



Maryland
Department of
the Environment

Appendix H

Impact Analysis of the GGRA of 2009 on Manufacturing Industry in MD

2019 GGRA Draft Plan

Impact Analysis of the Greenhouse Gas Reduction Act of 2009 on the Manufacturing Industry in Maryland

Prepared for
Maryland Department of Environment

Darius Irani, Ph.D., Chief Economist
Susan Steward, Senior Economist
Jessica Grimm, Senior Research Associate
Rebecca Ebersole, PMP, Senior Research Associate

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Regional Economic Studies Institute



TOWSON UNIVERSITY

Towson, Maryland 21252 | 410-704-3326 | www.towson.edu/resi

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1.0 Executive Summary

1.1 Overview

The Maryland Department of the Environment (MDE) tasked the Regional Economic Studies Institute (RESI) to complete an impact analysis of the policies from the *Greenhouse Gas Emissions Reduction Act (GGRA) 2012 Plan* on Maryland's manufacturing industry. RESI employed the REMI PI+ model using agency level data collected for the GGRA report to determine the impact on Maryland's Manufacturing industry. In this report, RESI assumed that all GGRA initiatives were implemented and results are reported for the Manufacturing industry by the four-digit North American Industry Classification System (NAICS) codes.

In addition to an economic impact analysis, RESI solicited feedback from regional manufacturers to include in the report. Manufacturer interviews included in this report are case studies of greenhouse gas reduction measures taken by these firms to remain compliant with government environmental mandates. RESI and representatives from MDE visited these manufacturers to witness their methods and interview them one on one in regard to the challenges faced with reducing greenhouse gas emissions, if any.

1.2 Historical Trend Analysis

To provide background for the economic impact analysis, RESI analyzed the current historical trends of Manufacturing in Maryland. RESI found the following:

- The average weekly wages in the Manufacturing industry increased from \$933 in 2002 to \$1,324 in 2012.
- Preliminary estimates indicate that average weekly wages increased by \$16 between 2012 and 2013—an increase from \$1,324 in 2012 to \$1,340 in 2013.¹
- The industry accounted for 5.9 percent of Maryland's total output in 2012.

The industry remains a vital component of Maryland's economic base, despite declines since the recent recession. Industry data indicates that the workforce is shifting to demand employees with middle skills and more training. Partnerships with state-based groups such as the Regional Manufacturing Institute (RMI) and state agencies such as Maryland Public Service Commission (PSC) and Maryland Energy Administration have assisted manufacturers through funding opportunities to meet energy efficiency goals.

National partnerships are also key in building the needed workforce, such as those with Manufacturing Extension Partnership (MEP) and the National Institute of Standards and Technology. This partnership seeks to build and establish training to meet the higher skill needs of employers by the local workforce. As the industry shifts towards a higher skill-based workforce, partnerships such as those between industry leaders, state agencies, and federal

¹ "Quarterly Census of Employment and Wages," Bureau of Labor Statistics, accessed April 9, 2014, <http://data.bls.gov/pdq/SurveyOutputServlet>.

agencies will be vital to producing the workforce needed to implement the policies outlined in the GGRA.

1.3 Economic Impact Findings

RESI analyzed the GGRA initiatives outlined in the GGRA to determine the economic impacts on the manufacturing industry. Using agency-provided data along with external research, RESI found the following:

- The manufacturing industry will create 113 total jobs by 2020 related to implementation of the policies between 2010 and 2020.
- Directly, policy implementation between 2010 and 2020 will result in 104 direct jobs created to support the greenhouse gas reduction policies under the GGRA.
- The *Computer and electronic product manufacturing* sector will experience the greatest gains in employment between 2010 and 2020.
- The industry's wages will increase to \$10.7 million by 2020.
- The industry's output will increase to \$26.5 million by 2020.

RESI's economic impact analysis confirms historical and current trend analyses. To implement the strategies outlined in the GGRA, Maryland will create an additional 113 jobs in the Manufacturing industry by 2020. Of these 113 jobs, nearly 54 percent will be created within higher skilled sectors, such as *Computer and electronic product manufacturing* and *Electrical equipment and appliance manufacturing*. Some sectors, such as *Food Manufacturing* and *Textile mills; Textile product mills* will see minimal job declines between 2010 and 2020 as the industry shifts to a higher-skilled workforce demand to meet policy implementation associated with the GGRA. Despite all the change in Maryland's Manufacturing industry, there is no conclusive evidence that any closures or relocations outside Maryland are directly attributable to the GGRA or climate change planning. Based on the analysis provided within this report, RESI finds no discernible impacts on the manufacturing sector as a result of the GGRA programs. Furthermore, RESI recommends based on this analysis that Maryland not adopt any manufacturing specific GHG regulations in the future.

2.0 Introduction

The Maryland Department of the Environment (MDE) tasked the Regional Economic Studies Institute (RESI) to complete an impact analysis of the policies from the *Greenhouse Gas Emissions Reduction Act (GGRA) 2012 Plan* on Maryland's manufacturing industry. RESI employed the REMI PI+ model using agency-level data collected for the GGRA report to determine the impact on Maryland's Manufacturing industry. In this report, RESI assumed that all GGRA initiatives were implemented and results are reported for the Manufacturing industry by the four-digit North American Industry Classification System (NAICS) codes.

In addition to an economic impact analysis, RESI solicited feedback from regional manufacturers to include in the report. Manufacturer interviews included in this report are case studies of greenhouse gas reduction measures taken by these firms to remain compliant with government environmental mandates. RESI and representatives from MDE visited these manufacturers to witness their methods and interview them one on one in regard to the challenges faced with reducing greenhouse gas emissions, if any.

3.0 Literature Review

3.1 Trends in Manufacturing in Maryland

Since 2002 employment in Manufacturing in Maryland has steadily declined. In 2002 average annual employment in the manufacturing sector reached nearly 157,000 but dropped to approximately 109,000 in 2012.² Manufacturing as a percent of total Maryland employment has seen a less drastic change than employment within the manufacturing sector alone. In 2002 Manufacturing encompassed more than 6 percent of Maryland's total employment; by 2012 that share decreased slightly to 4 percent.³ Despite employment declines, average weekly wages per worker have steadily increased. According to the Department of Labor, Licensing and Regulation (DLLR), average wages increased from \$933 to \$1,324 between 2002 and 2012. Average wages in Manufacturing have remained greater than average wages for Maryland industries overall.⁴

As seen in Figure 1, preliminary data for 2013 support the existing employment and wage trends. Employment in Manufacturing in Maryland decreased to fewer than 107,000 workers in 2013.⁵ Preliminary figures for 2013 show that average weekly wages continue to increase; average weekly wages rose to approximately \$1,340 in 2013, a \$16 increase from 2012.⁶

² "Employment and Payrolls - Industry Series – Maryland," Department of Labor, Licensing and Regulation, September 30, 2013, accessed October 24, 2013, <http://www.dllr.state.md.us/lmi/emppay/tab1md.shtml>.

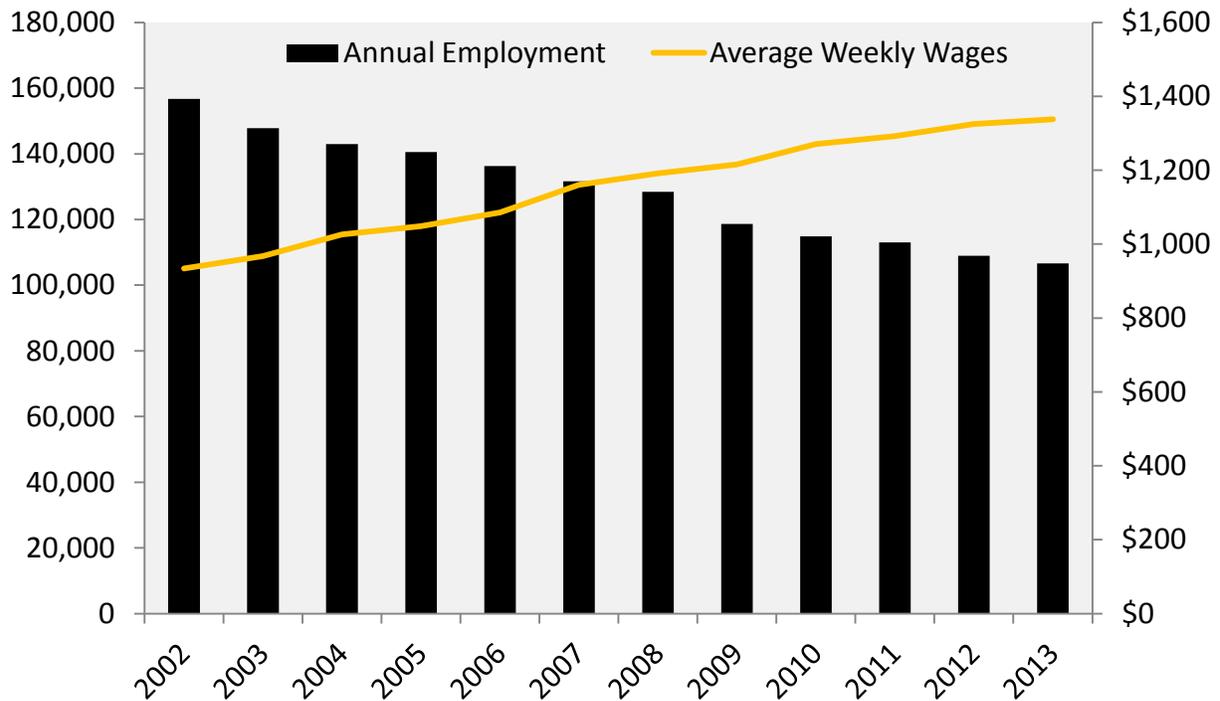
³ Ibid.

⁴ Ibid.

⁵ "Quarterly Census of Employment and Wages," Bureau of Labor Statistics.

⁶ Ibid.

Figure 1: Manufacturing Employment and Wages for Maryland⁷



Sources: BLS, QCEW

Regardless of employment declines, the manufacturing industry remains a vital enterprise for Maryland. In 2012 the manufacturing industry in Maryland

- Accounted for 5.9 percent of the total output in the state,
- Comprised 4.3 percent of the state’s total employed workforce,
- Produced output of \$18.7 billion, and
- Exported nearly \$11 billion worth of goods.⁸

According to the 2014 report “Impact of the Manufacturing Renaissance from Energy Intensive Sources” prepared for the U.S. Conference of Mayors and the Council on Metro Economies and the New American City, the manufacturing industry has been a “keystone of economic growth” since the end of the recession—specifically, in the nation’s metropolitan areas, such as the Baltimore-Columbia-Towson metropolitan statistical area (MSA), and in regard to industries that are energy intensive, such as Manufacturing.⁹ Metropolitan areas encompass a vast

⁷ QCEW wages and employment data reported here are seasonally adjusted.

⁸ “Maryland Manufacturing Facts,” National Association of Manufacturers, 1-2, 2012, accessed October 24, 2013, <http://www.nam.org/~media/40D1B093FBD64A17BCC68940B5A7F167/Maryland.pdf>.

⁹ “U.S. Metro Economies Report on Impact of Manufacturing Renaissance from Energy Intensive Sectors,” Global Insight and iHS, 1, 2013, accessed April 10, 2014, <http://www.usmayors.org/pressreleases/uploads/2014/0320-report-MetroEconomiesManufacturing.pdf>.

amount of the nation's total employment. In 2012 metropolitan areas encompassed nearly 80 percent of the nation's total employment and more than 80 percent of "real sales" that resulted from energy-intensive manufacturing industry components.¹⁰ The report forecasts that employment within energy-intensive manufacturing industry components will expand at the same rate as that expected on the national level through 2020. At 72 percent, the majority of projected expansion will occur in metropolitan areas.¹¹

Maryland has multiple organizations that support and/or promote the manufacturing industry. Since 1990 the Regional Manufacturing Institute (RMI) of Maryland has acted as an advocate for Maryland manufacturers.¹² With the help of a recent \$3 million grant, provided by the Maryland Public Service Commission and the Maryland Energy Administration, RMI aims to assist Maryland manufacturers in targeting energy efficiency opportunities.¹³ Maryland is also home to one of the nation's centers of the Manufacturing Extension Partnership (MEP) and the Maryland World Class Manufacturing Consortium.

Through partnerships with other MEP centers nationwide, as well as the National Institute of Standards and Technology, the Maryland MEP facilitates the growth of manufacturers.¹⁴ These partnerships allow the Maryland MEP to offer training in "Lean, Innovation Engineering, Advanced Manufacturing and Marketing."¹⁵ Additional Manufacturing support comes from the Maryland World Class Manufacturing Consortium. The Consortium aids manufacturers in meeting international demand and standards.¹⁶

3.2 Maryland's Manufacturing Industry and Greenhouse Gas Reduction

Under the Greenhouse Gas Reduction Act (GGRA) of 2009, the State of Maryland is required to produce the 25 percent reduction from 2006 levels by 2020. The bill also states that Manufacturing can only be regulated at a federal level, and the industry is therefore excluded from the GGRA.¹⁷ Greenhouse gas (GHG) emissions resulting from the state's Manufacturing

¹⁰ "U.S. Metro Economies Report on Impact of Manufacturing Renaissance from Energy Intensive Sectors," Global Insight and iHS, 1.

¹¹ Ibid.

¹² "About RMI," Regional Manufacturing Institute of Maryland, accessed October 24, 2013, <http://rmiofmaryland.com/about-rmi/>.

¹³ "Join the RMI's Next-Gen-M Energy Efficiency Program," Regional Manufacturing Institute of Maryland, October 14, 2013, accessed October 24, 2013, <http://rmiofmaryland.com/join-the-rmis-next-gen-m-energy-efficiency-program/>.

¹⁴ "Maryland Direct Financial Incentives 2014," Area Development, 2014, accessed April 10, 2014, <http://www.areadevelopment.com/stateResources/maryland/MD-Direct-Financial-Incentives-2014-124356.shtml>.

¹⁵ Ibid.

¹⁶ Ibid.

¹⁷ "Facts About The Greenhouse Gas Reduction Act of 2009," Maryland Department of the Environment, 1, accessed October 24, 2013, http://www.mde.state.md.us/assets/document/Air/ClimateChange/GGRA_factsheet.pdf.

industry make up a relatively small portion, only 4 percent, of the state’s total GHG emissions—this percent is not expected to change significantly by 2020.¹⁸

Regulation Impacts on Competitiveness

Maryland manufacturers must contend with regional, national, and international competitors. Due to this competitiveness, the industry’s GHG emissions are thought to be best regulated on a national level.¹⁹ State regulations cannot require the manufacturing industry to reduce GHG emissions nor can such regulations place higher financial burden on Maryland manufacturers unless required at the federal level.²⁰ Doing so would place Maryland’s Manufacturing sector at a competitive disadvantage.

While Manufacturing is currently excluded from GHG emissions reduction requirements, the GGRA encourages the manufacturing industry to reduce emissions voluntarily. In the future, it is possible that Manufacturing will be subject to reduction requirements; any GHG emissions reductions accomplished in Manufacturing in the short term will be applied to future reduction requirements.²¹ With the GGRA of 2009, Maryland continues to advocate for a strong federal GHG reduction program.²²

Energy Efficiency Investments

Across the U.S., companies have committed to at least a 25 percent reduction in energy intensity associated with manufacturing within 10 years—these companies are recognized by the Department of Energy’s as Better Plants Program Partners.²³ Some of these companies have already reached the 25 percent reduction goal, while others have accepted the Better Buildings, Better Plants Challenge and strive to obtain “enhanced levels of transparency and innovation” and have “agreed to make a significant near-term investment in energy efficiency at a chosen facility.”²⁴

On a more local level, progress is evident throughout the state. For example, in 2012 seasoning company McCormick & Company announced that its distribution center based in Belcamp, Maryland, reached “net-zero” through energy conservation measures—in other words, the

¹⁸ Facts About The Greenhouse Gas Reduction Act of 2009,” Maryland Department of the Environment.

¹⁹ “Chapter 172 (Senate Bill 278),” Maryland General Assembly, 2, 2009, accessed October 24, 2013, http://mgaleg.maryland.gov/2009rs/chapters_noln/Ch_172_sb0278E.pdf.

²⁰ Ibid, 7.

²¹ “Facts About The Greenhouse Gas Reduction Act of 2009,” Maryland Department of the Environment, 2.

²² Ibid.

²³ Office of Energy Efficiency & Renewable Energy, “Better Plants Program Partners,” U.S. Department of Energy, accessed January 7, 2015, http://www.energy.gov/eere/amo/better-plants-program-partners_.

²⁴ Ibid.

distribution center uses less electricity that it produces.²⁵ To achieve net-zero status at its Belcamp location, McCormick installed “energy-efficient interior and exterior lighting, occupancy sensors, HVAC upgrades, and energy efficient pallet conveyors,” with a solar array generating the surplus energy.²⁶

The Regional Manufacturing Institute of Maryland (RMI), in partnership with the Maryland Energy Administration, is using a recently obtained \$3 million grant “to help target energy efficiency opportunities with Maryland manufacturers in the BGE service territory.”²⁷ Those firms that meet program criteria can receive business services, such as a comprehensive energy audit and energy efficiency training, at minimal out-of-pocket cost (services that could cost more than \$30,000).²⁸ These services have the potential to reduce energy costs by 15 to 25 percent.²⁹ Current participants include the following:

- Chesapeake Specialty Chemical (Building Materials),
- Danko Arlington (pattern shop, foundry, and machine shop),
- Ellicott Dredge (Dredging Equipment Sector),
- Green Bay Packaging (Packaging Sector),
- GM Baltimore Operations (Automotive Sector),
- Maritime Applied Physics Corporation (Shipping Sector),
- Maryland Thermoform (Plastics Sector),
- Medifast (Dietary Meals/Snacks),
- Northrop Grumman Electronic Systems (Defense Electronics Sector),
- Sun Automation (Machinery Motors),
- U.S. Gypsum (Construction Materials), and
- Zentech Manufacturing (Electronics Sector).³⁰

Firms that have seen production increases due to previous energy efficiency measures, such as Hunt Valley’s Green Bay Packaging, have spoken out in favor of improved energy efficiency.³¹ Other programs, such as BGE’s Smart Energy Savers program, are aiding Maryland’s journey toward energy efficiency. BGE’s “success stories” include El Andariego, Mars Supermarkets, Pet

²⁵ “McCormick Distribution Center Achieves Net-Zero Energy Status,” Environmental Leader, April 17, 2012, accessed January 7, 2015, <http://www.environmentalleader.com/2012/04/17/mccormick-distribution-center-achieves-net-zero-energy-status/>.

²⁶ Ibid.

²⁷ Energy Solutions Center, “About the RMI Energy Efficiency Program,” Regional Manufacturing Institute of Maryland, accessed January 7, 2015, <http://rmienergysolutions.com/about-us/>.

²⁸ Ibid.

²⁹ Ibid.

³⁰ Ibid.

³¹ Jamie Smith Hopkins, “A bid to lower manufacturers’ energy bills,” The Baltimore Sun, April 21, 2014, accessed January 7, 2015. http://articles.baltimoresun.com/2014-04-21/business/bs-bz-manufacturers-energy-efficiency-20140414_1_energy-efficiency-energy-bills-manufacturers.

Depot, Ski Haus, and Under Armour.³² Under Armour operates two 300,000-plus-squarefoot distribution centers in Baltimore. Working with BGE, for a nearly 50 percent savings in retrofit costs, Under Armour recently installed nearly 900 new lighting fixtures between the two distribution centers.³³ These projects both aligned with the company's UA Green corporate mission, while producing a 28 percent reduction in kilowatt-hour (kWh) use per year and, therefore, generating ongoing energy savings in the future.³⁴

Others, such as Gaithersburg's MedImmune have "been able to achieve savings in such an aggressive way due to its partnerships with DOE's Industrial Assessment Center program and the Maryland Energy Administration, as well as energy efficiency rebates available via its electric utility, Pepco."³⁵ MedImmune aims to reduce energy intensity by 25 percent by 2020, and as of 2013 MedImmune has achieved an energy intensity reduction of 19.2 percent.³⁶

3.3 Greenhouse Gas Emissions Reduction Guidelines for Manufacturing

In the U.S., the greatest sources of GHG emissions include electricity production, transportation, industry, commercial and residential, agriculture, and land use and forestry.³⁷ Worldwide, electricity production followed by industry activity and forestry are the greatest sources of GHG emissions.³⁸ In 2006, the baseline year, industrial activity was responsible for approximately 7 percent of the total GHG emissions in Maryland.³⁹ In 2011 industrial activity was responsible for 20 percent of the total GHG emissions in the U.S.⁴⁰ To reduce GHG emissions, manufacturers and other industrial producers could increase energy efficiency, consider fuel switching, recycling, and institute training and awareness programs.⁴¹ Many of these options have been successfully implemented both nationally and worldwide.

³² "Success Stories," BGE, accessed January 7, 2015,

<http://www.bge.com/waystosave/business/bizlearnmore/bizsuccessstories/Pages/default.aspx>.

³³ "Under Armour," BGE, accessed January 7, 2015,

<http://www.bge.com/waystosave/business/bizlearnmore/bizsuccessstories/Pages/Under-Armour.aspx>.

³⁴ Ibid.

³⁵ MedImmune, "Maryland Manufacturer Pursues Energy Efficiency Improvements for Operational Savings," Maryland Energy Administration, accessed January 7, 2015,

<http://energy.maryland.gov/SEN/pdfs/MedImmune%20One%20Pager-042513.pdf>.

³⁶ Ibid.

³⁷ "Sources of Greenhouse Gas Emissions Overview," United States Environmental Protection Agency, September 9, 2013, accessed October 24, 2013, <http://www.epa.gov/climatechange/ghgemissions/sources.html>.

³⁸ "Global Greenhouse Gas Emissions Data," United States Environmental Protection Agency, September 9, 2013, accessed April 18, 2014, <http://www.epa.gov/climatechange/ghgemissions/global.html>.

³⁹ "Maryland's Plan to Reduce Greenhouse Gas Emissions," Maryland Department of the Environment, 8, December 31, 2011, accessed October 28, 2013.

<http://www.mde.state.md.us/programs/Air/ClimateChange/Documents/2011%20Draft%20Plan/2011GGRADRAFTPlan.pdf>.

⁴⁰ "Sources of Greenhouse Gas Emissions Overview," United States Environmental Protection Agency.

⁴¹ "Sources of Greenhouse Gas Emissions Industry Sector Emissions," United States Environmental Protection Agency, October 30, 2013, accessed October 30, 2013,

<http://www.epa.gov/climatechange/ghgemissions/sources/industry.html>.

Alabama

In Alabama, national policy affecting reduction of GHG emissions will impact a variety of industries, such as coal mining, energy, and manufacturing. These industries all have strong representation in the state.⁴² To mitigate GHG emissions, the recommended policy options for the state include the following:

- Increased energy efficiency,
- Waste reduction and increased recycling,
- Increased use of methane/natural gas,
- Transportation changes, and
- Sequestration.⁴³

California

Assembly Bill 32 passed in California in 2006. The bill included requirements that will help California meet GHG emissions reduction goals.⁴⁴ Specific requirements related to industrial activity include the adoption of required reporting regarding the level of greenhouse gas emissions as well as the adoption of set emissions limits.⁴⁵

Pennsylvania

While climate change will impact Pennsylvania's energy industry, activities associated with renewable energy, such as manufacturing activities, will provide new jobs and revenue growth.⁴⁶ Coal, which has the highest carbon content when compared to other fossil fuels, will remain the major fuel source in the state, creating the challenge of managing GHG emissions associated with coal.⁴⁷ ⁴⁸ In 2000, Pennsylvania's base year, coal production and use was responsible for 93 percent of the state's total energy-related emissions.⁴⁹ Due to the relatively controversial nature of coal and other fossil fuels, and Pennsylvania's abundance of such fuels, the state must seek viable uses of these natural resources.⁵⁰

⁴² Robert A. Griffin, William D. Gunther, and William J. Herz, "Policy Planning to Reduce Greenhouse Gas Emissions in Alabama Final Report," The University of Alabama, 16, December 1997, accessed October 28, 2013, http://www.epa.gov/statelocalclimate/documents/pdf/Alabama_action_plan.pdf.

⁴³ Ibid, 16-20.

⁴⁴ "Assembly Bill 32: Global Warming Solutions Act," California Environmental Protection Agency, accessed October 28, 2013, <http://www.arb.ca.gov/cc/ab32/ab32.htm>.

⁴⁵ Ibid.

⁴⁶ "Final Climate Change Action Plan," Pennsylvania Environmental Protection Agency, 2-3, December 18, 2009, accessed October 29, 2013, http://www.dcnr.state.pa.us/cs/groups/public/documents/document/dcnr_001957.pdf.

⁴⁷ "Coal," Center for Climate and Energy Solutions, accessed April 18, 2014, <http://www.c2es.org/energy/source/coal>.

⁴⁸ "Final Climate Change Action Plan," Pennsylvania Environmental Protection Agency, 2-3.

⁴⁹ "Final Climate Change Action Plan," Pennsylvania Environmental Protection Agency, 4-3.

⁵⁰ Ibid, 2-3.

Comparative International Findings

Efforts to reduce GHG emissions are not limited to the U.S.; nations and organizations worldwide are working toward GHG emissions reductions. Canada, for instance, is committed to reducing GHG emissions—primarily through regulations pertaining to Canada’s high emissions producing industries, like transportation and electricity.⁵¹ Canada has seen a decrease in emissions of 5.1 percent from 2005 to 2012; this decrease did not hinder economic growth, which increased by 10.1 percent during the same period.⁵² Other regulations implemented by Canada's climate change plan are performance standards for the major sources of emissions, with a focus on oil and gas, and other industrial emitters.⁵³

A multitude of well-known global corporations, such as Unilever, Avon, SC Johnson, and Whirlpool, have all moved toward processes to reduce the GHG emissions created during the manufacturing process. Unilever aims to reduce emissions to or below 2008 levels by 2020 (a reduction of 40 percent per tonne of production), to increase its use of renewable energy to 40 percent of total energy with a long-term goal of using 100 percent renewable energy.⁵⁴ In 2012 Unilever’s emission reductions were equivalent to that of reducing roadway congestion by approximately 200,000 cars.⁵⁵ As of 2012, all of Unilever’s sites located in the U.S., Canada, and European Union utilized certified renewable electricity sources.⁵⁶

Avon joined the Green Lights program, run by the U.S. Environmental Protection Agency, in 1994. At this time, Avon retrofitted many of its U.S.-based manufacturing and distribution locations with energy-efficient lighting.⁵⁷ Avon hoped to reduce GHG emissions created during operations by 20 percent compared to 2005 levels by 2020—a goal Avon exceeded in 2012 when reductions from the 2005 baseline reached 41 percent.⁵⁸ In the future, Avon hopes to switch to 100 percent clean energy, therefore eliminating emissions entirely.⁵⁹

⁵¹ “Canada’s Action on Climate Change,” Government of Canada, April 11, 2014, accessed April 18, 2014, <http://www.climatechange.gc.ca/default.asp?lang=En&n=72F16A84-1>.

⁵² “Reducing Greenhouse Gases,” Government of Canada, April 11, 2014, accessed April 18, 2014, <http://www.climatechange.gc.ca/default.asp?lang=En&n=4FE85A4C-1>.

⁵³ Ibid.

⁵⁴ “Reducing GHG from Manufacturing,” Unilever, 2014, accessed April 10, 2014, <http://www.unilever.com/sustainable-living/greenhousegases/reducingghgfrommanufacturing/>.

⁵⁵ Ibid.

⁵⁶ Ibid.

⁵⁷ “Energy & Greenhouse Gas Emissions Reduction Efforts,” Avon, the Company for Women, 2014, accessed April 10, 2014, <http://www.avoncompany.com/corporatecitizenship/corporateresponsibility/sustainability/minimizingoperationalfootprint/energy-greenhouse-gas-reduction.html>.

⁵⁸ “Energy & Greenhouse Gas Emissions Reduction Efforts,” Avon.

⁵⁹ Ibid.

In 2000 SC Johnson established benchmarks for its largest plants, five in total at the international level, regarding GHG emissions.⁶⁰ In 2002 the corporation implemented additional reduction guidelines covering all operations in the U.S.; these goals were surpassed in 2005.⁶¹ Over the past several years, SC Johnson has repeatedly set new reduction goals and continued to meet them. Most recently, SC Johnson began working toward an emissions reduction from global manufacturing of 48 percent compared to 2000 levels by 2016.⁶² As of 2012, emissions from global sites compared at 40.2 percent of 2000 levels, with preliminary 2013 figures moving SC Johnson even closer to its 2016 goal.⁶³

In 2003 Whirlpool stated its aim to accomplish a three percent emissions reduction from the 1998 base year by 2008.⁶⁴ Between 2003 and 2006, Whirlpool reduced GHG emissions by 4.1 million metric tons—the equivalent of planting nearly 1.4 million acres of trees.⁶⁵ In 2007 Whirlpool announced that it would further reduce GHG emissions by 6.6 percent by 2012; this announcement was made in support of Whirlpool’s commitment to environmentally-sound business practices.⁶⁶ Whirlpool hopes to meet its overall reduction goals through the introduction of energy efficient models to its product line to reduce the impact of these products, as well as implementing improvements in both manufacturing and freight operations.⁶⁷

Policies around the world are having vast impacts, and it is clear that successful policies regarding GHG emissions reduction have several key components in common. A 2003 Organization for Economic Co-Operation and Development report found three factors for success with greenhouse gas mitigation policies. Policies must be environmentally effective (i.e., reduce rather than reallocate), economically efficient (i.e., flexible options with minimal cost options), and have support.⁶⁸ These factors are also necessary if manufacturers worldwide are to remain competitive.

⁶⁰ “Reducing Greenhouse Gas Emissions,” SC Johnson, A Family Company, 2013, accessed April 10, 2014, <http://www.scjohnson.com/en/commitment/focus-on/conserving/reducing.aspx>.

⁶¹ Ibid.

⁶² Ibid.

⁶³ Ibid.

⁶⁴ “Reducing Greenhouse Gas Emissions,” Whirlpool Corporation, accessed April 10, 2014, http://www.whirlpoolcorp.com/responsibility/environment/performance/reducing_greenhouse_gas_emissions.aspx.

⁶⁵ Ibid.

⁶⁶ Ibid.

⁶⁷ Ibid.

⁶⁸ “Policies to Reduce Greenhouse Gas Emissions in Industry - Successful Approaches and Lessons Learned: Workshop Report,” Organisation for Economic Co-operation and Development International Energy Agency, 10, 2003, accessed March 12, 2014, <http://www.oecd.org/env/cc/2956442.pdf>.

3.4 The Effect of Greenhouse Gas Emissions Reduction

Energy Costs

A 2014 Boston Consulting Group study finds that manufacturers in the U.S. are poised to benefit from the rising production of natural gas nationwide.⁶⁹ The lower electricity prices have already spurred investment in energy-intensive industries—even in industries that are less energy-intensive, low cost natural gas is estimated to shave “1 to 2 percent off of U.S. manufacturing costs as the benefits eventually flow downstream through the value chain.”⁷⁰ BCG estimates that soon natural gas and electricity will account for just 2 percent and 1 percent, respectively, of average U.S. manufacturing costs—compared to the combined 7 to 13 percent energy costs seen in Japan and in the European Union.⁷¹ Low energy costs will further narrow the cost gap between the manufacturers in the U.S. and in China.⁷²

Transportation

Since 2010, following new greenhouse gas emissions standards implemented by the Obama administration, upfront vehicle prices have slightly increased (by approximately \$1,000) yet lifetime fuel savings have surpassed that—coming in at \$4,000 over the lifetime of the vehicle.⁷³ These estimates reflect a fuel efficiency of 35.5 miles per gallon required for standard cars and light trucks by model year 2016.⁷⁴ Since then, hybrid and electric vehicles have become increasingly popular—with the availability of electricity outweighing the availability of natural gas, vehicles of this type require less investment when compared to natural gas vehicles.⁷⁵ Alternatively, “the greatest opportunity to reduce greenhouse gas emissions...is through fuel substitution in fleets and heavy-duty vehicles.”⁷⁶

In some states, such as California, new transportation fuel policies benefit drivers and communities; however, trucking companies are not faring as well—the EPA Regulations are putting some trucking companies out of business.^{77 78} The same regulations implemented by

⁶⁹ “Nearly Every Manufacturer in the U.S. Will Benefit from Low-Cost Natural Gas,” The Boston Consulting Group, February 13, 2014, accessed January 7, 2015, <http://www.bcg.com/media/PressReleaseDetails.aspx?id=tcm:12-154623>.

⁷⁰ Ibid.

⁷¹ Ibid.

⁷² Ibid.

⁷³ Juliet Eilperin, “Emissions limits, greater fuel efficiency for cars, light trucks made official,” The Washington Post, April 2, 2010, accessed January 7, 2015, <http://www.washingtonpost.com/wp-dyn/content/article/2010/04/01/AR2010040101412.html>.

⁷⁴ Ibid.

⁷⁵ “Leveraging Natural Gas to Reduce Greenhouse Gas Emissions,” Center for Climate and Energy Solutions, June 2013, accessed January 7, 2015, http://www.c2es.org/publications/leveraging-natural-gas-reduce-greenhouse-gas-emissions_.

⁷⁶ Ibid.

⁷⁷ Erica Morehouse, “Transportation fuel policies continue to benefit drivers and communities across California,” Environmental Defense Fund, May 16, 2014, accessed January 7, 2015,

the California Air Resources Board (CARB) that will save drivers money will also put an “overwhelming burden for businesses, especially small businesses.”^{79 80} As of January 1, 2015, “trucks weighing 14,000 pounds to 26,000 pounds will be forced to install PM retrofits;” retrofits cost are generally between \$10,000 and \$20,000.⁸¹

Growth Opportunities

Natural gas exploration has taken place in more than 30 states nationwide, creating local jobs in its wake.⁸² Since the beginning of the Great Recession, states undergoing shale exploration have added nearly 1.4 million jobs; conversely states without shale exploration have lost more than 400,000 jobs.⁸³ According to 2014 study by the Perryman Group, natural gas exploration generates more than 9.3 million jobs and nearly \$1.2 trillion in annual gross product.⁸⁴ Moreover, a PricewaterhouseCoopers study, done on the behalf of the National Association of Manufacturers, estimated that natural gas will generate an additional 1 million U.S. manufacturing jobs by 2025.⁸⁵

3.5 Workforce Redevelopment

Manufacturing in Maryland and the U.S. as a whole has seen steady employment declines since 2002. The industry’s average per capita weekly wage, however, has increased. This trend indicates a shift in the type of Manufacturing jobs available. According to the Manufacturing Institute, due in part to the increased “technological sophistication” of manufacturing, the industry now requires “more process-oriented, team-oriented workers.”⁸⁶ As the industry evolves and the technical knowledge required of industry workers increases, the quality of available jobs is also increasing. Manufacturing jobs now require a higher level of training and education compared to traditional Manufacturing jobs. In 2000, 22 percent of the

<http://blogs.edf.org/californiadream/2014/05/16/transportation-fuel-policies-continue-to-benefit-drivers-and-communities-across-california/>.

⁷⁸ Wesley Coopersmith, “California EPA Regulation Puts Trucking Companies Out of Business,” June 20, 2012, access January 7, 2015, <http://www.freedomworks.org/content/california-epa-regulation-puts-trucking-companies-out-of-business>.

⁷⁹ Morehouse, “Transportation fuel policies continue to benefit drivers and communities across California.”

⁸⁰ Coopersmith, “California EPA Regulation Puts Trucking Companies Out of Business.”

⁸¹ Ibid.

⁸² “Jobs,” America’s Natural Gas Alliance, accessed January 7, 2015, <http://anga.us/why-natural-gas/jobs#.VKbsOyvF9yw>.

⁸³ Tyler Durden, “Jobs: Shale States vs Non-Shale States,” Zero Hedge, December 3, 2014, accessed January 7, 2015, <http://www.zerohedge.com/news/2014-12-03/jobs-shale-states-vs-non-shale-states>.

⁸⁴ Mella McEwen, “Study: Oil & Gas Industry Creates 9.3 Million Jobs in U.S.,” Midland Reporter-Telegram, August 31, 2014, accessed January 7, 2015, <http://www.cpapracticeadvisor.com/news/11674995/study-oil-gas-industry-creates-93-million-jobs-in-us>.

⁸⁵ “Jobs,” America’s Natural Gas Alliance.

⁸⁶ “Percent of Manufacturing Workforce by Education Level,” Manufacturing Institute, April 2014, accessed June 2, 2014, <http://www.themanufacturinginstitute.org/Research/Facts-About-Manufacturing/Workforce-and-Compensation/Workforce-by-Education/Workforce-by-Education.aspx>.

Manufacturing workforce in the U.S. held a Bachelor's degree or higher; this figure rose to approximately 29 percent in 2012.⁸⁷

Having evolved to a new level of technological sophistication, Manufacturing now requires the use of "precision machinery, computer modeling and high-tech tooling."⁸⁸ According to the National Association of Manufacturers (NAM), the industry needs employee development, lifelong learning, and adult education, and many think it is necessary to develop these aspects well before beginning a career.^{89 90}

In recent years, many states have adopted a Common Core (CC) curriculum for K-12 grade levels. The CC curriculum focuses on higher universal standards in regard to literacy and mathematics, focuses which help prepare students "for these higher-skilled, internationally competitive jobs."⁹¹ Beyond improvements made to the K-12 school system, many students who go on to earn a college degree often remain at a disadvantage. The industry lacks a standardized credentialing system, a limitation which creates an inadequate pool of desirable college graduates for employers in the industry.⁹²

The aim of the newly launched Skills for America's Future program is to "provide 500,000 community college students with standardized manufacturing credentials that will promise secure jobs within the sector."⁹³ Through the program, students can "earn valuable credentials that are portable and demanded by vast amounts of firms."⁹⁴ Partners of the for-credit program of study include the Gates Foundation, the Lumina Foundation, and several members involved in education and training such as individuals from the American Welding Society, the National Institute of Metalworking Skills, the Society of Manufacturing Engineers, and the Manufacturing Skills Standards Council.⁹⁵

⁸⁷ Ibid.

⁸⁸ Richard Haass and Klaus Kleinfeld, "Column: Lack of skilled employees hurting manufacturing," *USA Today News*, July 3, 2012, accessed June 2, 2014, <http://usatoday30.usatoday.com/news/opinion/forum/story/2012-07-02/public-private-manufacturing/56005466/1>.

⁸⁹ "Workforce Development and Training," National Association of Manufacturers, accessed June 2, 2014, <http://www.nam.org/Issues/Employment-and-Labor/Manufacturing-Workforce-Development.aspx>.

⁹⁰ "HRP-01 Education and the Workforce," National Association of Manufacturers, accessed June 2, 2014, <http://www.nam.org/Issues/Official-Policy-Positions/Human-Resources-Policy/HRP-01-Education-and-the-Workforce.aspx#202>.

⁹¹ Haass and Kleinfeld, "Column: Lack of skilled employees hurting manufacturing."

⁹² "President Obama and Skills for America's Future Partners Announce Initiatives Critical to Improving Manufacturing Workforce," Office of the Press Secretary, The White House, June 8, 2011, accessed June 2, 2014, <http://www.whitehouse.gov/the-press-office/2011/06/08/president-obama-and-skills-americas-future-partners-announce-initiatives>.

⁹³ Ibid.

⁹⁴ "President Obama and Skills for America's Future Partners Announce Initiatives Critical to Improving Manufacturing Workforce," Office of the Press Secretary.

⁹⁵ Ibid.

Skills for America's Future's partnerships also promote several other initiatives, such as the following:

- Helping manufacturers realize the need to implement credentials through "Boots on the Ground,"
- Building credentials into high school pathways,
- Providing new online tools for workers to earn and utilize these credentials,
- Improving awareness of such credentials through a Career Awareness Campaign,
- Increasing opportunities for at-risk youth to seek these careers and credentials, and
- Creating the next-generation engineering workforce.⁹⁶

Locally, the Maryland Manufacturing Extension Partnership (MD MEP) has several programs designed to train the new manufacturing workforce. These programs include the Manufacturing Boot Camp and the Manufacturing Incumbent Workforce Training Partnership.⁹⁷ Both programs are made possible through the Employment Advancement Right Now (EARN) program. The Manufacturing Boot Camp, a six-week training program, aims to "increase the skills of potential workers and enhance their employability."⁹⁸ Following an assessment of trainee skills, individuals will undergo training for skills including but not limited to the following:

- Work ethic,
- Job readiness,
- Professionalism,
- Problem solving,
- Basic mathematics and English,
- Communication, and
- Basic manufacturing skills.⁹⁹

An abbreviated version of this program was successfully piloted with Garrett Container Systems, Inc., a shipping and storage container manufacturer located in Western Maryland. Upon their completion of the program, ten of the program participants were hired by the company.¹⁰⁰

⁹⁶ Ibid.

⁹⁷ Courtney Gaddi, "Maryland Manufacturing Extension Partnership Works to Grow Manufacturing in Maryland," *Columbia Patch*, February 20, 2014, accessed June 2, 2014, <http://columbia.patch.com/groups/business-updates/p/maryland-manufacturing-extension-partnership-works-to-grow-manufacturing-in-maryland>.

⁹⁸ "EARN Maryland 2014 Planning Grant Strategic Industry Partnerships," Maryland Department of Labor, Licensing and Regulation, 7, accessed June 2, 2014, <http://www.dllr.maryland.gov/earn/earnsumsummaries.pdf>.

⁹⁹ Gaddi, "Maryland Manufacturing Extension Partnership Proves Manufacturing Bootcamp Program Successful With Pilot Program."

¹⁰⁰ Gaddi, "Maryland Manufacturing Extension Partnership Proves Manufacturing Bootcamp Program Successful With Pilot Program."

In addition to the Manufacturing Boot Camp, the MD MEP proposed the Manufacturing Incumbent Workforce Training Partnership. This proposal seeks to “address skills gaps in advanced machining, master craftsmen and other areas,” while alleviating the “burden on individual employers of incumbent worker training, such as tuition costs, wages and lost production time.”¹⁰¹

4.0 Relevant Maryland Case Studies

While Manufacturing is excluded from current state regulations that require a 25 percent reduction in GHG emissions from 2006 levels by 2020, impacts associated with reduction efforts are occurring in the industry. RESI reached out to manufacturers in Maryland to discuss the impacts that reduction requirements have made. To date, Redland Brick and General Motors Baltimore Operations are the two completed case studies.

4.1 Redland Brick

On Thursday, December 12, 2013, team members from RESI and MDE visited and toured Redland Brick, Inc., in Williamsport, Maryland. Barry Miller (Manager of Safety, Environmental, and Quality) met with team members to discuss the impacts that legislation has had on Redland Brick and to provide a guided tour of the Williamsport facilities.

A subsidiary of Belden Holding & Acquisition Company, Inc., Redland Brick has six brick manufacturing plants, including two in Maryland (Cushwa and Rocky Ridge) and one each in Pennsylvania (Harmar), Connecticut (KF), and Virginia (Lawrenceville). Redland Brick produces a wide range of brick products, including handmade, moulded, and extruded styles.¹⁰² Redland Brick’s two moulded brick plants, located in Maryland, “have established themselves as the premier moulded brick producers in the United States.”¹⁰³ In 2001 Redland Brick commissioned Harmar, located in suburban Pittsburgh, Pennsylvania. This plant offers “a variety of products including fireclay, red shale, and sand coated bricks” and is completely automated.¹⁰⁴ Located in South Windsor, Connecticut, is Redland’s KF plant. According to the company’s website, this plant “is a modern extruded plant that supplies quality brick products for New England and the Mid-Atlantic markets.”¹⁰⁵ Redland also owns the two plants of Lawrenceville Brick in Lawrenceville, Virginia. Redland Brick has the unique ability to limit waste resulting from manufacturing. If at any time during the brick making process a brick is deemed flawed, it can be cycled back through to the beginning of the brickmaking process.

¹⁰¹ “EARN Maryland 2014 Planning Grant Strategic Industry Partnerships,” Maryland Department of Labor, Licensing and Regulation, 7.

¹⁰² “Redland Brick Inc. – Brick Manufacturer,” Redland Brick, 2011, accessed April 14, 2014, <http://www.redlandbrick.com/aboutus.asp>.

¹⁰³ Ibid.

¹⁰⁴ Ibid.

¹⁰⁵ “Redland Brick Inc. – Brick Manufacturer,” Redland Brick.

To meet the Environmental Protection Agency's (EPA) Maximum Achievable Control Technology (MACT) requirements, in 2008 Redland Brick installed a new scrubber that cost approximately \$1 million.¹⁰⁶ This particular scrubber uses high-quality, expensive limestone in the scrubbing process. In the interest of further reducing waste, Mr. Miller has worked with the Connecticut Agricultural Experiment Station to complete an analysis that shows that the limestone used by Redland Brick, and therefore the limestone waste resulting from the scrubbing process, provides a pH level comparable to the regular lime commonly used in farming when added to topsoil. After the expensive changes made by Redland Brick to meet the 2008 MACT requirements, the legislation was overturned. EPA is now finalizing a second MACT standard for the same emissions.

Depending upon the outcome, Redland Brick may need to replace that scrubber, continue to operate it, or have it determined that the scrubber was never necessary. The combination of regulatory requirements and the housing market crash has crippled the brick industry. Redland is not aware of technology available on the market today that can be used in a brick kiln to reduce greenhouse gas emissions. If forced to reduce greenhouse gas emissions, Redland would likely be forced to reduce production. Reducing production would lead to job losses and an additional sizable strain on Redland Brick's ability to operate.

4.2 General Motors Baltimore Operations

In June 2015, team members from RESI spoke with a representative from the General Motors (GM) Baltimore Operations. Michael Martinko, Senior Environmental Engineer, spoke with team members to discuss the impacts that legislation has had on GM's Baltimore Operations since the early 2000s.

GM is a dynamic motor vehicle manufacturer with operations worldwide.¹⁰⁷ GM's domestic brands include Buick, Cadillac, Chevrolet, and GMC. With nearly 400 facilities and more than 20,000 dealers, GM's wide spread activity encompasses 6 continents and 120 countries.¹⁰⁸ GM strives to create new vehicles and technology as well as engineer state-of-the-art plants.¹⁰⁹ Through innovative technology development, such as electric vehicles and fuel saving technology, GM is working to shape the automotive industry of the future.¹¹⁰ The GM Baltimore Operations facility is located in White Marsh, Maryland.¹¹¹

¹⁰⁶ While MACT is not a GHG reduction requirement, it is aimed at criteria pollutants.

¹⁰⁷ "Our Company," General Motors, accessed June 22, 2015, http://www.gm.com/company/aboutGM/our_company.html.

¹⁰⁸ Ibid.

¹⁰⁹ Ibid.

¹¹⁰ "Our Company," General Motors.

¹¹¹ "Baltimore Operations," GM News, accessed June 22, 2015, http://media.gm.com/media/us/en/gm/company_info/facilities/powertrain/baltimore.html.

Opened in December 2000, GM Baltimore Operations encompasses more than 580,000 square feet.¹¹² This plant houses 1.81 megawatts of rooftop solar arrays and is landfill-free, meaning it recycles, reuses, or converts to energy all waste created from daily operations.¹¹³ In April 2011, the facility took first place in the *Baltimore Business Journal's* Annual Green Business Award Event; that same year, the facility earned Wildlife Habitat Council certification.¹¹⁴ In June 2012, the facility was included among the winners of the Maryland Green Registry Leadership Awards, and in 2013 Baltimore County honored Baltimore Operations in the Baltimore County Chamber of Commerce Business Hall of Fame for the facility's environmental efforts.¹¹⁵ More recently, in June 2014, the facility was recognized with a Project of Distinction Award from PV America for a smart microgrid charging technology, which uses a solar array and solar EV charging canopy to charge Chevrolet Volts or stores energy in a system to support the grid.¹¹⁶

GM committed to reduce its facilities' carbon intensity globally by 20 percent by 2020. While the solar array generates approximately 6 percent of GM Baltimore Operation's electricity, natural gas used in heat treating remains the facility's key contributor to GHG emissions. However, the plant maintains its commitment to operating landfill-free by recycling or reusing 90 percent of waste in 2013. In addition to the solar array on site at the facility, GM Baltimore Operations strives to reduce power usage during lunch hours by shutting down lights and running at a 20 percent level of production on weekends. GM Baltimore Operations recently met the Environmental Protection Agency's ENERGY STAR® Challenge for Industry by reducing the energy intensity of its operations by 15.5 percent in just three years. The site has continued other initiatives to reduce energy costs, such as moving from single speed compressors to variable speed compressors, a change that helps to reduce both energy and maintenance costs. Although the upfront cost is greater, Mr. Martinko noted that the long-term costs are diminished, which balances the short-term investment. GM Baltimore Operations attributes much of its success in leading the way as a manufacturer to collaborative environmental efforts with companies like Constellation Energy and TimberRock. These partnerships help GM Baltimore Operations continue to reduce its impact on climate change.

5.0 Economic Impacts from the GGRA on Manufacturing

Maryland's Manufacturing industry was one of the hardest hit industries in the state during the recession from 2007 through 2009. Upon passage of the GGRA, concerns arose about Manufacturing's ability to remain competitive if more costs were added after the recession. However, RESI's analysis shows that there are no net discernible impacts on Manufacturing from GGRA implementation.

¹¹² Ibid.

¹¹³ Ibid.

¹¹⁴ Ibid.

¹¹⁵ Ibid.

¹¹⁶ Ibid.

To determine the potential impacts associated with the GGRA, RESI used agency-specific data and external research to determine inputs for the analysis. These inputs included the following:

- Industry sales data,
- Energy consumption reduction estimates,
- Industry-level demand, and
- Tax credits.

Using these inputs, RESI ran the analysis using the REMI PI+ model, specifically calibrated to Maryland's economy, to determine impacts from 2010 through 2020. The following section discusses the impacts on employment, output, and wages.

5.1 Economic Impacts

To determine the level of impact on the Manufacturing industry, RESI ran all GGRA initiatives outlined in the GGRA from investment through operation. The following results are the impacts expected to occur in Maryland for the Manufacturing industry by 2020. Overall, RESI found no discernible impact on employment in the Manufacturing industry between 2010 and 2020. Figure 3 reports the findings for the 20 sectors that make up the industry at the four-digit NAICS level for employment in 2020.

Impact Analysis of the GGRA of 2009 on Manufacturing in Maryland

RESI of Towson University

Figure 2: Manufacturing Employment Impacts from GGRA Initiatives, 2020¹¹⁷

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	3.9	-0.4	3.5
Beverage and tobacco product manufacturing	4.4	-1.7	2.7
Chemical manufacturing	4.2	-1.0	3.2
Computer and electronic product manufacturing	9.3	29.2	38.5
Electrical equipment and appliance manufacturing	23.0	-0.4	22.6
Fabricated metal product manufacturing	16.3	-0.5	15.8
Food manufacturing	5.3	-13.7	-8.4
Furniture and related product manufacturing	-0.7	1.7	1
Machinery manufacturing	-2.9	5.2	2.3
Miscellaneous manufacturing	-1.1	3.4	2.3
Motor vehicles, bodies and trailers, and parts manufacturing	0.2	1.0	1.2
Nonmetallic mineral product manufacturing	14.3	-2.7	11.6
Other transportation equipment manufacturing	-1.5	-0.8	-2.3
Paper manufacturing	2.7	-1.5	1.2
Petroleum and coal products manufacturing	0.7	-0.3	0.4
Plastics and rubber product manufacturing	6.2	-2.2	4
Primary metal manufacturing	0.6	-1.0	-0.4
Printing and related support activities	14.1	-0.7	13.4
Textile mills; Textile product mills	0.0	-0.6	-0.6
Wood product manufacturing	4.9	-3.8	1.1

Sources: REMI PI+, RESI

As reported in Figure 2, the two greatest gaining sectors in terms of employment by 2020 from GGRA initiatives are *Computer and electronic product manufacturing* and *Electrical equipment and appliance manufacturing*. The sectors that are likely to experience minimal to no loss are *Food manufacturing*, *Other transportation equipment manufacturing*, and *Textile mills; Textile product mills*. Overall, most sectors are expected to see some minor increases in employment during that period.

In addition to an increase in employment, output for the industry is expected to grow through 2020. Impacts associated with the changes in output are reported in Figure 3.

Figure 3: Manufacturing Output Impacts from GGRA Initiatives, 2020¹¹⁸

¹¹⁷ The following impacts are those that are expected to occur in year 2020. Therefore, in year 2020, RESI expects that the *Apparel manufacturing; Leather and allied product manufacturing* sector will increase by 3.5 jobs.

Impact Analysis of the GGRA of 2009 on Manufacturing in Maryland

RESI of Towson University

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$213,645	-\$38,618	\$175,027
Beverage and tobacco product manufacturing	\$1,931,614	-\$423,644	\$1,507,970
Chemical manufacturing	\$6,739,902	\$1,829,887	\$8,569,789
Computer and electronic product manufacturing	\$1,836,413	\$2,108,593	\$3,945,006
Electrical equipment and appliance manufacturing	\$4,378,054	-\$128,919	\$4,249,135
Fabricated metal product manufacturing	\$2,347,909	-\$8,334	\$2,339,575
Food manufacturing	\$34,898,986	-\$35,919,825	-\$1,020,839
Furniture and related product manufacturing	-\$1,245,385	\$1,238,741	-\$6,644
Machinery manufacturing	\$1,222,865	-\$1,213,066	\$9,799
Miscellaneous manufacturing	\$1,214,402	-\$1,124,451	\$89,951
Motor vehicles, bodies and trailers, and parts manufacturing	\$1,463,898	-\$1,647,134	-\$183,236
Nonmetallic mineral product manufacturing	\$1,766,294	\$410,368	\$2,176,662
Other transportation equipment manufacturing	\$1,775,479	-\$1,865,199	-\$89,720
Paper manufacturing	\$520,176	\$7,570	\$527,746
Petroleum and coal products manufacturing	\$2,934,225	-\$2,128,244	\$805,981
Plastics and rubber product manufacturing	\$3,420,268	-\$1,553,721	\$1,866,547
Primary metal manufacturing	-\$53,062	\$663,211	\$610,149
Printing and related support activities	\$1,597,468	\$178,777	\$1,776,245
Textile mills; Textile product mills	\$93,151	-\$75,113	\$18,038
Wood product manufacturing	\$1,238,096	-\$2,137,476	-\$899,380

Sources: REMI PI+, RESI

By 2020, the greatest increase in output will be associated with the *Computer and electronic production manufacturing* and the *Chemical Manufacturing* sectors. Smaller sectors such as *Other transportation equipment manufacturing* and *Textile mills; Textile product mills* are expected to see minimal gains during that period.

Finally, RESI found that wages are expected to rise through 2020 in the manufacturing industry if all GGRA initiatives are implemented. Figure 5 reports the wage impacts over the 20 sectors that comprise the Manufacturing industry.

¹¹⁸ The following impacts are those that are expected to occur in year 2020. Therefore, in year 2020, RESI expects that the *Apparel manufacturing; Leather and allied product manufacturing* sector will increase by \$175,027 in output.

Impact Analysis of the GGRA of 2009 on Manufacturing in Maryland

RESI of Towson University

Figure 4: Manufacturing Wage Impacts from GGRA Initiatives, 2020¹¹⁹

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$67,541	-\$7,935	\$59,606
Beverage and tobacco product manufacturing	\$130,895	\$25,425	\$156,320
Chemical manufacturing	\$443,825	\$139,011	\$582,836
Computer and electronic product manufacturing	\$1,685,521	\$3,862,656	\$5,548,177
Electrical equipment and appliance manufacturing	\$1,825,196	-\$59,269	\$1,765,927
Fabricated metal product manufacturing	\$1,057,189	-\$59,759	\$997,430
Food manufacturing	\$663,109	-\$1,018,840	-\$355,731
Furniture and related product manufacturing	-\$262,103	\$284,368	\$22,265
Machinery manufacturing	\$268,869	-\$178,872	\$89,997
Miscellaneous manufacturing	-\$188,135	\$220,202	\$32,067
Motor vehicles, bodies and trailers, and parts manufacturing	\$83,647	-\$44,139	\$39,508
Nonmetallic mineral product manufacturing	\$604,918	\$72,718	\$677,636
Other transportation equipment manufacturing	\$277,546	-\$166,669	\$110,877
Paper manufacturing	\$508,840	-\$420,837	\$88,003
Petroleum and coal products manufacturing	\$101,596	-\$79,035	\$22,561
Plastics and rubber product manufacturing	-\$228,819	\$536,758	\$307,939
Primary metal manufacturing	-\$41,682	\$74,578	\$32,896
Printing and related support activities	\$284,661	\$212,314	\$496,975
Textile mills; Textile product mills	-\$116,148	\$124,413	\$8,265
Wood product manufacturing	\$277,286	-\$352,867	-\$75,581

Sources: REMI PI+, RESI

According to Figure 4, the sectors with the greatest gain in wages through 2020 are *Computer and electronic product manufacturing* and *Electrical equipment and appliance manufacturing*. Smaller gains are likely to be recorded in the *Textile mills; Textile product mills* sector and the *Petroleum and coal products manufacturing* sector.

5.2 Discussion

According to RESI's analysis, manufacturing will experience no discernible impact on employment between 2010 and 2020 if all policies are implemented. Manufacturing sectors

¹¹⁹ The following impacts are those that are expected to occur in year 2020. Therefore, in year 2020, RESI expects that the *Apparel manufacturing; Leather and allied product manufacturing* sector will increase by \$59,606 in wages.

associated with high and middle skilled labor, such as *Computer and electronic product manufacturing*, *Chemical manufacturing*, and *Electrical equipment and appliance manufacturing*, will experience the greatest impacts. Occupations within *Computer and electronic product manufacturing* include the following:

- Computer hardware engineers,
- Computer software engineers, applications,
- Computer software engineers, systems software,
- Electrical and electronic engineering technicians,
- Electrical and electronic equipment assemblers, and,
- Semiconductor processors.¹²⁰

Some of the occupations within this sector, such as computer hardware engineers, require at least a Bachelor's degree.¹²¹ This occupation pays a median salary of \$100,920, which is well above the median income for a Bachelor's degree according to The National Center for Education Statistics.¹²² ¹²³ However, some occupations, such as electrical and electronic engineering technicians, require less additional education opening career pathways for non-college graduates. According to the BLS's Occupational Outlook Handbook, electrical and electronic engineering technician jobs require a minimum of an Associate's degree.¹²⁴

Overall, RESI found that the GGRA's impact on Maryland may benefit Manufacturing for high-to middle-skilled labor. Although the workforce needed to meet this demand is likely to require additional education and training to meet specific industry needs, Maryland is poised to provide this workforce to prospective employees. Continued partnerships, as discussed in Section 3.0, will provide the fundamental groundwork in meeting employer demand related to implementation and operation of GGRA initiatives. However, there is no conclusive evidence that any change in the Manufacturing industry operations has been directly attributable to the GGRA.

¹²⁰ "Industries at a Glance: Computer and Electronic Product Manufacturing: NAICS 334," Bureau of Labor Statistics, date extracted on April 29, 2014, accessed April 29, 2014, <http://www.bls.gov/iag/tgs/iag334.htm>.

¹²¹ "Occupational Outlook Handbook: Computer Hardware Engineers," Bureau of Labor Statistics, last modified on January 8, 2014, accessed April 29, 2014, <http://www.bls.gov/ooh/architecture-and-engineering/computer-hardware-engineers.htm>.

¹²² Ibid.

¹²³ "Fast Facts: Income of Young Adults," National Center for Education Statistics, updated 2013, accessed April 30, 2014. <http://nces.ed.gov/fastfacts/display.asp?id=77>

¹²⁴ "Occupational Outlook Handbook: Electrical and Electronics Engineering Technicians," Bureau of Labor Statistics, last modified on January 8, 2014, accessed April 29, 2014, <http://www.bls.gov/ooh/architecture-and-engineering/electrical-and-electronics-engineering-technicians.htm>.

6.0 Conclusion

The reduction of greenhouse gas emissions is not only a statewide issue but one that extends internationally. Internationally recognizable companies such as Avon, Whirlpool, SC Johnson, and General Motors have worked with the industry to achieve reductions in greenhouse gas emissions domestically and abroad. Nationally, partnerships between industry leaders, and state and federal agencies continue to pursue greenhouse gas emissions. Regional partnerships such as those between RMI and PSC have assisted manufacturers in effectively reducing energy consumption through funding opportunities.

RESI's research indicates that the Manufacturing industry will see no discernible impacts from the greenhouse gas reduction strategies as outlined in the GGRA. In addition to this finding, RESI expects the following:

- The manufacturing industry will create 113 jobs by 2020 to meet the demand for greenhouse gas reduction.
- Sectors within the industry such as *Computer and electronic product manufacturing* and *Electrical equipment and appliance manufacturing* will see the greatest growth during this time.
- Lower skilled sectors such as *Food manufacturing* and *Textile mills* will see minimal declines in employment between 2010 and 2020.
- Wages for the industry will increase by \$10.7 million and output for the industry will grow by \$26.5 million by 2020.

Some manufacturers have implemented energy-efficient strategies as a method for reducing production costs rather than a method for achieving greenhouse gas reduction. As stated by Mr. Miller from Redland Brick, the brick industry sector has transformed its energy use over time. From wood to coal and finally to natural gas, these reductions have been more focused on reducing costs than reducing emissions. The use of natural gas rather than coal reduces emissions but also allows the producer to reduce production costs and remain competitive.

The EIA expects these energy costs to increase over the next five years. During this time, manufacturers will need to seek new methods of cost reduction to retain competitiveness. The expansion of new technologies, energy efficiency methods, and partnerships to achieve these goals at the least cost will be key in the success of the GGRA as well as the Manufacturing industry through 2020. RESI's findings indicate that workforce training will be crucial in meeting industry demand as more GGRA initiatives are implemented and fully operational by 2020.

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Appendix A—Annual Employment Impacts for the Manufacturing Industry

The following tables highlight the employment impacts associated with the GGRA to the Manufacturing industry in Maryland between 2010 and 2020.

Figure 5: Manufacturing Employment Impacts from GGRA Initiatives, 2010

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	1.3	0.0	1.3
Beverage and tobacco product manufacturing	1.6	0.0	1.6
Chemical manufacturing	10.1	0.6	10.7
Computer and electronic product manufacturing	3.7	2.5	6.2
Electrical equipment and appliance manufacturing	5.0	0.0	5
Fabricated metal product manufacturing	18.0	-0.3	17.7
Food manufacturing	2.5	-0.1	2.4
Furniture and related product manufacturing	2.2	0.2	2.4
Machinery manufacturing	1.8	0.3	2.1
Miscellaneous manufacturing	1.6	0.1	1.7
Motor vehicles, bodies and trailers, and parts manufacturing	1.7	0.0	1.7
Nonmetallic mineral product manufacturing	14.1	-0.4	13.7
Other transportation equipment manufacturing	0.5	0.1	0.6
Paper manufacturing	2.3	-0.1	2.2
Petroleum and coal products manufacturing	0.8	0.0	0.8
Plastics and rubber product manufacturing	6.0	-0.1	5.9
Primary metal manufacturing	0.6	0.2	0.8
Printing and related support activities	10.2	-0.1	10.1
Textile mills; Textile product mills	0.2	0.0	0.2
Wood product manufacturing	6.2	1.2	7.4

Sources: REMI PI+, RESI

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Figure 6: Manufacturing Employment Impacts from GGRA Initiatives, 2011

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	3.0	0.0	3.0
Beverage and tobacco product manufacturing	3.0	-0.1	2.9
Chemical manufacturing	15.7	1.2	16.9
Computer and electronic product manufacturing	21.7	22.0	43.7
Electrical equipment and appliance manufacturing	51.1	-1.1	50.0
Fabricated metal product manufacturing	30.0	0.7	30.7
Food manufacturing	4.5	-0.5	4.0
Furniture and related product manufacturing	2.1	1.6	3.7
Machinery manufacturing	-1.8	5.5	3.7
Miscellaneous manufacturing	0.8	2.3	3.1
Motor vehicles, bodies and trailers, and parts manufacturing	1.6	1.0	2.6
Nonmetallic mineral product manufacturing	23.8	-0.7	23.1
Other transportation equipment manufacturing	0.1	0.7	0.8
Paper manufacturing	3.2	-0.2	3.0
Petroleum and coal products manufacturing	1.4	0.0	1.4
Plastics and rubber product manufacturing	9.8	0.0	9.8
Primary metal manufacturing	1.0	0.3	1.3
Printing and related support activities	14.2	0.1	14.3
Textile mills; Textile product mills	0.2	0.0	0.2
Wood product manufacturing	10.4	0.8	11.2

Sources: REMI PI+, RESI

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Figure 7: Manufacturing Employment Impacts from GGRA Initiatives, 2012

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	3.7	-0.1	3.6
Beverage and tobacco product manufacturing	3.7	-0.3	3.4
Chemical manufacturing	15.9	1.2	17.1
Computer and electronic product manufacturing	10.6	11.4	21.9
Electrical equipment and appliance manufacturing	19.8	-0.2	19.6
Fabricated metal product manufacturing	32.6	-0.2	32.4
Food manufacturing	5.4	-1.1	4.3
Furniture and related product manufacturing	3.2	0.7	3.8
Machinery manufacturing	1.9	2.4	4.3
Miscellaneous manufacturing	2.5	1.0	3.5
Motor vehicles, bodies and trailers, and parts manufacturing	2.2	0.4	2.7
Nonmetallic mineral product manufacturing	26.0	-0.9	25.1
Other transportation equipment manufacturing	0.6	0.1	0.8
Paper manufacturing	3.4	-0.4	3.1
Petroleum and coal products manufacturing	1.3	0.0	1.2
Plastics and rubber product manufacturing	11.2	-0.3	10.9
Primary metal manufacturing	1.0	0.4	1.3
Printing and related support activities	16.5	-0.2	16.3
Textile mills; Textile product mills	0.3	-0.1	0.1
Wood product manufacturing	11.8	0.8	12.6

Sources: REMI PI+, RESI

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Figure 8: Manufacturing Employment Impacts from GGRA Initiatives, 2013

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	3.5	-0.1	3.4
Beverage and tobacco product manufacturing	3.6	-0.4	3.2
Chemical manufacturing	12.9	1.5	14.4
Computer and electronic product manufacturing	17.9	22.4	40.3
Electrical equipment and appliance manufacturing	44.1	-0.8	43.3
Fabricated metal product manufacturing	35.1	0.2	35.3
Food manufacturing	5.0	-3.2	1.8
Furniture and related product manufacturing	2.1	1.4	3.5
Machinery manufacturing	-1.0	5.2	4.2
Miscellaneous manufacturing	0.6	2.2	2.8
Motor vehicles, bodies and trailers, and parts manufacturing	1.6	0.9	2.5
Nonmetallic mineral product manufacturing	29.1	-1.1	28.0
Other transportation equipment manufacturing	0.0	0.3	0.3
Paper manufacturing	3.5	-0.5	3.0
Petroleum and coal products manufacturing	1.3	-0.1	1.2
Plastics and rubber product manufacturing	11.3	-0.4	10.9
Primary metal manufacturing	1.1	0.5	1.6
Printing and related support activities	15.6	-0.1	15.5
Textile mills; Textile product mills	0.2	-0.2	0.0
Wood product manufacturing	12.4	-0.1	12.3

Sources: REMI PI+, RESI

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Figure 9: Manufacturing Employment Impacts from GGRA Initiatives, 2014

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	3.9	-0.2	3.7
Beverage and tobacco product manufacturing	3.8	-0.6	3.2
Chemical manufacturing	11.4	1.7	13.1
Computer and electronic product manufacturing	11.6	15.8	27.4
Electrical equipment and appliance manufacturing	24.7	-0.3	24.5
Fabricated metal product manufacturing	27.0	-0.2	26.8
Food manufacturing	4.9	-4.9	0.0
Furniture and related product manufacturing	2.1	0.9	3.0
Machinery manufacturing	0.2	3.3	3.5
Miscellaneous manufacturing	1.2	1.3	2.6
Motor vehicles, bodies and trailers, and parts manufacturing	1.6	0.6	2.2
Nonmetallic mineral product manufacturing	22.4	-1.1	21.3
Other transportation equipment manufacturing	0.1	-0.1	0.0
Paper manufacturing	3.2	-0.7	2.5
Petroleum and coal products manufacturing	1.1	-0.1	1.0
Plastics and rubber product manufacturing	9.6	-0.4	9.1
Primary metal manufacturing	0.9	0.4	1.3
Printing and related support activities	15.6	-0.4	15.2
Textile mills; Textile product mills	0.2	-0.2	-0.1
Wood product manufacturing	9.6	-0.9	8.6

Sources: REMI PI+, RESI

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Figure 10: Manufacturing Employment Impacts from GGRA Initiatives, 2015

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	4.6	-0.2	4.4
Beverage and tobacco product manufacturing	4.7	-0.7	3.9
Chemical manufacturing	13.9	1.8	15.7
Computer and electronic product manufacturing	24.7	30.5	55.2
Electrical equipment and appliance manufacturing	53.0	-1.0	52.0
Fabricated metal product manufacturing	37.4	0.3	37.7
Food manufacturing	5.8	-6.6	-0.9
Furniture and related product manufacturing	1.7	2.0	3.7
Machinery manufacturing	-3.0	6.9	3.8
Miscellaneous manufacturing	-0.5	3.2	2.7
Motor vehicles, bodies and trailers, and parts manufacturing	1.3	1.2	2.4
Nonmetallic mineral product manufacturing	32.4	-1.6	30.8
Other transportation equipment manufacturing	-0.5	0.3	-0.2
Paper manufacturing	3.9	-0.9	3.1
Petroleum and coal products manufacturing	1.4	-0.1	1.3
Plastics and rubber product manufacturing	12.6	-0.6	12.0
Primary metal manufacturing	1.2	0.4	1.6
Printing and related support activities	19.8	-0.3	19.5
Textile mills; Textile product mills	0.1	-0.3	-0.2
Wood product manufacturing	13.2	-1.5	11.7

Sources: REMI PI+, RESI

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Figure 11: Manufacturing Employment Impacts from GGRA Initiatives, 2016

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	4.6	-0.3	4.3
Beverage and tobacco product manufacturing	4.7	-0.9	3.8
Chemical manufacturing	10.8	1.6	12.4
Computer and electronic product manufacturing	15.5	22.4	37.9
Electrical equipment and appliance manufacturing	29.1	-0.4	28.7
Fabricated metal product manufacturing	27.7	-0.3	27.4
Food manufacturing	5.5	-8.3	-2.8
Furniture and related product manufacturing	1.3	1.4	2.7
Machinery manufacturing	-1.5	4.5	3.0
Miscellaneous manufacturing	0.3	2.1	2.4
Motor vehicles, bodies and trailers, and parts manufacturing	1.2	0.8	2.0
Nonmetallic mineral product manufacturing	23.7	-1.6	22.1
Other transportation equipment manufacturing	-0.5	-0.2	-0.7
Paper manufacturing	3.5	-1.1	2.4
Petroleum and coal products manufacturing	1.2	-0.1	1.1
Plastics and rubber product manufacturing	10.1	-0.9	9.2
Primary metal manufacturing	0.9	0.2	1.1
Printing and related support activities	18.0	-0.6	17.4
Textile mills; Textile product mills	0.1	-0.4	-0.3
Wood product manufacturing	9.6	-2.5	7.1

Sources: REMI PI+, RESI

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Figure 12: Manufacturing Employment Impacts from GGRA Initiatives, 2017

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	5.1	0.0	5.0
Beverage and tobacco product manufacturing	5.8	-1.1	4.7
Chemical manufacturing	16.2	1.7	17.9
Computer and electronic product manufacturing	83.8	104.6	188.4
Electrical equipment and appliance manufacturing	145.8	-3.4	142.4
Fabricated metal product manufacturing	57.8	4.5	62.4
Food manufacturing	7.0	-9.9	-2.9
Furniture and related product manufacturing	-4.4	8.4	4.0
Machinery manufacturing	-21.2	23.2	2.0
Miscellaneous manufacturing	-13.3	14.7	1.4
Motor vehicles, bodies and trailers, and parts manufacturing	-2.7	4.1	1.4
Nonmetallic mineral product manufacturing	56.5	-2.6	53.9
Other transportation equipment manufacturing	-4.8	3.3	-1.4
Paper manufacturing	5.3	-1.0	4.3
Petroleum and coal products manufacturing	2.1	-0.2	1.9
Plastics and rubber product manufacturing	17.1	-0.6	16.5
Primary metal manufacturing	1.7	0.0	1.7
Printing and related support activities	21.6	2.0	23.5
Textile mills; Textile product mills	-0.2	-0.2	-0.5
Wood product manufacturing	20.0	-2.1	17.9

Sources: REMI PI+, RESI

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Figure 13: Manufacturing Employment Impacts from GGRA Initiatives, 2018

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	4.4	0.0	4.4
Beverage and tobacco product manufacturing	5.4	-1.4	4.1
Chemical manufacturing	11.3	1.0	12.3
Computer and electronic product manufacturing	82.0	113.4	195.5
Electrical equipment and appliance manufacturing	157.7	-3.9	153.8
Fabricated metal product manufacturing	45.0	5.2	50.2
Food manufacturing	6.4	-11.6	-5.2
Furniture and related product manufacturing	-7.3	9.4	2.2
Machinery manufacturing	-23.0	23.2	0.2
Miscellaneous manufacturing	-16.5	17.1	0.6
Motor vehicles, bodies and trailers, and parts manufacturing	-3.7	4.3	0.7
Nonmetallic mineral product manufacturing	46.4	-2.7	43.7
Other transportation equipment manufacturing	-5.9	3.7	-2.3
Paper manufacturing	4.3	-1.1	3.2
Petroleum and coal products manufacturing	1.6	-0.2	1.4
Plastics and rubber product manufacturing	13.2	-0.8	12.4
Primary metal manufacturing	1.3	-0.4	0.9
Printing and related support activities	17.5	2.7	20.2
Textile mills; Textile product mills	-0.3	-0.3	-0.6
Wood product manufacturing	15.5	-2.5	13.0

Sources: REMI PI+, RESI

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Figure 14: Manufacturing Employment Impacts from GGRA Initiatives, 2019

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	4.0	-0.3	3.7
Beverage and tobacco product manufacturing	4.7	-1.6	3.0
Chemical manufacturing	5.7	-0.5	5.1
Computer and electronic product manufacturing	22.1	45.0	67.1
Electrical equipment and appliance manufacturing	47.7	-1.1	46.7
Fabricated metal product manufacturing	26.6	0.5	27.1
Food manufacturing	5.2	-13.0	-7.7
Furniture and related product manufacturing	-1.5	3.1	1.6
Machinery manufacturing	-6.0	8.6	2.6
Miscellaneous manufacturing	-4.0	6.0	2.0
Motor vehicles, bodies and trailers, and parts manufacturing	-0.4	1.6	1.2
Nonmetallic mineral product manufacturing	24.9	-2.7	22.2
Other transportation equipment manufacturing	-2.2	0.0	-2.2
Paper manufacturing	2.9	-1.4	1.5
Petroleum and coal products manufacturing	1.0	-0.2	0.7
Plastics and rubber product manufacturing	8.3	-1.9	6.4
Primary metal manufacturing	0.8	-0.8	0.0
Printing and related support activities	13.5	0.1	13.6
Textile mills; Textile product mills	-0.1	-0.5	-0.6
Wood product manufacturing	8.3	-3.3	4.9

Sources: REMI PI+, RESI

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Figure 15: Manufacturing Employment Impacts from GGRA Initiatives, 2020

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	3.9	-0.4	3.5
Beverage and tobacco product manufacturing	4.4	-1.7	2.7
Chemical manufacturing	4.2	-1.0	3.2
Computer and electronic product manufacturing	9.3	29.2	38.5
Electrical equipment and appliance manufacturing	23.0	-0.4	22.6
Fabricated metal product manufacturing	16.3	-0.5	15.8
Food manufacturing	5.3	-13.7	-8.4
Furniture and related product manufacturing	-0.7	1.7	1.0
Machinery manufacturing	-2.9	5.2	2.4
Miscellaneous manufacturing	-1.1	3.4	2.3
Motor vehicles, bodies and trailers, and parts manufacturing	0.2	1.0	1.2
Nonmetallic mineral product manufacturing	14.3	-2.7	11.6
Other transportation equipment manufacturing	-1.5	-0.8	-2.3
Paper manufacturing	2.7	-1.5	1.2
Petroleum and coal products manufacturing	0.7	-0.3	0.5
Plastics and rubber product manufacturing	6.2	-2.2	4.0
Primary metal manufacturing	0.6	-1.0	-0.4
Printing and related support activities	14.1	-0.7	13.4
Textile mills; Textile product mills	0.0	-0.6	-0.6
Wood product manufacturing	4.9	-3.8	1.1

Sources: REMI PI+, RESI

Appendix B—Annual Output Impacts for the Manufacturing Industry

The following tables highlight the output impacts associated with the GGRA to the Manufacturing industry in Maryland between 2010 and 2020.

Figure 16: Manufacturing Output Impacts from GGRA Initiatives, 2010

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$94,903	-\$2,525	\$92,378
Beverage and tobacco product manufacturing	\$672,766	-\$3,862	\$668,904
Chemical manufacturing	\$5,167,544	\$494,917	\$5,662,461
Computer and electronic product manufacturing	\$1,265,981	\$706,372	\$1,972,353
Electrical equipment and appliance manufacturing	\$738,830	\$8,609	\$747,439
Fabricated metal product manufacturing	\$1,686,367	-\$50,148	\$1,636,219
Food manufacturing	\$894,864	\$4,124	\$898,988
Furniture and related product manufacturing	\$364,258	-\$96,868	\$267,390
Machinery manufacturing	-\$122,588	\$403,682	\$281,094
Miscellaneous manufacturing	\$261,958	\$39,613	\$301,571
Motor vehicles, bodies and trailers, and parts manufacturing	\$4,183,581	-\$3,708,946	\$474,635
Nonmetallic mineral product manufacturing	\$1,200,929	-\$35,060	\$1,165,869
Other transportation equipment manufacturing	\$165,602	\$40,459	\$206,061
Paper manufacturing	\$425,175	-\$21,491	\$403,684
Petroleum and coal products manufacturing	\$1,182,126	-\$48,639	\$1,133,487
Plastics and rubber product manufacturing	\$1,070,274	\$4,552	\$1,074,826
Primary metal manufacturing	\$229,859	\$148,953	\$378,812
Printing and related support activities	\$1,495,866	-\$17,480	\$1,478,386
Textile mills; Textile product mills	\$27,195	-\$2,692	\$24,503
Wood product manufacturing	\$491,313	\$64,966	\$556,279

Sources: REMI PI+, RESI

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Figure 17: Manufacturing Output Impacts from GGRA Initiatives, 2011

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$172,720	-\$6,734	\$165,986
Beverage and tobacco product manufacturing	\$1,341,575	-\$72,780	\$1,268,795
Chemical manufacturing	\$9,321,764	\$797,065	\$10,118,829
Computer and electronic product manufacturing	\$5,023,113	\$6,430,400	\$11,453,513
Electrical equipment and appliance manufacturing	\$8,321,291	-\$158,889	\$8,162,402
Fabricated metal product manufacturing	\$3,482,996	-\$75,425	\$3,407,571
Food manufacturing	\$2,170,760	-\$470,388	\$1,700,372
Furniture and related product manufacturing	\$440,802	\$6,320	\$447,122
Machinery manufacturing	\$466,451	\$137,517	\$603,968
Miscellaneous manufacturing	\$519,019	\$16,835	\$535,854
Motor vehicles, bodies and trailers, and parts manufacturing	\$845,439	-\$122,041	\$723,398
Nonmetallic mineral product manufacturing	\$2,512,994	-\$85,010	\$2,427,984
Other transportation equipment manufacturing	\$227,670	\$159,257	\$386,927
Paper manufacturing	\$629,966	\$16,143	\$646,109
Petroleum and coal products manufacturing	\$2,380,733	-\$54,375	\$2,326,358
Plastics and rubber product manufacturing	\$2,035,651	\$3,682	\$2,039,333
Primary metal manufacturing	\$510,022	\$310,610	\$820,632
Printing and related support activities	\$2,264,693	-\$66,287	\$2,198,406
Textile mills; Textile product mills	\$71,719	-\$25,393	\$46,326
Wood product manufacturing	\$1,032,239	\$66,287	\$1,098,526

Sources: REMI PI+, RESI

Impact Analysis of the GGRA of 2009 on Manufacturing in Maryland

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Figure 18: Manufacturing Output Impacts from GGRA Initiatives, 2012

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$227,653	-\$11,805	\$215,848
Beverage and tobacco product manufacturing	\$1,878,507	-\$164,235	\$1,714,272
Chemical manufacturing	\$11,264,988	\$1,216,700	\$12,481,688
Computer and electronic product manufacturing	\$3,340,246	\$3,315,252	\$6,655,498
Electrical equipment and appliance manufacturing	\$3,350,295	-\$3,581	\$3,346,714
Fabricated metal product manufacturing	\$5,084,786	-\$149,915	\$4,934,871
Food manufacturing	\$3,843,341	-\$1,681,702	\$2,161,639
Furniture and related product manufacturing	\$626,299	-\$44,096	\$582,203
Machinery manufacturing	\$1,002,100	-\$214,257	\$787,843
Miscellaneous manufacturing	\$918,073	-\$282,951	\$635,122
Motor vehicles, bodies and trailers, and parts manufacturing	\$1,073,565	-\$237,684	\$835,881
Nonmetallic mineral product manufacturing	\$4,084,305	-\$144,965	\$3,939,340
Other transportation equipment manufacturing	-\$1,261,570	\$1,746,332	\$484,762
Paper manufacturing	\$822,222	-\$36,180	\$786,042
Petroleum and coal products manufacturing	\$2,277,876	-\$36,635	\$2,241,241
Plastics and rubber product manufacturing	\$2,882,450	-\$11,457	\$2,870,993
Primary metal manufacturing	\$654,863	\$495,259	\$1,150,122
Printing and related support activities	\$2,734,350	-\$125,457	\$2,608,893
Textile mills; Textile product mills	\$100,785	-\$41,163	\$59,622
Wood product manufacturing	\$1,731,956	\$50,679	\$1,782,635

Sources: REMI PI+, RESI

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Figure 19: Manufacturing Output Impacts from GGRA Initiatives, 2013

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$251,512	-\$17,333	\$234,179
Beverage and tobacco product manufacturing	\$2,081,966	-\$295,504	\$1,786,462
Chemical manufacturing	\$12,530,887	\$828,774	\$13,359,661
Computer and electronic product manufacturing	\$4,957,832	\$6,140,568	\$11,098,400
Electrical equipment and appliance manufacturing	\$7,418,773	-\$100,402	\$7,318,371
Fabricated metal product manufacturing	\$5,125,728	-\$166,124	\$4,959,604
Food manufacturing	\$854,583	\$961,703	\$1,816,286
Furniture and related product manufacturing	\$605,173	-\$22,969	\$582,204
Machinery manufacturing	\$1,197,037	-\$409,985	\$787,052
Miscellaneous manufacturing	\$2,730,851	-\$2,106,407	\$624,444
Motor vehicles, bodies and trailers, and parts manufacturing	\$991,605	-\$219,685	\$771,920
Nonmetallic mineral product manufacturing	\$4,137,489	-\$182,907	\$3,954,582
Other transportation equipment manufacturing	\$1,395,170	-\$962,520	\$432,650
Paper manufacturing	\$913,107	-\$101,149	\$811,958
Petroleum and coal products manufacturing	\$2,295,401	-\$96,267	\$2,199,134
Plastics and rubber product manufacturing	\$3,076,228	-\$26,078	\$3,050,150
Primary metal manufacturing	\$1,007,213	\$493,876	\$1,501,089
Printing and related support activities	\$2,807,574	-\$186,850	\$2,620,724
Textile mills; Textile product mills	\$278,954	-\$214,447	\$64,507
Wood product manufacturing	\$1,674,523	-\$281,708	\$1,392,815

Sources: REMI PI+, RESI

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Figure 20: Manufacturing Output Impacts from GGRA Initiatives, 2014

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$274,139	-\$22,913	\$251,226
Beverage and tobacco product manufacturing	\$2,451,365	-\$564,339	\$1,887,026
Chemical manufacturing	\$16,168,286	-\$1,837,320	\$14,330,966
Computer and electronic product manufacturing	\$2,689,489	\$5,463,488	\$8,152,977
Electrical equipment and appliance manufacturing	\$4,232,302	\$18,281	\$4,250,583
Fabricated metal product manufacturing	\$4,016,429	-\$206,809	\$3,809,620
Food manufacturing	\$2,702,260	-\$1,126,998	\$1,575,262
Furniture and related product manufacturing	\$718,091	-\$155,215	\$562,876
Machinery manufacturing	\$1,024,614	-\$405,242	\$619,372
Miscellaneous manufacturing	\$482,114	\$110,122	\$592,236
Motor vehicles, bodies and trailers, and parts manufacturing	\$1,269,548	-\$578,387	\$691,161
Nonmetallic mineral product manufacturing	\$3,359,083	-\$203,029	\$3,156,054
Other transportation equipment manufacturing	\$128,712	\$266,106	\$394,818
Paper manufacturing	\$966,832	-\$215,261	\$751,571
Petroleum and coal products manufacturing	\$1,732,295	-\$105,705	\$1,626,590
Plastics and rubber product manufacturing	\$2,953,533	\$6,613	\$2,960,146
Primary metal manufacturing	\$1,083,521	\$606,923	\$1,690,444
Printing and related support activities	\$2,905,159	-\$389,393	\$2,515,766
Textile mills; Textile product mills	\$57,431	\$15,206	\$72,637
Wood product manufacturing	\$1,286,665	-\$522,494	\$764,171

Sources: REMI PI+, RESI

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Figure 21: Manufacturing Output Impacts from GGRA Initiatives, 2015

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$327,851	-\$29,535	\$298,316
Beverage and tobacco product manufacturing	\$2,336,665	-\$112,266	\$2,224,399
Chemical manufacturing	\$3,781,011	\$13,596,312	\$17,377,323
Computer and electronic product manufacturing	\$9,685,559	\$5,504,631	\$15,190,190
Electrical equipment and appliance manufacturing	\$9,128,097	-\$91,949	\$9,036,148
Fabricated metal product manufacturing	\$4,881,700	-\$283,430	\$4,598,270
Food manufacturing	\$2,965,177	-\$1,274,888	\$1,690,289
Furniture and related product manufacturing	\$980,659	-\$339,686	\$640,973
Machinery manufacturing	\$1,791,360	-\$1,106,106	\$685,254
Miscellaneous manufacturing	\$1,606,052	-\$961,202	\$644,850
Motor vehicles, bodies and trailers, and parts manufacturing	\$2,151,327	-\$1,613,560	\$537,767
Nonmetallic mineral product manufacturing	\$4,149,767	-\$308,118	\$3,841,649
Other transportation equipment manufacturing	-\$163,474	\$560,612	\$397,138
Paper manufacturing	\$1,258,261	-\$400,506	\$857,755
Petroleum and coal products manufacturing	\$2,197,149	-\$231,220	\$1,965,929
Plastics and rubber product manufacturing	\$3,749,117	-\$83,596	\$3,665,521
Primary metal manufacturing	\$1,270,825	\$781,611	\$2,052,436
Printing and related support activities	\$2,900,178	\$213,412	\$3,113,590
Textile mills; Textile product mills	\$108,233	-\$23,820	\$84,413
Wood product manufacturing	\$1,564,820	-\$738,303	\$826,517

Sources: REMI PI+, RESI

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Figure 22: Manufacturing Output Impacts from GGRA Initiatives, 2016

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$271,255	-\$37,494	\$233,761
Beverage and tobacco product manufacturing	\$2,530,208	-\$698,599	\$1,831,609
Chemical manufacturing	\$9,954,553	\$2,585,322	\$12,539,875
Computer and electronic product manufacturing	\$3,816,454	\$5,520,227	\$9,336,681
Electrical equipment and appliance manufacturing	\$5,106,054	-\$55,186	\$5,050,868
Fabricated metal product manufacturing	\$4,078,895	-\$504,299	\$3,574,596
Food manufacturing	\$3,694,064	-\$2,976,505	\$717,559
Furniture and related product manufacturing	\$205,647	\$146,930	\$352,577
Machinery manufacturing	\$1,234,626	-\$748,723	\$485,903
Miscellaneous manufacturing	\$27,626	\$366,605	\$394,231
Motor vehicles, bodies and trailers, and parts manufacturing	-\$233,556	\$452,424	\$218,868
Nonmetallic mineral product manufacturing	\$3,521,037	-\$435,120	\$3,085,917
Other transportation equipment manufacturing	\$100,828	\$84,907	\$185,735
Paper manufacturing	\$1,383,137	-\$734,514	\$648,623
Petroleum and coal products manufacturing	\$1,853,499	-\$424,105	\$1,429,394
Plastics and rubber product manufacturing	\$1,880,853	\$876,775	\$2,757,628
Primary metal manufacturing	\$1,068,608	\$447,144	\$1,515,752
Printing and related support activities	\$1,594,898	\$683,873	\$2,278,771
Textile mills; Textile product mills	\$259,256	-\$200,131	\$59,125
Wood product manufacturing	\$1,133,600	-\$929,972	\$203,628

Sources: REMI PI+, RESI

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Figure 23: Manufacturing Output Impacts from GGRA Initiatives, 2017

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$261,522	-\$28,729	\$232,793
Beverage and tobacco product manufacturing	\$3,127,804	-\$1,273,199	\$1,854,605
Chemical manufacturing	\$10,116,640	\$1,525,363	\$11,642,003
Computer and electronic product manufacturing	\$18,668,643	\$22,807,428	\$41,476,071
Electrical equipment and appliance manufacturing	\$25,481,266	-\$607,122	\$24,874,144
Fabricated metal product manufacturing	\$4,110,311	-\$549,557	\$3,560,754
Food manufacturing	\$2,467,082	-\$2,208,642	\$258,440
Furniture and related product manufacturing	\$183,264	-\$194,912	-\$11,648
Machinery manufacturing	\$7,054,717	-\$7,470,977	-\$416,260
Miscellaneous manufacturing	\$12,324,903	-\$12,438,817	-\$113,914
Motor vehicles, bodies and trailers, and parts manufacturing	\$7,346,827	-\$8,691,142	-\$1,344,315
Nonmetallic mineral product manufacturing	\$3,726,945	-\$737,582	\$2,989,363
Other transportation equipment manufacturing	-\$1,489,072	\$1,463,004	-\$26,068
Paper manufacturing	\$3,217,563	-\$2,536,655	\$680,908
Petroleum and coal products manufacturing	\$2,062,788	-\$708,029	\$1,354,759
Plastics and rubber product manufacturing	\$2,571,846	\$68,910	\$2,640,756
Primary metal manufacturing	\$2,390,261	-\$1,128,463	\$1,261,798
Printing and related support activities	\$2,056,315	\$502,472	\$2,558,787
Textile mills; Textile product mills	-\$71,767	\$85,215	\$13,448
Wood product manufacturing	\$996,381	-\$1,064,055	-\$67,674

Sources: REMI PI+, RESI

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Figure 24: Manufacturing Output Impacts from GGRA Initiatives, 2018

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$252,357	-\$32,177	\$220,180
Beverage and tobacco product manufacturing	\$2,922,896	-\$1,284,659	\$1,638,237
Chemical manufacturing	\$5,734,817	\$4,290,684	\$10,025,501
Computer and electronic product manufacturing	\$17,370,557	\$22,369,824	\$39,740,381
Electrical equipment and appliance manufacturing	\$28,036,356	-\$703,219	\$27,333,137
Fabricated metal product manufacturing	\$1,514,875	\$1,343,401	\$2,858,276
Food manufacturing	\$5,959,473	-\$6,153,599	-\$194,126
Furniture and related product manufacturing	\$5,271,158	-\$5,522,391	-\$251,233
Machinery manufacturing	-\$103,083,527	\$102,230,974	-\$852,553
Miscellaneous manufacturing	-\$186,036,880	\$185,575,972	-\$460,908
Motor vehicles, bodies and trailers, and parts manufacturing	-\$47,911,394	\$46,142,299	-\$1,769,095
Nonmetallic mineral product manufacturing	\$16,466,157	-\$13,932,561	\$2,533,596
Other transportation equipment manufacturing	-\$1,251,104	\$1,048,773	-\$202,331
Paper manufacturing	-\$934,274	\$1,541,811	\$607,537
Petroleum and coal products manufacturing	\$2,061,569	-\$1,047,719	\$1,013,850
Plastics and rubber product manufacturing	\$2,436,338	-\$235,389	\$2,200,949
Primary metal manufacturing	-\$421,842	\$1,361,164	\$939,322
Printing and related support activities	\$1,617,420	\$609,151	\$2,226,571
Textile mills; Textile product mills	-\$56,346	\$43,389	-\$12,957
Wood product manufacturing	\$593,083	-\$1,025,069	-\$431,986

Sources: REMI PI+, RESI

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Figure 25: Manufacturing Output Impacts from GGRA Initiatives, 2019

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$227,381	-\$38,499	\$188,882
Beverage and tobacco product manufacturing	\$1,861,513	-\$371,444	\$1,490,069
Chemical manufacturing	\$8,628,825	-\$545,061	\$8,083,764
Computer and electronic product manufacturing	\$4,271,675	\$6,064,376	\$10,336,051
Electrical equipment and appliance manufacturing	\$8,697,316	-\$245,073	\$8,452,243
Fabricated metal product manufacturing	\$346,863	\$1,838,945	\$2,185,808
Food manufacturing	\$9,154,797	-\$9,893,362	-\$738,565
Furniture and related product manufacturing	\$1,452,869	-\$1,496,097	-\$43,228
Machinery manufacturing	\$2,210,542	-\$2,359,087	-\$148,545
Miscellaneous manufacturing	\$1,872,284	-\$1,944,182	-\$71,898
Motor vehicles, bodies and trailers, and parts manufacturing	\$2,755,307	-\$3,275,326	-\$520,019
Nonmetallic mineral product manufacturing	\$1,497,307	\$536,369	\$2,033,676
Other transportation equipment manufacturing	\$329,684	-\$462,086	-\$132,402
Paper manufacturing	-\$311,302	\$770,491	\$459,189
Petroleum and coal products manufacturing	\$3,137,543	-\$2,559,628	\$577,915
Plastics and rubber product manufacturing	\$2,781,636	-\$1,075,439	\$1,706,197
Primary metal manufacturing	-\$293,527	\$998,181	\$704,654
Printing and related support activities	\$1,315,287	\$177,773	\$1,493,060
Textile mills; Textile product mills	\$61,414	-\$48,362	\$13,052
Wood product manufacturing	\$503,621	-\$1,282,048	-\$778,427

Sources: REMI PI+, RESI

Impact Analysis of the GGRA of 2009 on Manufacturing in Maryland

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Figure 26: Manufacturing Output Impacts from GGRA Initiatives, 2020

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$213,645	-\$38,618	\$175,027
Beverage and tobacco product manufacturing	\$1,931,614	-\$423,644	\$1,507,970
Chemical manufacturing	\$6,739,902	\$1,829,887	\$8,569,789
Computer and electronic product manufacturing	\$1,836,413	\$2,108,593	\$3,945,006
Electrical equipment and appliance manufacturing	\$4,378,054	-\$128,919	\$4,249,135
Fabricated metal product manufacturing	\$2,347,909	-\$8,334	\$2,339,575
Food manufacturing	\$34,898,986	-\$35,919,825	-\$1,020,839
Furniture and related product manufacturing	-\$1,245,385	\$1,238,741	-\$6,644
Machinery manufacturing	\$1,222,865	-\$1,213,066	\$9,799
Miscellaneous manufacturing	\$1,214,402	-\$1,124,451	\$89,951
Motor vehicles, bodies and trailers, and parts manufacturing	\$1,463,898	-\$1,647,134	-\$183,236
Nonmetallic mineral product manufacturing	\$1,766,294	\$410,368	\$2,176,662
Other transportation equipment manufacturing	\$1,775,479	-\$1,865,199	-\$89,720
Paper manufacturing	\$520,176	\$7,570	\$527,746
Petroleum and coal products manufacturing	\$2,934,225	-\$2,128,244	\$805,981
Plastics and rubber product manufacturing	\$3,420,268	-\$1,553,721	\$1,866,547
Primary metal manufacturing	-\$53,062	\$663,211	\$610,149
Printing and related support activities	\$1,597,468	\$178,777	\$1,776,245
Textile mills; Textile product mills	\$93,151	-\$75,113	\$18,038
Wood product manufacturing	\$1,238,096	-\$2,137,476	-\$899,380

Sources: REMI PI+, RESI

Appendix C—Annual Wage Impacts for the Manufacturing Industry

The following tables highlight the wage impacts associated with the GGRA to the Manufacturing industry in Maryland between 2010 and 2020.

Figure 27: Manufacturing Wage Impacts from GGRA Initiatives, 2010

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$31,752	-\$795	\$30,957
Beverage and tobacco product manufacturing	\$83,802	-\$2,003	\$81,799
Chemical manufacturing	\$814,488	\$46,336	\$860,823
Computer and electronic product manufacturing	\$1,049,388	\$26,216	\$1,075,605
Electrical equipment and appliance manufacturing	\$259,106	-\$191	\$258,915
Fabricated metal product manufacturing	\$480,081	-\$13,961	\$466,120
Food manufacturing	\$238,633	-\$32,827	\$205,806
Furniture and related product manufacturing	\$89,403	-\$19,512	\$69,891
Machinery manufacturing	\$30,828	\$95,365	\$126,193
Miscellaneous manufacturing	\$87,557	\$7,880	\$95,437
Motor vehicles, bodies and trailers, and parts manufacturing	\$349,847	-\$282,522	\$67,325
Nonmetallic mineral product manufacturing	\$288,208	-\$8,711	\$279,497
Other transportation equipment manufacturing	\$153,438	-\$40,440	\$112,998
Paper manufacturing	\$104,224	-\$5,350	\$98,874
Petroleum and coal products manufacturing	\$41,244	-\$1,708	\$39,536
Plastics and rubber product manufacturing	\$238,722	-\$3,532	\$235,190
Primary metal manufacturing	\$52,826	\$5,895	\$58,721
Printing and related support activities	\$458,069	-\$4,255	\$453,814
Textile mills; Textile product mills	\$17,083	-\$4,494	\$12,589
Wood product manufacturing	\$80,160	\$11,322	\$91,483

Sources: REMI PI+, RESI

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Figure 28: Manufacturing Wage Impacts from GGRA Initiatives, 2011

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$64,359	-\$2,295	\$62,064
Beverage and tobacco product manufacturing	\$199,135	-\$17,359	\$181,776
Chemical manufacturing	\$1,603,562	\$18,648	\$1,622,210
Computer and electronic product manufacturing	\$641,910	\$6,137,928	\$6,779,839
Electrical equipment and appliance manufacturing	\$2,935,886	-\$64,804	\$2,871,082
Fabricated metal product manufacturing	\$1,021,080	-\$21,033	\$1,000,047
Food manufacturing	\$839,280	-\$379,045	\$460,236
Furniture and related product manufacturing	\$140,174	-\$3,684	\$136,490
Machinery manufacturing	\$231,776	\$73,895	\$305,670
Miscellaneous manufacturing	\$174,238	\$18,682	\$192,919
Motor vehicles, bodies and trailers, and parts manufacturing	\$129,324	\$360	\$129,683
Nonmetallic mineral product manufacturing	\$602,113	-\$21,510	\$580,603
Other transportation equipment manufacturing	-\$45,140	\$304,882	\$259,742
Paper manufacturing	\$187,954	-\$13,206	\$174,748
Petroleum and coal products manufacturing	\$83,397	-\$1,965	\$81,432
Plastics and rubber product manufacturing	\$507,421	-\$14,708	\$492,713
Primary metal manufacturing	\$195,630	-\$63,163	\$132,467
Printing and related support activities	\$761,471	-\$19,592	\$741,879
Textile mills; Textile product mills	\$99,382	-\$69,535	\$29,848
Wood product manufacturing	\$172,940	\$13,094	\$186,035

Sources: REMI PI+, RESI

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Figure 29: Manufacturing Wage Impacts from GGRA Initiatives, 2012

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$92,201	-\$4,413	\$87,787
Beverage and tobacco product manufacturing	\$311,118	-\$45,527	\$265,591
Chemical manufacturing	\$2,109,066	-\$60,226	\$2,048,840
Computer and electronic product manufacturing	\$1,722,385	\$2,302,458	\$4,024,843
Electrical equipment and appliance manufacturing	\$1,203,645	-\$15,924	\$1,187,720
Fabricated metal product manufacturing	\$1,520,733	-\$42,919	\$1,477,814
Food manufacturing	\$1,764,470	-\$1,098,482	\$665,988
Furniture and related product manufacturing	\$220,929	-\$21,802	\$199,127
Machinery manufacturing	\$449,929	-\$43,545	\$406,383
Miscellaneous manufacturing	\$358,362	-\$103,245	\$255,117
Motor vehicles, bodies and trailers, and parts manufacturing	\$175,464	-\$6,091	\$169,373
Nonmetallic mineral product manufacturing	\$976,182	-\$36,222	\$939,960
Other transportation equipment manufacturing	\$422,206	-\$40,990	\$381,216
Paper manufacturing	\$257,729	-\$26,235	\$231,494
Petroleum and coal products manufacturing	\$92,157	-\$1,430	\$90,727
Plastics and rubber product manufacturing	\$765,000	-\$37,196	\$727,805
Primary metal manufacturing	\$293,844	-\$96,805	\$197,039
Printing and related support activities	\$970,864	-\$38,938	\$931,926
Textile mills; Textile product mills	\$88,722	-\$43,439	\$45,283
Wood product manufacturing	\$290,657	\$11,004	\$301,661

Sources: REMI PI+, RESI

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Figure 30: Manufacturing Wage Impacts from GGRA Initiatives, 2013

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$106,737	-\$6,850	\$99,887
Beverage and tobacco product manufacturing	\$387,835	-\$73,467	\$314,368
Chemical manufacturing	\$2,448,878	-\$387,237	\$2,061,641
Computer and electronic product manufacturing	\$2,857,241	\$4,366,951	\$7,224,192
Electrical equipment and appliance manufacturing	\$2,749,000	-\$66,157	\$2,682,843
Fabricated metal product manufacturing	\$1,608,243	-\$49,273	\$1,558,970
Food manufacturing	-\$383,121	\$1,091,305	\$708,184
Furniture and related product manufacturing	\$383,856	-\$179,546	\$204,310
Machinery manufacturing	\$527,382	-\$73,750	\$453,632
Miscellaneous manufacturing	\$1,490,033	-\$1,200,321	\$289,712
Motor vehicles, bodies and trailers, and parts manufacturing	\$188,051	-\$16,418	\$171,633
Nonmetallic mineral product manufacturing	\$1,029,939	-\$48,020	\$981,919
Other transportation equipment manufacturing	-\$302,310	\$734,632	\$432,322
Paper manufacturing	\$316,737	-\$47,027	\$269,710
Petroleum and coal products manufacturing	\$100,578	-\$3,826	\$96,752
Plastics and rubber product manufacturing	\$825,178	-\$48,105	\$777,073
Primary metal manufacturing	\$112,662	\$125,801	\$238,463
Printing and related support activities	\$1,100,932	-\$54,790	\$1,046,142
Textile mills; Textile product mills	\$175,818	-\$125,176	\$50,642
Wood product manufacturing	\$297,513	-\$26,262	\$271,251

Sources: REMI PI+, RESI

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Figure 31: Manufacturing Wage Impacts from GGRA Initiatives, 2014

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$106,349	-\$9,232	\$97,118
Beverage and tobacco product manufacturing	\$505,962	-\$209,843	\$296,119
Chemical manufacturing	\$3,418,328	-\$1,397,168	\$2,021,161
Computer and electronic product manufacturing	\$1,019,198	\$4,274,849	\$5,294,047
Electrical equipment and appliance manufacturing	\$1,587,013	-\$4,494	\$1,582,520
Fabricated metal product manufacturing	\$1,342,349	-\$56,843	\$1,285,506
Food manufacturing	\$1,718,509	-\$1,225,305	\$493,204
Furniture and related product manufacturing	\$302,418	-\$106,144	\$196,274
Machinery manufacturing	\$594,195	-\$193,904	\$400,291
Miscellaneous manufacturing	\$19,434	\$211,600	\$231,034
Motor vehicles, bodies and trailers, and parts manufacturing	\$173,974	-\$18,667	\$155,307
Nonmetallic mineral product manufacturing	\$1,068,040	-\$55,146	\$1,012,893
Other transportation equipment manufacturing	-\$33,623	\$451,464	\$417,841
Paper manufacturing	\$290,903	-\$62,464	\$228,439
Petroleum and coal products manufacturing	\$85,647	-\$4,268	\$81,379
Plastics and rubber product manufacturing	\$803,884	-\$78,018	\$725,866
Primary metal manufacturing	\$364,144	-\$130,554	\$233,589
Printing and related support activities	\$1,118,724	-\$92,237	\$1,026,486
Textile mills; Textile product mills	-\$170,856	\$218,552	\$47,696
Wood product manufacturing	\$305,658	-\$61,100	\$244,558

Sources: REMI PI+, RESI

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Figure 32: Manufacturing Wage Impacts from GGRA Initiatives, 2015

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$124,804	-\$11,574	\$113,230
Beverage and tobacco product manufacturing	\$30,042	\$305,639	\$335,680
Chemical manufacturing	\$332,876	\$2,113,835	\$2,446,711
Computer and electronic product manufacturing	\$7,477,982	\$2,738,498	\$10,216,481
Electrical equipment and appliance manufacturing	\$3,526,396	-\$87,249	\$3,439,147
Fabricated metal product manufacturing	\$1,614,689	-\$80,532	\$1,534,156
Food manufacturing	-\$3,118,075	\$3,624,845	\$506,770
Furniture and related product manufacturing	\$457,740	-\$238,171	\$219,570
Machinery manufacturing	\$1,449,639	-\$1,042,140	\$407,499
Miscellaneous manufacturing	\$229,597	\$37,771	\$267,368
Motor vehicles, bodies and trailers, and parts manufacturing	\$212,601	-\$40,342	\$172,259
Nonmetallic mineral product manufacturing	\$1,266,581	-\$79,868	\$1,186,713
Other transportation equipment manufacturing	-\$101,389	\$588,141	\$486,752
Paper manufacturing	\$370,471	-\$97,694	\$272,777
Petroleum and coal products manufacturing	\$115,520	-\$9,440	\$106,080
Plastics and rubber product manufacturing	\$990,006	-\$146,413	\$843,593
Primary metal manufacturing	\$208,227	\$57,343	\$265,570
Printing and related support activities	\$1,273,313	-\$86,342	\$1,186,971
Textile mills; Textile product mills	-\$54,213	\$105,942	\$51,729
Wood product manufacturing	\$294,595	-\$92,612	\$201,982

Sources: REMI PI+, RESI

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Figure 33: Manufacturing Wage Impacts from GGRA Initiatives, 2016

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$124,331	-\$20,503	\$103,828
Beverage and tobacco product manufacturing	\$317,091	-\$8,093	\$308,998
Chemical manufacturing	\$1,192,499	\$306,794	\$1,499,293
Computer and electronic product manufacturing	\$2,385,912	\$4,483,764	\$6,869,676
Electrical equipment and appliance manufacturing	\$1,978,879	-\$15,403	\$1,963,476
Fabricated metal product manufacturing	\$1,396,050	-\$162,590	\$1,233,459
Food manufacturing	-\$1,038,027	\$1,384,149	\$346,122
Furniture and related product manufacturing	-\$972,187	\$1,122,941	\$150,754
Machinery manufacturing	\$355,852	-\$36,040	\$319,812
Miscellaneous manufacturing	-\$1,081,302	\$1,286,830	\$205,528
Motor vehicles, bodies and trailers, and parts manufacturing	\$63,431	\$51,299	\$114,730
Nonmetallic mineral product manufacturing	\$919,502	-\$116,847	\$802,655
Other transportation equipment manufacturing	\$72,820	\$314,831	\$387,651
Paper manufacturing	\$364,107	-\$169,172	\$194,935
Petroleum and coal products manufacturing	\$91,412	-\$18,107	\$73,306
Plastics and rubber product manufacturing	\$580,696	\$175,869	\$756,565
Primary metal manufacturing	\$58,837	\$136,284	\$195,121
Printing and related support activities	\$757,136	\$229,042	\$986,178
Textile mills; Textile product mills	-\$864	\$43,809	\$42,945
Wood product manufacturing	\$289,822	-\$132,844	\$156,978

Sources: REMI PI+, RESI

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Figure 34: Manufacturing Wage Impacts from GGRA Initiatives, 2017

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$131,969	-\$30,523	\$101,445
Beverage and tobacco product manufacturing	\$376,986	-\$71,920	\$305,067
Chemical manufacturing	-\$1,343,875	\$2,772,524	\$1,428,649
Computer and electronic product manufacturing	\$15,191,860	\$19,468,494	\$34,660,353
Electrical equipment and appliance manufacturing	\$10,234,696	-\$262,523	\$9,972,173
Fabricated metal product manufacturing	\$1,408,095	-\$135,992	\$1,272,103
Food manufacturing	-\$225,199	\$394,257	\$169,058
Furniture and related product manufacturing	\$214,010	-\$123,043	\$90,967
Machinery manufacturing	\$1,759,791	-\$1,694,346	\$65,445
Miscellaneous manufacturing	\$1,809,360	-\$1,702,714	\$106,646
Motor vehicles, bodies and trailers, and parts manufacturing	\$374,788	-\$342,461	\$32,328
Nonmetallic mineral product manufacturing	\$961,687	-\$170,015	\$791,672
Other transportation equipment manufacturing	-\$87,697	\$354,217	\$266,519
Paper manufacturing	\$563,713	-\$361,925	\$201,788
Petroleum and coal products manufacturing	\$96,682	-\$28,808	\$67,874
Plastics and rubber product manufacturing	\$877,685	-\$149,252	\$728,433
Primary metal manufacturing	\$274,622	-\$100,232	\$174,390
Printing and related support activities	\$943,180	\$149,102	\$1,092,282
Textile mills; Textile product mills	-\$10,725	\$40,876	\$30,152
Wood product manufacturing	\$218,977	-\$166,301	\$52,675

Sources: REMI PI+, RESI

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Figure 35: Manufacturing Wage Impacts from GGRA Initiatives, 2018

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$83,577	\$284	\$83,861
Beverage and tobacco product manufacturing	\$459,797	-\$203,421	\$256,375
Chemical manufacturing	-\$14,341	\$1,214,995	\$1,200,654
Computer and electronic product manufacturing	\$15,625,723	\$21,405,361	\$37,031,084
Electrical equipment and appliance manufacturing	\$11,619,208	-\$280,979	\$11,338,229
Fabricated metal product manufacturing	\$157,290	\$912,446	\$1,069,736
Food manufacturing	\$568,696	-\$557,249	\$11,447
Furniture and related product manufacturing	\$2,832,442	-\$2,808,608	\$23,834
Machinery manufacturing	-\$24,052,933	\$23,970,090	-\$82,843
Miscellaneous manufacturing	-\$26,803,351	\$26,815,836	\$12,485
Motor vehicles, bodies and trailers, and parts manufacturing	-\$1,836,745	\$1,844,798	\$8,053
Nonmetallic mineral product manufacturing	\$1,594,329	-\$922,408	\$671,921
Other transportation equipment manufacturing	-\$232,763	\$416,471	\$183,708
Paper manufacturing	\$58,451	\$116,360	\$174,811
Petroleum and coal products manufacturing	\$98,266	-\$44,091	\$54,175
Plastics and rubber product manufacturing	\$580,499	\$40,301	\$620,800
Primary metal manufacturing	\$11,762	\$131,162	\$142,924
Printing and related support activities	\$395,754	\$584,606	\$980,360
Textile mills; Textile product mills	-\$5,992	\$24,579	\$18,587
Wood product manufacturing	\$157,413	-\$142,374	\$15,039

Sources: REMI PI+, RESI

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Figure 36: Manufacturing Wage Impacts from GGRA Initiatives, 2019

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$75,067	-\$8,216	\$66,850
Beverage and tobacco product manufacturing	\$87,359	\$110,338	\$197,697
Chemical manufacturing	\$9,378,203	-\$8,610,795	\$767,409
Computer and electronic product manufacturing	\$4,089,844	\$7,439,774	\$11,529,618
Electrical equipment and appliance manufacturing	\$3,657,725	-\$115,540	\$3,542,185
Fabricated metal product manufacturing	\$807,662	\$262,704	\$1,070,366
Food manufacturing	-\$167,261	-\$45,717	-\$212,978
Furniture and related product manufacturing	-\$43,186	\$72,353	\$29,167
Machinery manufacturing	\$483,898	-\$416,258	\$67,640
Miscellaneous manufacturing	\$356,165	-\$300,913	\$55,252
Motor vehicles, bodies and trailers, and parts manufacturing	\$142,040	-\$92,235	\$49,805
Nonmetallic mineral product manufacturing	\$594,689	\$116,894	\$711,583
Other transportation equipment manufacturing	\$151,113	-\$6,566	\$144,547
Paper manufacturing	-\$75,143	\$190,334	\$115,192
Petroleum and coal products manufacturing	\$178,536	-\$145,228	\$33,308
Plastics and rubber product manufacturing	\$1,208,731	-\$817,855	\$390,876
Primary metal manufacturing	-\$66,626	\$135,495	\$68,869
Printing and related support activities	\$474,823	\$137,616	\$612,439
Textile mills; Textile product mills	\$10,272	\$2,947	\$13,219
Wood product manufacturing	\$170,706	-\$202,718	-\$32,012

Sources: REMI PI+, RESI

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Figure 37: Manufacturing Wage Impacts from GGRA Initiatives, 2020

Manufacturing Sector	Direct	Indirect/Induced	Total
Apparel manufacturing; Leather and allied product manufacturing	\$67,541	-\$7,935	\$59,606
Beverage and tobacco product manufacturing	\$130,895	\$25,425	\$156,321
Chemical manufacturing	\$443,825	\$139,011	\$582,837
Computer and electronic product manufacturing	\$1,685,521	\$3,862,656	\$5,548,178
Electrical equipment and appliance manufacturing	\$1,825,196	-\$59,269	\$1,765,927
Fabricated metal product manufacturing	\$1,057,189	-\$59,759	\$997,431
Food manufacturing	\$663,109	-\$1,018,840	-\$355,731
Furniture and related product manufacturing	-\$262,103	\$284,368	\$22,265
Machinery manufacturing	\$268,869	-\$178,872	\$89,997
Miscellaneous manufacturing	-\$188,135	\$220,202	\$32,067
Motor vehicles, bodies and trailers, and parts manufacturing	\$83,647	-\$44,139	\$39,508
Nonmetallic mineral product manufacturing	\$604,918	\$72,718	\$677,636
Other transportation equipment manufacturing	\$277,546	-\$166,669	\$110,877
Paper manufacturing	\$508,840	-\$420,837	\$88,003
Petroleum and coal products manufacturing	\$101,596	-\$79,035	\$22,561
Plastics and rubber product manufacturing	-\$228,819	\$536,758	\$307,939
Primary metal manufacturing	-\$41,682	\$74,578	\$32,896
Printing and related support activities	\$284,661	\$212,314	\$496,975
Textile mills; Textile product mills	-\$116,148	\$124,413	\$8,266
Wood product manufacturing	\$277,286	-\$352,867	-\$75,581

Sources: REMI PI+, RESI

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