hrs	Method	Year Appr
ANNE ARUNDEL	**CEN564**	GEOTHERMAL/SOLAR: HIGH PERFORMANCE HOMES	2	CLAS/LAB	2014
ANNE ARUNDEL	**OPT465**	INSTALLATION AND DESIGN OF SOLAR PANEL SYSTEM	48	CLAS/LAB	2013
ANNE ARUNDEL	**TGT868**	GREEN CARS: A SOLAR POWERED SYSTEM	18	CLAS/LAB	2014
CARROLL	**VOC352**	SOLAR HOT WATER	5	CLAS/LAB	2013
CARROLL	**VOC437**	NATIONAL ELEC CODE STNDS FOR SOLAR PV SYS	4	CLAS/LAB	2012
BALTIMORE COUNTY	**VOA864**	SOLAR POWER PROFESSIONAL PART A	72	DIST ED	2012
BALTIMORE COUNTY	**VOA865**	SOLAR POWER PROFESSIONAL PART B	72	DIST ED	2012
SOUTHERN MARYLAND	**TEC752**	Intro to Solar Photovoltaics	48	CLAS/LAB	2012
CHESAPEAKE	**TEC754**	Solar Photovoltaic System Ins	72	CLAS/LAB	2013
HAGERSTOWN	**PLC593**	RESIDENTIAL SOLAR APPLICATIONS	4	CLAS/LAB	2012
HAGERSTOWN	**TRD023**	SOLAR PV INSTALLER CERT	45	CLAS/LAB	2014
HAGERSTOWN	**TRD044**	SOLAR PV INSTALLER	24	CLAS/LAB	2012

HAGERSTOWN	**TRD048**	SOLAR/WIND FIREFIGHTER SAFETY	5	CLAS/LAB	2012
HAGERSTOWN	**TRD098**	SOLAR THERMAL HOT WATER SYS	20	CLAS/LAB	2013
HAGERSTOWN	**TRD113**	NABCEP SOLAR CERT. EXAM PREP	9	CLAS/LAB	2013
HAGERSTOWN	**TRD131**	SOLAR PV INSTALL FOR ELEC WORK	27	CLAS/LAB	2013
HAGERSTOWN	**IA1180**	NEC REQ/SOLAR PHOTOVOLT SYS	12	CLAS/LAB	2013
MONTGOMERY	**TTG509**	SOLAR PV ELECTRIC INSTALL	45	CLAS/LAB	2012
MONTGOMERY	**TTG515**	SOLAR THERMAL DES/INSTAL	45	CLAS/LAB	2013
MONTGOMERY	**TTG521**	SOLAR PV DESIGN / INSTALLATION	60	CLAS/LAB	2014
MONTGOMERY	**TTG523**	SOLAR THERMAL DESIGN/INSTALL//	60	CLAS/LAB	2014
MONTGOMERY	**TTG527**	SOLAR PV/SMALL WIND NEC APPL//	12	CLAS/LAB	2014
PRINCE GEORGE'S	**CIE301**	FUNDAMENTALS OF SOLAR HOT WATER HEATING	72	DIST ED	2012
WORWIC	**ITM016**	INTRO TO SOLAR AND RENEWABLE ENERGY	50	CLAS/LAB	2012

CLEAN ENERGY Result: 1 Course

College	Course No.	Course Title	State Hrs	Method	Year Appr
PRINCE GEORGE'S	**ENR527**	CLEAN ENERGY FOR THE 21ST CENTURY	18	CLAS/LAB	2013

SUPPLY-CHAIN MANAGEMENT & TRANSPORTATION Result: 15 Courses

College	Course No.	Course Title	State Hrs	Method	Year Appr
ALL	**ONL334**	SUPPLY CHAIN MANAGEMENT FUNDAMENTALS	30	DIST ED	2012
ANNE ARUNDEL	**DLC352**	SUPPLY CHAIN MANAGEMENT FUNDAMENTALS	29	DIST ED	2014
CATONSVILLE	**MGT332**	SUPPLY CHAIN MANAGEMENT FUNDAMENTALS	29	DIST ED	2014
CATONSVILLE	**MGT644**	INTRO TO SUPPLY CHAIN MANAGEMENT	8	CLAS/LAB	2013
BALTIMORE COUNTY	**CI3862**	SUPPLY CHAIN MANAGEMENT FUNDAMENTALS	29	DIST ED	2013

CECIL	**TLI136**	SUPPLY CHAIN & INVENTORY MGT.	18	CLAS/LAB	2014
CECIL	**WGI151**	SUPPLY CHAIN MANAGEMENT APPS	29	DIST ED	2012
CHA	**BUS505**	Supply Chain Mgt	29	DIST ED	2014
CHESAPEAKE	**CEG249**	SUPPLY CHAIN MANAGEMENT FUNDAMENTALS	29	DIST ED	2014
HAGERSTOWN	**PRD340**	SUPPLY CHAIN MANAGEMENT	29	DIST ED	2014
HAGERSTOWN	**PRD790**	PURCHASING/SUPPLY CHAIN MNG I	120	DIST ED	2013
HAGERSTOWN	**PRD792**	PURCHASE/SUPPLY CHAIN MNG III	120	DIST ED	2013
MONTGOMERY	**ETG496**	SUPPLY CHAIN MGMT. FUNDAMENTAL	29	DIST ED	2013
MONTGOMERY	**ETG519**	SUPPLY CHAIN MGMT APPLICATIONS	29	DIST ED	2013
PRINCE GEORGE'S	**MGT628**	SUPPLY CHAIN MANAGEMENT FUNDAMENTALS	29	DIST ED	2012

Table 5: Credit Degrees and Certificates in Renewable and Alternative Energy

College	Degree	Type (Credit Hours)	Required Courses
HAGERSTOWN	Alternative Energy	Degree (AAS, 60)	Geothermal installation Solar photovoltaic Installation Wind Energy Installation Customer Service others: Intro to Alternative Energy, HVAC, plumbing, electricity, pumps & motors, instrumentation & process control
WOR-WIC	Environmental Energy Technology	Degree (AAS, 65)	Intro to Wind Turbine Technology (2cr with lab) Intro to Solar and Renewable Energy (3cr; all theory)
ANNE ARUNDEL	Alternative and Sustainable Energy Systems	Certificate (16)	Home electricity reduction, with emphasis on the RESNET Home Energy Rater certification *No coursework in renewable energy generation*
BALTIMORE COUNTY	Advanced HVAC and Energy	Certificate (13)	Residential Load Calculations and Refrigeration; emphasis on HVAC load reduction *No coursework in renewable energy generation*
BALTIMORE COUNTY	Alternative Energy	Certificate (29)	One class required: "overview of renewable energies as applied to the HVAC Industry" (3cr) Emphasis on home-HVAC energy savings and associated certification
WOR-WIC	Environmental Energy Technology	Certificate (27)	Environmental Science, Introduction to Wind Turbine Technology, Introduction to Geographic Information-GIS, Introduction to Solar and Renewable Energy, Basic Electricity, Modern Manufacturing Techniques

Table 6: Credit Degree Programs in supply-chain management and transportation logistics.

College	Degree	Type (Credit Hours)
ANNE ARUNDEL	Business Management – Logistics and Supply Chain Option	Degree (AAS, 60)
CECIL	Transportation & Logistics — Supply Chain Management	Degree (AAS, 70)
CECIL	Transportation & Logistics — Transportation Management	Degree (AAS, 67)
ANNE ARUNDEL	Supply Chain Management	Certificate (approval pending)
ANNE ARUNDEL	Certificate in Transportation, Logistics, and Cargo Security	Certificate (18)
CECIL	Transportation & Logistics — Commercial Transportation	Certificate (30)
CECIL	Transportation & Logistics — Transportation Management	Certificate (27)
HAGERSTOWN	Commercial Transportation Management	Certificate (25)