

**APPENDIX J:
WORKER TRAINING AND BUSINESS RESEARCH INFRASTRUCTURE FOR
BIOFUEL INDUSTRY IN NEW YORK**

**RENEWABLE FUELS ROADMAP AND
SUSTAINABLE BIOMASS FEEDSTOCK SUPPLY FOR NEW YORK
Final Report**

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ABSTRACT

Appendix J examines two important components of a foundation for the eventual deployment of next generation biofuel production in New York State:

- (1) The worker training infrastructure
- (2) The capacity of New York State business and research institutions to provide knowledge, problem solving capacity, and business support services

Worker Training Infrastructure

This labor force training assessment focuses on three key questions:

1. What types of jobs will be created?
2. What job training programs are in place?
3. What steps are needed to ensure that a skilled labor force is available in New York State?

The economic impact analysis (Appendix I) estimates that the three scenarios addressed by the Renewable Fuel Roadmap (Roadmap) may result in approximately 3.8 to 14.2 thousand new jobs over a ten year period, but most will be in crop-based, forestry-based, and transportation (trucking) sectors, with a very small share of these jobs (about 275 to 1,320) in the refineries themselves.

This Appendix J identifies many job training programs already in place that are equipped to address the needs of next generation biofuel production for a trained labor force. Many of these programs are being managed to address changing needs of local bio-manufacturing employers. With adequate planning and affirmative steps to ensure that this training infrastructure is sustained and integrated with statewide efforts to support biofuel industry growth, these programs should be able to meet New York's labor force training needs. The ongoing efforts of the New York State (NYS) Department of Labor (DOL) and the New York State Energy Research and Development Authority (NYSERDA) aim to ensure that workforce training is available to support the expansion of a clean energy industry. These efforts will provide a foundation in state policy and workforce development programming that may ensure that this training infrastructure is sustained and well focused.¹

Business and Research Organization Infrastructure

Next generation cellulosic ethanol bio-refineries are not yet commercial. There are many scientific and engineering hurdles to be overcome and business development models to be created. This Section of Appendix J identifies:

¹ See The NYS DOL published report, New York State Clean Energy Industry: Labor Market and Workforce Intelligence (May 2009). It describes the efforts of the NYS DOL to prepare the state workforce to participate in growth of clean energy industry. That analysis identifies biofuel production among the potential new workforce employers and addresses general strategies to ensure that training programs effectively serve the needs of employers and workers.

- Existing businesses, research institutions, and programs that provide knowledge, problem solving capacity, and business support services a growing biofuel industry may need; and
- Steps New York may take to inform and encourage participation by industrial and research institution resources in the continuing Roadmap planning.

These many programs and institutions provide a foundation for biofuel industry research and business support. Their capacity to serve significant growth in biofuel production in New York would be enhanced by nurturing a research consortium that would focus specifically on issues posed by next generation biofuel industry deployment in New York and the Northeast.

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This section of Appendix J assesses New York’s existing capacity to address the labor force training challenges posed by the expansion of renewable fuel production considered in this Roadmap. The focus is on three key questions:

1. What types of jobs will be created, including jobs at new renewable fuel production facilities as well as jobs outside the plant in the surrounding communities doing work that provides products and services required by the fuel production facilities, e.g., feedstock production, processing and transportation?
2. What training programs are in place to address the needs of forecast growth in renewable fuel production in the immediate future and over the next 10 years?
3. What steps are needed to ensure that a skilled labor force is available, that local workers are qualified, to serve the projected increases in renewable fuel production in New York State?

“Biofuel operations might not bring many jobs, but they tend to pay well. And when the next generation of biofuels comes online, developed in conjunction with biopower, the payoff for states with nimble—and integrated—economic and workforce development programs can be enormous” (White et al., 2008, p. 34).

The expansion of biofuels production in New York State will require a skilled labor force and will provide the state workforce with employment opportunities. These labor force demands and opportunities arise from increases in research, forest industry jobs, and the reclamation of former agricultural lands that are currently idle; and later, in production facilities for second generation biofuels, ethanol from cellulose and biodiesel, and renewable diesel from alternative crops and feedstocks.

The challenge for labor force training is to ensure that a skilled labor force is successfully recruited and available to support any sought-for expansion of renewable fuel production as new job opportunities become available. Recruitment and training programs aim to synchronize training with the growth in workforce; imbalances frustrate workers unable to find employment for their new skills or employers seeking to staff facilities representing large capital investments.

1.1 WHAT KINDS OF JOBS WILL RENEWABLE FUELS GROWTH YIELD?

A recent report by the NYS DOL (2009) observes, “...the clean energy industry largely employs workers with the same skills as other related businesses; compete in the same labor markets; and are affected by the same labor supply/demand relationships. So while new occupational titles will emerge for the clean energy industry, the skills for the vast majority of these occupations will be very similar to existing job titles, with incremental skill enhancements specific to the industry”

The assessment of workforce training needs for the Roadmap reaches a similar conclusion. The next generation biofuel industry contemplated in the three scenarios considered by the Roadmap will generate a relatively small number of specialized new refinery jobs, the development of the new biofuel refineries will produce a much larger number of jobs in familiar occupations, primarily agriculture and forestry based feedstock production and processing, and transportation services required to transport feedstock products from field to refinery.

“We know that the average biofuel plant employs about 35 workers. Because of the economies of scale associated with ethanol and biodiesel production, increased capacity does not necessarily translate into job expansion. A plant can double its output without doubling its labor force. An ethanol plant that grows from 40 MGY to 100 MGY might grow from 35 to 50 workers. A biodiesel plant expanding from 4 MGY to 10 MGY could operate at the same general staffing levels—12—with some anticipated additions to marketing personnel.

Biofuels jobs look much like traditional jobs in chemical manufacturing. Typical occupations, which range from truck drivers and shipping clerks to chemical technicians and electronics repairers, are outlined in the Jobs-At-A-Glance [Figure J-1]

Beyond direct production—and this is where the numbers get funny—jobs multipliers have run amok. Inaccurate use of input-output models have inflated job creation numbers. Reputable studies have now demonstrated that the biofuel industry jobs multiplier is a modest three to four, rather than the 18-51 claimed by a variety of promoters across the Midwest. This means that as plants pull in capital goods and feedstocks, and workers and investors spend their wages and dividends, three or four additional jobs may be generated in the local economy for every direct job created at the plant. The good news is that local ownership increases the biofuel jobs multiplier” (White et al., 2008).

Training serves the dual objectives of ensuring that sought-for renewable fuels expansion is not hindered by labor shortages and ensuring that the local labor force has the skills required to take advantage of the job opportunities growth the renewable fuels industry may create.

1.1.1 Job Impacts

Biofuel production facilities require relatively few workers to operate once the production facility has been constructed and put into operation. A commercial scale grain ethanol plant (i.e., a plant producing 50 million gallons of biofuel per year) will employ about 35 to 40 full time workers. The operation of such a plant will involve fuel production, processing and transport and other services from the local economy that may account for as many as 200 jobs near the plant, largely in such activities as feedstock production, processing and transportation. Doubling the capacity of this plant 100 million gallons per year, however, may only increase the plant employment to 45 to 60 workers, less than a one-third increase (Swenson et al. 2006).

During grain ethanol’s rapid expansion through 2007 only three to five plants were expected to be built in New York. At best the high end for job creation for grain ethanol plants then would have been 1,000 to 1,250 jobs. In 2009 only one commercial scale ethanol plant was operating in New York.

The economic impact analysis prepared for this Roadmap (Appendix I) projects the jobs² that may result from expansion of biofuel production for each of the three Roadmap scenarios. The economic analysis of the three Roadmap scenarios finds that the potential for “job growth exists in the New York economy for direct ethanol processing jobs as well as the production and transport of biomass feedstocks,” meaning both jobs at the refineries themselves as well as indirect jobs (Swenson 2009).

The analysis projects:

- Direct employment in biofuel production plants (refineries);
- Direct employment in the local businesses that provide goods and services purchased by the biofuel production plants;
- Employment that will result from workers spending their income on goods and services (indirect jobs); and
- Employment that will result from biofuel plant investors spending some of their income on goods and services (indirect jobs).

Table J-1. Summary of the Statewide Job Impact Estimates.

	Scenario # 1 (jobs)	Scenario #2 (jobs)	Scenario #3 (jobs)
Refinery Jobs	275	798	1,320
Sum of Refinery Inputs	3,341	12,880	11,552
Refinery Worker Spending Impacts	130	389	644
Direct Investment Income Impacts	147	536	673
Total – All Impacts	3,891	14,604	14,189

Note: The economic analysis provided estimates of job impacts for two assumptions about fuel prices: first, assuming that fuel prices remain approximately the level in real terms for the next ten years; and second, assuming that fuel prices jump significantly during the next ten years. The economic impact analysis explores these two assumptions. This job training assessment does not get into the details of these two assumptions because the range of job creation impacts is encompassed by the three scenarios for the base case level price assumptions. See Appendix I to observe how the assumptions impact each of the three Roadmap scenarios.

This assessment of the job training resources needed to support biofuel production focuses on the refinery jobs and the jobs in business providing goods and services to the refinery. These are the jobs that must be

² The Appendix I economic analysis estimates the number of job positions that are created. Jobs are the number of positions that are involved in some type of industrial activity expressed on an annualized basis. Jobs are not, however, expressed as Full Time Equivalents. For example a seasonal farm job is a job, as is a full-time factory job producing ethanol.

filled by productive workers if this expansion of renewable fuel production is to occur unimpeded by shortages of trained workers. The additional jobs induced by spending of refinery workers and plant investors provide an important stimulus for the local economy; however, this analysis assumes they are not essential for the orderly expansion of biofuel production. About 40 % of the jobs in the non-refinery categories identified in Table J-1 and Table J-2 are induced jobs and, therefore, may not be the primary concern of biofuel-focused job training programs (Swenson 2009).

1.1.2 Direct employment at biofuel refineries

A biofuel production plant will require a relatively small number of highly skilled production engineers and a larger number of workers who will operate and maintain the plant with skills that may be obtained through on-the-job training or from local post-secondary training programs that adapt their curriculum to the current needs of the local economy. The Roadmap base case Scenario 1 analysis examined refineries with about 90 MGY capacity that employ about 70 workers each; Scenario 2 addressed 12 refineries (at four locations) with about 110 MGY capacity that would employ an average of about 66 workers each; and Scenario 3 addressed a relatively large number (22-24) smaller distributed refineries, each with about 60 MGY capacity and each employing about 60 workers.

A study using U.S. Bureau of Labor Statistics data noted biofuels industry jobs are very similar to traditional chemical manufacturing jobs with respect to skills required and wages (White and Walsh 2008). Figure J-1 shows biofuels jobs, skills and median wages at a glance.

Figure J-1. Training, Jobs and Median Wages for Biofuel Refineries At-a-Glance (Adapted with permission from *Greener Pathways: Jobs and Workforce Development in the Clean Energy Economy, (2008), S. White and J. Walsh. Center on Wisconsin Strategy (COWS).*

New York Resources for Training & Research	Education & Training	Workplace & Career	Typical Jobs & Wages
NY Community Colleges and Universities with focus in bio-manufacturing programs	Advanced Postgraduate Education	Technical Professional & Managerial Jobs	Work experience in related occupation Sales representatives, wholesale & manufacturing, technical & scientific products (\$71K)
State University of New York Colleges and Universities with focus on Renewable Energy, Environmental Sciences, Resource Economics, Forestry, Agriculture, Sustainability, Biofuels Research, Advanced Biomedical & Bioengineering, Life Sciences, Equipment/machinery Design Theory and Repair, Education, Economic Development and Extension programs	4-year Baccalaureate Applied Associate Degree		Long-term on-the-job training (1-5 y apprenticeships) Chemical plant and system operators (\$51K)
Private Colleges and Universities in New York with focus on manufacturing studies, energy systems research, biotechnology, liquid biofuels, environmental impacts, economics, bioengineering, chemical engineering	1 or 2-year Technical Diploma	Entry-level Technician Jobs	Associate Degree Chemical technicians (\$46K) Postsecondary Vocational Award Electrical and electronics repairers, commercial & industrial equipment \$47K)
NY Boards of Cooperative Educational Services (BOCES)	Short-term Occupation/Industry Certificate	Entry-level Skilled Jobs	Moderate-term on-the-job training (1-12 months) Chemical equipment operators & tenders (\$43K) Truck drivers, heavy & tractor-trailer (\$40K) Separating, filtering, clarifying, precipitating & still machine setters, operators & tenders (\$38K) Mixing & blending, machine setters, operators & tenders (\$31K)
NYSTAR Centers for Advanced Technology	Secondary Level Adult Basic Education (ABE) English Language Learners (ELL)	Semi-Skilled Jobs	
New York State Energy Research & Development Authority	Vocational- Workplace Basics Adult Basic Education English Language Learners		Short-term on-the-job training Shipping & receiving, traffic clerks (\$32K) Laborers & freight, stock & material movers, hand (\$27K)
New York business and trade associations with focus on renewable energy (Renewable Energy Network of Entrepreneurs in Western NY, New York Biotechnology Association, Environmental Business Association of New York State (EBA-NYS))	Intensive Work Readiness and Support	Jobs not requiring previous training or specific skills	

The anticipated emergence of the cellulose ethanol industry in New York State will employ additional workers as plants are constructed and begin operations. Jobs in biofuel production refineries represent a relatively small share of the total job impact, less than 10%, projected by the Appendix I economic analysis. Table J-1., which summarizes the job impact estimates from the Roadmap economic analysis presented in Appendix I, indicates that statewide biofuel refinery employment may range from 275 to 1,320 jobs by 2020. While not significant perhaps, on a statewide basis, these jobs are likely to be concentrated in rural areas of the state and provide well-paying sustained jobs.³

In addition, two sectors, forestry and agriculture, areas that have been in decline, will be called upon to produce and process the cellulose-based feedstocks. This increase in feedstock production demand from New York biofuel plants will require workers skilled in cellulose feedstock production and processing. The Appendix I economic impact analysis indicates about half of all jobs created by refinery expansion in the three Roadmap scenarios will be crop or forestry based feedstock production and processing. Another quarter of the jobs will be involved in trucking the agriculture and forestry feedstocks to the new refineries. Table J-2 summarizes the statewide estimates of total (direct and indirect) input job growth by business sector for each Roadmap scenario.

³ Unlike construction jobs and even some agricultural and forestry jobs that often go through “boom bust” cycles, biofuel plants will supply stable jobs that are year-round and will last for many years.

Table J-2. Estimates of Jobs Created by Biofuel Refinery Growth, Statewide.

Job Sector	Scenario #1	Scenario #2	Scenario #3
Crop based	656	3,464	3,690
Forest based	1,019	3,061	3,269
Agriculture and Forestry based	1,675 (43%)	6,525 (45%)	6,959 (49%)
Transport to refinery	886	3,744	1,765
Transport from refinery	26	86	99
Transportation based	912 (23%)	3,830 (26%)	1,864 (13%)
Materials and machinery	26	81	104
Business Services	26	79	168
Insurance	82	251	323
Waste disposal	110	336	411
Water	27	83	101
Enzymes	58	177	217
Chemicals	55	170	207
Financing	369	1,348	1,196
Subtotal – Input Sector Jobs	3,340 (86%)	12,880 (88%)	11,550 (82%)
Direct jobs at the refinery	275 (7%)	798 (6%)	1,320 (9%)
All induced jobs due to direct worker and investor spending	276 (7%)	925 (6%)	1,317 (9%)
Total Jobs	3,891 (100%)	14,604 (100%)	14,189 (100%)

Estimates include direct and induced job growth resulting from biofuel refinery expansion

Source: Working papers from Roadmap Economic Analysis, Appendix I (Swenson, 2009)

The emerging biorefineries are likely to create jobs for plumbers, electricians, plant operations, and process engineering. Employment opportunities for such common general trades already exist and have well developed recruitments training programs. What will be necessary is for workforce training boards, unions, and other professionals engaged in workforce development to begin to identify specialty requirements of the industry and to work to incorporate this training into existing training programs.

Workforce training may be segmented into jobs in the bio-refinery, and “upstream” jobs that will be created in feedstock supply. Some limited expansion of “downstream” jobs may occur in transport, storage, and

blending, but these jobs will be limited and will likely be absorbed by the petroleum industry. The good news is that much of that training infrastructure is in place. Historically many of these training needs have been provided by colleges/community colleges/BOCES/labor unions/cooperative extension.

Next generation cellulosic feedstock to biofuel plants will require some new specialized jobs related to the processing of cellulose, fats, oils, and lipids. Process engineering bio-refinery operations will, for example, require a background in and a thorough understanding of transesterification, fermentation, and the processing of enzymes. Only a few of the jobs in each new bio-refinery will require specialized training. Therefore, the need to provide highly specialized workforce training will be limited because the number of job opportunities requiring highly specialized training is likely to be quite limited.

Specialized training programs need to be coordinated very closely with the industry. Lessons can be taken from the biotechnology industry. This experience provides useful lessons. For example:

- Keep the degree programs more general and the specific training open to students and to people currently working in the industry.
- Use of adjunct professors from the industry, seminars, evening and weekend courses vs. courses that are part of a specific degree program are better suited for this training.

Second generation biofuels plants will result in increased demand for biomass feedstocks. That increased demand will have an impact on job creation in agriculture and forestry. This will require additional specialized training needs and create additional new jobs in agriculture and forestry.

The increased demand for woody biomass from forests will require a new generation of forest industry workers. In addition to training, a significant outreach effort will be required to attract new workers. The current logging industry is characterized by an aging workforce and an overall loss of loggers. Some of the loss in the workforce is being made up through mechanization of logging. However the added volume of forest woody biomass that would be expected for an expanding biofuels industry will require an increase in trained loggers⁴ and wood procurement specialists.

Agriculture will also be a significant producer of future woody and herbaceous perennial crops for bio-refineries. Growing and harvesting perennial energy crops may not be significantly different from growing forage but the upstream and downstream support for farmers will result in new jobs and training requirements. Upstream jobs would include nurseryman and seed producers. Downstream jobs would be provided by feedstock integrators and specialized harvesting operations.

The “refinery jobs” cited above result directly from the expansion of biofuel production contemplated by the three Roadmap scenarios. Employment in the other job categories, however, includes job impacts

⁴ There is likely to be a significant change in the way wood is harvested for a biofuel refinery vs. timber. The term logger may not accurately describe the future employees engaged in woody biomass procurement.

induced by expanded economic activity related to biofuel plant construction and operation. David Swenson, the author of the input-output based economic analysis of these Roadmap scenarios, observes, “... the total jobs, for example, in crop or forest-based systems include the on-the-farm or forest-based direct jobs plus all input jobs to that farm or forest operation, plus all induced jobs that would have resulted.” (Swenson 2009) About 60 % of the estimated jobs in the other three categories (i.e., Sum of Refinery Inputs, Refinery Worker Spending Impacts, and Direct Investment Income Impacts) are direct jobs; the remaining 40% are indirect jobs, induced by the expenditures of workers, and investors.

Because the Roadmap scenarios assume that feedstock production will not displace existing farm or forestry production, all the jobs associated with feedstock production are new jobs. They do not involve redirecting forestry or farm workers from producing a current crop to producing biofuel feedstock (e.g., switching land now used to grow corn for animal feed, to growing switchgrass for biofuel feedstock). Non-refinery job impacts from biofuel production will be reduced if this assumption does not prevail. It is reasonable to assume that if job training resources are adequate to meet the job growth outlined in Appendix I, these programs should be able to serve slower job growth as well.

1.2 WHAT TRAINING PROGRAMS ARE IN PLACE TO ADDRESS LABOR FORCE DEVELOPMENT NEEDS?

There are already in place a significant number of biotechnology focused training programs in New York State. Currently these programs focus largely on preparing people for employment in the biopharmaceutical industry, not biofuel production. The largest recent growth in biotechnology employment has been in the pharmaceutical industry. Biofuel production is relatively new to New York State and has so far been responsible for relatively few jobs. There are now only two commercial biofuel refineries operating in New York State, one ethanol and one biodiesel, and only a few more being planned.

One of the strengths of existing biotechnology training programs is their links to employers, links that ensure that the training effectively prepares workers for the jobs employers need to fill.

New York State energy and economic development planning is already focused on the benefits to New York of tapping projected growth trends for renewable energy and other clean energy based business. The NYS DOL has tapped funds provided by the federal Workforce Investment Act to provide a One-Stop Career Center system. New York’s One-Stop Career Center system includes 33 Local Workforce Investment Areas, each administered by a Local Workforce Investment Board. This program provides resources and links to New York’s energy planning tying together the separate workforce training programs of many of the programs cited here. Further, Empire State Development includes workforce training grants in its portfolio of tools it may use to attract clean energy industries to New York (Energy Cost and Economic Development Brief 2009). While not now focused specifically on biofuel production, these state programs provide resources that may support biofuel technology workforce training programs and provide

planning and program coordination among separate workforce training efforts to ensure that available resources are used effectively.

While biofuel production remains small, colleges, universities, and technical training programs have already focused on preparing the workforce for employment opportunities in emerging biotechnology industries.

Finger Lakes Community College serves as one of the six regional host sites for the Northeast Bio-manufacturing Center and Collaborative (NBC2). The NBC2 is multi-state regional alliance of community colleges that works in collaboration with industry, education and government organizations to prepare the workforce for work opportunities in biomanufacturing (www.biomanufacturing.org). In New York, this regional alliance includes the following community colleges and university programs:

- Erie Community College (Buffalo)
- Finger Lakes Community College (Canandaigua)
- Genesee Community College (Batavia)
- Hudson Valley Community College (Troy)
- Jamestown Community College (Jamestown)
- Onondaga Community College (Syracuse)
- Monroe Community College (Rochester)
- Tompkins-Cortland Community College (Dreyden)
- Cornell University – Center for Life Sciences Enterprise
- Rochester Institute of Technology

The NBC2 programs focus primarily on biopharmaceutical industry needs but these programs involve core skills training that can be adapted to the needs of biofuel manufacturing as this industry expands.

In the last two or three years the NBC2 has recognized a need to support the “cross over” from traditional biopharmaceutical to biofuels. The New York State Foundation for Science, Technology and Innovation (NYSTAR) was the first to recognize that the various groups involved in biofuels development in New York were acting as separate entities and not working together. NYSTAR brought Finger Lakes CC, RIT, and Cornell University together.

NBC2 can now be more responsive to requests from the biofuels industry. The NBC2’s infrastructure is able to ramp-up quickly (one year) to have training programs in place. This is the result of already having developed the materials and training methods generated by partners FLCC, RIT and Iowa Biodevelopment.

The Roadmap process will be important to NBC2. What the NBC2 needs to know is what types of jobs will be created, how fast, and where the industry will expand. Then the NBC2 will know how many training locations will be required and if they need to be at universities or colleges.

The traditional biopharmaceutical industry is slowing down in Northeast. There are already trained people working in and outside the biopharmaceutical industry in New York that could fill new biofuels jobs with only some retraining. The specific training that would be required for jobs in the biofuels industry is only a small component of the overall training required to work in the bio-manufacturing sector, biofuels included. Establishing the “manufacturing mentality” is 90% of the job training, only 10% would be specific to biofuels. People that are already coming out of a manufacturing background would therefore need little training. A qualified workforce is a large advantage for New York in attracting biofuels manufacturers (Hewlett 2009; Merrill 2009).

Following are examples of selected training programs that already exist in New York State that may be well equipped to address the job training needs that will accompany any expansion of biofuel production capacity in New York State.

Cornell University’s Department of Biological and Environmental Engineering (BEE) in the College of Agriculture and Life Sciences, has established a master's of engineering program focused on biofuels in response to an expected increase in demand for trained biofuel engineers. Graduate study in BEE covers a broad range of topics including fermentation system design, enzyme technology, and genetic engineering as applied to food processing; enzymes, microorganisms, and plants as active components of bio-industries; management of soil and water resources; and sustainable development.

The State University of New York College of Environmental Science and Forestry (SUNY ESF) now offers both a degree program in bioprocess engineering (<http://www.esf.edu/pbe/bpe/default.htm>) and a minor in renewable energy.

The SUNY ESF Bioprocess Engineering program seeks to train engineers who will work in the emerging bio-processing and biofuels industry to produce energy and related chemical products from renewable resources. Students in this program master a variety of subjects that are normally found in a chemical engineering program, and supplement those studies with advanced courses specific to bioprocess engineering. The program focuses on the use of wood and other renewable biomass materials to replace petroleum in energy and industrial product applications. Examples of this technology include the bio-processing of ethanol, acetic acid, polymers, and other chemicals that have traditionally been produced from fossil fuels such as oil, coal, and natural gas.

In the past both traditional and renewable energy sources have been studied one resource at a time and usually from the perspective of a single discipline. The SUNY ESF minor in renewable energy will provide students an opportunity to examine different sources of traditional and renewable energy simultaneously in the context of our total energy use using a systems perspective. This minor will be interdisciplinary in nature with instructors from different disciplines teaching the core courses. The Renewable Energy minor is available to all ESF undergraduate students.

The Workforce Investment Board (WIB) of Herkimer, Madison, and Oneida Counties Inc. has partnered with the State University at Morrisville, Herkimer County Board of Cooperative Educational Services (BOCES), Cornell Cooperative Extension of Oneida County, Mohawk Valley EDGE, and the Chamber Alliance of the Mohawk Valley, The WIB is currently working on assessing the skills needed at all stages of the biofuels energy system so that training can be developed at the appropriate levels to meet the existing and projected demand;

- Assessing the K-12 schools and vocational training through BOCES that will be required to develop renewable energy workers for the future;
- Increasing connections between the workforce education system and agribusiness to develop skills training necessary to increase economic opportunity in biofuels; and
- Developing career path maps for the biofuels industry.

Rochester Institute of Technology (RIT) has been in the biotechnology business for 20 years. In 1983 it became the first college in New York to offer a biotechnology degree. Today RIT has several programs that could aid an emerging second generation biofuels industry. The Biotechnology Program is a flexible program keyed to needs of employers that can adapt as the biofuel industry expands. The RIT programs are designed by communicating extensively with the industries for which students are being trained to serve. The industry employers have partnered with RIT in developing training program curricula.

Morrisville State College (State University of New York College at Morrisville) has launched a program focused on developing training programs to support expansion of the biofuel production industry. Morrisville State College hosts the New York Center for Liquid Biofuels in Cortland County and the Renewable Energy Training Center and operates an Educational Opportunity Center in Onondaga County and a branch campus in Chenango County.

Morrisville State College Renewable Energy Training Center is undertaking skills mapping to determine the skills needed at all stages of the biofuels production and delivery system. The skills mapping will support the development of academic courses and a new A.A.S. degree program in Renewable Energy Technology, as well as technical training programs that effectively match the skills needs of an expanding biofuels industry. The Morrisville State College assessment will address the market needs of private sector firms as well as opportunities emerging for the region's public colleges.

(www.morrisville.edu/alternativeenergy/biodiesel.aspx and <http://retc.morrisville.edu>)

Workforce training programs like those offered through Morrisville's Renewable Energy Training Center ensure that shortages of skilled workers do not impede the development of the renewable fuels industry. These training programs ensure that the local labor force has access to the training needed to compete for emerging job opportunities (Ballard et al. 2009).

1.3 WHAT STEPS ARE NEEDED TO ENSURE THAT A SKILLED LABOR FORCE IS AVAILABLE?

New York State has a strong base of workforce training programs that, if sustained, should have little difficulty meeting the needs of the new biofuel production operations in New York contemplated by the Roadmap.

Current workforce programs provide a solid foundation for the expansion of existing grain to ethanol and biodiesel production. These programs, if sustained, will provide New York with the training resources needed to meet the workforce training requirements of a future cellulose-to-ethanol industry.

The One-Stop Career Center Program supported by the NYS DOL may be positioned to provide the leadership and coordination needed to sustain the existing workforce training infrastructure and to link it to statewide energy planning for biofuel industry expansion in New York.

1.3.1 Findings

- There will be job creation but the training requirements can be met through existing programs. Job creation modeling conducted for this Roadmap indicates that while approximately 3.8 to 14.2 thousand jobs may be created over a ten year period, most will be in crop based, forestry based, and transportation (trucking) sectors, with a very small share of these jobs, about 275 to 1,320, in the refineries themselves. Existing job training infrastructure should be able to serve this growth. While job growth may be “lumpy” as new projects are deployed with adequate planning existing training programs should be able to address training needs. It will be important that job training programs are timed to meet the needs for new employees to ensure that expansion of a state biofuel industry is not impeded by lack of trained workers. At the same time people entering these training programs and post secondary curricula, should have a reasonable expectation that jobs will be available.
- Expansion of “Upstream” jobs in agriculture and forestry will require recruitment and retention programs since these sectors are currently losing workers. In addition new skills related to agricultural and forestry practice and technology will need to be addressed.
- Although New York has an established training infrastructure, planning is required to define the specialized training needs required to provide a productive labor force for “second generation” biofuel plant technology.
- New York State’s college and university biotechnology programs are establishing valuable collaborative relationships with the state’s emerging biofuel industry that may play an important role in ensuring that their programs, especially their education programs, relate effectively to the needs of the emerging biofuel production industry.

NYSERDA is a principal sponsor of the National Conference on Renewable Energy and Energy Efficiency Education held annually.⁵ This conference is co-sponsored by the U.S. Department of Energy and the NYS DOL. This conference provides a continuing opportunity to assemble and coordinate biofuel-focused training programs in New York State and the Northeast.

1.3.2 Sustaining an Effective Biofuel Training Infrastructure in New York

New York's robust training infrastructure can meet the challenge of an expanding biofuel production industry if it has the information and resources to keep in step with the pace of biofuel industry growth. Following are steps that should be investigated to ensure that this happens.

- Discussions with individuals engaged in New York's bio-manufacturing and biofuel training suggest that it would be productive to convene meetings regularly, perhaps annually, of biofuel stakeholders including state agencies such as NYSERDA and the New York State Economic Development Corporation. The current annual workforce conference program may provide an opportune venue to initiate such regular meetings. Such meetings may address projected estimates of workforce requirements and the capacity of training programs to serve those needs. These meetings will help to ensure industry employers contribute to the training capacity assessment and to advise what changes in training may be needed to ensure that training programs provide the specific skills required by the workers they will employ.
- Workforce training and retention incentives for the agriculture and forestry sectors should be explored. Training incentives serve two functions: (1) to encourage employers to provide on-the-job training to new employees to develop their skills, for example in the operation of the heavy equipment these industries use, and (2) to provide support for the salaries of new, recently trained workers to ensure that they do not defect to employment opportunities in other industries after training.
- College and university biotechnology programs should be encouraged to establish collaborative relationships with the New York's emerging biofuel industry to ensure that their programs, especially their education programs, relate effectively to the needs of the emerging biofuel production industry. Colleges and universities should investigate opportunities
 - to hire adjunct professors directly from the biofuels industry and
 - to develop in-service training or certificate programs in addition to or in place of specialized biofuel degree programs
- The possibility of creating a single core resource center through which all training materials flow, and through which all human resource needs are addressed should be investigated. Other states

⁵ NYSERDA is a principal sponsor of the National Conference on Renewable Energy and Energy Efficiency Education held annually. The third annual conference will be held November 18-20, 2009 in Albany, NY. This conference is co-sponsored by the U.S. Department of Energy and the NYS Department of Labor. For more information see: http://www.nyserda.org/Press_Releases/2009/PressReleas20091709_1.asp.

such as Massachusetts and New Jersey have such core centers. A single core resource center would contribute to efforts to attract biotechnology companies to New York by providing industry with a single location that can address all workforce development needs. Having a single core resource center with a single point of contact would strengthen New York's ability to attract new biorefinery developers.

2 CURRENT INDUSTRIAL AND RESEARCH BASE FOR BIOFUEL INDUSTRY

Following up on the assessment of biofuel training capacity in the previous Section J.1, this section of Appendix J examines the current industrial and research base that may serve a new biofuel industry in New York.

Next generation cellulosic ethanol bio-refineries are not yet commercial. There are many scientific and engineering hurdles to be overcome and business development models to be created. This Section of Appendix J identifies:

- Existing businesses, research institutions, and programs that provide knowledge, problem solving capacity, and business support services a growing biofuel industry may need; and
- Steps New York may take to inform and encourage participation by industrial and research institution resources in the continuing Roadmap planning.

New York has significant intellectual resources and state of the art research facilities, identified below. These institutions provide a valuable resource base that should be used to achieve Roadmap objectives. Following is a list of university, college, government, and business supported research institutions whose work is building a foundation of knowledge and expertise, which may support efforts to develop a strategy to meet New York State's economic and environmental goals for renewable fuels during the next decade and beyond. This list is neither exhaustive nor does it describe all the biofuel-relevant work these institutions are carrying out. This list provides a starting point for organizing the community of such research institutions to serve the Roadmap goals.

2.1 INDUSTRY AND RESEARCH INSTITUTIONS IN NEW YORK STATE

Biofuels Research and Development Enhancement Act (H.R. 2773) established the Bioresearch Centers for Systems Biology Program. The Bioresearch Center program established at least five regionally located centers. The centers authorized in this bill are to include those already established by the Secretary of Energy and are not to be in addition to already established centers. With centers already being established in three of the nation's five Petroleum Administration for Defense Districts (PADDs), the committee expects that the next two centers to be established would be in the PADDs without an established center. This would result in a total of at least five regionally distributed centers. New York is a part of PADD 1 – East Coast.

Center for Integrated Manufacturing Studies (CIMS) – Rochester Institute of Technology.

The mission of CIMS is “... to increase the competitiveness of manufacturers through applied technology and training. CIMS represents a dynamic collaboration of in-house technical experts, as well as academic, industry and government resources.” (<http://www.cims.rit.edu/mission.aspx>)

Clarkson University

Is conducting research ranging from the conversion of biomass to fuels using thermo-chemical and biological means, such as biocatalytic microreactors, to sociology research to investigate the cause of farmers’ reluctance to adopt new energy technologies, such as anaerobic digestion, even when they provide economic benefits. Collaborations with area farmers and Cool Brands, Inc., a local dairy processing plant, have been established to transfer research results to energy consumers/generators.

Cooperative State Research, Education, and Extension Service (CSREES) works in partnership with the land-grant university system, other colleges and universities, and public and private research and education organizations to initiate and develop agricultural research, extension, higher education, and related international activities to advance knowledge for agriculture, the environment, human health and well-being, and communities. FFY budget \$1 billion.

Cornell University

Cornell’s Biofuels Research Laboratory serves as the hub of Cornell’s research and development of sustainable and economical biofuels derived from nonfood crops. The new lab moves Cornell to the forefront of renewable energy research and is the centerpiece of the university’s work on cellulosic biofuel and bioproducts. According to Cornell the goal of the laboratory is to develop renewable energy sources that will stimulate opportunities for New York agriculture. Five separate labs are equipped to focus on different aspects of biofuels research, including two growth chambers for specialty plants. Researchers are working to overcome the physical, chemical and biological barriers to liberating sugars from such alternative energy crops as switchgrass, biomass sorghum and other perennial grasses as well as woody biomass, and to biologically convert these sugars into such biofuels as ethanol, butanol or hydrogen.

(www.news.cornell.edu/stories/March08/biofuels.lab.lm.html)

Cornell Agriculture and Life Sciences (CALS) Bioenergy Feedstock Project.

“The CALS Bioenergy Feedstock Project is part of a multi-disciplinary renewable energy research effort supported by Cornell University, the College of Agriculture and Life Sciences, the New York Farm Viability Institute (NYFVI), the Northern New York Agricultural Development Program (NNYADP), and other public and private institutions.” The program has gathered a multidisciplinary team of scientists, engineers, economists, and educators to:

- Work on a “systems approach,” addressing the current challenges in the development of cellulosic ethanol and associated bio-based industries;

- Examine how to overcome the physical, chemical and biological barriers to liberating sugars from energy crops such as switchgrass, cold tolerant sorghum, and woody biomass;
- Develop methods of biologically converting these sugars from energy crops into biofuels such as ethanol, butanol, hydrogen, and methane.

(www.cals.cornell.edu/cals/upload/Cornell-CALSGrandChallenge.pdf)

Northeast Sun Grant Initiative (centered at Cornell University)

“The Sun Grant Research Initiative Act of 2003 advances the research, development and implementation of bioenergy and bioproducts technologies in the United States. The Sun Grant Research Initiative Act of 2003 was introduced to the U.S. Congress by Senator T. Daschle (SD) and Senator W. Frist (TN) and was first authorized under Title IX, Section 9011 of the Farm Security and Rural Investment Act of 2002. The U.S. Department of Agriculture has provided annual planning grant funds from 2002 to the present to the five Regional Sun Grant Centers of Excellence. In the Northeast Region, these funds have been used to identify and build a consensus on research, education and outreach priorities for the region.”

(<http://www.nesungrant.cornell.edu/cals/sungrant/difference/index.cfm>)

Morrisville State College

Morrisville State College and its research partner, Empire AgriFuel, LLC, plans to construct an oilseed crushing and "green" biofuel blending facility in Cortlandville, NY. The crushing plant will initially be capable of handling up to 200 tons per day, or approximately 2.4 million bushels of soy and or canola per year, and produce 5 million gallons of clean, "green" biodiesel. Groundbreaking research in the use of biofuels in locomotive transportation will be conducted as well as in biodiesel use and production, including emissions, stability, performance and options for by-products. Through collaboration with the New York Susquehanna and Western Railroad, the center also plans to establish a research facility in Binghamton, NY.

New York Biotechnology Association

The New York Biotechnology Association is a not-for-profit trade association dedicated to the development and growth of New York State-based biotechnology-related industries and institutions and to strengthening the competitiveness of New York State as a premier global location for biotechnology/biomedical research, education, and industry. (<http://www.nyba.org/>)

National Institute of Sustainable Energy (NISE)

In partnership with Einhorn Yaffee Prescott - Architecture and Engineering, The Energy and Environmental Technology Applications Center (E2TAC) at the State University of New York at Albany is home to the NISE, which oversees joint R&D, workforce training, business advancement, and commercialization programs in sustainability and zero energy technologies. Activities include building information modeling, energy modeling, system monitoring and control, and sustainable new energy technology demonstrations such as an on-site energy test farm.

New York State Foundation for Science Technology and Innovation (NYSTAR)

NYSTAR funds a series of 15 Centers for Advanced Technology (CATs) charged to conduct applied research in close partnership with New York State companies. Each center is funded at \$1 million per year, and several will make grants available to faculty outside the home university provided they bring a matching partner. Several CATs with bioscience focus were renewed for 10 years after a recent program review:

- **Center for Life Science Enterprise** at Cornell, which integrates this originally agriculture biotech-oriented program into a larger Institute for Biotechnology and Life Sciences
- **Center for Advanced Biomedical and Bioengineering Technologies**, a medical-device-oriented center at the University at Buffalo

NYSTAR has also published a summary of cellulosic ethanol research expertise at colleges, universities, and laboratories throughout New York that provides additional information on many of the research organizations identified in this Appendix (NYSTAR 2009).

Polytechnic University

Polytechnic researchers have bioengineered a fuel-latent plastic that can be easily converted into biodiesel. The next phase of the research will entail engineering more efficient, low-cost processes for manufacturing the bioplastic and converting it into biodiesel. Economic generation of biodiesel, and onsite conversion into fuel is an important step in developing this green technology and reducing waste.

Rensselaer Polytechnic Institute (RPI) – Center for Biotechnology & Interdisciplinary Studies

The Center is home to the new Gen*NY*sis Center for Bioengineering and Medicine funded by New York State. In addition, Rensselaer has received \$750,000 in federal funding to support the creation of a new **Center for Quantitative and Computational Bioscience** to be housed at RPI.

(www.rpi.edu/research/biotech/index.html) The Gen*NY*sis grant will support essential infrastructure for the Center for Biotechnology and Interdisciplinary Studies.

([http://news.rpi.edu/update.do?artcenterkey=334&setappvar=page\(1\)](http://news.rpi.edu/update.do?artcenterkey=334&setappvar=page(1)))

Rensselaer Polytechnic Institute Center for Future Energy Systems Research

The new Center for Future Energy Systems will focus on renewable energy and energy conservation systems, with an initial emphasis on fuel cells and the hydrogen economy, smart lighting, smart displays, and emerging renewable energy systems. Future research priorities will track new scientific developments and marketplace opportunities.

State University of New York College of Environmental Science and Forestry (SUNY ESF)

SUNY ESF is home to the SUNY Center for Sustainable and Renewable Energy, a 64-campus research and development clearinghouse in the critical area of energy sufficiency and sustainability. The Center has a statewide role as a scientific and academic policy advisor to the American Bioenergy Association—the

acknowledged national bioenergy industry association and policy voice. The Center is presently conducting research and investigation in the following areas:

- Renewable carbonate fuel cell operations
- Photovoltaic power generation
- Solar-fueled hydrogen generation
- Biomass energy feedstock agro-forestry production
- Biomass feedstock production from New York's forest-products industry
- Biomass combined heat and power sole-firing and co-firing with fossil fuels energy production
- Biomass gasification for synthetic gas
- Hydrogen extraction and biotechnical hydrogen production from biomass

2.2 INVOLVING NEW YORK'S RESEARCH INSTITUTIONS IN ROADMAP PLANS

Well beyond the common technical and economic challenges that the entire biofuels industry shares, New York will have its own unique challenges. As other sections of this Roadmap explain, New York will differ from farm belt states such as Minnesota in producing large volumes of crop-based renewable fuels feedstock that will support many large scale renewable fuel production facilities. The way the biofuels industry will develop in New York poses its own set of challenges that reflect New York's resource strengths and limitations. This will require that the State's industrial and research base work cooperatively to identify and develop new technology and processes that will help the biofuels industry to grow and to compete. For example, biofuel facilities in New York may require the capability to process multiple feedstocks, plants may need to be designed to be small and more dispersed, or preprocessing of feedstocks may be required.

There are many examples of university industry partnerships that have a focused research agenda. The Sun Grant Initiative research program focuses on biofuels and bioenergy. New York's Great Lakes Research Consortium (GLRC) focuses on the needs of managing the resources of the nation's Great Lakes.⁶

Creation of a research program that addresses specifically the issues posed by biofuel development that are important to New York should be considered. A biofuels consortium could help focus biofuels research by New York colleges and universities on the factors that are unique to New York and to the specific role that advanced biofuels can play in New York. Just as the GLRC addresses research needs of the Great Lakes region, a New York biofuels consortium program would bring scientists together to share insights from their work and plan future collaborative research unique to New York.

⁶ The GLRC is an organization of seventeen colleges and universities in New York, with nine affiliate campuses in Ontario, dedicated to collaborative research and education on the Great lakes. The research consortium was formed to focus on the unique role of the Great Lakes that border New York and their contributions to the state.

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