The Greening of Mississippi’s Economy: 
the Manufacturing Sector Part II - Petroleum, 
Chemical, Plastics, and Rubber Products
In 2009, Mississippi and Louisiana partnered to research economic development opportunities and workforce needs associated with the region’s green economy. Through a $2.3 million grant from the U.S. Department of Labor, a consortium of the Mississippi Department of Employment Security, Mississippi State University, Louisiana Workforce Commission, and Louisiana State University conducted an extensive study of economic activity that is beneficial to the environment. This and other research products were developed as part of that effort.

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Description of Sector

The *North American Industry Classification System (NAICS)* describes the Manufacturing sector, NAICS 31 – 33, as engaged in the transformation of materials into new products through mechanical, physical, or chemical means. Manufacturing often takes place in plants, factories, and mills using specialized equipment. However, this sector also includes hand-crafted materials transformations taking place in homes, tailor shops, or bakeries. Most of the materials used by manufacturers are raw materials that are purchased from other industries such as agriculture, mining and quarrying, or other manufacturing units. Outputs from manufacturers may be utilized by end users or as feedstocks for other manufacturing processes.¹ In Mississippi, this sector employs 137,579 people representing 12.7 percent of total nonfarm employment.² In 2009, the private entities in the Manufacturing sector were responsible for $16,182 million, or 16.9 percent of Mississippi’s gross state product.³ The state’s Petroleum, Chemical, Plastics, and Rubber Manufacturing subsectors represent 11 percent of all manufacturing jobs in Mississippi which is 1.3 percent of total state employment.⁴

The subsectors of the Manufacturing sector considered in this report are 324-326. The *North American Industry Classification System* defines those subsectors accordingly:

324—Petroleum and Coal Products Manufacturing
325—Chemical Manufacturing
326—Plastics and Rubber products Manufacturing

The *Mississippi Green Jobs Survey* was conducted during the third and fourth quarters of 2010 as part of this research effort to quantify and characterize the green economy in Mississippi. The survey provides a baseline measure of green employment. The survey results show an estimated 17,360 primary green jobs⁵ in Mississippi across all sectors, which represent 1.6 percent of Mississippi’s nonfarm employment. An estimated 32,300 support green jobs⁶ raises the total number of jobs involved in green activity categories to 49,660 jobs or 4.6 percent of nonfarm employment. The survey found that Mississippi’s entire Manufacturing sector accounted for 3,813 primary green jobs and 2,378 support green jobs. These survey results reveal that 4.5 percent of jobs in the Manufacturing sector as a whole are green with 2.8 percent primary green jobs and 1.7 percent support green jobs.

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¹ A primary green job is defined as one where more than 50 percent of an employee’s time is devoted to one of the seven green activity categories: renewable energy; energy efficiency; greenhouse gas reduction; pollution reduction and clean-up; recycling and waste reduction; sustainable agriculture, natural resource conservation and coastal restoration; and education, compliance, public awareness and training supporting the other categories.

² Support green jobs are defined as those essential to an organization’s involvement in one of the activity categories, but not requiring more than 50 percent of an employee’s effort.
Introduction to the Green Component of the Petroleum, Chemical, Plastics, and Rubber Manufacturing Sector

Because of the size and diversity of the Manufacturing sector, and because of the economic and environmental significance of certain sub-sectors of this sector, manufacturing is being addressed in three reports for the state of Mississippi. The refineries, chemical, plastics and rubber manufacturers are being considered together in one report and agriculturally-sourced manufacturing including food and beverages, textiles, and wood and paper products are being considered in another. This report will focus on activities in the Petroleum and Coal Products, Chemical, and Plastics and Rubber Manufacturing sector.

Nationally, the Petroleum, Chemical, Plastics, and Rubber Manufacturing sector represented $412,408 million or 2.9 percent of U.S. GDP in 2008. In Mississippi, those same sectors of the Manufacturing sector represented $5,839 million or 6.0 percent of state GDP in 2008. These complementary industries draw on raw materials in a similar way and also produce both green goods and unique inputs to green goods completed by other manufacturers.

According to the Energy Information Administration, Mississippi’s crude oil production is concentrated in the southern half of the state. Crude from these wells is processed at just three refineries which account for only about 2 percent of total U.S. refining capacity. The state’s largest refinery, located in Pascagoula, primarily processes crude from Central and South America. Mississippi’s natural gas production is less robust. The state’s output represents less than 1 percent of the U.S. total and marketed production has fallen dramatically since 2003 despite newly completed wells at Mariner Field near the Gulf coast and at the Maben Field in the Black Warrior Basin.

Mississippi’s Petroleum Refining and Chemical Manufacturing industries both rely heavily on raw supplies of crude oil and the byproducts of the oil refining process to produce the materials that make up products that can be considered green. Referred to as the “feedstock for modern society,” these industries are indirectly responsible for the green goods or for the specialized inputs required for green goods that are helping to drive sustainability efforts across other industries. Chemical and plastics products help make cars lighter and more fuel efficient, make construction materials longer lasting and more energy efficient, help reduce the volatility of paints and adhesives, create high efficiency batteries for laptops and electric vehicles, and produce packaging and containers that are highly recyclable. In an April, 2010 report by CBS News entitled, “10 Green Giants That Could Change the World,” chemical companies Dow, Johnson Controls and Honeywell were all recognized for their contributions to energy efficiency and renewable energy. The core processes of these manufacturers, however, require substantial energy and natural resources inputs and result in the production of greenhouse gases and other types of pollution.
This report will focus on the environmentally beneficial activities of the Petroleum, Chemical, Plastics, and Rubber Manufacturing sector in Mississippi in two major areas: goods and services and business practices. Discussions of this sector’s involvement in environmentally beneficial activities will be provided where significant involvement by the sector is found. As with other components of this project, green was defined based on seven green activity categories:

1. Renewable Energy
2. Energy Efficiency
3. Greenhouse Gas Reduction
4. Pollution Reduction and Clean-up
5. Recycling and Waste Reduction
6. Sustainable Agriculture, Natural Resource Conservation and Coastal Restoration
7. Education, Compliance, Public Awareness and Training Supporting the Other Categories

Each activity category includes: the research, development, production and distribution of a final good or service; the supply of unique parts or inputs to a final good or service; and production processes and business practices regardless of the final good or service produced. The table below indicates which environmentally beneficial categories will be featured in this report.

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**Green Goods and Services**

In March of 2010, the Bureau of Labor Statistics issued the “Green Goods and Services Industries by NAICS Code” that documented green products produced by each industry. This list reported companies in the Petroleum, Chemical, Plastics, and Rubber Manufacturing sector as makers of indirect green goods. These industries of the Manufacturing sector in Mississippi are actively supporting environmentally beneficial technologies and products by producing renewably-sourced fuels and plastics, cleaner burning fuels, highly recyclable materials, and components for organic fertilizers.
Renewable Energy

Building on the core competencies developed over many decades through the production of conventional fossil fuels, petroleum refineries are also producing biofuels and fuel blends to supplement their core business activity. The raw materials for these products are often sourced, at least in part, from renewable resources. In the case of Mississippi, new companies specializing exclusively in the production of renewably-sourced fuels are making significant investments in the state. Bunge-Ergon, a Vicksburg ethanol refinery produces 54 million gallons of corn-based ethanol each year and is capable of scaling up production as demand warrants. In August of 2010, the state announced that KiOR, a Texas biofuel company, would invest $500 million in 5 biofuel production facilities in Mississippi. These facilities will create a crude-oil substitute from a specialized process that transforms biomass into oil with a proprietary catalyst system that mimics the natural process that normally takes millions of years. KiOR’s renewable “Re-Crude” can later be refined into gasoline, diesel and other transportation fuels. The five facilities will also contribute to the creation of 1,000 direct and indirect jobs by 2015 according to the Mississippi Development Authority. KiOR’s facilities will be located in Columbus, Newton and one other southwestern location. The final two locations are still being determined.

Mississippi also saw three more high-profile renewable energy announcements affecting the petrochemical manufacturing industry in June of 2011. First, Elevance Renewable Sciences, an Illinois company, announced that it would purchase the Delta BioFuels facility in Adams County and convert it into a biorefinery. The $225 million project is expected to create 165 full-time jobs over the next five years and an additional 300 construction jobs. Elevance will enlarge the 800,000 square foot refinery in Natchez resulting in a “world-scale” facility. The facility converts renewable, natural oils into a variety of products such as biodiesel, additives for lubricants and fuels, make-up, detergents, and plastics.

Enerkem also announced in June of 2011 that it would bring the world’s first commercial-scale garbage-to-ethanol plant to Pontotoc, Mississippi under the name Enerkem Mississippi Biofuels. The facility, which is expected to be completed by 2013, should produce 10 million gallons of biofuel a year. The plant will utilize 190,000 tons of municipal solid waste per year from the Three Rivers Solid Waste Management Authority of Mississippi to produce ethanol. A portion of the waste will also be recycled. Ground breaking is expected sometime in 2011.

Finally, BlueFire Renewables Inc. announced that it had completed the initial site preparation for its planned cellulosic ethanol plant in Fulton, Mississippi. The plant will use wood wastes as feedstock for the production of nearly 19 million gallons of ethanol per year.
**Energy Efficiency**

This sector is also assisting with improvements to energy efficiency. Progress in the Chemical Manufacturing industry is helping to advance electric vehicle technology inside the United States. In Michigan, Dow chemical has teamed with a battery company to produce lithium-ion batteries for next generation electric vehicles, and Florence, Mississippi is home to a North American branch of Exide Technologies, a battery manufacturer that is creating new products for hybrid vehicles.16

**Greenhouse Gas Reduction**

Producers in the Petroleum, Chemical, Plastics, and Rubber Manufacturing sector have a large role in determining the state’s overall greenhouse gas emissions. Despite some unavoidable emissions associated with this subsector of the Manufacturing sector, a number of establishments are producing goods that will have a role in lowering greenhouse gases. Total global emissions have been reduced by the Chemical Manufacturing industry thanks to the innovative products they have brought to market. According to the American Chemistry Council, without the Chemical Manufacturing industry’s contributions to green goods and services, greenhouse gas emissions would have been 8-11 percent higher in 2005.17 Chemical products used in new insulation materials have helped save on carbon emissions, compact fluorescent lighting, and changes to plastic packaging, marine coatings, automotive plastics, cold-water detergents, engine efficiency, and plastic piping have also contributed to greenhouse gas savings according to the industry.18 New bioplastics produced by the industry are also moving away from the usual petroleum-based products in favor of those made from biomass. Because bioplastics in general are using plants as their feedstock, the carbon dioxide released in the processing of those biological feedstocks had already been present in the atmosphere for the plant’s consumption resulting in no net change in atmospheric carbon levels.

**Pollution Prevention and Clean Up**

Although undertaken mainly as a response to federal regulations, petroleum refiners and chemical manufacturing companies are producing fuels that produce less pollution than older formulations. Ergon Refining, Inc. announced an increase in its production capacity from its Vicksburg location in 2006 after building three new units for hydrogen-related and deasphalting processes that are necessary for the production of ultra-low sulfur diesel.19

The Chemical Manufacturing industry is also helping to prevent pollution by producing low VOC paints, adhesives, coatings and polishes used to improve indoor air quality.20 Dow chemical, for example, now produces a flooring product that is free of zinc and a new binder product that can be used in low-odor paints.21 The Chemical Manufacturing industry also plays a role in cleaning up environmental disasters like the BP oil spill in the Gulf of Mexico. COREXIT, the main dispersant used on the surface and underwater to combat the spill, is a product of Nalco. Although the manner and scale of dispersant deployment in response to the BP oil spill had never been tested, the use of
chemical dispersants like COREXIT is common practice in mitigating the damages caused by marine oil spills in many parts of the world.

Recycling and Waste Reduction

The refining of crude oil yields a wide array of products that can be used as feedstocks by chemical and plastics manufacturers and even byproducts that might otherwise be considered waste are sold and transported to nearby facilities for further processing into useful products. Asphalt is one such naturally-occurring byproduct of crude refining. For over 40 years, used, ground tires, known as crumb rubber, have been added to asphalt mixtures to create what is known as rubberized asphalt. This product, used to resurface highways and roads, is smoother and quieter than non-rubberized asphalt and helps keep 1,500 tires out of landfills for every lane-mile of paving. In 2001, about 80 percent of all scrap tires in the United States were recycled into products like rubberized asphalt, used as fill in construction projects, or burned as fuel additives. When not recycled, improperly handled scrap rubber can lead to dangerous, high heat fires that are difficult to put out, can trap rain water that mosquitos breed in, and not only take up space in landfills due to their size, but also tend to resist burial by “floating” to the top of landfills. According to the Environmental Protection Agency rubberized asphalt uses 220 million pounds, or 12 million tires, which accounts for 4.3 percent of all scrap tires generated in the United States. Asphalt is also blended with waste paper and worn out roof shingles to create new roofing shingles which helps reduce waste.

Plastics manufacturers are also heavily involved in the indirect production of green goods thanks to their participation in recycling and waste reduction efforts. Polyethylene terephthalate (PET) is a plastic resin used in polyester clothing and food and beverage containers marked with the number “1.” These plastics are highly recyclable and widely available in the waste stream. High-density polyethylene (DHPE) is another petroleum-based plastic marked with the number “2.” A sturdier plastic, it is used in milk jugs, fuel tanks, laundry detergent bottles, piping, and many other containers. Recycled plastic resins can be reformed into plastic bags, packaging, pipes, foam, and plumbing fixtures. Plastic resins and rubber are also being used to make carpet, playground equipment, flooring, and health care products. According to a recent study by the American Chemistry Council, the Association of Postconsumer Plastic Recyclers, and the National Association for PET Container Resources, there are significant reductions in the amount of energy required and greenhouse gases emitted when incorporating recycled PET and DHPE into new products even when considering the energy, wastes, and emissions required to collect, sort, separate, and reprocess used PET and DHPE products. For each pound of recycled PET flake, energy use can be reduced by 84 percent and greenhouse gases by 71 percent over virgin PET. The amount of PET post-consumer
containers recycled in 2008 would save 30 trillion BTUs of energy and 1.1 million tons of carbon
dioxide over using virgin PET resins.26

Chemical manufacturers are also creating new chemicals from chlorinated hydrocarbon wastes. By creating dry cleaning and ozone-friendly refrigerants from chlorinated hydrocarbons, PPG is able to reduce the waste of this material by 70 percent.27

**Sustainable Agriculture, Natural Resource Conservation, and Coastal Restoration**

The Chemical Manufacturing industry is responsible for manufacturing components for inclusion in some organic fertilizers and pesticides and the special organic products needed to formulate medicines and cosmetics. In addition to creating products to improve agricultural efficiency, DuPont is also producing a 100 percent bio-based product to replace petroleum based ingredients in skin and hair care products.28

**Education, Compliance, Public Awareness, and Training**

The Environmental Protection Agency has teamed with the Chemical Manufacturing industry to create a “Green Chemistry Program” a voluntary program that recognizes accomplishments in chemistry that have scientific, economic and environmental benefits. In addition to supporting research in green chemistry technologies, the program promotes educational activities including the development of materials and curriculum for use in industry and academics. The program also supports outreach projects at scientific meetings and elsewhere around the world.29

**Green Business Practices**

Mississippi’s oil refineries, chemical manufacturers, and plastics and rubber facilities are tremendous economic engines for the state, vital suppliers of inputs for products in many other industries.30 This high level of productivity also yields a large environmental impact. This portion of the Manufacturing sector has high energy needs, produces air and water pollution, and can also create hazardous solid wastes. This large environmental footprint creates equally large opportunities to reduce that impact through improved production processes and business practices.

According to an Environmental Protection Agency report, *Energy Trends in Selected Manufacturing sectors: Opportunities and Challenges for Environmentally Preferable Outcomes*, chemical manufacturers and petroleum refiners are the largest energy consumers in the Manufacturing sector. Although the Chemical Manufacturing and Petroleum Refining industries are large energy users, they are not significant purchasers of electricity. Instead, they rely heavily on natural gas and byproducts of their internal manufacturing or refining processes for the majority of their power. Nationally, chemical manufacturers rely on natural gas for 44 percent of their energy needs with only 14 percent coming from electricity. In refineries, the primary energy input, 68 percent, is from
fuel gas created during the refining process while natural gas makes up another 27 percent of their energy requirements with only 4 percent coming from electricity. Across the United States, the Chemical Manufacturing industry alone accounts for 10 percent of the country's total natural gas consumption with 55 percent used as boiler fuel and 40 percent used for direct process inputs. Despite the reliance on a relatively clean-burning fuel, these high levels of fossil fuel combustion inevitably lead to high levels of greenhouse gas emissions. In addition to carbon dioxide, other gases released by industrial processes in this corner of the Manufacturing sector are sulfur dioxide (SO₂), carbon monoxide (CO), and Nitrogen Oxide (NO and NO₂ together referred to as NOx). Of these secondary air pollutants, 61 percent are the result of running boilers and 33 percent is from other industrial processes. The following sections will detail ways in which businesses in Mississippi’s Petroleum, Chemical, Plastics, and Rubber Manufacturing sector are taking steps to reduce the environmental impact of their production processes.

**Renewable Energy**

A number of organizations are now promoting the development of biofuels among related industries in Mississippi. The Mississippi Biomass and Renewable Energy Council, the Mississippi Development Authority’s Energy Division, and the Strategic Biomass Solutions program of the Mississippi Technology Alliance are all working to advance the research and business climate for biomass-fueled renewable energy products.

One chemical manufacturer in Mississippi is using renewable energy to power its operations. DuPont’s Delisle, Mississippi facility utilizes methane produced by decomposing material, also known as biogas, in the nearby Pecan Grove Landfill. The landfill gas is filtered and treated at Pecan Grove and then piped five miles to DuPont where it uses the 2,700 cubic foot per minute supply to run its boilers. This system allows for environmental benefits equivalent to removing 6,500 cars from the road for one year, reducing oil consumption by 79,000 barrels per year, heating 20,000 homes per year, or planting 10,000 acres of forest per year.

**Energy Efficiency**

With high energy needs also comes large potential for energy savings. Fuel and input costs can considerably impact profit margins in the Chemical Manufacturing industry and incentivize energy savings. Much of these energy efficiencies are achieved through combined heat and power systems, also known as CHP or cogeneration. These systems are widely-utilized across the sector helping to decrease energy intensity, a measure of fuel consumption per dollar of shipped goods, by 10.5 percent between 1998 and 2002. The high steam requirements for the operation of these plants make petro-chemical refineries excellent candidates for combined heat and power (CHP). Of refineries already relying on CHP, 75 percent comes from natural gas-fired power systems with combustion turbines and recovery steam generators that are then used to generate more power via
steam turbines. Some manufacturing facilities are producing surplus electricity from these systems and selling it back to the grid.\textsuperscript{36} Refineries have the third largest cogeneration capacity among manufacturing entities allowing the industry to meet 30 percent of its electrical requirements with onsite power generation, most of which is cogenerated.\textsuperscript{37} Mississippi’s chemical manufacturing industry has an early example of the successful and efficient implementation of a CHP system in its now bankrupt Mississippi Chemical Corporation Yazoo City facility. The company installed a cogeneration system consisting of a gas turbine a waste heat recovery boiler and supplemental burners in 1984 that resulted in estimated yearly savings of $5,616,600.\textsuperscript{38} A combined heat and power system is also in place at Ergon, Inc.’s Vicksburg facility. Installed in 1994, the CHP system uses a gas fired turbine and steam turbine that saves the company $1.7 million per year.\textsuperscript{39}

Unfortunately, coming trends and regulations will require an increase in energy intensive operations for oil refiners. As heavy and sour crude oils are relied on more and more to meet demand, refiners will face higher energy requirements to process those less than premium crudes. Tar sands and shale oil are also more energy intensive to process into usable fuel products. Demand is also expected to grow for synthetic fuels and blending components which are associated with higher energy inputs and greater carbon dioxide emissions. Finally, refiners’ contributions to putting more renewable fuels into the transportation systems in accordance with the Renewable Energy Standard will necessitate more gasoline blending and greater ethanol production, which is more energy intensive than traditional petroleum refining.\textsuperscript{40}

Despite these challenges, both the Chemical Manufacturing industry and the Petroleum Refineries industry are participating in programs individually and collectively to lessen their impact on the environment. Since 1974, the Chemical Manufacturing industry as a whole has reduced its energy consumption by almost half.\textsuperscript{41} Dow chemical reported savings of 1,700 trillion Btu of energy since 1994 in its 2009 sustainability report and reductions in energy intensity of 38 percent which have saved the company over $9.2 billion.\textsuperscript{42}

Both the American Chemistry Council, which represents 90 percent of the Chemical Manufacturing industry, and the American Petroleum Institute, have signed on as members of “Climate Vision” and the Department of Energy’s (DOE) “Industries of the future/Industrial Technologies Program” in order to seek even more improvements to energy efficiency in their operations.

Under the Climate Vision program, the American Petroleum Institute has pledged a 10 percent increase in energy efficiency by 2012 with an emphasis on increased usage of combined heat and power, methane and carbon venting reductions, and better tracking and reporting methods for greenhouse gas emissions.\textsuperscript{43} American Chemistry Council members committed to support the search
for increased production efficiencies and the development of “efficiency-enabling products” that could be used by other industries. As part of the DOE Industrial Technologies Program the Chemical Manufacturing and Petroleum Refining industries aim for a 30 percent reduction in energy intensity from 2002 levels by 2020 and to commercialize more than 10 new energy efficiency technologies by the end of 2010.

Energy Management Systems are also being employed by chemical manufacturers to promote continuous improvements in energy efficiency. These systems have been encouraged by the Department of Energy and the EPA’s ENERGY STAR program, a program best known for labeling electronic devices and appliances that meet energy efficiency standards, but also certifies homes and businesses for energy efficiency and works in partnership with different industries to improve the environment and lower energy costs. Energy Management Systems seek energy efficiency improvements through organizational practices and policies, team development, planning and evaluation, tracking and measuring, communication and engagement, and evaluation and corrective measures. A systematized approach to energy efficiency would also consider important components of petro-chemical facilities like motors and pumps, which are often the largest electricity users at refineries for improvements, possible replacement and maintenance.

Cooper Tire and Rubber Company, a national tire manufacturing company with two facilities located in Mississippi, is involved in several energy efficient improvements within their company. Cooper Tire and Rubber Company joined U.S. EPA ENERGY STAR Partner Program as part of corporate-wide initiative to cut back on energy usage. Cooper Tire and Rubber Company has agreed to measure and track energy performance within their facilities, implement energy saving measures, disseminate the importance of energy efficiency to their employees and the public, and support the ENERGY STAR Challenge. The ENERGY STAR Challenge for Industry is a nationwide program that challenges America’s commercial and industrial buildings to make energy efficiency improvements of ten percent, or more, within five years. Cooper Tires is also implementing energy efficiency measures to their fleet of tractors and trailers. For example, Cooper Tires has planned and controlled routes, and fuel is purchased through one distributor to ensure consistent quality and mileage. Tractors are equipped with an auxiliary power unit (APU) that provides power to the tractor cab. This eliminates idling of the tractor engine to provide power during breaks which reduces fuel consumption and emissions. Cooper Tires has installed farings on two trailers on a trial basis; the farings improve the air flow around the moving trailer which reduces drag and, ultimately, reduces fuel consumption. Cooper Tires national and international facilities occupy over twenty two million square feet of floor space with more than 41,000 light fixtures. Cooper Tires has been replacing older style lights in selected locations with energy efficient and motion sensor lights. A
typical project involves replacing 500 lights in a portion of a warehouse which results in over a thirty percent energy reduction.\textsuperscript{54}

**Greenhouse Gas Reduction**

In addition to energy efficiency commitments under the Climate Vision program, the American Chemistry Council has also committed to an 18 percent reduction in greenhouse gas emissions from 1990 levels by 2012.\textsuperscript{55} Specific examples of companies making significant reductions are Dow and ExxonMobil. Dow has reduced its absolute greenhouse gas emissions by 20 percent since 1994, which has prevented nearly 90 million metric tons of carbon dioxide from entering the atmosphere.\textsuperscript{56} ExxonMobil reported reductions of normalized emissions of combined volatile organic compounds (VOCs)\textsuperscript{c} and nitrogen oxides (NOx)\textsuperscript{d} from chemical operations by more than 10 percent and has reduced hydrocarbon flaring by 23 percent since 2008.\textsuperscript{57}

As the nation’s second largest consumer of energy, most of which is from the combustion of fossil fuels, petroleum refineries are a major source of greenhouse gas emissions. Production processes at the refineries such as running heaters and boilers produce carbon dioxide, as do fluid catalytic cracking units, hydrogen manufacturing units, and sulfur recovery plants. Methane can also be released through leaks, crude oil storage tanks, asphalt blowing, delayed coking units and blow down systems.\textsuperscript{58} Because of the high energy use, one of the best ways petroleum refineries can cut back on their greenhouse gas emissions are through energy efficiency improvements. Refineries can also adjust their steam generation processes, improve insulation of boilers and pipes, replace water softeners with reverse osmosis systems, and recover heat from process flue gas.\textsuperscript{59}

**Pollution Prevention and Clean Up**

Activities in this subsector of the Manufacturing sector produce pollution in a variety of ways. Plastics manufacturing can release chemicals in the form of spills, leaks, and dust emissions. These manufacturers can produce wastewater tainted by unsafe chemicals, release fugitive emissions due to the high heat of operations, allow pellets into the natural environment, and produce solid wastes that are slow to degrade.\textsuperscript{60} Rubber manufacturers mainly produce concerns over fugitive emissions, solid wastes, wastewater and hazardous materials.\textsuperscript{61} The Petroleum Refineries industry releases 75 percent

\textsuperscript{c} According to EPA, volatile organic compounds are released into the air during the manufacture or use of everyday products. They evaporate into the air under normal indoor temperature and pressure conditions. They are of concern as both indoor and outdoor air pollutants. In this industry VOCs are released outdoors during the manufacturing process and indoors when VOC-containing products are used. Outdoors VOCs contribute to photochemical smog under certain conditions. Indoors, they can lead to health impacts for those exposed. (www.epa.gov/iaq/voc2.html).

\textsuperscript{d} According to EPA, nitrogen oxides are highly reactive gasses all of which are included under National Air Quality Standards. Nitrogen dioxide is the most harmful of the group forming quickly from tailpipes and smokestacks. It contributes to the formation of ground-level ozone, fine particle pollution, and is linked with numerous respiratory problems. (www.epa.gov/oaqps001/nitrogenoxides).
of its toxic release inventory into the air, 24 percent into the water and 1 percent into the land. Air emissions are also common due to the volatility of the compounds themselves. Aromatic hydrocarbons like benzene, toluene, xylene, and cyclohexane are commonly emitted as are compounds of sulfuric acid and ammonia. Because of these emissions concerns, businesses in these industries expend considerable resources for abatement resulting in considerable green employment in this sector. The significant funds spent on environmental compliance and protection also introduce strong incentives for pollution reduction measures that can affect operating procedures, manufacturing processes, and recycling efforts.

Well-aware of these environmental impacts, the American Chemistry Council has been participating in an industry-wide performance initiative called “Responsible Care” that has helped U.S. companies reduce environmental releases more than 75 percent since 1988. This initiative also produced reductions in hazardous air pollutant emissions of 13 percent between 2007 and 2008 and reductions of greenhouse gas intensity by 28 percent since 1992.

Recycling and Waste Reduction

No evidence of significant involvement for this activity category was found in the Petroleum, Chemical, Plastics, and Rubber Manufacturing sector.

Sustainable Agriculture, Natural Resource Conservation, and Coastal Restoration

No evidence of significant involvement for this activity category was found in the Petroleum, Chemical, Plastics, and Rubber Manufacturing sector.

Education, Compliance, Public Awareness, and Training

The wide array of environmental compliance issues that arise in the Petroleum, Chemical, Plastics, and Rubber Manufacturing sector have led to compliance staffing commitments at these facilities. Most, if not all manufacturers have dedicated staff to ensure environmental compliance and proper reporting.

The Chemical Manufacturing industry also regularly employs “community advisory panels” (CAPs), a manifestation of the industry’s “Responsible Care” initiative that emerged as a response to major accidents that occurred in the 1980s. Community advisory panels create lines of communication between processing facilities and their neighboring communities along issues of plant operations, community concerns, and environmental performance. Despite skepticism of the CAPs and charges that the groups are more about public relations than actual communication between the chemical manufacturer and the surrounding neighborhood, they have had success in forging relationships between the two groups of stakeholders. Although the relationship fostered by the CAP meetings helped residents to be more trusting of the health and environmental information
provided by the plant, the collaborations do not yet translate into community-sourced changes to environmental impacts at the plants.68

**Economic Factors**

The high energy needs and the existing infrastructure of the Petroleum, Chemical and Plastics, and Rubber Manufacturing sector make it a natural leader for innovations in renewable energy, energy efficiency and greenhouse gas reduction. Since energy is a primary input in the production process for this industry, manufacturers face strong incentives to use energy more efficiently and doing so can greatly reduce their greenhouse gas emissions. Since 1974, chemical product manufacturers have reduced their energy consumption by nearly half.55 The industry utilizes combined heat and power systems or cogeneration to produce much of their own energy. Although originally motivated by the cost savings associated with producing and using heat and power more efficiently, some manufacturers are finding that their electricity production exceeds their electricity demands allowing them to become suppliers of electricity to the grid.

Much of the existing infrastructure and core competencies developed over many decades of production in the petroleum Manufacturing sector make it easy for producers to shift towards production of biofuels and fuel blends. Many of these processes are associated with high costs financially and environmentally. However, as demand for biofuels and fuel blends increases, manufacturers in these industries can leverage their existing expertise to produce new products and processes to meet the growing demands.

The Petroleum, Chemical, Plastics and Rubber Manufacturing sector has long been aware of the fact that the synergies among them necessitate their proximal location to one another. There is great benefit in being able to reduce transportation costs between manufacturers in this industry. Many are able to trade the byproducts of production with one another, creating an input to the production process of one manufacturer out of what would otherwise be considered waste and in some cases pollution from another manufacturer. For example, new projects exist in the state for the capture and sequestering of CO₂ in ethylene oxide and methane chemical plants, which would then be transported via pipeline to assist in enhanced oil recovery. The ethylene oxide plant in Plaquemine and the methane plant in Lake Charles will soon be able to prevent the release of CO₂ generated during the production process and provide a useful product to those involved in enhanced oil recovery.
Public Policy

Public Policy has impacted the greening of the Petroleum, Chemical, Plastics, and Rubber Manufacturing sector in Mississippi by encouraging new, environmentally beneficial manufacturing establishments to operate in the state and by creating laws and regulations requiring existing manufacturers to adhere to higher environmental standards. Recent acts by the Mississippi legislature and federal offices have helped to encourage environmentally beneficial businesses in this sector. Funds from the United States Department of Energy’s portion of the American Recovery and Reinvestment Act (ARRA) supported the Enerkem waste-to-ethanol project and the BlueFire cellulosic ethanol plant. Another $80 million from the United States Department of Agriculture’s Biorefinery Assistance Program went to Enerkem. The DOE also supported BlueFire with another loan guarantee from a renewable energy program. The state of Mississippi has also worked to attract these green businesses through incentive and tax packages. A package approved during a special session of the legislature helped ensure that KiOR chose Mississippi for its five biorefineries.

Policy and regulations also help to ensure that establishments in this sector are operating with as much environmental efficiency as possible. This sector is highly regulated by nearly every major environmental statute. Because so many of this sector’s emissions are air emissions, Clean Air Act (CAA) regulations are especially salient. The Clean Air Act, amended most recently in 1990, is designed to reduce air pollutants including smog and acid rain, to reduce emissions of toxic air pollutants with harmful effects on human health, and to phase out the production and use of chemicals that degrade the atmospheric ozone layer. The six most commonly regulated air pollutants under the CAA are particulate matter, ground-level ozone, carbon monoxide, sulfur oxides, nitrogen oxides, and lead.

Recently, there have been signs that carbon dioxide and other greenhouse gases will be included in the CAA because of the potential harm from climate change. In Massachusetts vs. Environmental Protection Agency, twelve states and several local governments sued the EPA for not regulating greenhouse gases emitted by the transportation sector as air pollutants under the law. In April of 2007, the court ruled in a 5 to 4 decision that EPA did in fact have the authority to regulate carbon dioxide and other greenhouse gases as air pollutants under the Clean Air Act if the agency determined that greenhouse gases represented a threat to human health and the environment. After that ruling, EPA Administrator Jackson signed two findings declaring greenhouse gases in their “current and projected concentrations” did represent threats to public health, and that the combined releases from new motor vehicle engines did in fact contribute to greenhouse gas pollution and threaten human health. Although this activity focused mainly on the Transportation and Warehousing sector, actors in the Petroleum, Chemical, Plastics, and Rubber Manufacturing sector took careful notice because the Clean Air Act is applied to both mobile and stationary sources of air
pollution. Refineries were also implicated as producers of transportation fuels. These signs that stationary sources of air pollution like factories, chemical plants, and refineries would be placed under more stringent greenhouse gas regulation have prompted the American Chemistry Council to call for Congress to postpone these regulations.\textsuperscript{75} In addition to affecting the industry directly, there are concerns that increased pressure on other utilities and manufacturers will prompt fuel switching from higher emitting fuels like coal to natural gas which will then increase the price of natural gas, a main fuel source and process input for the industry.\textsuperscript{76}

In October of 2009, EPA published a mandatory rule for the reporting of greenhouse gases from large emissions sources that requires data collection beginning in January, 2010. This rule, instituted under the “Greenhouse Gas Reporting Program” will require the reporting, but not control, of GHG emissions and other relevant information from reporting sources to gain data on emissions from specific industries, individual facilities within those industries, and to gain information on factors that lead to GHG emissions and how facilities could act to reduce them.\textsuperscript{77} This requirement could be the beginning of changes that force refineries to drastically cut back on greenhouse gas emissions.\textsuperscript{78}

The EPA also issued a series of rules regarding Clean Air Act permits covering greenhouse gas emissions in December of 2010 with particular emphasis on oil refineries. Beginning in January of 2011, large industrial facilities (with 75,000 tons per year carbon dioxide equivalent emissions) already obliged to file for permits for non-greenhouse gas air emissions were also obligated to file for greenhouse gas permits if they were undertaking new construction or major modifications to existing facilities. In July, 2011 all facilities emitting more than 100,000 tons per year of carbon dioxide equivalents will need greenhouse gas permits. Facilities emitting fewer than 50,000 tons of greenhouse gases per year, however, will be exempt from permitting until 2016.\textsuperscript{79}

Along with industry concerns about greenhouse gas regulation under the Clean Air Act, there are also protests about proposed changes to ground level ozone standards under the CAA. Ground level ozone is not an emission like carbon dioxide, but the result of chemical reactions between outdoor heat and volatile organic compounds (VOCs) and nitrogen oxides (NOx). Exposure to elevated levels can lead to decreased lung function, aggravate asthma, increase emergency room visits, and prompt premature deaths. In 2008 new ozone standards were adopted that were later criticized by the EPA’s own scientific panel for their leniency. The 2010 ozone proposal would lower ground level ozone concentrations from 75 parts per billion to somewhere in the range of 70-60 parts per billion which the American Petroleum Institute says would, “devastate the US economy.”\textsuperscript{80} Economic projections by the industry put the cost of this regulation at $676.8 billion in losses to gross domestic product by 2020 and possibly putting the entire country into nonattainment.\textsuperscript{81}
Another significant law affecting the petrochemical and refining industries in Mississippi is the Toxic Substances Control Act (TSCA) of 1976. This law gave the Environmental Protection Agency the power to regulate new chemicals before they enter the market and existing chemicals when they pose a risk to health or the environment. The law requires that manufacturers, processors, and distributors of chemicals inform the EPA if there is a reasonable suspicion that the material poses a substantial risk to health or the environment. Recently there has been a push to modernize the 1976 law to respond to the 20,000 additional chemicals that have come into the market since the law was passed. In addition, due to the structure of the law the EPA has only tested 200 chemicals of the 80,000 on the market in the United States and has regulated only five. Proposals to update the TSCA would place the burden for testing chemicals for health and environmental safety on EPA rather than on the producers of the chemicals themselves. Although changes to the Toxic Substances Control Act would force the chemical industry to adapt to new rules, the American Chemistry Council and its members have announced a recognition that the law needs to be modernized and support for those efforts.

Other key regulations facing this collection of manufacturing industries are the Clean Water Act and the Safe Drinking Water Act. At many chemical, plastics, rubber, and refinery facilities, wastewater from cooling, heating, and cleaning processes can provide environmental concerns. Under the Clean Water Act and the Safe Drinking Water act these industries must make efforts to protect the chemical, physical, and biological integrity of surface waters and underground injections, biological wastes, and other threats to drinking water supplies. These subsectors of the Manufacturing sector are most affected by these laws under point source discharge limitations, pre-treatment requirements for wastewater, oil and hazardous waste spill prevention measures, and wetland impacts.

These subsectors of the Manufacturing sector are also regulated by the Resource Conservation and Recovery Act (RCRA) which concerns hazardous waste and non-hazardous solid wastes; the Universal Waste Rule which streamlines waste management for batteries, pesticides, mercury-containing equipment and lamp bulbs; the Comprehensive Environmental Response, Compensation, and Liability Act, also known as Superfund, which created a tax on the Chemical Manufacturing and Petroleum Refining industries that feeds into a trust fund used to respond and clean up after releases of hazardous substances; and the Emergency Planning and Community Right to Know Act which mandates notification in the case of emergency releases of chemicals and state and local planning for those emergencies.
Technology

Technology is a major driving force allowing these industries to maintain their production needs and environmental compliance and to bring new products to market with positive benefits to the environment. Certain technologies are designed to create final goods and services that have a lower environmental benefit, while others create environmental benefits during production.

Considerable research and capital has been invested in processes to produce cleaner fuels to comply with federal fuel standards. Similarly, considerable research and capital has been invested in new pollution monitoring and controls to reduce levels of pollutants in air, water, and solid wastes in accord with new more stringent federal and state environmental regulations. For example, infrared cameras have improved leak detection, monitoring of mechanical conditions and flares, and offered a much more efficient and effective means of documenting and fixing equipment leaks.

Technological developments are also affecting this sector’s ability to capture carbon. New combustion processes for boilers known as oxy-combustion that rely on nearly pure supplies of oxygen rather than the natural blend of gases found in the atmosphere are under development that would require technology to remove nitrogen from the air and then absorbers and compressors for the higher concentration of carbon dioxide that results from the high oxygen combustion. Techniques also exist that rely on solvents to scrub the carbon dioxide from post-combustion exhaust streams. Low maintenance membrane technology is also improving that could potentially capture 80 percent of the carbon from combustion.86

New opportunities to reuse rubber are emerging as well. Rubber must be de-vulcanized in order for it to be fully recycled into products able to replace virgin rubber compounds in a cost-effective manner. During vulcanization sulfur or other elements are added to rubber that is altered through chemical processes to produce improved performance characteristics.87 New technology is allowing for the reversal of that process through a mechano-chemical reaction that re-opens the sulfur bonds so that the product once again resembles virgin rubber.88

Another potential technological breakthrough with environmental benefits would be the development of better renewably-sourced plastics. A considerable amount of effort is now being employed to research the feasibility of bio-based feed stocks for plastics production. Dow recently announced that it was developing the world’s largest bio-derived plastics facility to convert sugar cane to polyethylene in Brazil.89 Similarly, Toyota is opening a bioplastics plant that will convert sweet potatoes into a range of plastic products that can be used in its cars or sold to other markets.90
Job Growth and Workforce Development

Considering primary and support jobs, green employment in the Petroleum, Chemical, Plastics, and Rubber Manufacturing sector is expected to grow at a significantly higher rate than the overall sector during the next ten years reaching 2,466 in 2020 relative to the 2010 baseline of 1,711 estimated from the Green Jobs survey. That growth is not expected to occur at a steady rate throughout the projection horizon. Given the nature of the impact of developing a large-scale project in the state, large jumps in green employment are expected to correspond with the opening of new facilities. During the first two years, green employment is projected to rise considerably to 1,808 in 2011 and 1,934 in 2012. By 2015, most of the gains from economic development projects that have already been announced will have been realized, and green employment will reach 2,427. In the following years, the growth rate is anticipated to return to the long-term growth exhibited within the sector with green employment reaching 2,466 in 2020, though future economic development projects could further increase that projection.

This is a growing sector in the state with significant potential to play a prominent role in reducing the environmental impact of manufacturing. As new policies and regulations are put into place, the sector will have an increasing demand for compliance officers to ensure compliance and perform reporting duties as well as chemical engineers to develop methods for reducing manufacturers' environmental impact. With new regulations, these industries may see increased demand for chemical engineers to solve the increasingly complex problems of further reducing the environmental impact of these operations.

Finally, it should be noted that the anticipated employment growth of green jobs in the Petroleum, Chemical, Plastics, and Rubber Manufacturing sector will be comprised of a combination of the creation of new green jobs and the gradual greening of existing jobs. While the contribution of each factor has yet to be determined, training providers should consider the unique training needs brought on by each of these changes. For some green occupations, existing workers will need training to enhance their skills. For other occupations, curricula may be needed to provide a more comprehensive training for new workers or those entering a new occupation.

Key Players

American Chemistry Council (ACC): www.americanchemistry.com
A trade association which represents companies engaged in the chemistry business.

*The starting point for a sector’s green jobs projection is the survey estimate, which includes private and public entities in each sector. Baseline growth rates were taken from the state’s primary employment projections, which include only private sector establishments, and supplemented with additional information on future changes to the green economy collected through this research effort.*
American Petroleum Institute (API): www.api.org
A trade association which represents companies engaged in the oil and natural gas industry.

BlueFire Ethanol: http://bluefireethanol.com
Company converting cellulose from wood wastes and urban trash into ethanol. BlueFire Ethanol will be opening a plant in Fulton, Mississippi.

Bunge-Ergon: www.bunge-ergon-vicksburg.com
A corn ethanol producer located in Vicksburg, Mississippi.

Enerkem: www.enerkem.com
A waste-to-biofuel producer opening a facility in Pontotoc, Mississippi.

KiOR: www.kior.com
A “next generation” renewable fuel company that will be locating five production facilities in Mississippi.

Major Mississippi Refineries and Chemical and Petrochemical Manufacturers

Mississippi Department of Environmental Quality (MDEQ): www.deq.state.ms.us
Exists to provide comprehensive environmental protection to the people of Mississippi to promote and protect health, safety and welfare while considering employment and economic development. Regulates polluting sources, provides permits according to law, conducts inspections of permitted facilities, responds to environmental emergencies, and issues enforcement actions.

Mississippi Development Authority (MDA): www.mississippi.org
The leading economic and community development agency in Mississippi. Operates the Energy Division and Clean Energy Initiative focusing on attracting and providing incentives for clean energy companies including renewable fuel manufacturers.

National Petrochemical and Refiners Association (NPRA): www.npra.org
A trade association representing American manufacturers of the U.S. supply of gasoline, diesel, jet fuel, other fuels and home heating oil, as well as the petrochemicals used as building blocks for thousands of products.
**U.S. Environmental Protection Agency (EPA):** [www.epa.gov](http://www.epa.gov)

Federal agency established for the protection of human health and the environment. Enforcement agency of federal environmental legislation such as the Clean Air Act and Clean Water Act.
Notes


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