8-1-2009

Maine's Green Economy: An Overview of Renewable Energy and Energy Effciency Sectors

Maine Department of Labor

Maine Center for Workforce Research and Information

John Davulis Economist

JOHN ELIAS BALDACCI
GOVERNOR

STATE OF MAINE
DEPARTMENT OF LABOR
CENTER FOR WORKFORCE RESEARCH AND INFORMATION
45 COMMERCE DRIVE
AUGUSTA, MAINE
04330

LAURA A. FORTMAN
COMMISSIONER

JOHN DORRER
DIVISION DIRECTOR

Maine's Green Economy:

An Overview of Renewable Energy and Energy Efficiency Sectors

A publication of:

Center for Workforce Research and Information

Maine Department of Labor

Prepared by:

John Davulis, Economist

Issued August 2009 Augusta, Maine

PHONE: (207) 623-7900 TTY 1-800-794-1110 FAX: (207) 287-2947

Preface

This is the first in a series of reports from the Maine Department of Labor, Center for Workforce Research and Information examining the "Green Economy" in Maine. Considerable emphasis and resources have been dedicated in the American Recovery and Reinvestment Act of 2009 to invest in America's future by cleaning the environment, conserving energy, and developing renewable energy sources. Policymakers expect that such investment will not only improve our environment, but also create new job opportunities that will help American workers improve their economic standing.

This report addresses a number of the broad questions: What do we mean by the "Green Economy?" What industry segments comprise the " Green Economy?" What industry segments comprise the renewable energy and energy efficiency sectors in Maine? What criteria should be used to evaluate the need and potential for targeted education and training initiatives in the "Green Economy?"

Subsequent research efforts and reports will focus more directly on job creation and growth by industry and occupation with a particular emphasis on identifying the knowledge, skills and abilities that workers need for jobs in the "Green Economy". We are also mounting a more sustained effort to track the composition and size of the renewable energy and energy efficiency sectors in Maine. Rapidly developing technologies and innovative public policies pose challenges to traditional industry and occupational taxonomy used to convey a picture of the "Green Economy". Our work will seek to keep up with these developments. We will search for new tools to support our analysis and above all, we look forward to collaborating with representatives of industry, education, and the advocacy community in shaping our research agenda.

We wish to thank John Davulis as the primary author of this report. John previously served as the chief economist for Central Maine Power Company and brought long and deep experience with the energy industry and issues in Maine to this project.

John Dorrer, Director
Center for Workforce Research and Information
Maine Department of Labor

Table of Contents

Introduction

The growing international demand for energy and natural resources has had a negative impact on Maine consumers, businesses, and its climate. The cost of energy and of material inputs used in manufacturing processes has risen dramatically. Additionally, the emission of greenhouse gases has climbed to an alarming level. The need to reduce Maine's dependence on fossil fuels by increasing energy efficiency and pursuing renewable energy resources is apparent. This evolution to a green economy requires new knowledge, skills, and abilities. Understanding how the Maine labor market is changing is an important component of effective public policy decisions and workforce training initiatives.

While the greening of the Maine economy is in part an abandonment of practices that are wasteful in terms of energy and/or resource use, it is also a necessary progression and an opportunity for renewed economic growth. As Maine achieves success in transitioning toward a greener economy, it can expect to see the benefits of increasing the productivity of its business, improving the energy efficiency and lowering the cost of heating and cooling its buildings, and reducing its reliance on foreign oil by investing in renewable energy resources (wind, biomass, solar, hydro) – while creating good jobs and a cleaner environment.

As John Podesta *et al.* have observed, "The challenge we face is nothing short of the conversion of an economy sustained by high-carbon energy—putting both our national security and the health of our planet at serious risk—to one based on low-carbon, sustainable sources of energy. The scale of this undertaking is immense and its potential enormous."[1]

For many advocates, there is a moral dimension to the Green Economy. "Indeed, discussions about green collar jobs dovetail into several parallel movements to promote alternative energy. The variety of objectives voiced by members of the broad emerging green coalition can be distilled into four main motives: 1) environmental protection and sustainability; 2) economic development and job creation; 3) national security; and 4) moral obligation."[2]

This report proposes answers to a number of the questions:

- What do we mean by the Green Economy?
- What industry segments comprise the Green Economy?
- How big is the Renewable Energy and Energy Efficiency (RE&EE) sector in the U.S.?

[1] John Podesta, Todd Stern, and Kit Batten, "Capturing the Energy Opportunity: Creating a Low-Carbon Economy", Progressive Growth, November 2007, p. 1.

[2] Marc Anderberg, GREEN COLLAR WORKERS and Other Mythical Creatures, Texas Workforce Commission, August 1, 2008, p. 16.

- What are the growth prospects for the RE&EE segments?
- What industry segments comprise the RE&EE sectors in Maine?
- What criteria should be used to evaluate the need and potential for targeted education and training initiatives in the Green Economy?

What do we mean by the Green Economy?

The Occupational Information Network (O*NET) program is the nation's primary source of occupational information on hundreds of standardized and occupation-specific descriptors. The O*NET System defines the green economy as **"… economic activity related to reducing the use of fossil fuels, decreasing pollution and greenhouse gas emissions, increasing the efficiency of energy usage, recycling materials, and developing and adopting renewable sources of energy."**[3]

Likewise, the Obama Administration has proposed the following definition: **"Green jobs are jobs that provide products and services which use renewable energy resources, reduce pollution, conserve energy and natural resources and reconstitute waste."**[4]

The United Nations Environment Programme would expand this definition further to include **"… jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption through high efficiency strategies; de-carbonize the economy; and minimize or altogether avoid generation of all forms of waste and pollution."**[5]

The Apollo Alliance would add a social objective that green jobs should be good jobs that pay a livable wage: "The shift to a green economy creates an unparalleled opportunity to address not only unemployment and the climate crisis but also deeply rooted social problems such as poverty and inequality. Decisions made today about green jobs will have profound consequences for our economy, environment, and social fabric for decades to come."[6]

---

[3] Phil M. Lewis & David W. Rivkin, Greening of the World of Work: Implications for O*NET-SOC and New & Emerging Occupations, presentation to the Green Jobs Study Group, Workforce Information Council, 3/13/2009.

[4] This definition was offered in the context of the Middle Class Task Force's first meeting on February 27, 2009; see http://www.whitehouse.gov/blog_post/save_the_date_1/.

[5] Green Jobs: Toward Decent Work in a Sustainable, Low-Carbon World, United Nations Environment Programme, September 2008, p. 3.

[6] Philip Mattera *et al*., High Road or Low Road? Job Quality in the New Green Economy, The Apollo Alliance, February 3, 2009, p. 5.

The overarching objective of the green economy is to promote activities that reduce the use of fossil fuels, encourage the development of renewable energy resources, reduce pollution and mitigate carbon emissions, increase energy efficiency and minimize the use of natural resources, and recycle waste materials. However, the greenness of economic activities and occupations is not an either/or, black/white proposition. Rather, we are dealing with a continuum, with shades of gray, degrees of sustainability. And, many "green" activities are not without controversy – corn ethanol may require more BTUs to produce than is gained from finished product, renewable energy portfolio standards (RPS) often increase the cost of producing electricity, coal is an abundant and cheap source of energy in many regions of the world, nuclear power and carbon capture technologies have their own unique problems, etc.

What industry segments comprise the Green Economy?

As BW Research Partnership has observed, "Unlike a traditional industry cluster – Green Technology is identified not by a connected supply chain, but by the objectives of the products and services that are developed within this industry."[7] In this spirit, the O*NET program[8] proposes the following sectors as comprising the core of the green economy:

- **Research, Design, and Consulting Services**
  - *"Indirect jobs" to the green economy which includes activities such as energy consulting or research and other related business services*
- **Manufacturing**
  - *Industrial manufacturing of green technology as well as energy efficient manufacturing processes*
- **Renewable Energy Generation**
  - *Developing and using energy sources such as solar, wind, geothermal, and biomass*
- **Governmental and Regulatory Administration**
  - *Activities by public and private organizations associated with conservation and pollution prevention, regulation enforcement, and policy analysis and advocacy*
- **Energy Efficiency**
  - *Increasing energy efficiency (broadly defined), making energy demand response more effective, constructing "smart grids," etc.*
- **Agriculture and Forestry**
  - *Using natural pesticides, efficient land management or farming, and aquaculture*

[7] BW Research Partnership, The Economic and Workforce Development Opportunities of Green Technology, November 15, 2007.

[8] Lewis & Rivkin, *Op. cit.*

- **Recycling and Waste Reduction**
  - *Solid waste and wastewater management, treatment, and reduction, as well as processing recyclable materials*
- **Energy Trading**
  - *Buying and selling energy as an economic commodity, as well as carbon trading projects*
- **Energy and Carbon Capture**
  - *Capturing and storing energy and/or carbon emissions, as well as technologies related to power plants using the integrated gasification combined cycle (IGCC) technique.*

To this list, the Environmental Defense Fund[9] would add the following sectors:

- **Green Buildings**
  - *Design & development, building materials*
- **Transportation**
  - *Vehicles, fuels & systems*
- **Non-Profit Sector**
  - *Policy analysis & advocacy.*

While there may be general agreement on the sectors which should be included in a comprehensive definition of the Green Economy, the counting of jobs within any particular segments remains problematic. To wit, Nicholas Jolly has commented,

> Further difficulty arises because some occupations are "green" one day and "non-green" the next, or may be only partially green. For example, a construction firm may install solar heating systems on a residence or commercial building for one project and not for the next. Another example is automobile manufacturers. Today, some employees in this industry may be building vehicles that run on biofuels, electricity, hydrogen or fuel cells. At the same time, other employees for the same company will be producing traditional gas-powered vehicles, some with substantially lower fuel efficiency. Further, what about manufacturing plants that construct automobile parts that reduce auto emissions, yet use inefficient production processes? Are the workers for this company truly "green"? And still further, consider a company whose sole product is fuel cells; should the office clerks, accountants, custodians, and other non-production workers be included in the count of green jobs?[10]

[9] Environmental Defense Fund, Green Jobs Guidebook: Employment Opportunities in the New Clean Economy, September 25, 2008, p. 3.

[10] Nicholas A. Jolly, "How 'Green' is Connecticut's Economy", The Connecticut Economic Digest, Vol. 13, No. 12, December 2008, pp. 1-2.

Recognizing the issue raised by Jolly, the O*NET program proposes a simultaneous focus on occupations as well as sectors of the green economy[11]. The program identifies three categories of occupations:

(1) **Green Increased Demand Occupations**, where there is an increase in the demand for an existing occupation with some changes in work context, but few if any significant changes in work (tasks) and worker requirements of the occupation;

(2) **Green Enhanced Skills Occupations**, where significant changes in work and worker requirements occur; while the essential purposes of the occupation remain the same, certain tasks, skills, knowledge, and external elements have changed; and

(3) **Green New & Emerging Occupations**, where the impact of green economy activities and technologies creates unique work and worker requirements, which results in the generation of a new occupation relative to the O*NET taxonomy.

How big is the Renewable Energy & Energy Efficiency (RE&EE) sector?

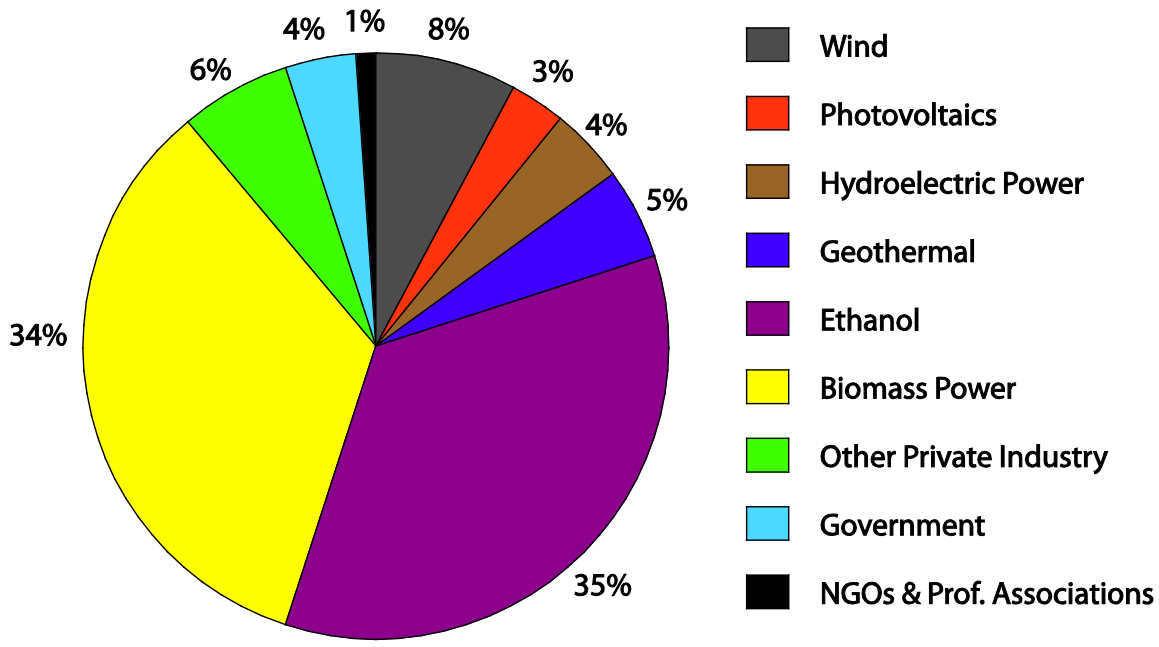
Depending upon the sectors one includes in the definition of the green economy and the breadth of the occupations included within individual segments, estimates of the size of the green economy can vary greatly. There have been two major efforts to quantify the size of the renewable energy and energy efficiency sectors in the U.S. – a 2007 study prepared for the American Solar Energy Society (ASES) and a 2008 report prepared for the U.S. Conference of Mayors.

Roger Bezdek, writing for the ASES, estimates there were about 3.7 million jobs in the U.S. directly related to renewable energy and energy efficiency in 2006.[12] Of this number, 193,500 jobs were in the renewable energy (RE) industry – with 69% of the RE total being associated with ethanol and biomass power. Chart 1 shows the distribution of jobs within the renewable energy segment, based on Bezdek's analysis.

[11] Lewis & Rivkin, *Op. cit.*

[12] Roger Bezdek, Renewable Energy and Energy Efficiency: Economic Drivers for the 21st Century, American Solar Energy Society, November 2007, p. 31.

Chart 1. Distribution of Employment in the Renewable Energy Industry



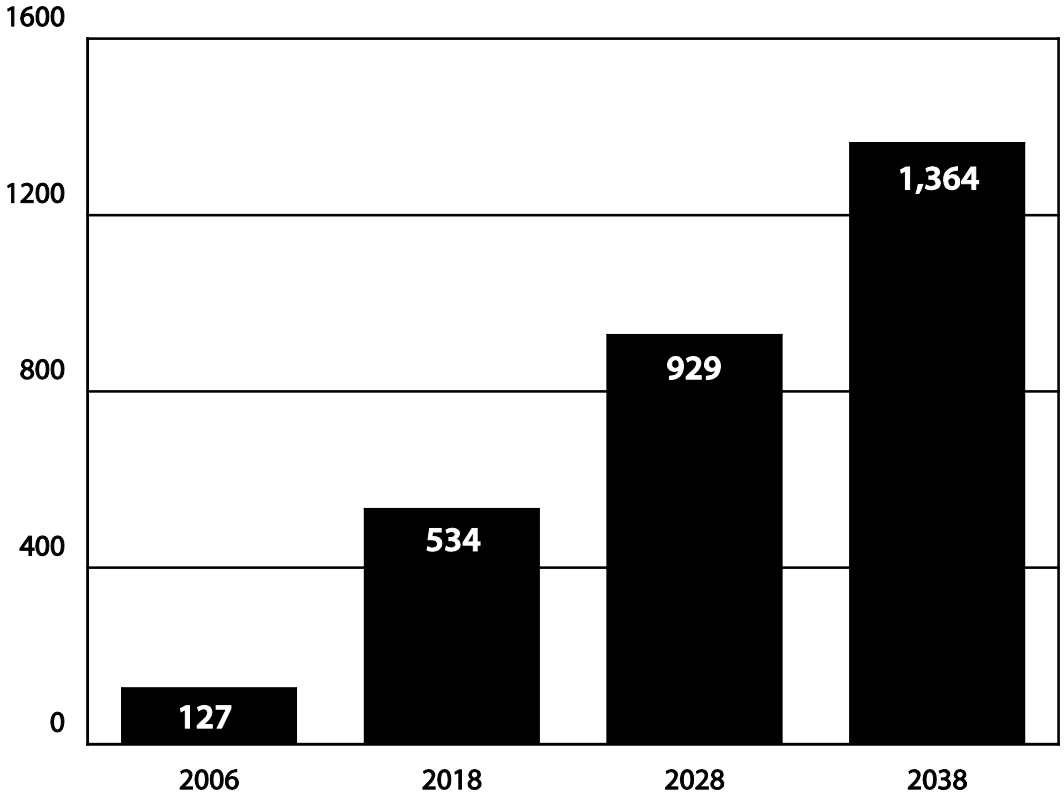
Source: Roger Bezdek, Renewable Energy and Energy Efficiency: Economic Drivers for the 21st Century, American Solar Energy Society, November 2007

Is this a reasonable estimate? It appears to be. In another study[13], Global Insight puts the number of jobs associated with renewable power generation at 127,200 – including persons working at nuclear power plants, which were excluded by Bezdek. In addition, Global Insight estimates that there are 57,500 green jobs in agriculture and forestry associated with the production of biofuel stocks. Adding those two components together, we get about 185,000 jobs – which is very close to the ASES figure.

Both studies are optimistic that substantial employment growth will occur in the renewable energy industry in the years ahead. Bezdek anticipates 190% growth by 2030, and Global Insight projects that 1.2 million new jobs will be created in the renewable power generation segment by 2038. Chart 2 provides Global Insight's estimates on employment growth.

[13] Global Insight, Inc., Current and Potential Green Jobs in the U.S. Economy, Prepared for: The United States Conference of Mayors and the Mayors Climate Protection Center, October 2008, p. 5.

Chart 2. Employment in the Renewable Power Generation Sector (000s)



Source: Global Insight, Inc., Current and Potential Green Jobs in the U.S. Economy, Prepared for:The United States Conference of Mayors and the Mayors Climate Protection Center, October 2008

The variance in the estimates for the size of the energy efficiency industry in the U.S., however, is very large. Bezdek's analysis concludes that there were 3.5 million people directly involved in the energy efficiency industry in 2006.[14] Otherwise, Global Insight puts the number of jobs in the energy efficiency segment at about 566 thousand. Clearly, the analysts are working with different definitions. The ASES definition is very inclusive, and Global Insight's perspective is more focused.

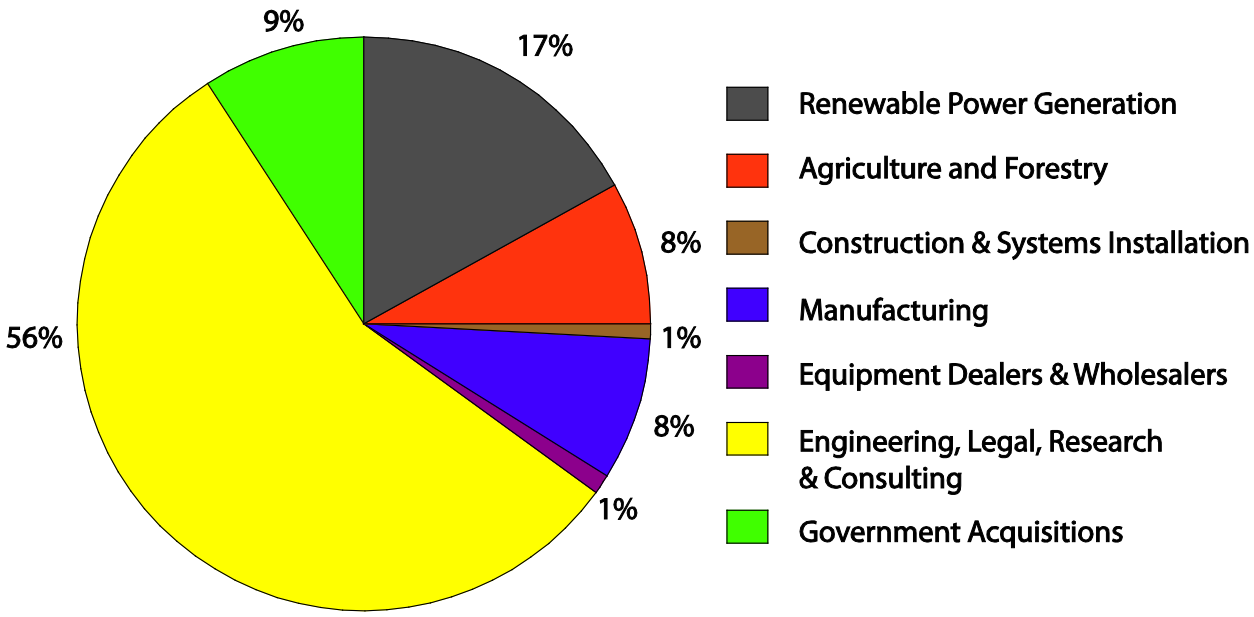
Global Insight defines green jobs as any activity that generates electricity using renewable or nuclear fuels, agriculture jobs supplying corn or soy for transportation fuel, manufacturing jobs producing goods used in renewable power generation, equipment dealers and wholesalers specializing in renewable energy or energy-efficiency products, construction and installation of energy and pollution management systems, government administration of environmental programs, and supporting jobs in the engineering, legal, research and consulting fields. The ASES definition includes many more

[14] Bezdek, *Op. cit.*, p. 30.

manufacturing jobs (related to the production of vehicles, appliances, computers, etc.) plus 1.3 million recycling jobs.

In total, Global Insight estimates that there were about 751 thousand persons working in green jobs in 2006. Chart 3 shows how Global Insight's estimate breaks down into more defined segments.

Chart 3. Distribution of Employment in the Renewable Energy and Energy Efficiency Industry



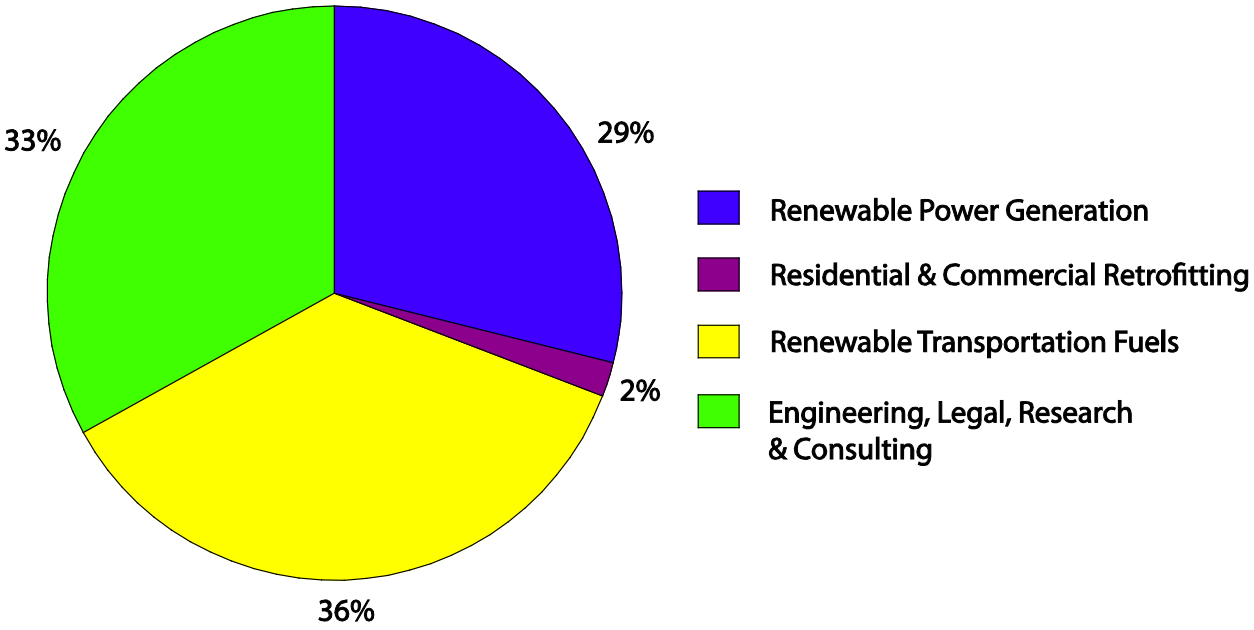
Source: Global Insight, Inc., Current and Potential Green Jobs in the U.S. Economy, Prepared for: The United States Conference of Mayors and the Mayors Climate Protection Center, October 2008

The employment outlook for the renewable energy and energy efficiency sectors is very positive. Global Insight estimates that 2.5 million new jobs will be created by 2018 and 4.2 million by 2038. The next chart highlights where Global Insight expects the job growth to occur. In summary, Global Insight concludes:

> The potential growth in Green Jobs is significant in that it could be the fastest growing segment of the United States economy over the next several decades and dramatically increase its share of total employment. The current count of 750,000 jobs amounts to less than one-half of a percent of total

current jobs. The generation of 4.2 million new Green Jobs would more than quintuple the total count and could provide as much as 10% of new job growth over the next 30 years.[15]

Chart 4. Distribution of New Jobs Created by 2038



Source: Global Insight, Inc., Current and Potential Green Jobs in the U.S. Economy, Prepared for:The United States Conference of Mayors and the Mayors Climate Protection Center, October 2008

How big is renewable energy and energy efficiency sector in Maine? Based upon Global Insight's metric, there were about 2,500 RE&EE jobs in the Pine Tree State in 2006. That's about 0.4% of Maine's total wage and salary employment. Global Insight estimates that Maine's renewable energy and energy efficiency sector will grow at an annual rate of 7.1%, or by about 600 jobs per year, 2006-2038. Within Maine's metropolitan areas, Global Insight estimates that Bangor had 458 green jobs in 2006, Lewiston-Auburn had 157, and the Portland-South Portland-Biddeford area had 954. [16]

[15] Global Insight, *Op. cit.*, p. 17.

[16] Global Insight, *Op. cit.*, p. 26.

What industry segments comprise the RE&EE sector in Maine?

Based upon Maine's industrial mix and future growth potential, as a starting place, we are considering the following economic segments[17] as the ones where we will find green jobs:

- **Agriculture, Forestry, Fishing and Hunting**, only the portion of segment associated with:
  - Soybean, Oilseed, Corn, Hay Farming (crops for ethanol)
  - Other Aquaculture (algae for ethanol)
  - Support Activities for Forestry (biomass for fuel, wood pellets, ethanol)

- **Utilities**, only the portion of segment associated with:
  - Hydroelectric Power Generation
  - Combined Heat & Power Generation (cogeneration)
  - Other Electric Power Generation (wood, trash, wind, wave, solar, etc.)
  - Electric Power Transmission and Distribution (necessary infrastructure, smart grid)

- **Construction**, at least the portion of segments associated with:
  - Residential Remodeling
  - Power and Communication Line & Related Structures Construction

- **Manufacturing**, portions of the following segments:
  - **Food Manufacturing** (Wet Corn Milling, Soybean Processing, Other Oilseed Processing)
  - **Wood Product Manufacturing** (Wood Window and Door Manufacturing, Manufactured Homes, All Other Miscellaneous Wood Product Manufacturing)
  - **Chemical Manufacturing** (Industrial Gas Manufacturing, Ethyl Alcohol Manufacturing)
  - **Plastics and Rubber Products Manufacturing** (Polystyrene Foam Products, Urethane and Other Foam Product Manufacturing)
  - **Nonmetallic Mineral Product Manufacturing** (Mineral Wool Manufacturing)
  - **Fabricated Metal Product Manufacturing** (Metal Window and Door Manufacturing)
  - **Machinery Manufacturing** (Heating Equipment, Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing, Turbine and Turbine Generator Set Units)
  - **Computer and Electronic Product Manufacturing** (Semiconductor and Related Device Manufacturing, Automatic Environmental Controls, Instruments and Related Products Manufacturing)

[17] Industry sectors and subsectors are based upon the hierarchical structure of the 2007 North American Industry Classification System (NAICS) for the United States.

- **Wholesale Trade**, relevant portion of the segment associated with:
  - Roofing, Siding, and Insulation Material Merchant Wholesalers
  - Plumbing and Heating Equipment and Supplies (Hydronics) Merchant Wholesalers (includes solar panels)
  - Warm Air Heating and Air-Conditioning Equipment and Supplies Merchant Wholesalers (includes wood stoves)

- **Retail Trade**, only the portion of segment associated with:
  - Other Fuel Dealers (wood & wood pellets)

- **Professional, Scientific, and Technical Services**, portions of the following segments:
  - Architectural Services
  - Engineering Services
  - Building Inspection Services
  - Interior Design Services
  - Industrial Design Services
  - Process, Physical Distribution, and Logistics Consulting Services
  - Other Management Consulting Services
  - Environmental Consulting Services
  - Other Scientific and Technical Consulting Services
  - Research and Development in Biotechnology
  - Research and Development in the Physical, Engineering, and Life Sciences (except Biotechnology)

- **Educational Services**, relevant portion of the segment associated with providing training for RE&EE occupations:
  - Colleges, Universities, and Professional Schools
  - Professional and Management Development Training
  - Other Technical and Trade Schools

- **Health Care and Social Assistance**, relevant portion of the segment associated with:
  - Other Community Housing Services

- **Other Services (except Public Administration)** , relevant portion of the segment associated with:
  - Other Electronic and Precision Equipment Repair and Maintenance
  - Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance
  - Appliance Repair and Maintenance

- **Environment, Conservation and Wildlife Organizations**, relevant portions

- **Public Administration**, relevant portion of the segment associated with:
  - Administration of Air and Water Resource and Solid Waste Management Programs
  - Administration of Conservation Programs
  - Administration of Housing Programs
  - Regulation and Administration of Communications, Electric, Gas, and Other Utilities
  - Regulation of Agricultural Marketing and Commodities

What criteria should be used to evaluate the need and potential for targeted education and training initiatives in the Green Economy?

While some of the green jobs in Maine's renewable energy and energy efficiency sector are old jobs (e.g., those related to the production of combined heat and power at paper mills) and others have been in existence for a number of years (e.g., jobs at Efficiency Maine that are associated with promoting energy conservation), many other jobs will be created in new and emerging industries – wind power, wood pellets, renewable transportation fuels, cold climate heat pumps, energy trading, etc. Some of these jobs will require a new set of the knowledge, skills, and abilities (KSAs) to perform the tasks expected. If so, investments in workforce training to impart the required KSAs will need to be considered.

What criteria should be used to evaluate the need and potential for targeted education and training initiatives and the value of investing in the green economy? Marc Aderberg of the Texas Workforce Commission proposes that an outcomes-based approach be used.

> Only the measurable outcomes of discrete work activities can serve as adequate criteria for evaluating competing grant applications for round one funding under WIA's new Title X. Therefore, it should be incumbent on any party submitting a proposal to quantify the following:
>
> 1) For the job designated as the object of green education and training under WIA's Title X (herein called the "target-job"), what are the net energy savings relative to a comparable job producing the equivalent conventional product or one which uses a more conventional production process?
>
>   a. This dimension would allow the proposer to build a case for training or retraining workers (regardless of their occupational classifications) to be productive as telecommuters who ostensibly would have a smaller carbon footprint while generating the same output.

b. It would give preference to training workers for remanufacturing any product over those who make the same product from scratch.

2) How would the target job contribute to improving national security or address the revenue leakage problem? How many barrels of foreign oil will be displaced annually by the activities of each worker in the target-job? (This dimension would allow for the training of oil field workers in new techniques for discovering, extracting and processing domestic reserves – a potentially crucial interim solution for the nation's energy woes.)

3) What does the target-job contribute to the net reduction in the "carbon footprint" of the worker's employer or of consumers who buy/use the firm's goods and services?

4) Will the KSAs required to perform the job be so radically different that:

a. a new curriculum will have to be devised to impart the required KSAs;

b. once the KSAs have been mastered, the worker will be more productive and add more value to the firm's goods and services than his or her non-green counterpart; and

c. will the productivity gains (in terms of efficiency or value-added) warrant some sort of green wage premium, salary or bonus?[18]

Anderberg's suggested approach is appealing, and it has a parallel in the kind of benefit/cost assessment used by the Maine Public Utilities Commission to determine the cost effectiveness of an energy conservation measure. With regard to training and investment decisions, a possible baseline metric would focus primarily on various factors related to the jobs created. Quantifiable benefits would be compared to quantifiable costs. The quantifiable benefits would include

- Increase in earnings from new jobs
- Value of efficiency gains (energy savings)
- Value of reduced emissions
- Indirect multiplier effects related to the above.

The quantifiable costs would include:

- Decrease in earnings from jobs lost
- Training and other assistance costs
- Impact on energy delivery costs
- Indirect multiplier effects to the above.

[18] Marc Anderberg, *Op. cit.*, p. 21.

Along these lines, the American Council for an Energy-Efficient Economy (ACEEE) recently performed a study that attempted to quantify the benefits and costs of pursuing an energy conservation strategy in the State of Michigan. They conclude that "… cost-effective investments in the combination of energy efficiency and renewable energy generation technologies can actually reduce overall electricity costs, boost net employment, and reduce air pollutants within the state."[19] Without debating the merits of the ACEEE analysis[20], any strategy that reduces consumer costs, increases net employment and reduces greenhouse gas emissions is clearly a desirable path to pursue and to invest in. And, it is worthwhile to attempt to calculate the benefits and costs of a proposed strategy even if one can't do it precisely, because you can compare the relative merits (order-of-magnitude estimates) of different options based upon the same assumptions.

To calculate the economic effects of investments in particular industry sectors, there are a number of options. One is using the Bureau of Economic Analysis's RIMS II multipliers; another is using the IMPLAN or the REMI models; and, finally, some impact models (e.g., JEDI models) have been developed to allow the user to analyze the economic impact of constructing and operating power generation and biofuel plants. The Maine State Planning Office uses both RIMS II and the REMI model to develop economic impact analyses of changes in the Maine economy. Academic staff at the University of Southern Maine and the University of Maine have expertise in running the REMI model and the IMPLAN model, respectively.

Based upon an input-output framework for the U.S. economy, the BEA has developed a method for estimating regional I-O multipliers known as RIMS II (Regional Input-Output Modeling System).

> Using RIMS II for impact analysis has several advantages. RIMS II multipliers can be estimated for any region composed of one or more counties and for any industry, or group of industries, in the national I-O table. The accessibility of the main data sources for RIMS II keeps the cost of estimating regional multipliers relatively low. Empirical tests show that estimates based on relatively expensive surveys and RIMS II-based estimates are similar in magnitude.
>
> BEA's RIMS multipliers can be a cost-effective way for analysts to estimate the economic impacts of changes in a regional economy. However, it is important to keep in mind that, like all

[19] John A. "Skip" Laitner and Martin G. Kushler, More Jobs and Greater Total Wage Income: The Economic Benefits of an Efficiency-Led Clean Energy Strategy to Meet Growing Electricity Needs in Michigan, American Council for an Energy-Efficient Economy, Report E07X, December 2007, p. iv.

[20] This task is a difficult one to model. Very few energy/economy/environment models exist that are of sufficient scope and quality to capture the complex feedback relationships involved.

> economic impact models, RIMS provides approximate order-of-magnitude estimates of impacts. RIMS multipliers are best suited for estimating the impacts of small changes on a regional economy. For some applications, users may want to supplement RIMS estimates with information they gather from the region undergoing the potential change. [21]

Shown in Table 1 are RIMS II estimates for industrial segments in Maine for 2006. The **Final-demand Output** column indicates the total dollar change in output that occurs in all industries for each additional dollar of output delivered to final demand by the industry corresponding to the entry. The **Final-demand Earnings** column represents the total dollar change in earnings of households employed by all industries for each additional dollar of output delivered to final demand by the industry corresponding to the entry. The **Final-demand Employment** column identifies the total change in number of jobs that occurs in all industries for each additional one million dollars of output delivered to final demand by the industry corresponding to the entry. The **Direct-effect Employment** column represents the total change in number of jobs in all industries for each additional job in the industry corresponding to the entry.

[21] http://www.bea.gov/regional/rims/brfdesc.cfm

Table 1. RIMS II Multipliers for Maine

Based on 2006 U.S. Annual Input-Output Data and 2006 Regional Data

Industrial Segment	Final-demand Output	Final-demand Earnings	Final-demand Employment	Direct-effect Employment
	(dollars)	(dollars)	(# of jobs)	(# of jobs)
Crop and animal production	1.744	0.349	22.27	1.48
Forestry, fishing, and related activities	2.537	0.641	30.43	2.40
Mining, except oil and gas	1.452	0.306	7.73	2.20
Utilities	1.363	0.250	5.23	3.07
Construction	2.066	0.683	22.57	1.89
Wood product manufacturing	2.415	0.580	20.83	3.38
Nonmetallic mineral product manufacturing	1.909	0.475	13.77	2.45
Primary metal manufacturing	1.518	0.279	6.50	3.38
Fabricated metal product manufacturing	1.753	0.471	12.97	2.16
Machinery manufacturing	1.745	0.513	12.83	2.21
Computer and electronic product manufacturing	1.978	0.617	14.42	2.78
Electrical equipment and appliance manufacturing	1.715	0.424	10.50	2.56
Motor vehicle, body, trailer, and parts manufacturing	1.747	0.394	10.81	2.60
Other transportation equipment manufacturing	1.755	0.530	12.33	2.37
Furniture and related product manufacturing	2.029	0.541	18.52	2.07
Miscellaneous manufacturing	1.952	0.594	16.93	2.07
Food, beverage, and tobacco product manufacturing	1.919	0.394	12.74	3.28
Textile and textile product mills	1.870	0.433	12.92	2.43
Apparel, leather, and allied product manufacturing	1.928	0.526	16.15	2.13
Paper manufacturing	1.982	0.415	11.31	5.09
Printing and related support activities	2.026	0.577	17.47	2.03
Petroleum and coal products manufacturing	1.588	0.310	7.53	3.36
Chemical manufacturing	1.737	0.355	8.12	4.47
Plastics and rubber products manufacturing	1.667	0.363	10.03	2.42
Wholesale trade	1.812	0.562	15.15	2.13
Retail trade	1.840	0.572	24.50	1.50
Air transportation	1.651	0.418	11.91	2.41
Rail transportation	1.635	0.406	9.58	2.89
Water transportation	1.909	0.413	13.23	3.07
Truck transportation	2.003	0.606	18.64	2.13
Transit and ground passenger transportation	1.851	0.641	34.52	1.33
Pipeline transportation	1.521	0.246	6.11	6.23
Other transportation and support activities	1.870	0.777	21.14	1.73
Warehousing and storage	1.830	0.708	24.27	1.51
Publishing including software	1.840	0.515	16.39	1.94
Motion picture and sound recording industries	1.849	0.476	18.75	1.78
Broadcasting and telecommunications	1.786	0.358	9.29	3.53
Information and data processing services	1.871	0.492	15.30	2.31
Federal Reserve banks, credit intermediation and related services	1.591	0.440	12.15	1.97
Securities, commodity contracts, investments	2.019	0.739	22.49	1.81
Insurance carriers and related activities	2.218	0.614	15.11	2.93
Funds, trusts, and other financial vehicles	1.740	0.442	9.60	4.79
Real estate	1.431	0.170	7.79	2.08
Rental and leasing services and lessors of intangible assets	2.022	0.470	16.71	2.47
Professional, scientific, and technical services	1.989	0.717	20.93	1.93
Management of companies and enterprises	2.010	0.691	16.14	2.43
Administrative and support services	1.937	0.622	27.17	1.55
Waste management and remediation services	1.939	0.526	16.75	2.21
Educational services	2.038	0.759	31.74	1.48
Ambulatory health care services	1.976	0.752	19.99	1.96
Hospitals and nursing and residential care facilities	2.049	0.738	23.03	1.83
Social assistance	2.020	0.752	37.45	1.37
Performing arts, museums, and related activities	1.883	0.685	30.40	1.46
Amusements, gambling, and recreation	1.814	0.550	27.40	1.40
Accommodation	1.798	0.487	22.27	1.52
Food services and drinking places	1.899	0.522	29.06	1.39
Other services	1.944	0.575	23.46	1.66

The multipliers of most interest are those shown in the Final-demand Employment and Direct-effect Employment columns. For example, a one million dollar increase in the output in the Utilities segment can be expected to increase employment by 5.23 jobs, and each job created in the Utilities sector will result in creation of 3.07 jobs in the Maine economy. Comparing these order-of-magnitude estimates across segments gives us a sense of where investments would be most effective.

Many believe that the IMPLAN and the REMI models provide a better basis for calculating the economic impact of changes in the economy. The ACEEE used the IMPLAN[22] model in their Michigan analysis, and the National Renewable Energy Laboratory (NREL) has adopted IMPLAN estimates in developing their Job and Economic Development Impact, or JEDI, models.

The REMI model is a very, comprehensive economic model which has been successfully linked to energy and environment models. As its developers, Regional Economic Models, Inc., describe it,

> The REMI model is a dynamic forecasting and policy analysis tool that can be variously referred to as an econometric model, an input-output model, or even a computable general equilibrium model. In fact, REMI integrates several modeling approaches, incorporating the strengths of each methodology while overcoming its limitations. The result is a comprehensive model that answers "what if…?" questions about your economy.
>
> REMI models contain detailed industries. At its core, the REMI model incorporates the complete inter-industry relationships found in input-output models.
>
> REMI models are dynamic; they demonstrate economic changes over time, allowing firms and individuals to change their behavior in response to changing economic conditions. These responses are based in part on general equilibrium economic theory.
>
> REMI models are sometimes referred to as "econometric models," due to the underlying equations and response estimations using advanced statistical techniques.
>
> The spatial dimension of the economy is represented by the underlying "New Economic Geography" structure of the REMI model. This incorporates the productivity and competitiveness benefits due to the concentration, or agglomeration, of economic activity in cities and metropolitan areas, and to the clustering of industries.[23]

[22] http://implan.com/index.php?option=com_frontpage&Itemid=1

[23] http://www.remi.com/index.php?page=overview&hl=en_US

Using the REMI model one could examine the economic/demographic effects of economic events over time.

Another alternative would be to adapt economic models developed by various organizations to reflect Maine's situation. For example, the National Renewable Energy Laboratory (NREL) has developed some easy-to-use models that help analyze the economic impacts of constructing and operating power plants. The Job and Economic Development Impact, or JEDI, models[24] were first developed to model wind energy projects. NREL now offers models to analyze the job and economic impacts of biofuel plants and concentrating solar power, coal and natural gas power plants.

Options related to estimating the job and economic impact of energy conservation projects are more limited. While much effort has been expended on addressing the cost effectiveness of energy efficiency measures, relatively little attention has been focused on the jobs created. Previously we have mentioned the analysis performed by the American Council for an Energy-Efficient Economy for the State of Michigan. The ACEEE has indicated that they working on refining and documenting an economic impact model that has been used in various studies[25] – the Dynamic Energy Efficiency Policy Evaluation Routine, or DEEPER model.

In another recent study for the New England Clean Energy Council, Kevin Doyle (an independent consultant d/b/a "Green Economy") examined the workforce needs of the residential energy efficiency sector in Massachusetts. [26] Doyle reviewed the work practices of the Massachusetts Low Income Weatherization Assistance Program and the Massachusetts Residential Conservation Services Program. Together the two programs had a combined budget of about $86 million in 2008. Together they utilized 795 full-time equivalent employees (including subcontractors) in that year. That's roughly 9.2 full-time equivalent employees per million dollars of residential conservation spending. Assuming the RIMS II direct-effect employment multiplier of 1.89 (for the construction segment) would suggest that 17.4 total jobs will be created for each million dollars of expenditure. However, each million dollars of residential conservation spending has to come from somewhere (i.e., from a tax or a system benefit charge on

[24] http://www.nrel.gov/analysis/analysis_tools.html

[25] Most recently the ACEEE has completed an analysis for the State of Ohio: American Council for an Energy-Efficient Economy, *et al*., Shaping Ohio's Energy Future: Energy Efficiency Works, Report E092, March 2009.

[26] Kevin Doyle, Final Report of Investigation into Residential Energy Workforce Needs, New England Clean Energy Council, May 26, 2009.

utility bills). So the true gain in jobs created would have to be offset by the number of jobs that would have been created by the consumer spending that would have otherwise occurred. Looking at the RIMS II table for Maine, each million dollars of output growth in the retail segment results in an increase in employment of about 11.9 total jobs. Net of the jobs forgone, the net amount of jobs created associated with a million dollars of residential conservation spending would be about 5.5 jobs. To this result, one could add the value of reduced consumer energy costs and subtract the effect of lost revenue in the utility sector due to reduced demand for energy.

While the calculation of the avoided greenhouse gas (GHG) emissions associated with any economic initiative is relatively straightforward, valuing the reductions in dollar terms is more difficult. It may be sufficient to conclude that strategy A is better than B on the basis of carbon emissions. However, a net reduction in GHG emissions is neither a necessary, nor a sufficient, condition for pursuing a particular economic option – until we as a society have developed an agreed upon methodology for valuing the environmental benefits of the option. Carbon trading may present us with an acceptable metric for valuing such benefits in the future.

The immediate goal is to begin the process of counting and categorizing green jobs with the understanding that the clarity of the terrain will improve and the breadth of our definitions will become more precise. The adoption of an outcomes-based approach for evaluating competing initiatives is desirable. However, the ideal valuing process is not yet fully determined. Patience with the exactitude of the benefits and costs calculated should be encouraged.