

JOBS IN THE ENVIRONMENTAL INDUSTRY IN OHIO AND THE UNITED STATES

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TABLE OF CONTENTS

LIST OF TABLES	iv
LIST OF FIGURES	iv
EXECUTIVE SUMMARY	v
I. INTRODUCTION	1
II. THE U.S. ENVIRONMENTAL PROTECTION INDUSTRY AND RELATED JOBS	3
II.A. Emergence of the Environmental Protection Industry	3
II.B. Environmental Protection as a Recession Proof Industry	5
II.C. The Current Size and Structure of the Industry	6
II.D. Prospects for the Future	7
III. DEFINING AND ESTIMATING ENVIRONMENTAL JOBS	10
III.A. What Constitutes an Environmental Job?	10
III.B. The Types of Jobs Created in the Environmental Industry	12
III.C. The Jobs Distribution in Typical Environmental Companies	15
IV. THE OHIO ECONOMY IN 2003	19
V. THE ENVIRONMENTAL INDUSTRY AND JOBS IN OHIO	22
V.A. Summary of the Environmental Industry and Jobs in Ohio	22
V.B. Environmental Jobs in Ohio by Industrial Sector	23
V.C. Environmental Jobs in Ohio by Occupation and Skill	25
V.D. The Environmental Industry as an Economic Driver for Ohio	30

TABLE OF CONTENTS
(Continued)

VI.	SUMMARY PROFILES OF SELECTED OHIO ENVIRONMENTAL COMPANIES	32
VI.A.	Aqua Tech Environmental Laboratories Inc.	32
VI.B.	BWXT of Ohio	32
VI.C.	Environmental Quality Management	35
VI.D.	EXTOL Insulation Systems	35
VI.E.	First Solar, LLC	36
VI.F.	FORRY	37
VI.G.	Gelles Laboratories	38
VI.H.	Malcolm Pirnie	39
VI.I.	Midwest Environmental Control	41
VI.J.	Venture Lighting	41
VI.K.	Wastequip	42
VI.L.	YSI	43
VII.	OPPORTUNITIES IN OHIO STATE GOVERNMENT PROGRAMS FOR ENCOURAGING ENVIRONMENT-RELATED JOBS	45
VII.A.	State Government Perceptions on Jobs and the Environment	44
VII.B.	Opportunities: Possible State Initiatives That Could be Used to Encourage Environment-Related Industries and Jobs and Maximize Benefits	46
VII.B.1.	The Third Frontier Project	46
VII.B.2.	The Research and Development Investment Loan Fund	47
VII.B.3.	The Clean Ohio Fund	47
VII.B.4.	Governor's Office of Science and Technology	48
VII.B.5.	The Edison Technology Centers	48
VII.B.6.	Percentage of Income Payment Plan	49
VII.B.7.	Energy Efficiency Skills for Professionals	50
VII.B.8.	National Center for Industrial Competitiveness Capital Fund	50
VII.B.9.	The Innovation Ohio Fund	50
VII.B.10.	Technology Investment Tax Credit Program	50
VII.B.11.	Defense Conversion Assistance Program	51
VII.C.	Ohio Coal Development Office -- Support Dwarfs That For the Environmental Industry	51
VII.D.	Examples of State Assistance to Environment-Related Industries	52
VII.D.1.	Fuel Cells	52
VII.D.2.	Photovoltaics	54

TABLE OF CONTENTS
(Continued)

VIII. SUMMARY OF MAJOR FINDINGS	55
BIBLIOGRAPHY	59
APPENDIX: U.S. COMMERCE DEPARTMENT ESTIMATES OF THE ENVIRONMENTAL INDUSTRY IN OHIO	67
BUILDING DIAGNOSTICS RESEARCH INSTITUTE, INC.	72
MANAGEMENT INFORMATION SERVICES, INC.	72

LIST OF TABLES

1.	Environmental Protection Expenditures and Jobs in the U.S. Economy, 1970 - 2020	3
2.	Typical Employee Profile of a 100-person Environmental Remediation Services Company, 2003	17
3.	Typical Employee Profile of a 250-person Wind Turbine Manufacturing Company, 2003	18
4.	Earnings by Industry of Employment in Ohio and the U.S. in 2003	21
5.	Jobs in Ohio in 2003, by Industry, including Environmental Employment	23
6.	Environmental Jobs Generated in Ohio in 2003, by Selected Occupations	26
7.	Summary of the Select Ohio Environmental Companies Profiled	33
A.1.	U.S. Department of Commerce Estimates of the U.S. and Ohio Environmental Industries, 1999	68
A.2.	U.S. Department of Commerce Estimates of the Ohio Environmental Industry by Metropolitan Statistical Areas, 1999	69
A.3.	Pollution Abatement Costs and Expenditures Estimates for Ohio and the U.S. From the Census MA200 Survey, 1999	70

LIST OF FIGURES

1.	The Environmental Job Spectrum	13
2.	Selected U.S. Jobs Created in 2003 by Environmental Expenditures	14

EXECUTIVE SUMMARY

Objective of the Report

The objective of this report is to examine and describe the environmental industry and its jobs impact and jobs creation potential in the state of Ohio, and to provide national context on the U.S. environmental industry as a whole.

The relationship between jobs and the environment is important to examine, in view of the size of the environmental industry and because the jobs impact of environmental management has been at times controversial. The report aims to examine the “trade-off” between jobs and environmental protection and highlight specific examples of how the environmental industry in Ohio and nationally has had, and could have, jobs benefits. Therefore, this report:

- Assesses the current size of the environmental industry and related jobs in the U.S. and the prospects for the future
- Analyzes the concept and definition of an “environmental job”
- Estimates the size and the industrial sector composition of the environmental industry in Ohio in 2003
- Estimates the jobs created in Ohio in 2003 by environmental protection and their importance to the state economy
- Estimates the occupation and skill levels of these jobs
- Identifies a sample of typical environmental companies in Ohio, the products and services they provide, their geographic location, and the number of jobs they create
- Identifies state government initiatives and policies that could facilitate further development of environmental industries in Ohio
- Discusses how encouraging environmental and related industries in Ohio could form an integral part of state economic development strategy
- Presents findings and conclusions

Findings -- The National Context

MISI has extensive experience analyzing the environmental industry. We have found that, over the past four decades, protection of the environment has grown rapidly to become a major sales-generating, profit-making, job-creating U.S. industry. Yet, we have also found that the importance of the environmental industry to the U.S. economy is still not fully understood by policy makers or the public at large.

MISI estimates that in 2003 protecting the environment generated \$301 billion in total industry sales, \$20 billion in corporate profits, 4.97 million jobs, and \$45 billion in Federal, state, and local government tax revenues. Moreover, the industry transcends traditional understanding of “green jobs,” often wrongly assumed to be jobs for people to plant trees or clean up toxic waste sites or pollution accidents. (All estimates of the size of the environmental industry and jobs impact rely upon definitions used. MISI estimates rely upon the definitions in Chapter III.)

The environmental industry will continue to grow for the foreseeable future. MISI forecasts that in the U.S. real expenditures (2003 dollars) will increase from \$301 billion in 2003 to \$357 billion in 2010, \$398 billion in 2015, and \$442 billion in 2020; environmental employment will increase from 4.97 million jobs in 2003 to 5.39 million jobs in 2010, 5.76 million jobs in 2015, and 6.38 million jobs in 2020.

Environmental protection created nearly five million jobs in the U.S. in 2003, and these were distributed widely throughout all states and regions in the U.S. The vast majority of the jobs created by environmental protection are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc., and most of the persons employed in these jobs may not even realize that they owe their livelihood to protecting the environment.

Environmental protection is a large and growing industry in Ohio, and MISI estimates that in 2003:

- Sales due to environmental industries in Ohio totaled \$12.2 billion
- The number of environment-related jobs in the state totaled more than 176,000
- The environmental industry in Ohio generated 3.2 percent of gross state product
- Environment-related jobs comprised 3.3 percent of total Ohio employment

- Ohio environmental industries generated 4.1 percent of the sales of the U.S. environmental industry
- With 3.9 percent of the nation's population, employment earnings in the Ohio manufacturing sector account for almost six percent of manufacturing earnings nationally.
- Environment-related jobs in Ohio comprised 3.5 percent of the total number of environment-related jobs in the U.S.
- Environment-related employment in the state has been increasing in recent years between one and two percent annually.

Most of the environmental jobs in Ohio are in the private sector, and these are heavily concentrated in several sectors, including manufacturing, professional, scientific, and technical services, and educational services.

Types of Environmental Jobs in Ohio

Environmental jobs in Ohio are widely distributed through all occupations and skill levels, and requirements for virtually all occupations are generated by environmental expenditures. Thus, in Ohio as in the U.S. generally, the vast majority of the jobs created by environmental protection are standard jobs for all occupations.

Nevertheless, we found that, in Ohio, the importance of environmental expenditures for jobs in some occupations is greater than for others. For some occupations, such as environmental scientists and specialists, environmental engineers, hazardous materials workers, water and liquid waste treatment plant operators, environmental science protection technicians, refuse and recyclable material collectors, and environmental engineering technicians, virtually all of the demand in Ohio is created by environmental protection activities.

However, in occupations not traditionally identified as environment-related, a significant share of the jobs is also generated by environmental protection. While, on average, environment-related employment in Ohio comprises only 3.3 percent of total employment, in 2003 environmental protection generated jobs for a larger than average share of many professional, scientific, high-tech, and skilled workers in the state.

Our survey of existing environmental companies in Ohio revealed a wide range of firms, and they are located throughout the state, in major urban centers, suburbs, small towns, and rural areas; they range in size from small firms of 25 employees to large firms employing thousands; they are engaged in a wide variety of activities, including remediation, manufacturing, testing, monitoring, analysis, etc.; and they include some of the most sophisticated, high-tech firms in the state. A number of these firms have created significant numbers of new jobs over the past six months, and one of

them is in the process of quadrupling its manufacturing capacity – at a time when Ohio has been consistently losing jobs, especially in manufacturing.

Salience of the Jobs-Environment Link in Ohio at the Policy Level

We found that Ohio state government policy continues to project a general presumption that environmental protection and economic development/job creation may be incompatible and present opposing goals and constituencies. This presumption is not supported by empirical data and is inconsistent with the importance and potential of the environmental industry in Ohio for positive jobs impact. We identified a number of existing state initiatives and interventions that could be used to assist the environmental industry and create jobs.

Key Points

First, contrary to common perception, most of the jobs created by environmental protection – both nationwide and in Ohio -- are *not* for “environmental specialists.” The vast majority of the jobs created by environmental protection are standard jobs for a wide variety of occupations.

Second, as noted above, environmental jobs in Ohio are concentrated within a number of sectors, including manufacturing and professional, scientific, and technical services. This is significant because Ohio is one of the most manufacturing-intensive states in the nation and is currently very concerned with preserving, modernizing, and expanding its manufacturing base. Environmental protection offers a means of doing this, and investments in the environment can greatly assist Ohio’s manufacturing sector.

Third, since the late 1960s, protection of the environment has grown rapidly to become a major U.S. industry. Protection of the environment and remediation of environmental problems will continue to be a growing and profitable industry in the U.S., and astute business and labor leaders, government officials, and policymakers in Ohio – and in other states – should be cognizant of this.

Fourth, all regions and states benefit substantially from environmental expenditures. Many of the economic and employment benefits flow directly to states – such as Ohio -- whose policymakers and government officials often see only costs and disadvantages from environmental protection. Yet, these policymakers and the public should welcome information that environmental protection offers substantial opportunities for economic development and job creation.

Fifth, investments in environmental protection will create large numbers of jobs for highly skilled, well-paid, technical workers, including college-educated professionals, many with advanced degrees, requiring advanced training and technical expertise, many of them in the manufacturing sector.

These are the kinds of jobs that states seek to attract and which provide the foundation for entrepreneurship and economic growth. These types of jobs are also a prerequisite for a prosperous, middle class society able to support state and local governments with tax revenues,

Sixth, but perhaps most important, this study demonstrates that environmental protection can form an important part of a strategy for Ohio based on attracting and retaining professional, scientific, technical, high-skilled, well paying jobs, including manufacturing jobs. There is no inherent institutional impediment in Ohio to using existing state economic assistance policies and incentives to facilitate and encourage development of the environmental industry in the state, especially given that industry's strong pre-existing economic traction.

Contents of the Report

- Chapter II -- History and current status of the U.S. environmental industry; provides industry and job forecasts through 2020
- Chapter III -- Definition of environmental jobs; illustrates the typical composition of occupational employment within environmental companies
- Chapter IV -- The current state of the Ohio economy and labor market
- Chapter V -- Size, employment, and industrial and occupational composition of the environmental industry in Ohio
- Chapter VI – Profiles of typical environmental firms in the state
- Chapter VII -- Ohio Policy Context, Opportunities and Gaps; discusses the state's current perception of the relationship between jobs and the environment and identifies state programs that could be used to assist environmental firms
- Chapter VIII – Summary of Major Findings

I. INTRODUCTION

The nexus between jobs and the environment will increase in importance in the future as the U.S. and other nations strive to meet pressing need for employment and income generation, while also confronting the challenges of multi-source pollution, energy waste and inefficiency, traffic congestion, climate change, scarcity of potable and usable water, electric grid reliability, etc. The prevailing view among economic development proponents has been that environmental protection is negative for jobs and employment. However, this view is not supported by empirical evidence. In addition, it is possible to estimate and document the overlooked size of the environmental industry in the U.S. as a whole, and at the state level, and the jobs this industry has protected and created.

The challenge -- and opportunity -- is to begin to shift the debate from “trade-offs” between jobs and environmental protection to a new level of congruent and integrated environmental and economic policy. This report provides information on jobs creation among individual environmentally-related companies as recently as May 2004, and we also note the results of prior research on the environmental industry over time.

Here we:

- Assess the current size of the environmental industry and related jobs in the U.S. and the prospects for the future
- Analyze the concept of an “environmental job”
- Estimate the size and the industrial sector composition of the environmental industry in Ohio in 2003
- Estimate the jobs created in Ohio in 2003 by environmental protection and their importance to the state economy
- Estimate the occupation and skill levels of these jobs
- Identify a sample of environmental companies in Ohio, the products and services they provide, their geographic location, and the number of jobs created
- Identify state government programs that could be used to facilitate development of environmental industries in Ohio

- Discuss how encouraging environment and related industries in Ohio could form an integral part of state economic development strategy
- Summarize the major research findings

II. BACKGROUND: THE U.S. ENVIRONMENTAL PROTECTION INDUSTRY AND RELATED JOBS

II.A. Emergence of the Environmental Protection Industry

Contrary to general public perception and public policy understanding, since the late 1960s, protection of the environment has grown rapidly to become a major sales-generating, profit-making, job-creating industry. Expenditures in the U.S. for environmental protection (EP) have grown (in constant 2003 dollars) from \$39 billion per year in 1970 to \$301 billion per year by 2003 -- increasing more rapidly than GDP over the same period. As shown in Table 1:

- In 1970, environmental protection expenditures totaled \$39 billion (2003 dollars).
- In 1980, environmental protection expenditures totaled \$121 billion (2003 dollars).
- In 1990, environmental protection expenditures totaled \$204 billion (2003 dollars).
- In 2003, environmental protection expenditures totaled \$301 billion (2003 dollars).

Table 1
Environmental Protection Expenditures and Jobs
In the U.S. Economy, 1970 - 2020

	Expenditures (billions of 2003 dollars)	Jobs (thousands)
1970	\$39	704
1975	77	1,352
1980	121	2,117
1985	158	2,838
1990	204	3,517
1995	235	4,255
2003	301	4,974
2010	357	5,392
2015	398	5,756
2020	\$442	6,377

Source: Management Information Services, Inc., 2004.

For comparison, it is interesting to note that if "EP" were a corporation, it would rank higher than the top of the Fortune 500. Also, for comparison, MISI's estimate of 2003 EP expenditures (\$301 billion) ranks it higher than the sales of \$259 billion for Wal-Mart, the largest corporation in the U.S.

Many companies, whether they realize it or not, owe their profits -- and in some cases their existence -- to EP expenditures.¹ Many workers, whether they realize it or not, would be unemployed were it not for these expenditures: In 2003 environmental protection created nearly five million jobs distributed widely throughout the nation. To put this into perspective, the size of environment-related employment is:

- Over ten times larger than employment in the U.S. pharmaceuticals industry
- Nearly six times larger than the apparel industry
- Almost three times larger than the chemical industry
- Fifty percent greater than employment in religious organizations
- Nearly half the employment in hospitals
- Almost one-third the size of the entire construction industry

Further, while MISI forecasts that the rate of growth in expenditures for environmental protection will decline over the next decade, real expenditures will continue to increase substantially.²

Are Environmental Jobs “Productive?”

It is sometimes suggested that investments in environmental protection are "nonproductive," i.e., expenditures lots of money on anything -- for example, building pyramids in the desert -- would stimulate industry and create jobs. However, environmental protection is hardly "make work." EP investments build tangible and intangible long-term assets, not the least among them is a healthier, safer, cleaner, and more livable environment nationwide and in Ohio -- an important recruiting factor in attracting the new "high tech" firms strongly courted by all states, not to mention residents, tourists, high-visibility events, and investors.

Environmental protection is an exemplary public good, and according to the Harris pollsters this issue has consistently enjoyed wider and stronger public support

¹In this report, "Expenditures" refers to all public and private spending in the environmental sector (EP spending) and is used interchangeably with "sales."

²The rate of growth declines because the total size of the industry continues to increase.

than virtually any other issue over the past three decades. Investments in plant and equipment which produce this strongly desired public good are as productive as those that produce automobiles, television sets, golf balls, or defense systems that we are willing to pay for directly in the prices of products or indirectly through the government.

It is also sometimes alleged that environmental standards penalize certain states and regions at the expense of others. While this can be sometimes true, the point has been overused. MISI's research does not support the contention that economic hardship in a given state or region can be blamed on "unreasonable" environmental laws. Further, MISI has found that the overall relationship between state environmental policies and economic/job growth is positive, not negative.

It is significant that many environmental economic and employment benefits flow directly to states whose policymakers and government officials often see only costs and disadvantages from environmental protection.³ Funds expended on pollution abatement and control programs are not wasted, but, rather, investments in environmental protection contribute as much to the well-being and labor markets of the nation and individual states as money spent on other goods competing for scarce private and public funds. All regions and states benefit substantially, and many states benefit at greater than proportionate rates from U.S. EP expenditures.

Over the past three decades protecting the environment has been a major public priority. The legislation enacted has significantly improved the nation's environment and has set in motion ongoing programs that will have significant effects on the nation's environment, economy, and job market well into the 21st century. Importantly, protection of the environment and remediation of environmental problems will continue to be a growing and profitable industry in the U.S. Astute businessmen, labor leaders, government officials, and policymakers should become more cognizant of opportunities inherent in the environmental industry.

II.B. Environmental Protection as a Recession Proof Industry

Expenditures to protect the environment has been one of the most rapidly and consistently growing "recession proof" industries in the economy for the past three decades, and real EP expenditures (2003 dollars) increased from \$39 billion in 1970 to \$301 billion in 2003. This represents nearly an eight-fold increase in expenditures in barely more than three decades -- a sustained real average rate of growth of about

³For example, in 1986 MISI assessed the economic and jobs impacts of acid rain control legislation on Ohio and found that, contrary to what was then widely believed, such legislation would actually create more jobs in the state than it would imperil. See Alvin Cook and Jerome Rosenberg, "The Ohio Story: The Economic and Employment Benefits of Controlling Acid Rain." *Amicus Journal*, Vol. 8, No. 2, 1986, pp. 5-8. More recently, in a study of vehicle fuel efficiency standards, MISI found that -- contrary to the common perception -- enhanced CAFE standards would create a large number of jobs (29,300) in Ohio. See Management Information Services, Inc. and 20/20 Vision Education Fund, *Fuel Standards and Jobs: Economic, Employment, Energy, and Environmental Impacts of Revised CAFE Standards Through 2030*, Washington, D.C., 2002.

eight percent per year over the period. This compares with an average annual rate of growth of GDP that averaged between two and three percent over the same period. That is, since the late 1960s, expenditures for pollution abatement and control has been increasing at a rate nearly three times as large as that of GDP.

As might be expected, this rate of growth has not been consistent. In the early 1970s, EP expenditures were increasing nearly 15 percent per year, by the late 1980s they were increasing at about seven percent annually, and by the late 1990s were increasing at about four percent annually. This is to be anticipated as the industry grew and matured -- but even the most recent growth rates of four percent are higher than the growth rate of GDP. In 1970, EP expenditures accounted for 0.9 percent of GDP, whereas by 2003 the U.S. was devoting about three percent of GDP to pollution control and abatement and related environmental programs.

More interesting, perhaps, is the "recession-proof" nature of this industry:

- In the late 1970s the U.S. economy was reeling from inflationary shocks, record interest rates, energy crises, and anemic economic growth, but between 1975 and 1980 EP expenditures grew nearly 60 percent, from \$77 billion to \$121 billion.
- In the early 1980s the U.S. experienced the most severe economic recession in half a century, with many industries experiencing depression-level problems, but between 1980 and 1985 EP expenditures increased by \$37 billion -- 31 percent.
- During the early 1990s the U.S. experienced a relatively mild recession, with GDP declining one percent and unemployment increasing to 7.5 percent; nevertheless, between 1990 and 1995 EP expenditures increased from \$204 billion to \$235 billion -- 15 percent.
- Between 2000 and 2003, while U.S. economic and job growth was generally anemic, the EP industry expanded continuously, growing to \$301 billion.

However, MISI forecasts that the rate of growth of EP expenditures will gradually decline over the next decade, as the industry grows and matures.

II.C. The Current Size and Structure of the Environmental Industry and Jobs Created

As stated earlier, if "EP" were a corporation, it would rank higher than the top of the Fortune 500:

- MISI estimates that in 2003 EP expenditures totaled \$301 billion.
- In 2003, Wal-Mart, the largest U.S. corporation, had sales of \$259 billion.
- In 2003, the number two U.S. corporation, Exxon Mobil, had sales of \$213 billion, while the third-ranked corporation, General Motors, had sales of \$196 billion.

Clearly, providing the goods and services required for environmental protection has become a major U.S. industry with significant effects on the national economy and labor market and on those of individual states.⁴

MISI estimates that in 2003 protecting the environment generated:

- \$301 billion in total industry sales
- \$20 billion in corporate profits
- 4.97 million jobs
- \$45 billion in Federal, state, and local government tax revenues

II.D. Prospects for the Future

It is likely that the environmental industry will continue to grow for the foreseeable future:

- The environmental industry has grown and matured over the past four decades into a large, viable industry.
- Environmental processes and practices have been incorporated into most manufacturing and service industries.
- Pollution prevention is increasingly being utilized instead of “end of the pipe” pollution abatement remedies, and entire manufacturing process are being designed to limit environmental degradation from the beginning of the production process.

⁴All estimates of the size of the environmental industry rely critically on the exact definition of the industry. Since there is no official definition, estimates of the size of the environmental industry differ according to the source. In MISI's case, the definition of the industry includes human and environmental sustainability principles, and MISI's estimates thus include a broader range of environmental activities in the economy than some other denitions that have been developed.

- Over the years, a large number of environmental regulations have been enacted at the local, state, and Federal levels and will continue to generate requirements for environmental technology and services well into the future -- even in the unlikely event that no new environmental regulations are enacted.
- Environmental protection and regulation is strongly desired by the public, as verified in numerous public opinion polls conducted over the past 30 years.
- As the U.S. economy continues to grow, environmental problems resulting from urban sprawl, environmental degradation, energy consumption, increasing population, traffic congestion, mobile source pollution, and related problems will continue to increase the demand for environmental remediation.
- The public is increasingly being given the choice of purchasing environmentally benign products and “green” energy, and is responding favorably. Major corporations -- such as, for example, Ford and British Petroleum -- have noted this preference and are reorienting themselves as environmentally friendly companies.
- Problems that the U.S. and the rest of the world face in the future will likely increase the demand for environment-related technology, services, and labor. To cite the most obvious example, global warming presents a long-term challenge that is being addressed by various international and national legislative and mandatory regulatory initiatives such as the Kyoto protocol, the McCain-Lieberman bill in the U.S. Senate, and the Climate Stewardship Act in the U.S. House of Representatives. Also, individual states have begun to establish and institute climate action plans. Thus, mitigating climate change and reducing and managing greenhouse gas emissions will likely create demand for hundreds of billions of dollars of output from the environmental, energy efficiency, and renewable energy industries.

MISI anticipates that the environmental industry will continue to grow slightly faster than U.S. GDP over the coming decade, although this rate of growth will gradually diminish and will approach that of GDP. This is to be expected, since the industry has grown large and matured. Nevertheless, it will likely continue to be relatively “recession proof” because it is largely driven by statutes and regulations that must be complied with irrespective of the state of health of the nation’s economy.

Thus, Table 1 indicates that MISI forecasts EP to continue to be a growing, recession proof industry well into the 21st century, offering unique entrepreneurial,

profit, and job opportunities for all types of businesses and workers. **MISI forecasts that in the U.S. real expenditures (2003 dollars) will increase from \$301 billion in 2003 to:**

- \$357 billion in 2010
- \$398 billion in 2015
- \$442 billion in 2020

Environmental protection expenditures generate large numbers of jobs throughout all sectors of the economy and within many diverse occupations. As shown in Table 1, MISI forecasts that U.S. employment created directly and indirectly by EP expenditures will increase from 4.97 million jobs in 2003 to:

- 5.39 million jobs in 2010
- 5.76 million jobs in 2015
- 6.38 million jobs in 2020

Until the U.S. reaches a level of creating and managing a sustainable environment, the environmental protection industry will continue to outpace most other industries in the U.S. economy. Until then, the environmental industry is projected to grow at a rate 2-3 percent faster than many other industries.

These major economic opportunities have tended to go overlooked by economic development policymakers and government officials. Nevertheless, significant economic opportunities do exist and can be maximized and leveraged for broad social and environmental advantage.

III. DEFINING AND ESTIMATING ENVIRONMENTAL JOBS

III.A. What Constitutes an Environmental Job?

Ambiguities and Questions

As discussed in Chapter II, environmental protection created nearly five million jobs in the U.S. in 2003, and these were distributed widely throughout all states and regions within the U.S. But how many of these are “environmental jobs” or “green jobs?” More specifically, what constitutes an “environmental job?” While a definitive analysis of this important topic is outside the scope of this report, our review of the literature indicates that there is no rigorous, well-accepted definition of an environmental job. Rather, the definitions used are often loose and contradictory.

Clearly, an ecologist or an environmental engineer working in private industry or for an environmental advocacy organization would constitute an environmental job, as would an employee of the federal or a state environmental protection agency. However, there are ambiguities. For example, most people would agree that the positions in a firm that assembles and installs solar thermal collectors on residences and commercial office buildings for solar heating and solar hot water heating would be considered environmental jobs. But what about the jobs involved in producing those solar panels, especially if the factory involved used coal-based energy, one of the most controversial fossil fuels in terms of emissions, especially greenhouse gases? Here these manufacturing jobs are included as jobs created indirectly by environmental expenditures.

Most analysts would consider jobs in a recycling plant to be environmental jobs. But what if the recycling plant itself produces air pollution?

What factory in Ohio that produces scrubbers for coal-fired power plants in adjacent Indiana? It seems clear that the jobs in the Ohio factory should be considered green or environmental jobs, even though the user of the scrubbers in Indiana may cause pollution in Ohio.

What about environmental engineers and environmental controls specialists working in a coal-fired power plant? What about the workers who produce environmental control equipment for the plant?

There are many manufacturing establishments throughout the United States that produce products for the automotive industry. Should those that produce components for fuel-efficient vehicles be considered part of the environmental industry, but not those that produce components for gas guzzlers? If so, is there any way to accurately distinguish between these? Should all factories producing catalytic converters be considered environmental jobs, even when some of these converters are used on low miles-per-gallon vehicles?

These relevant questions have, in fact, been generated by shifts in environmental policy itself. The early stages of the environmental movement in the 1970s and 1980s focused primarily on "end-of-the pipe" solutions. That is, the remedies and controls focused on cleaning or minimizing air, water, or solid waste pollutants after they had been produced. However, more recently during the 1980s and 1990s, environmental protection has gradually evolved to include entire processes, so, rather than cleaning up at the end of the pipe, the entire manufacturing and servicing processes are being designed to minimize the production of pollutants. Therefore, it is possible that very efficient processes designed to produce relatively little waste output could actually result in a decrease in the number of environmental jobs if these are defined strictly as "end of the pipe" jobs. A widespread program of energy efficiency, energy conservation, and demand-side management could ultimately result in less need for electric power to begin with and could result in the shutting down of a coal-fired electric power plant. While some may view such a shutdown as an environmental plus, many environmental jobs in that power plant involving pollution abatement and control would be in this case lost. Is this jobs loss desirable?

There is also the issue of how to take account of indirect job creation and how broadly or narrowly to define an indirect environmental job. For example, what of ancillary jobs created across the street from a factory producing solar collectors shortly after it opens, such as a doughnut shop, fast food restaurant, dry cleaner, etc. whose customers are primarily the workers at the renewable energy factory. Are these latter jobs also considered to be "indirect" green jobs or environmental jobs? We include such indirect jobs in this report, though we also conclude they are not "as green" as the direct jobs created.

While solid waste abatement and control is a major area of environmental concern, does this imply that all persons engaged in trash collection business are performing environmental jobs?

What part of the tourism industry constitutes "ecotourism," and are all jobs associated with ecotourism green jobs? Are then all the environmental externalities and costs produced by tourists, such as water use or waste, to be forgiven if these tourists are engaged in ecotourism?

Are all land management programs and all forms of alternative energy green industries, with all jobs counting as environmental jobs?

Definitions and Concepts Used in This Report

MISI considers that jobs can be considered to be "green" relative to the way the job was performed previously, i.e., in a production process, a change in technology that reduces waste emissions or energy consumption makes the jobs in that process "greener" than before. Still, can these jobs continue to be counted as environmental

jobs when newer technology makes available ways of furthering green production, e.g., further reducing energy consumption?

Two approaches can be used to address the relativity cited. The first approach targets environmental jobs, which could be new jobs or the greening of existing jobs, and defines a green job as one that emphasizes activities that contribute to environmentally sustainable development. A second approach focuses on the economy as a whole, defining a green economy as an economy that is environmentally sustainable, and environmental jobs as those jobs required to make an economy environmentally sustainable. Similarly, the term “environmental sector” is used to collectively describe companies involved in businesses designed to limit negative environmental impacts. However, this definition of green jobs as employment opportunities arising from expenditures on activities that support environmentally sustainable development, or which reduce negative impacts on the environment, also presents ambiguities.

Therefore, based on extensive research and literature review, MISI considers that environmental jobs are perhaps best understood when viewed in a continuum across a spectrum, with jobs that generate obvious environmental resource degradation or extraction at one end; a range of greener jobs involving clean production measures and technologies to reduce environmental impacts in the center, and the other end of the spectrum where jobs have a positive environmental impact (see Figure 1).

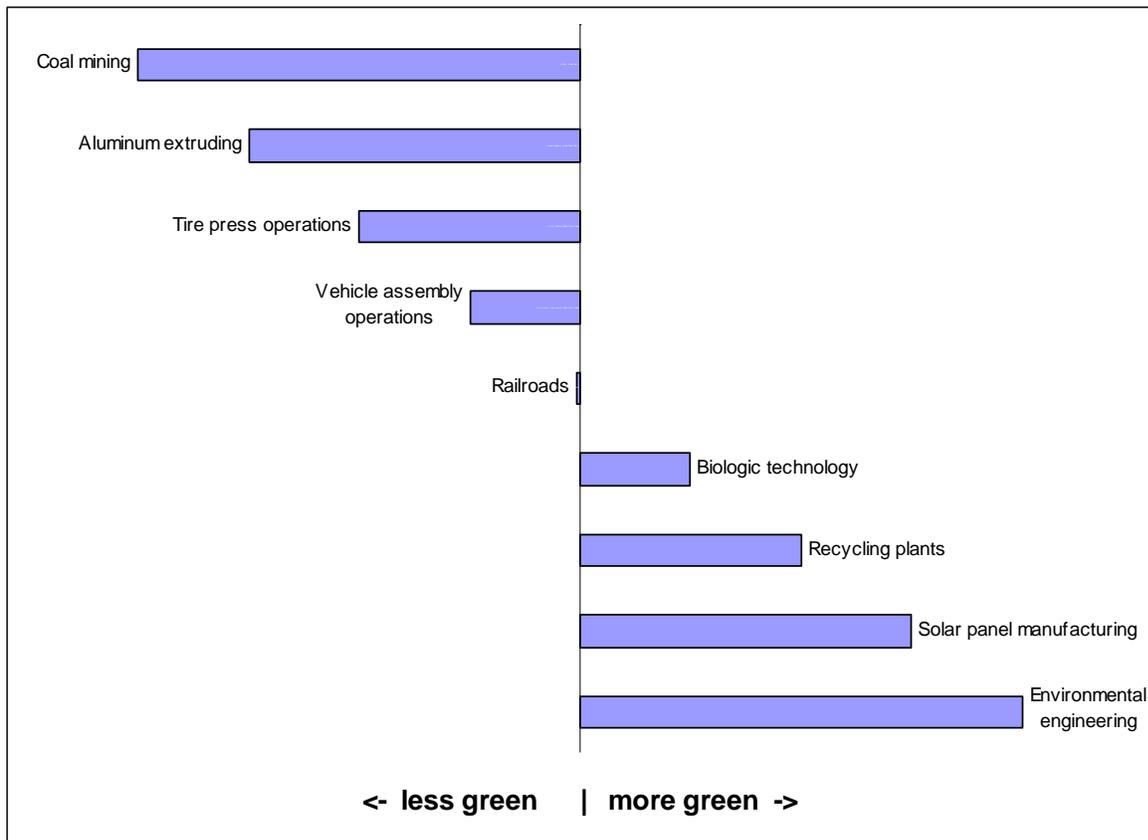
Using the spectrum concept, MISI defines environmental industries and green jobs as those which, as a result of environmental pressures and concerns, have produced the development of numerous products, processes, and services, which specifically target the reduction of environmental impact. Environment-related jobs include those created both directly and indirectly by environmental protection expenditures.

III.B. Types of Jobs Created in the Environmental Industry

There exists relatively little rigorous and comprehensive research addressing the practical relationship between environmental protection and existing jobs or future job creation. Even some research in this area sponsored by environmental organizations is off the mark, in that it has tended to emphasize jobs creation in classically green activities, such as environmental lawyers or workers in recycling plants.

However, while these jobs certainly count as jobs related to the environment, MISI’s data suggests that the classic environmental job constitutes only a small portion of the jobs created by environmental protection. The vast majority of the jobs created by environmental protection are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc. In fact, most of the persons employed in these jobs may not even realize that they owe their livelihood to protecting the environment.

Figure 1
The Environmental Job Spectrum

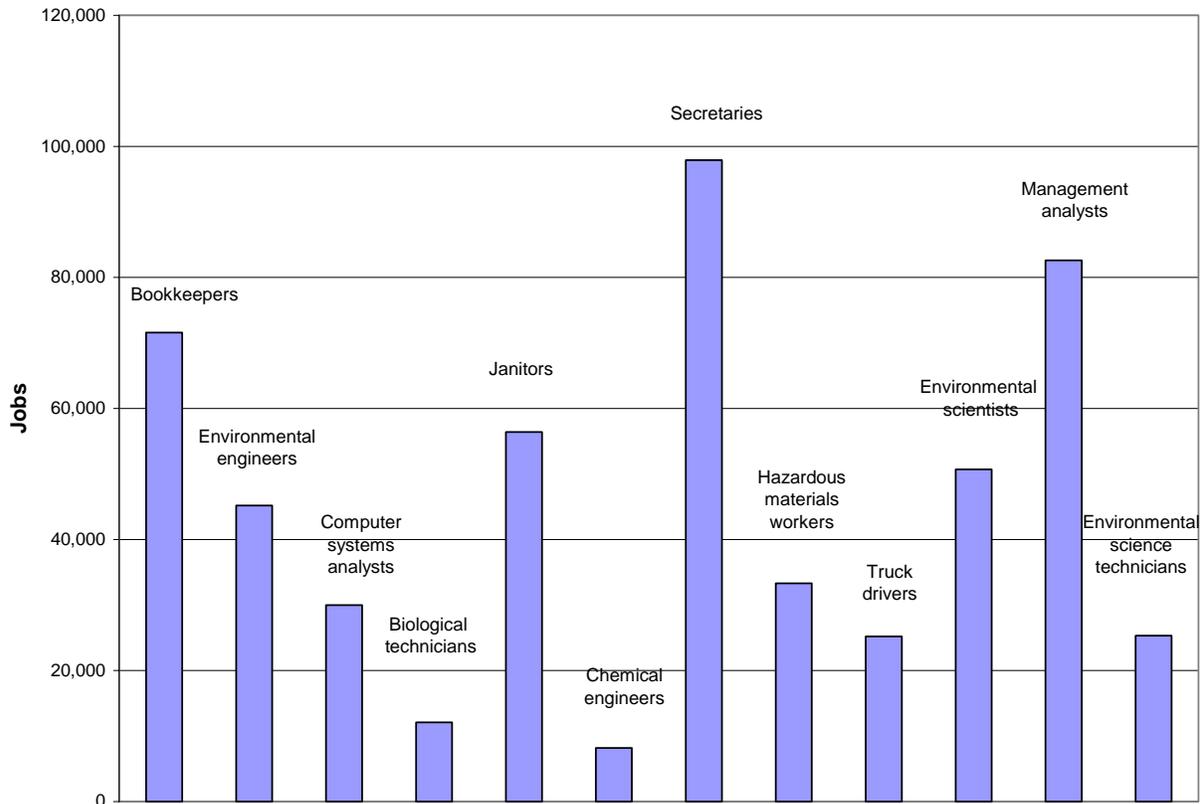


Source: Management Information Services, Inc., 2004.

For example, as illustrated in Figure 2, in the U.S. in 2003, environmental protection created:

- More jobs for secretaries (97,900,) than for environmental scientists (50,700).
- More jobs for management analysts (82,600) than for environmental engineers (45,200).
- More jobs for bookkeepers (71,600) than for hazardous materials workers (33,300).
- More jobs for janitors (56,400) than for environmental science technicians (25,000).

Figure 2
Selected U.S. Jobs Created in 2003 by Environmental Expenditures



Source: Management Information Services, Inc., 2004.

- More jobs for computer systems analysts (30,000) than for chemical engineers (8,200)
- More jobs for truck drivers (25,200) than for biological technicians (12,100)

More generally, arguments stressing the economic benefits and job creation resulting from environmental protection and clean energy initiatives are not currently being made in a rigorous manner which disaggregates these benefits to a level of detail that is meaningful to policymakers. The level of detail required is at the sector, industry, state, city, and county level, and the jobs created have to be identified by industry, category, skill, and specific occupation at the state and local level. This report provides data at such levels of detail.

III.C. The Jobs Distribution in Typical Environmental Companies

There are many thousands of environmental companies located throughout the United States and they generate jobs for nearly five million workers in virtually every community. These firms:

- Range from the very small one or two person “mom and pop” shops to very large firms employment thousands of workers.
- Employ workers at all levels of skills, from the most basic and rudimentary to the very high skilled technical and professional
- Include environmental service firms and manufacturing firms
- Include those whose market is local, those whose market is state and regional, those who market is national, and those whose market is international.
- Face the same problems, challenges, and opportunities as other companies

Given the wide diversity in the size, function, and technologies of environmental companies, it is impossible to estimate the job profile of the “average” environmental firm. However, it is possible to identify the jobs and earnings profiles of typical types of firms involved in environment-related areas of work. Tables 2 and 3 illustrate this:

- Table 2 shows the 2003 occupational job distribution and employee earnings of a typical environmental remediation services company.
- Table 3 shows the 2003 occupational job distribution and employee earnings of a typical wind turbine manufacturing company.

These tables illustrate the points made above.

First, firms working in the environmental and related areas employ a wide range of workers at all educational and skills levels and at widely differing earnings levels.

Second, in environmental companies, many of the employees are not classified as “environmental specialists.” For example, even in the environmental remediation services firm profiled in Table 2, most of the workers are in occupations such as laborers, clerks, bookkeepers, accountants, maintenance workers, cost estimators, etc. All of these employees owe their jobs and livelihoods to environmental protection, but, in general, they perform the same types of activities at work as employees in firms that have little or nothing to do with the environment.

This is illustrated even more forcefully in Table 3. The occupational job distribution of a typical wind turbine manufacturing company differs relatively little from that of a company that manufactures other products. Thus, the production of wind turbines and wind turbine components requires large numbers of engine assemblers, machinists, machine tool operators, mechanical and industrial engineers, welders, tool and die makers, mechanics, managers, purchasing agents, etc. These are “environmental” workers only because the company they work for is manufacturing a renewable energy product. Importantly, with the current national angst concerning the erosion of the U.S. manufacturing sector and the loss of U.S. manufacturing jobs, it is relevant to note that many environmental and renewable energy technologies are growing rapidly.⁵ In at least some states, these types of firms can help revitalize the manufacturing sector and provide the types of diversified, high-wage jobs that all states seek to attract.

⁵For example, windpower is the most rapidly growing source of electrical power in the world.

Table 2
Typical Employee Profile of a 100-person
Environmental Remediation Services Company, 2003

Occupation	Employees	Earnings
Hazardous Materials Removal Workers	22	\$36,204
Septic Tank Servicers and Sewer Pipe Cleaners	8	30,419
Construction Laborers	7	32,382
First-Line Supervisors/Managers of Construction/Extraction	5	50,673
Truck Drivers, Heavy and Tractor-Trailer	5	33,044
General and Operations Managers	3	86,258
Laborers and Freight, Stock, and Material Movers	2	21,620
Truck Drivers, Light Or Delivery Services	2	27,437
Office Clerks	2	23,384
Refuse and Recyclable Material Collectors	2	26,796
Insulation Workers	2	32,256
Secretaries (except Legal, Medical, and Executive)	2	25,998
Bookkeeping, Accounting, and Auditing Clerks	2	31,217
Plumbers, Pipefitters, and Steamfitters	1	41,202
Executive Secretaries and Administrative Assistants	1	36,729
Maintenance and Repair Workers	1	30,849
Environmental Engineering Technicians	1	36,939
Operating Engineers and Other Const. Equip. Operators	1	40,520
First-Line Supervisors/Managers of Office/Administrative	1	47,576
Chief Executives	1	116,435
Construction Managers	1	73,994
Cleaners of Vehicles and Equipment	1	21,704
Cost Estimators	1	56,753
Janitors and Cleaners	1	25,746
Environmental Engineers	1	69,930
Industrial Truck and Tractor Operators	1	27,741
Carpenters	1	38,588
Construction and Maintenance Painters	1	33,296
Accountants and Auditors	1	53,865
Dispatchers (except Police, Fire, and Ambulance)	1	29,537
Water and Liquid Waste Treatment Plant and System Operators	1	31,049
First-Line Supervisors/Managers of Transportation Operators	1	46,914
Sales Representatives, Wholesale and Manufacturing	1	42,683
Customer Service Representatives	1	30,366
First-Line Supervisors/Managers of Mechanics and Repairers	1	49,088
Environmental Scientists and Specialists	1	62,003
Receptionists and Information Clerks	1	22,775
Environmental Science and Protection Technicians	1	44,867
Other employees	12	47,422
Employee Total (121 occupations in the industry)	100	\$39,621

Source: Management Information Services, Inc., 2004.

Table 3
Typical Employee Profile of a 250-person
Wind Turbine Manufacturing Company, 2003

Occupation	Employees	Earnings
Engine and Other Machine Assemblers	31	\$33,359
Machinists	27	37,191
Team Assemblers	16	27,668
Computer-Controlled Machine Tool Operators	12	37,254
Mechanical Engineers	10	65,772
First-Line Supervisors/Managers of Production/Operating	10	54,705
Inspectors, Testers, Sorters, Samplers, and Weighers	8	37,202
Lathe and Turning Machine Tool Setters/Operators/Tenders	6	36,729
Drilling and Boring Machine Tool Setters/Operators/Tenders	4	36,509
Welders, Cutters, Solderers, and Brazers	4	36,530
Laborers and Freight, Stock, and Material Movers	4	28,466
Maintenance and Repair Workers	4	41,318
Tool and Die Makers	4	40,047
Grinding/Lapping/Polishing/Buffing Machine Tool Operators	4	31,899
Multiple Machine Tool Setters/Operators/Tenders	4	37,517
Industrial Engineers	3	64,659
Industrial Machinery Mechanics	3	42,315
Engineering Managers	3	99,404
Shipping, Receiving, and Traffic Clerks	3	29,516
General and Operations Managers	3	110,702
Industrial Production Managers	3	85,512
Industrial Truck and Tractor Operators	3	31,416
Purchasing Agents	3	51,702
Cutting/Punching/Press Machine Setters/Operators/Tenders	3	28,907
Production, Planning, and Expediting Clerks	3	41,601
Milling and Planing Machine Setters/Operators/Tenders	3	37,380
Mechanical Drafters	2	44,090
Customer Service Representatives	2	36,036
Bookkeeping, Accounting, and Auditing Clerks	2	32,760
Office Clerks, General	2	27,227
Sales Representatives, Wholesale and Manufacturing	2	50,757
Janitors and Cleaners	2	28,476
Sales Engineers	2	66,591
Accountants and Auditors	2	54,873
Tool Grinders, Filers, and Sharpeners	2	40,520
Executive Secretaries and Administrative Assistants	2	39,638
Mechanical Engineering Technicians	2	46,767
Electricians	2	45,570
Other employees	48	45,969
Employee Total (126 occupations in the industry)	250	\$42,726

Source: Management Information Services, Inc., 2004.

IV. THE OHIO ECONOMY IN 2003

Economic conditions in Ohio were relatively stable in 2003, and gross state product totaled \$380 billion. The Ohio population reached just over 11.4 million, generally growing at a rate of 0.2 - 0.3 percent over the last few years, substantially below the U.S. average population growth of 1.2 percent. Ohio is the nation's seventh most populous state, and accounts for just over 3.9 percent of the U.S. total population. Eighty-five percent of the state's population lives within metropolitan areas (15th among states) and about 11 percent of its population live at or below the poverty level.

The civilian labor force grew to slightly over 5.9 million during the year and total employment hovered around 5.5 million, almost approaching 5.6 million. The state's unemployment rate remained in the 6.0 percent to 6.3 percent range during the year, very close to the national 6.0 percent average rate. The state has approximately 270,000 business establishments.

The state has a number of economic strengths, and ranks at or above the U.S. average with respect to:

- Federal R&D funds received per capita
- The percent of its population completing high school
- The percent of bachelor's degrees granted
- The percent of science and engineering graduate students
- The percent of engineers in its workforce
- Employment in high-tech industries
- Patents issued to state residents

Table 4 shows the earnings by industry of employment in Ohio and how these compare to the U.S. averages. This table shows that Ohio ranks relatively low with respect to sectors such as agriculture, mining, utilities, information, finance, insurance, and real estate. However, the salient feature illustrated in this table is the importance in Ohio of manufacturing, and it is one of the most manufacturing intensive states in the nation. Specifically:

- With 3.9 percent of the nation's population, employment earnings in the Ohio manufacturing sector account for almost six percent of manufacturing earnings nationally.

- More important, almost 19 percent of every dollar earned in the state is earned by employees in the manufacturing sector – compared to 12 percent nationally.
- The Ohio/U.S. index for manufacturing is 156, much higher than for any other sector.

Manufacturing is thus the linchpin of the Ohio economy:

- Ohio has one of the world's largest manufacturing economies.
- Manufacturing is Ohio's largest sector, representing more than 21 percent of Ohio's Gross State Product (GSP).
- Ohio has more than 17,600 manufacturing firms providing 850,000 jobs.
- Ohio manufacturers contribute \$80 billion to Ohio's gross state product.
- Ohio ranks third in the U.S. in manufacturing and accounts for nearly six percent of the nation's manufacturing output.
- During the last four years, Ohio's exports of manufactured products have increased more than those of any other state.
- Ohio leads the nation in value-added production of primary metals and plastic and rubber products, and ranks second in the production of fabricated metals and transportation equipment.
- Ohio is the nation's sixth largest exporter, generating \$28 billion in revenue per year. It is second among states in the number of manufacturing jobs tied to exports, with more than one in five manufacturing jobs tied to exporting.

The second-largest sector based on employment earnings is the public administration sector comprised of state, local and federal government employees, accounting for 16 percent. The third largest sector is health care and social assistance.

Table 4
Earnings by Industry of Employment in Ohio and the U.S. in 2003

	Ohio (mill.\$)	Ohio Share of U.S.	Ohio Share of Earnings	U.S. Share of Earnings	Ohio Index
Personal Income	344,560	3.7%	-	-	-
Agriculture, Forestry, Fishing and Hunting	1,132	1.5%	0.5%	1.2%	40
Mining	970	1.8%	0.4%	0.8%	49
Utilities	1,973	2.8%	0.8%	1.1%	77
Construction	13,878	3.4%	5.7%	6.2%	92
Manufacturing	45,383	5.7%	18.8%	12.1%	156
Wholesale Trade	12,933	3.8%	5.4%	5.1%	104
Retail Trade	17,418	3.9%	7.2%	6.8%	107
Transportation and Warehousing	7,291	3.5%	3.0%	3.2%	95
Information	6,047	2.3%	2.5%	4.1%	62
Finance and Insurance	14,031	2.8%	5.8%	7.6%	77
Real Estate and Rental and Leasing	3,430	2.8%	1.4%	1.9%	75
Professional, Scientific, and Technical Services	17,169	2.9%	7.1%	8.9%	80
Management of Companies and Enterprises	7,065	5.2%	2.9%	2.1%	140
Administrative/Support/Waste Management/Remediation Services	8,564	3.4%	3.5%	3.8%	93
Educational Services	2,757	3.0%	1.1%	1.4%	82
Health Care and Social Assistance	26,579	4.2%	11.0%	9.7%	114
Arts, Entertainment, and Recreation	2,560	3.3%	1.1%	1.2%	89
Accommodation and Food Services	6,992	3.3%	2.9%	3.3%	88
Other Services	6,669	3.6%	2.8%	2.8%	99
Public Administration	38,795	3.5%	16.1%	16.9%	95

Source: Management Information Services, Inc., 2004.

V. THE ENVIRONMENTAL INDUSTRY AND JOBS IN OHIO

V.A. Summary of the Environmental Industry and Jobs in Ohio

MISI estimates that in 2003:

- Sales of the environmental industries in Ohio totaled \$12.2 billion
- The number of environment-related jobs totaled more than 176,000
- The environmental industry in Ohio comprised 3.2 percent of gross state product
- Environment-related jobs comprised 3.3 percent of Ohio employment
- Ohio environmental industries accounted for 4.1 percent of the sales of the U.S. environmental industry
- Environment-related jobs in Ohio comprised 3.5 percent of the total number of environment-related jobs in the U.S.
- Environment-related employment in the state has been increasing in recent years between one and two percent annually.

V.B. Environmental Jobs in Ohio by Industrial Sector

Table 5 shows the industrial distribution of total employment and of environmental employment in Ohio in 2003.

Comparison of the industrial sector distribution of environment-related jobs in Ohio with that of total employment in the state is instructive. A significant portion of the environmental jobs is in the public administration sector which, given the public nature of environmental protection, is to be expected. However, most of the environmental jobs in Ohio are in the private sector, and focusing on these reveals that they are heavily concentrated in several sectors. Of particular note is that the private sector environmental industry in Ohio is more manufacturing intensive than other average private sector activity in the state:

- 29 percent of private sector jobs in the environmental industry are in manufacturing, compared to 18 percent in manufacturing among all private sector industrial activities in Ohio.

**Table 5
Environmental-Related Jobs in Ohio in 2003, by Industry**

Industry	Establishments	Total Employment	Environmental Employment	Environmental Jobs (percent)
Agriculture, Forestry, Fishing and Hunting	341	1,564	129	8.3
Mining	702	10,505	678	6.5
Utilities	602	26,109	5,949	22.8
Construction	24,488	212,409	7,061	3.3
Manufacturing	15,145	805,716	28,149	3.5
Wholesale Trade	15,279	243,493	3,634	1.5
Retail Trade	39,762	591,557	322	0.1
Transportation and Warehousing	6,445	130,002	516	0.4
Information	3,760	103,334	148	0.1
Finance and Insurance	16,934	248,897	209	0.1
Real Estate and Rental and Leasing	9,669	66,212	248	0.4
Professional, Scientific, and Technical Services	22,436	221,765	24,657	11.1
Management of Companies and Enterprises	1,828	134,502	1,848	1.4
Administrative/Support/Waste Management/ Remediation Services	13,066	319,058	17,242	5.4
Educational Services	2,624	97,489	3,186	3.3
Health Care and Social Assistance	25,871	678,618	1,205	0.2
Arts, Entertainment, and Recreation	3,733	58,265	399	0.7
Accommodation and Food Services	22,010	410,303	187	0.0
Other Services	29,312	229,701	2,465	1.1
Public Administration	-	801,500	77,877	9.7
State Total	254,007	5,390,999	176,109	3.3

Source: Management Information Services, Inc., 2004.

- 25 percent of environmental jobs are in professional, scientific, and technical services, compared to 5 percent of all private sector jobs in the state.
- 18 percent of environmental jobs are in administrative, support, and waste management services, compared to 7 percent of all private sector jobs in the state.
- 4 percent of environmental jobs are in educational services, compared to 2 percent of all private sector jobs in the state.

Conversely, there are relatively few environmental jobs in other sectors of the Ohio economy:

- Less than one percent of environmental jobs are in the retail trade sector, compared to 13 percent in retail trade among all private sector jobs in the state.
- Less than one percent of environmental jobs are in the finance and insurance sector, compared to 5 percent among all private sector jobs in the state.
- Only 2 percent of environmental jobs are in the health care and social service sector, compared to 15 percent among all private sector jobs in the state.
- Less than one percent of environmental jobs are in the transportation and warehousing sector, compared to 3 percent among all private sector jobs in the state.

Assessing the portion of total state employment in each industrial sector accounted for by environmental jobs indicates that the 176,000 environmental jobs account for about 3.3 percent of the total 5.4 million jobs in Ohio. However, this distribution is uneven among industry sectors:

- Nearly 23 percent of employment in the utilities sector consists of environmental jobs, primarily water, waste treatment, sanitation, and related facilities.
- Nearly 10 percent of public administration employment in the state consists of environmental jobs.
- More than 11 percent of Ohio jobs in the professional, scientific, and technical services are environmental jobs.
- About 3.5 percent of the state's manufacturing employment is environment-related – slightly higher than the 3.3 percent average for environmental jobs of total state employment.
- Only very small portions of total state employment in sectors such as food services, entertainment, real estate, finance, insurance, and retail trade are comprised of environmental jobs.

Key Observations on Jobs Distribution

The concentration of environmental jobs within certain industrial sectors is instructive and interesting.

While accounting for 3.3 percent of total state employment, the industrial sector composition of environmental employment is highly skewed in favor of certain sectors. For example, nearly one-third of private sector environmental jobs are in manufacturing, compared to less than 20 percent of all private sector employment, and one-fourth of private sector environmental jobs are in professional, scientific, and technical services, compared to only five percent of all private sector jobs in the state.

This indicates that investments in the environment will provide a greater than proportionate assist to Ohio's manufacturing sector. As noted in Chapter IV, Ohio is one of the most manufacturing-intensive states in the nation and is currently very concerned with preserving, modernizing, and expanding its manufacturing base. Table 5 indicates that the environmental industry can aid in this objective.

Similarly, environmental investments generate, proportionately, five times as many jobs professional, scientific, and technical services as the state average. Jobs in this sector are the high-skilled, high-wage, technical and professional jobs that Ohio – and other states – seeks to attract and retain. Table 5 indicates that investments in environmental protection can be of considerable assistance here.

V.C. Environmental Jobs in Ohio by Occupation and Skill

Environmental employment in Ohio can be disaggregated by specific occupations and skills, and this information for 2003 for selected occupations is given in Table 6. This table illustrates that environmental jobs in Ohio are widely distributed through all occupations and skill levels and, while the number of jobs created in different occupations differs substantially, employment in virtually all occupations is generated by environmental spending.

As noted in Chapter III, the vast majority of the jobs created by environmental protection are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc. and most of the persons employed in these jobs may not even realize that they owe their livelihood to protecting the environment. This is borne out in Table 6, which lists the jobs created by environmental protection in Ohio in 2003 within selected occupations. This table shows that in 2003 environmental protection generated in Ohio:

- More jobs for welders (385) than for biochemists (43)
- More jobs for office clerks (5,301) than for environmental engineers (1,470)
- More jobs for executive secretaries and administrative assistants (3,467) than for hazardous materials removal workers (1,240)

Table 6
Environmental Jobs Generated in Ohio in 2003, by Selected Occupations

Occupation	Jobs
Accountants and Auditors	1,847
Biochemists and Biophysicists	43
Biological Technicians	429
Bookkeeping, Accounting, and Auditing Clerks	2,536
Budget Analysts	180
Chemists	621
Customer Service Representatives	2,716
Computer Programmers	977
Computer Support Specialists	899
Electrical and Electronic Engineering Technicians	912
Electricians	556
Environmental Science and Protection Technicians, Including Health	950
Environmental Engineering Technicians	750
Environmental Engineers	1,470
Environmental Scientists and Specialists, Including Health	2,490
Executive Secretaries and Administrative Assistants	3,467
Financial Managers	1,003
Geoscientists, Except Hydrologists and Geographers	229
Hazardous Materials Removal Workers	1,240
Health and Safety Engineers	140
Human Resources Assistants, Except Payroll and Timekeeping	316
Industrial Machinery Mechanics	442
Inspectors, Testers, Sorters, Samplers, and Weighers	1,152
Janitors and Cleaners, Except Maids and Housekeeping Cleaners	2,000
Landscape Architects	140
Machinists	675
Management Analysts	1,380
Mechanical Engineers	986
Office Clerks	5,301
Plumber, Pipefitters, and Steamfitters	353
Refuse and Recyclable Material Collectors	3,490
Semiconductor Processors	240
Septic Tank Services and Sewer Pipe Cleaners	710
Truck Drivers, Heavy and Tractor Trailer	1,366
Water and Liquid Waste Treatment Operators	4,670
Welders, Cutters, Solders, and Brazers	385

Source: Management Information Services, Inc., 2004.

- More jobs for bookkeeping and accounting clerks (2,536) than for environmental scientists and specialists (2,490)
- More jobs for plumbers (353) than for health and safety engineers (140)
- More jobs for janitors (2,000) than for environmental science technicians (950)
- More jobs for customer service representatives (2,716) than for environmental scientists and specialists (2,490)
- More jobs for machinists (675) than for landscape architects (140)
- More jobs for inspectors and testers (1,152) than for chemists (621)

Thus, many workers in Ohio are dependent on environmental protection for their employment, although they often would have no way of recognizing that connection unless it is brought to their attention.

The importance of environmental spending for jobs in some occupations is much greater than in others. For some occupations, such as environmental scientists and specialists, environmental engineers, hazardous materials workers, water and liquid waste treatment plant operators, environmental science protection technicians, refuse and recyclable material collectors, and environmental engineering technicians, virtually all of the demand in Ohio is created by environmental protection activities. This is hardly surprising, for most of these jobs are clearly identifiable as “environmental” jobs.

However, in many occupations not traditionally identified as environment-related, a greater than proportionate share of the jobs are also generated by environmental protection. Recalling that, on average, environment-related employment in Ohio comprises only 3.3 percent of total employment, in 2003 environmental protection expenditures generated jobs for a greater than proportionate share – as much as ten percent or more -- of many professional occupations in the state, including:

- Computer software applications engineers
- Electrical and electronics engineers
- Computer programmers
- Landscape architects
- Operations research analysts

- Biochemists and biophysicists
- Computer systems software engineers
- Network systems and data communications analysts
- Medical scientists (except epidemiologists)
- Chemical engineers
- Management analysts
- Civil engineers

For many other occupations, also not traditionally identified as environment-related, a greater than proportionate share of the jobs is also generated by environmental protection. Again recalling that, on average, environment-related employment in Ohio comprises only 3.3 percent of total employment, in 2003 environmental protection generated jobs for as much as ten percent or more of many highly skilled, technical occupations in the state, including:

- Chemical technicians
- Electrical and electronic equipment assemblers
- Architecture and civil drafters
- Electrical and electronics engineering technicians
- Employment, recruitment, and placement specialists
- Chemical plant and system operators
- Chemical technicians
- Mechanical engineering technicians
- Engine and other machine assemblers
- Coil winders and finishers
- Technical writers
- Electrical and electronics drafters

- Electrical and electronics repairers (powerhouse, substation and relay)
- Chemical plant and system operators
- Surveying and mapping technicians

The above findings are significant for they indicate that state investments in environmental protection will create jobs in greater than proportionate share in two categories Ohio -- and other states -- are eager to attract:

- College-educated professional workers, many with advanced degrees
- Highly skilled, technical workers, with advanced training and technical expertise, many of them in the manufacturing sector.

Environmental protection thus generates jobs that are disproportionately for highly skilled, well paid, technical and professional workers, who in turn underpin and provide foundation for entrepreneurship and economic growth.

Finally, there are many occupations for which requirements in Ohio generated by environmental protection are close to the average of 3.3 percent of total employment; these include:

- Secretaries, except legal, medical, and executive
- Customer service representatives
- General and operations managers
- Laborers
- Janitors and cleaners
- Sales representatives
- Maintenance and repair workers
- Sales representatives
- Stock clerks

- Team assemblers
- Inspectors and testers
- Shipping and receiving clerks
- Carpenters
- Data entry keyers
- Electricians
- Operating engineers

V.D. The Environmental Industry as an Economic Driver for Ohio

This study demonstrates that environmental protection can form an important part of a strategy for Ohio based on attracting and retaining professional, scientific, technical, high-skilled, well paying jobs, including manufacturing jobs. While a successful strategy must have other components as well, rarely has any state recognized the economic and jobs benefits that could flow from specifically encouraging the development of environmental and environment-related industries as an economic development initiative. Indeed, usually the opposite is the case: States tend to view environmental economic costs as economically negative.

While designing such a development strategy is outside the scope of this report, there are concrete examples of environment-related initiatives that could create substantial numbers of jobs in Ohio. For example:

- This study demonstrates that, at present in Ohio, environmental protection is creating nearly 200,000 jobs in the state, and these are disproportionately high-skilled, professional, scientific, technical, well paying jobs – many of them in manufacturing.
- A 2002 joint study by MISI and 20/20 Vision estimated that an aggressive strengthening of U.S. Federal Corporate Average Fuel Economy (CAFE) standards would create over 29,000 jobs in Ohio – more jobs than in any other state except Michigan. Thus, contrary to what many believe, the production of more fuel-efficient vehicles would create substantial numbers of jobs in Ohio, not reduce them.⁶

⁶Management Information Services, Inc. and 20/20 Vision Education Fund, *Fuel Standards and Jobs: Economic, Employment, Energy, and Environmental Impacts of Revised CAFE Standards Through 2030*,

- A 2002 study by the University of Illinois estimated that investments in renewable energy and energy efficiency would create more than 25,000 jobs in Ohio.⁷
- A 2001 MISI study of environment-related jobs policies in the Midwestern states identified a number of opportunities and initiatives for job creation in Ohio.⁸
- A 1999 study sponsored by the World Wildlife Fund and the Energy Foundation estimated that an aggressive strategy to implement the Kyoto Climate Change Protocol in the U.S. would create over 41,000 jobs in Ohio.⁹

Finally, it is interesting to compare an environment-related economic development strategy with some of the other economic development strategies that Ohio (and other states) have traditionally relied upon. For example, in 1993, Ohio, Pennsylvania, and Kentucky bid against each other using tax incentives, development funds, and other concessions to attract a Canadian steel mill that would create 800 jobs. Kentucky won the bidding, at a cost of \$14 million in foregone tax revenues for relatively few jobs created. It would have been interesting to know what a concomitant investment in diverse environmental industries might have yielded in terms of jobs.

In any case, today, given the multiplier effect of environmental spending and investment, it is likely that many more jobs could be created, with the same amount of “foregone” tax revenues, through a systematic program to develop the environmental industry. Our findings show this is especially true in Ohio, which currently has a thriving, job creating environmental industry, currently generating over 176,000 jobs in the state, to a large extent unbeknownst to most Ohioans and probably to most policymakers. Such a systematic program of investment could have significant positive and potentially transformational impact. It is a matter of more fully linking classic economic development approaches with a better understanding of the role and reach of environmental programs and expenditures as a factor contributing to that development.

Washington, D.C., 2002.

⁷Regional Economics Applications Laboratory, *Job Jolt: The Economic Impacts of Repowering the Midwest*, University of Illinois, Chicago, 2002.

⁸Management Information Services, Inc., *Survey of Jobs and the Environment Issues in Six Midwestern States: Identifying Policy Challenges and Opportunities*, report prepared for the Joyce Foundation, Chicago, July 2001.

⁹Tellus Institute and Stockholm Environment Institute, *America's Global Warming Solutions*, Boston, August 1999.

VI. SUMMARY PROFILES OF SELECTED OHIO ENVIRONMENTAL COMPANIES

We conducted a survey of existing environmental companies in Ohio, examining a functional, technological and geographic mix of companies. Our research revealed a wide range of firms, and they:

- Are located throughout the state, in major urban centers, suburbs, small towns, and rural areas.
- Range in size from small firms of 25 employees to large firms employing thousands
- Are engaged a wide variety of activities, including remediation, manufacturing, testing, monitoring, analysis, etc.
- Include some of the most sophisticated, high-tech firms in the state

Summary descriptions of a representative sample of these firms are given in Table 7 and are discussed below. Information presented is current as of May 2004.

VI.A. Aqua Tech Environmental Laboratories Inc.

Aqua Tech Environmental Laboratories Inc. (ATEL) is located in Marion, Ohio, in central Ohio between Columbus and Toledo, and specializes in analytical and mobile laboratory services for compliance and information purposes. It was founded in 1978, has 70 employees, and has created five new jobs within the past six months. ATEL's employees are about 90 percent engineering/technical and 10 percent sales/administrative, and its business is about 50 percent government/public sector and 50 percent private – commercial and industrial. It has no international sales.

ATEL is a leader in the environmental testing industry and it focuses on providing quality defensible data to its clients, which has been the key to the laboratory's success over the last quarter-century. Using its resources of experienced technical and professional staff, extensive listing of accreditations and national geographic coverage from its four state-of-the-art facilities, ATEL offers strong partnerships providing seamless and comprehensive analytical testing and project management support.

The firm offers a full range of analytical services to support testing requirements under the Resource Conservation and Recovery Act, the Safe Drinking Water Act, the National Pollutant Discharge Elimination System, the Ohio Voluntary Action Program, Leaking Underground Storage Tanks, and other government regulated programs. ATEL also offers testing services for a variety of specialty needs such as ICP-MS analysis, HPLC and explosives testing, Bioassay/Toxicity testing (Ohio VAP certified), azide analyses, and Pheophytin analyses.

Table 7
Summary of the Select Ohio Environmental Companies Profiled

Company	Location	Products/Services	Jobs
Aqua-Tech Environmental Laboratories, Inc.	Marion (central Ohio, between Columbus and Toledo)	Testing and analysis of drinking water	70
BWXT of Ohio, Inc.	Miamisburg (10 miles southwest of Dayton)	Nuclear clean-up and remediation	500+
Environmental Quality Management, Inc.	Cincinnati	Environmental engineering and remediation	200+
EXTOL of Ohio, Inc.	Norwalk (North central Ohio, midway between Cleveland and Toledo)	Industrial insulation	40
First Solar, LLC	Perrysburg (suburb of Toledo)	Manufacture of solar photovoltaic modules	150
Forry, Inc.	Chagrin Falls (Cleveland suburb)	Largest supplier of end user particulate process controls in the U.S.	120
Gelles Laboratories	Dublin (suburb of Columbus)	Asbestos testing and analysis	110
Malcolm Pirnie	Akron, Cincinnati, Cleveland	One of the largest U.S. environmental engineering, science, and consulting firms.	1,400
Midwest Environmental Control, Inc.	Toledo	Environmental remediation services	25
Venture lighting	Solon (Cleveland suburb)	Energy efficient metal halide lighting systems	300
Wastequip	Cleveland	Manufacture of waste control products	1,100
YSI, Inc.	Yellow Springs (10 miles northeast of Dayton)	Environmental sensors, monitoring, and data products	50

Source: Management Information Services, Inc., 2004.

ATEL provides mobile laboratory services on a national basis. Its mobile laboratories are outfitted with full-scale bench-top analytical instrumentation and equipment, and its clients receive final analytical results along with extensive QA/QC documentation as specified in SW 846 or the U.S. EPA Drinking Water Methodology. Legally enforceable data are generated onsite to be used for closures or legal action.

VI.B. BWXT of Ohio

BWXT of Ohio (BWXTO) is the remediation contractor for the Department of Energy (DOE) Miamisburg Environmental Management Project at the defunct nuclear production Mound site in Miamisburg, Ohio, about ten miles southwest of Dayton. It employs more than 500 staff at the site, which obviously represents the classic “clean-up” type of environmental investment and spending.

The Department of Energy, Ohio Field Office, Miamisburg Environmental Management Project and BWXTO are cleaning up the Mound facility and transferring it by parcels of property to the Miamisburg Mound Community Improvement Corporation (MMCIC) for reuse. DOE and MMCIC signed a sales contract for the entire site to be transferred to the Miamisburg community at the completion of the clean up. Through the parcelization process, DOE transfers title to real property (land and buildings within a designated boundary) by deed to the MMCIC for reuse.

More than 40 percent of the site’s 305 acres have been transferred to MMCIC for reuse and economic development as a technology and industrial park. Since it assumed responsibility for remediating the Mound site on October 1, 1997, BWXTO has demolished, removed, or has worked with the Department of Energy to transfer to the community approximately half of the buildings at the Mound site.

The Mound facility has been the largest single employer in Miamisburg for over 50 years, and its remediation, transfer, and reuse is a critical element for maintaining the viability of the local economy. The reuse of the site for private enterprise, creation of jobs, and generation of tax revenues is designed to offset the closure of the former nuclear weapons production facility, and the projected project completion date is 2006.

The Mound Action Committee offers an open forum for stakeholders to discuss issues or concerns they may have regarding the site restoration and remediation process. The Mound Reuse Committee, comprised of representatives of local government, business, Mound labor union leadership, and environmental groups, offers a public forum for issues pertaining to site reuse. Both committees are a resource pool for creating subcommittees, and these committees focus their efforts on an identified issue, and then submit recommendations to DOE based on their conclusions.

BWXTO is a unit of BWX Technologies, Inc., (BWXT) of Lynchburg, Virginia, a diversified manufacturer of nuclear components and advanced energy products that manages DOE sites in ten states. BWXT is a wholly-owned subsidiary of McDermott International, Inc., a leading worldwide energy and environmental services company.

VI.C. Environmental Quality Management

Environmental Quality Management, Inc. (EQM) is an environmental engineering and remediation company headquartered in Cincinnati. In addition to Cincinnati, the firm has offices in Chicago; Denver; Durham, North Carolina; Las Vegas; New Orleans; Portsmouth, Ohio; Roanoke, Virginia; Sacramento; San Antonio; and Seattle. It has over 200 employees. EQM's employees are about 90 percent engineering/technical and 10 percent sales/administrative, and its business is about 90 percent government/public sector and 10 percent private – commercial and industrial. Less than one percent of its sales are international.

EQM offers expertise in air quality, water management, solid/hazardous waste management, site assessment and remediation, ecological resource assessment, industrial hygiene and safety, technology research and evaluation, technical support services, and project support staff. It has managed some of the most complex environmental projects that have been conducted in the United States over the past 25 years, and provides expertise and experience coupled with application of state-of-the-art technology to meet environmental project needs.

EQM has considerable experience in managing and conducting environmental projects for a wide variety of governmental agencies, and is currently involved with five major government programs designed to assist agencies with environmental issues. EQM's mix of non-regulatory governmental contracts with EPA, DOD, and DOE is complimented by a significant industrial base that includes work across the U.S. in the steel, cement, chemical, consumer products, automotive, and aerospace industries.

EQM was named in the 2003 top 100 environmental firms by *Engineering News-Record*, and was listed as the 87th largest environmental firm with revenues of \$51.2 million. It was also listed among the top 20 firms in air issues in the U.S. The firm participated in the clean-up of the World Trade Center and the recovery of the Space Shuttle Columbia debris.

VI.D. EXTOL Insulation Systems

EXTOL Insulation Systems is located in Norwalk, Ohio, in the north central part of the state, and provides energy saving and moisture resistant insulations such as Cellular Glass, Polyisocyanurate, Styrofoam®, Perlite, and Phenolic for mechanical piping systems to all 50 states and throughout the world. The firm has 40 employees,

and its business is about 90 percent commercial and industrial. It has substantial international sales.

The firm is a fabricator of thermal insulation systems for pipes, fittings, valves, and vessels. It offers total manufacturing capabilities, complete product offerings, technical services, and WBE, FBE, DBE, and HUBZone certifications. It provides a complete line of vapor and weather barrier jackets, coatings, adhesives, sealants and other accessories, and EXTOL Complete Fabricated Insulation Systems include:

- Insulation materials -- cellular glass, Isocyanurate, Styrofoam, Perlite, and Phenolic
- Fabricated shapes -- pipe coverings, pre-formed fittings and valves, curved sidewall segments, contoured head segments, flat board, beveled lags, multiple layers, shiplap/tongue, and grooves for pipes and fittings, and routing and/or sizing to accommodate traced pipe systems
- Weather/vapor barrier jackets -- PVC, aluminum, stainless steel, galvanized steel, ASJ, asphaltic based wraps, EPDM, Mylar, tedlar and hypalon available factory applied or cut and rolled (with or w/out SSL)
- Specialty systems -- precision engineered contoured vessel head systems, isowrap® rigid pipe and tank wrap refrigeration valve systems with matching covers, exel-lap (ship-lap) complete pipe and fitting systems, pre-insulated pipe support systems, and composite insulation systems
- Accessories -- weather and vapor barrier mastics, joint sealers and caulking, adhesives, stainless steel and aluminum banding and clips, tapes, froth packs, mechanical fasteners, and applicator guns

VI.E. First Solar, LLC

First Solar, LLC produces photovoltaic (PV) module products used by electric utilities and commercial, distributed generation power plant projects, and is a leader in the development and manufacture of high quality thin film solar modules. It is located in Perrersyburg, near Toledo, and has over 150 employees. It has significant international sales.

First Solar has invested heavily in developing advanced, thin film semiconductor deposition and high volume manufacturing processes essential to achieve the low cost, high product quality and module efficiency required to make solar energy economically viable across a broad range of applications. First Solar's goal is to dramatically reduce

the cost of solar electricity and make solar generated electricity an important part of the 21st century electricity infrastructure.

The firm has developed a solar module product platform that is manufactured using a unique and proprietary High Rate Vapor Transport Deposition (HRVTD) process that optimizes the cost and production throughput of thin film PV modules. The process deposits semiconductor material while the glass remains in motion, completing deposition of stable, non-soluble compound semiconductor materials. The process produces no emissions of any kind while producing solar modules that can create clean energy for 20 years or more. First Solar has been recognized by *R&D Magazine* as inventing one of the most technologically significant new products of 2003 for the development of the HRVTD process. The firm owns 28 patents (issued and pending) relating to thin film PV module manufacturing and related processes.

First Solar's modules are optimized for grid-connected solar power plant operators who depend on high, predictable energy output and low installed system costs to maximize the return on their solar power plant investment. Sales have been concentrated to a select group of project developers and system integrators engaged in the development of solar power plants in the U.S. and Europe.

First Solar is a leader in the development and manufacture of solar modules that deliver high energy yield. The company's innovations in rapid semiconductor deposition and efficient, automated manufacturing result in short energy payback time and long energy production life for its solar modules. First Solar's initial production facility, a 75,000 square foot highly automated manufacturing plant was opened in 2001, and the firm broke ground in 2003 on a plant expansion project that will increase plant capacity to 25MW by 2005.

VI.F. FORRY

FORRY, Inc is a Cleveland-based company specializing in particulate control systems for applications in utility, pulp/paper, cement, and steel processes. It was founded in 1978, has 120 employees, and has created 15 new jobs within the past six months. FORRY's employees are about 50 percent engineering/technical and 30-40 percent sales/administrative, and its business is about 10 percent government/public sector and 90 percent private – commercial and industrial. About five percent of its business is international.

FORRY designs, installs and services auxiliary control systems for utility and heavy industrial customers, and it is the largest supplier of end user particulate process controls in the United States. FORRY is a leader in the integration of particulate delivery, conversion, cleaning, collection, and disposal systems, and provides a growing platform of inter-related control systems.

FORRY's initial products involved microprocessor controls for precipitator rapping, and this technology expanded to include microprocessor based voltage controls in the early 1980s. Since then, FORRY has introduced two new generations of rapping controls and three new generations of voltage controls, all reflecting the combination of new electronic technology and increased customer expectations.

In the mid 1980s, FORRY introduced controls for vacuum and pressure based fly ash handling systems and a fabric filter system control. In the late 1980s, FORRY introduced the first integrated precipitator management system capable of online monitoring of plant conditions and dynamic control of precipitator performance to achieve the optimum balance between plant conditions and precipitator power consumption. This system, called PCMenu, was presented in a DOS-based graphical interface. PCMenu and the subsequent MPCMenu systems provide graphing, data logging, waveform display, and real-time monitoring tools, and information for this control system was gathered by connecting all of the components into a fiber optic-based loop centered in the newly released FORRY Central Control Unit.

In the early 1990s, FORRY embarked on a larger program to provide additional auxiliary control systems to its existing customer base. Comprehensive sootblowing and flue gas conditioning controls were introduced, and the ash handling system was expanded to provide integration of fly ash, bottom ash, and pyrites. These new control systems, coupled with Microsoft Windows, human machine interfaces, clientserver support, and third party industry standard communications, form a plant-wide particulate handling system. Each control provides bi-directional communications, allowing on-the-fly changes in individual control performance based on the collective system state.

VI.G. Gelles Laboratories

Gelles Laboratories is located in Dublin, a suburb of Columbus, and is a full service asbestos laboratory with capabilities in the analysis of bulk samples, including dust and soil and air and water samples. It has 110 employees, and has created 15 new jobs within the past six months. Gelles employees are about 90 percent engineering/technical and 10 percent sales/administrative, and its business is about 90 percent private – commercial and industrial. About 30 percent of its business is international.

Gelles has been analyzing samples for asbestos since the early 1980s, and its diverse facilities and technical staff permit it to analyze unusual or difficult samples. The Dublin facilities consist of 26,000 square feet of offices and laboratories, and include state-of-the-art electrochemical test instrumentation, high temperature autoclaves, a soils laboratory, servo-hydraulic and mechanical cyclic load machines, an asbestos testing laboratory, a metallography laboratory, inhibitor test equipment, a coating and polymer laboratory, high temperature-pressure steam loops, multi-phase flow loops, scanning and transmission electron microscopes, and an atomic force microscope. The firm conducts most NACE/ASTM standard corrosion related test methods and

specializes in one-of-a-kind test systems specially designed to solve client problems. Its facilities have capabilities for full-scale pipe burst tests (up to 30-inch in diameter and 30-feet long), high temperature materials testing, corrosion inhibitor testing, H₂S testing, electrochemical testing, and asbestos testing.

Gelles is accredited by the National Institute of Standards and Technology and the National Voluntary Laboratory Accreditation Program for the analysis of bulk and air samples for asbestos fibers, and it participates in the Proficiency Analytical Testing program for determining the fiber concentration in air samples by Phase Contrast Microscopy. Bulk sample analysis is conducted by polarized light microscopy and supplemented in special cases by gravimetric analysis, scanning electron microscopy, or analytical electron microscopy. These techniques have not only been utilized to identify asbestos and to quantify its concentration, but have also been applied to completely characterize all components present in some commercial asbestos-containing materials. Air sample analysis for asbestos is conducted using analytical electron microscopy. The protocols used at Gelles include AHERA regulations promulgated for monitoring asbestos in schools NIOSH 7402, an extension of the PCM methodology NIOSH 7400.

Drinking water samples are analyzed by Gelles with the AEM using the protocol designated under Phase II/Phase V rules of the Safe Drinking Water Act. Reliable results are ensured through an extensive quality assurance program including equipment calibrations, continuing staff training, contamination monitoring, proficiency testing, and repeat and inter-laboratory analyses.

Gelles is part of CC Technologies, an engineering, research, and testing firm specializing in corrosion control, fitness-for-service, pipeline/plant integrity analysis, corrosion monitoring, materials evaluation and selection, asbestos analysis, and design and development of instrumentation and software.

VI.H. Malcolm Pirnie

Malcolm Pirnie is one of the largest firms in the U.S. focused on environmental issues, and for over a century has provided environmental engineering, science, and consulting services to 3,000 public and private clients. Of its 1,400 employees, 150 work out of its offices in Akron, Cincinnati, and Cleveland, and it has added five new jobs in Ohio over the past six months. The firm's employees are about 80 percent engineering/technical and 20 percent sales/administrative, and its business is about 90 percent government/public sector and 10 percent private – commercial and industrial. It has relatively little international sales.

Malcolm Pirnie has built its practice and reputation on technical excellence and innovation, and its staff of engineers, scientists, consultants, designers, architects, and technical support personnel are located in more than 40 offices nationwide. More than 100 Pirnie projects over the last ten years have been recognized for engineering

excellence in competitions nationwide, and the firm is a recognized source in developing environmental policy, management, and technology

Malcolm Pirnie was founded in 1895 as consulting practice in Boston to solve "problems in water supply, sewerage and sewage disposal." The firm's reputation grew as early projects helped define where the emerging environmental profession was headed. New technologies such as rapid sand filtration and disinfection were perfected as the firm developed drinking water supplies for new Florida resorts and engineered water treatment plants and reservoirs along the Eastern seaboard. After various transitions in partners and management, the firm evolved to become Malcolm Pirnie Civil Engineer in 1930. By 1940, the firm had a staff of 25 devoted almost exclusively to Army and Navy work and defense projects across the country and in Puerto Rico, developing the high-purity oxygen concept to heighten effectiveness of aerobic wastewater treatment.

Spurred by the first federal environmental law passed in 1948, Malcolm Pirnie's water process experts continued to engineer drinking water facilities for America's cities. They expanded their focus from producing biologically safe water using filtration to concern about its chemical constituents, and revolutionized large-plant design by applying new high-rate technologies.

During the 1960s and 1970s, having developed expertise in large sewage treatment facilities, the firm designed innovative nitrification plants for New York State's Capital District that initiated the cleanup of the badly polluted Hudson River. Malcolm Pirnie engineered challenging environmental facilities overseas and designed improved processes to treat complex industrial wastes. With the 1970s, the first Earth Day signaled a new environmental era, and Pirnie's services were in demand for major projects in cities all across the country, including Cleveland and Cincinnati. New technologies and disciplines were added, expanding the firm's capabilities from engineering to environmental sciences and planning. In the 1980s, Superfund hazardous waste investigations and cleanups from Love Canal to Marathon Battery were a major focus for the firm, while a new array of drinking water quality issues related to organic contamination drove innovative project designs. The firm expanded into environmentally sound, state-of-the-art solid waste management and air quality solutions, and into new issues such as odor control and air toxics. Pirnie's engineers and scientists continue to evaluate and apply new technologies designed to safeguard public health and the environment.

Malcolm Pirnie is a closely-held "S" corporation with headquarters in White Plains New York. All shares are owned by full-time employees who are also officers or senior managers of the firm. The firm's annual revenues exceed \$200 million and it is ranked by the *Engineering News Record* among the top 25 U.S. firms in many environmental areas, including environmental science, water treatment and desalination, sewerage and solid waste, wastewater treatment, hazardous waste, chemical and soil remediation, and site assessment and compliance.

VI.I. Midwest Environmental Control

Midwest Environmental Control (MEC) is located in Toledo and specializes in environmental remediation. It was founded in 1983 and has 25 employees. MEC's employees are about 25 percent engineering/technical and its business is about 50 percent government/public sector and 50 percent private – commercial and industrial. About five percent of its sales are international.

MEC has been providing cost-effective, high quality environmental services to customers across the country for two decades, and the firm has conducted thousands of projects in virtually every setting and degree of complexity. Recognizing the need for asbestos abatement services, MEC was originally established to serve clients throughout Northwest Ohio. Since its founding, MEC has grown and evolved to offer a greater range of services to customers across the country and has expanded its functions to include diverse hazardous materials remediation services. The company has grown steadily, expanding from its position of dominance in the Northern Ohio market to serve major clients throughout the United States. Managing projects ranging from small, underground tank removals to complex, multi-million dollar remediation projects for the Department of Defense, the company serves a diverse client base, including major corporations, institutions, small businesses, and the Federal Government.

MEC is a leader in environmental remediation, providing the experience, technical knowledge, and resources necessary to ensure full regulatory compliance and a high level of customer satisfaction. The firm offers the expertise necessary to deal with complex environmental problems, and provides a high level of professional service and cost-effective solutions.

MEC has worked with numerous clients throughout Ohio and the U.S., including the U.S. Army Corps of Engineers, Edwards AFB, Vandenberg AFB, Nellis AFB, Fort Irwin, the U.S. Bureau of Prisons, and others. Its unique experience includes asbestos abatement aboard a satellite launch vehicle, runway striping removal for the U.S. Air Force, work for NASA at the Dryden Research Laboratory, and hazardous materials removal and demolition at numerous facilities and locations.

VI.J. Venture Lighting

Venture Lighting, International is located in Solon, Ohio, a suburb of Cleveland, and specializes in energy efficient metal halide lighting systems. It was founded in 1983, has 300 employees, and has created 50 new jobs within the past six months. Venture's employees are about 80 percent manufacturing, 10 engineering/technical and 10 percent sales/administrative. Its business is about 80 percent commercial and industrial, with the remainder being residential and government/public sector.

Venture was founded as a metal halide, high intensity discharge lamp (light bulb) manufacturing company based in Cleveland. Venture CEO Wayne Hellman began the development of the company after a 16 year career with General Electric during which he pioneered innovations for metal halide lighting. Mr. Hellman, along with a small core group of marketing and engineering managers from GE, formed Venture Lighting.

From its inception, Venture has been the only company in the world focused exclusively on the advancement of metal halide lighting technology. The company emphasis continues to be the development of breakthrough, superior quality metal halide technology for the world market, including materials, system components, systems, and production equipment. Venture aspires to be the best metal halide lamp company in the world and to dominate the development of metal halide lamps for general lighting.

Venture has continued to develop innovative, environmentally-friendly products designed for a wide range of metal halide lighting applications. Venture's high quality, competitively priced metal halide lamps, including the innovative new Uni-Form® pulse start system, have accelerated the annual market growth rate of metal halide to double that of other lighting technologies. In recent years, advancements in metal halide technology have extended its use from outdoor applications to commercial, retail, and office space uses. Venture offers a wider selection of metal halide lamp types than any other manufacturer and, of the 300 plus lamp types marketed by Venture, more than half are unique lamps designed and manufactured exclusively by the company. Of the new lamp types offered by competitors over the past decade, about 50 percent were originally developed by Venture. Venture's Uni-Form® pulse start technology continues to lead the industry with its state-of-the-art system approach to metal halide lighting.

Venture is committed to the continued development of new technology and applications for metal halide. As the lighting industry evolves and shifts toward high-end technologies, Venture intends to maintain its position at the forefront of metal halide technological advancement worldwide.

VI.K. Wastequip

Wastequip, Inc. is located in Cleveland and manufactures waste control and recycling products. It was founded in 1989 and has 1,100 employees, including 30 in Ohio. The firm's employees are 80 percent manufacturing, 10 percent engineering/technical, and 10 percent sales/administrative, and its business is about 90 percent government/public sector and private – commercial and industrial. About five percent of its sales are international.

Wastequip has been consolidating the industry for two decades, and it currently owns 22 waste-handling equipment manufacturing plants in the U.S. and Canada. The company provides large and small metal containers for on-site waste collection, balers and compactors for waste processing, and containers, trailers, hoists, and

other mechanical equipment used for transporting solid, liquid, and hazardous waste. It produces refuse, recycle, garbage, and waste equipment including compactors, balers, hoists, transfer trailers, transfer stations, vacuum units containers, truck hoists, vacuum tanks, and airport trailers designed for moving frontload containers at airports. Its customers include solid waste disposal firms, commercial businesses, and government agencies.

Wastequip is a world leader in the design and manufacture of various solid waste and garbage containers and handling equipment. Its provides top quality, innovative products like trailers, containers, hoists, balers, compactors, and Cusco vacuum vehicles. The firm offers everything from vacuum tanks and garbage compactors to roll off trailers and roll off truck hoists, and its containers come in different varieties such as side load, rear load, and roll off to ensure that its customers have the best option for their waste and recycling needs.

Wastequip's reputation has been earned by providing top-quality, innovative products and total customer service. Founded with the objective of consolidating the waste equipment industry, Wastequip has grown into a \$200 million corporation, and it is continually strengthening its position through strategic acquisitions. It has benefited from many efficiencies of scale, and efficiencies have been realized in areas such as material procurement, engineering, manufacturing, and distribution. Wastequip plans to continue to grow through internal development and acquisitions and to meet and exceed its customers' specific needs.

VI.L. YSI

YSI, Inc. is located in Yellow Springs, Ohio, between Dayton and Columbus, and specializes in environmental sensors, monitoring, and data products. It was founded in 1948, has 50 employees, and has substantial international sales.

YSI was founded as Yellow Springs Instruments by alumni of Antioch College. The company's initial product was the first quartz crystal electronic timer for the U.S. Air Force, its first commercial instrument was the Model 3A Dielectric Constant meter, and it produced interchangeable thermistor temperature probes and associated instrumentation. By 1960, YSI had 40 employees and numerous instruments that had gained wide acceptance among scientists and researchers. A European distribution network was established, and new and innovative products were developed. In 1970, YSI demonstrated the enzyme-activated polarographic measurement of glucose in water, proving that glucose could be measured in whole blood with the presence of the glucose oxidase, and YSI was able to market its pioneering Model 23 Glucose Analyzer.

In 1983, an Employee Stock Ownership Plan was established, and the company began to focus on niche markets, combined marketing and engineering teams, initiated quality improvement programs, and laid the groundwork for strategic alliances with domestic and global partners. Sales and distribution networks were established in the

Far East, and restructuring that began in 1986 continued with the creation of product focus groups supported by a core functional organization.

During the 1990s, the firm adhered to a well-defined plan of providing quality products to specific global niche markets while continuing to reduce costs. YSI recognized its core competency in sensor technology and committed three million dollars for a new facility to house the stepped-up sensor measurement technology teams, and YSI's existing facility was renovated.

YSI has three business units: Environmental, Temperature, and Life Sciences. YSI Environmental is the largest business unit and it manufactures instrumentation for measuring and monitoring water quality and quantity. Its market is segmented into six primary categories: Coastal/estuaries, surface water, groundwater, drinking water, aquaculture, and wastewater. Recent YSI environmental projects include marine sanctuary site categorization studies, a watershed monitoring project in Romania, aiding ecological research on lake Victoria, Tanzania, Africa, analysis of the world's largest water reclamation district, optical monitoring system projects for lake Oconee water quality, partnerships to protect aquatic life, surveying aquatic diversity in the Grand Canyon, monitoring a South American village's water supply, monitoring water quality in the lower great Miami river basin, and recycling surplus medical supplies.

YSI prides itself on being an ecologically sustainable company that takes, makes, and disposes of materials and waste in an environmentally responsible manner. It utilizes recycling programs, has reduced energy usage in its facilities, and utilizes energy efficient design and manufacturing processes.

VII. OPPORTUNITIES IN OHIO STATE GOVERNMENT PROGRAMS FOR ENCOURAGING ENVIRONMENT-RELATED JOBS

VII.A. State Government Perceptions on Jobs and the Environment

Among some policymakers and economic leaders in Ohio there may be a general presumption that environmental protection and economic development/job creation are incompatible opposing goals. For example:

- On March 1, 2001, Christopher Jones, Director of the Ohio EPA, testified before the State Legislature and distinguished between two types of programs: Those designed to protect the environment and those designed to foster economic development and create jobs, and stated that it is important that the goals of the former not interfere with the goals of the latter.
- In December 2003, an Ohio Manufacturing Summit, co-hosted by Governor Bob Taft and Senator George Voinovich, was held in Columbus and focused on issues related to Ohio manufacturing. The summit singled out environmental issues as an economic deterrent and recommended easing environmental mandates on businesses and relaxing current clean air regulations.
- Governor Taft has introduced a 2004 Jobs Bill that does not address the potential of the environmental and related industries for job creation. However, it does recommend expenditure of funds to preserve defense jobs by having Ohio oppose DOD efforts to realign and close unneeded DOD facilities in the state, though these may be closed eventually.
- Governor Taft appointed a Jobs Cabinet consisting of the Directors of most of the State Departments and has given it a six point agenda. The agenda implies that the state will oppose Federal environmental regulatory mandates.¹⁰
- In August 2003, the Ohio Department of Transportation published its *Jobs and Progress Plan*. The Plan's major feature is the recommended expenditure of \$5 billion on highway construction.

VII.B. Opportunities: Possible State Initiatives That Could Be Used To Encourage Environment-Related Industries and Jobs and Maximize Benefits

¹⁰"Taft Jobs Cabinet," Office of the Governor, 2004.

There are a number of state government programs and initiatives that could be used to stimulate environment-related industries and jobs in Ohio. Some of the more important ones are summarized below. All of the initiatives and programs discussed could be maximized to strengthen the environmental industry and tap inherent leverage and multiplier effect benefits, building upon the existing robust industry.

VII.B.1. The Third Frontier Project

The \$1.6 billion Third Frontier Project is the largest economic development program ever initiated in Ohio, and is designed to create thousands of new, high-paying jobs throughout the state, expand research and development in Ohio, and start new high-tech companies and develop state-of-the-art products. The Project is:

- Investing \$500 million to build world-class research facilities, known as Centers of Innovation.
- Investing \$500 million to support early stage capital formation and the development of new products.
- Distributing \$100 million in low interest loans to help finance high paying, high-growth job opportunities and support advanced manufacturing technologies to help existing industries become more productive.

The goal is that, through Third Frontier Project investments, additional federal and private sector support will help generate billions of dollars of revenues for Ohio's economy, leading to the development of new products and the creation of thousands of high-paying jobs in the state.

One element of the Project is the Ohio Research Commercialization Grant Program, which was created to improve the commercial viability of the Small Business Innovation Research, Small Business Technology Transfer, and Advanced Technology Program research and development projects. The intent is to improve the ability of small technology companies to assess and realize the commercial potential of research projects and to promote the competitiveness of these companies through the augmentation of federal R&D funding. The Third Frontier Commission awards grants to eligible applicants on a competitive basis.

Third Frontier Project funds can be – and have been -- used (see section VII.D) to help create environment-related industries and jobs. This prong could be greatly expanded.

VII.B.2. The Research and Development Investment Loan Fund

The Research and Development Investment Loan Fund (R&D Fund) was created to position Ohio to compete aggressively for private-sector R&D investments that will create high-wage jobs, and it targets large investments from companies with significant assets and sales. The R&D Fund assists in financing the acquisition, construction, and related costs of technology, facilities, and equipment. Assistance from the state is provided in the form of low-interest loans, and the R&D Fund can finance up to 50 percent of a project's allowable costs, with loans ranging from \$1.5 to \$25 million. Businesses that are meeting the project requirements (job creation commitments, timely loan repayments, etc.) are eligible for a dollar-for-dollar credit against their Ohio Corporate Franchise Tax, equal to the amount of principal repaid on the loan. The maximum credit is \$150,000 each year, which is non-refundable and cannot be carried forward. Environment-related industries are eligible for loans under this program and could be used for optimal jobs creation impact and benefit.

VII.B.3. The Clean Ohio Fund

The goal of the Clean Ohio Fund is to improve the quality of life in Ohio through community-directed investments to stimulate economic development and revitalize urban areas, and it is funded with a \$400 million bond fund. There are four competitive funding programs:

- The Clean Ohio Green Space Conservation Program helps to fund preservation of open spaces, sensitive ecological areas, and stream corridors.
- The Clean Ohio Agricultural Easement Purchase Program supports the permanent preservation of Ohio's most valuable farmland through the purchase of development rights.
- The Clean Ohio Trails Fund works to improve outdoor recreational opportunities by funding trails for outdoor pursuits of all kinds.
- The Clean Ohio Revitalization Fund supports the cleanup of polluted properties so that they can be restored to productive uses.

The Fund is a "classically green"-oriented entity, obviously creates jobs, but has no component that maximizes, publicizes, or further develops the current jobs creation benefits or potential. However, the fund does have substantial resources, and the goals of the Fund are broad enough to include environment-related jobs programs. Thus, the jobs component of this program could be readily optimized.

VII.B.4. Governor's Office of Science and Technology

The Governor's Office of Science and Technology (GOST) is working to prepare the state for the shift to a knowledge-based economy from one based on manufacturing and to make the most efficient use of available state resources to encourage wealth creation in the state through technology. By facilitating communication between state funded intermediaries, research universities, two-year colleges, state and Federal government, industry, and two of Ohio's Federal research laboratories -- NASA Lewis Research Center and the Air Force Research Laboratory at Wright Patterson Air Force base -- GOST seeks to optimize the creation of a technology-based infrastructure.

In 1998, GOST established the Technology Action Fund (TAF) to support projects that contribute to the strength of the technological and industrial sectors of Ohio's economy. The Technology Action Board sets TAF funding priorities and procedures and chooses grantees on a competitive basis. Environmental technologies are currently not a TAF priority, but there is no reason why they could not be prioritized for jobs benefits.

VII.B.5. The Edison Technology Centers

The Edison Technology Centers link industry with academia and government in partnerships to strengthen industrial competitiveness through technological innovation. Each of the Centers offers capabilities in specific technologies, including advanced manufacturing, polymers, materials and processes, welding and materials joining, biotechnology, and environmental technologies. Companies involved in the Edison Technology Center programs benefit from relationships with world class universities and Federal research facilities, providing state-of-the-art basic and applied research technologies; a range of technical services including testing, technology analysis and assessment, training, hotlines, business and economic studies, information database retrieval, pilot plant and microfactory assistance and computer modeling; and networking and services which cover informational needs through frequent seminars, forums and conferences. There are currently seven Edison Centers:

- CAMP, Inc., in Cleveland, which provides manufacturing, engineering, technical management, and other services for manufacturers.
- The Edison Biotechnology Centers in Cleveland, Columbus, and Cincinnati, which promote the growth of the Ohio biomedical/biotechnology industry
- EISC, Inc., in Toledo, which moves Ohio companies toward world-class excellence through manufacturing modernization.

- The Edison Materials Technology Center, in Kettering, which provides problem-solving and applied research in materials and processing technologies, including metals, ceramics, composites and polymers.
- The Edison Welding Institute, in Columbus, which provides materials joining and engineering expertise to manufacturers throughout the United States.
- TechSolve, Inc., in Cincinnati, which provides assistance to manufacturers and manufacturing-related businesses in waste reduction, machining, operations analysis, industrial engineering, energy conservation, and computer-aided process planning.
- Ohio's IT Alliance, in Dayton, which provides regional economic development programs designed to support Ohio's extensive information technology industry.

One or more of these centers could focus on environmental technologies and jobs.

VII.B.6. Percentage of Income Payment Plan

The Percentage of Income Payment Plan (PIPP) program is designed to help poor people keep their homes warm in winter, and was established by the Public Utilities Commission in 1983 in response to hardships caused by a harsh, very cold winter. It is a small amount in each bill, but collectively it totals \$100 million annually.

The Electric Restructuring Bill enacted in 2000 codified PIPP and transferred administration of the program from the electric companies to the Ohio Department of Development. The utilities remit the funds in the rates for PIPP to a Universal Service Fund, and the Office of Community Services administers the fund. There are additional funds available in the Universal Service Fund for weatherization, energy efficiency, and related initiatives. To maximize efficiency from weatherization, it is coordinated with local community housing rehabilitation programs, and weatherization staff help reduce the energy cost to homeowners, thus releasing funds to cover debt service for additional rehabilitation. Community development rehabilitation activities benefit from these skills, and weatherization programs are conducted in sound structures with adequate electric service under good roofs.

While most of the PIPP funds are used to assist low income persons in paying their utility bills, discretionary funds are available for energy efficiency and related programs. A portion of these discretionary monies could, in theory, be used to support environment-related jobs initiatives, especially if the funds focused on jobs training and jobs creation for low income persons.

VII.B.7. Energy Efficiency Skills for Professionals

Energy Efficiency Skills for Professionals (EESP) is a program offered by the Ohio Department of Development, and it provides professionals in the building industry such as architects, engineers, code officials, contractors, and vocational and technical education students and instructors with training in building performance. Courses on the 1995 Model Energy Code and ASHRAE 90.1 are among those currently offered, and the EESP program provides a way for Ohio building industry professionals to keep current on advances in building energy efficiency. This knowledge will allow them to incorporate those advances into the design and construction of buildings in Ohio, and the construction of more energy efficiency buildings will result in energy savings, reduced operating costs, and environmental benefits.

EESP is probably the state's closest approximation to an environmental jobs initiative.

VII.B.8. National Center for Industrial Competitiveness Capital Fund

The National Center for Industrial Competitiveness Capital Fund of the Ohio Department of Development works to enhance the industrial competitiveness of existing commercial enterprises, to assist defense dependent companies commercialize, and to help launch new technology based companies. Among its services are financial, technical, and management support, which are provided to companies working in advanced materials, structures and processes, manufacturing technologies, machinery and equipment, information networks, software, and data systems.

VII.B.9. The Innovation Ohio Fund

The Innovation Ohio Loan Fund provides financing assistance for projects that generate new high-value jobs, increased tax revenues, and a more competitive and robust presence in targeted industry sectors.

VII.B.10. Technology Investment Tax Credit Program

Ohio's Technology Investment Tax Credit Program offers a variety of benefits to Ohio taxpayers who invest in small R&D and technology-oriented firms. Through this program, Ohio investors may reduce their state taxes by up to 25 percent of the amount they invest in qualified, technology-based Ohio companies. The program's maximum credit of \$37,500 per investment may be applied to personal income tax, corporation franchise tax, public utility excise tax, or the tax on dealers in intangibles.

VII.B.11. Defense Conversion Assistance Program

Created in 1994 by the Ohio Legislature, the Defense Conversion Assistance Program (DCAP) functions within the Technology Division of the Ohio Department of Development. The program assists Ohio businesses, communities, and individuals in adjusting to the effects of defense reductions and associated funding cutbacks. DCAP funding empowers defense dependent companies and communities to employ specific capabilities or resources to help expand their position in the commercial marketplace. The funds help companies and communities protect jobs by making them more competitive, and facilitates the process of job creation through investments in business expansion and the application of defense technologies.

The potential exists to utilize this defense conversion program to create environmental firms and jobs in Ohio.

VII.C. Ohio Coal Development Office -- Support Dwarfs That For the Environmental Industry

The above roster of opportunities perhaps going can be contrasted with its support of the coal industry.

The Ohio Coal Development Office (OCDO) supports the development and implementation of technologies that can use Ohio's vast reserves of high sulfur coal in an environmentally sound manner. In Ohio, nearly 90 percent of the electricity is produced from coal, and clean coal technologies (CCTs) can help maintain the jobs of those who produce and use coal. CCTs also have excellent export potential as developing countries use of coal, and use of these technologies, is expected to increase enormously over the next decade. Since its inception, OCDO has co-sponsored more than 100 projects at various stages of R&D; however, its priority is focused on the large-scale demonstration end of the R&D continuum. Ohio has largest coal R&D program in the country and leads the nation in CCT deployment. OCDO:

- Funds coal R&D projects and seeks projects which are at their final stages (i.e., making their final tests, scale-up, process optimization) and which, when complete, will result in a permanent installation that uses Ohio coal.
- Is investigating the beneficial reuse of CCT by-products.
- Is funding research to improve sorbents, i.e., materials that remove pollutants from flue gas streams.

- Established the Clean Environment Development Facility, a state-of-the-art combustion test unit that is currently performing air toxics tests.
- Oversees the Ohio Coal Testing and Development facility, a mini-commercial, state-of-the-art coal preparation plant.
- Co-hosts seminars on CCT and related issues and organizes technology transfer "open houses" at its project sites.
- Continuously advocates the greater use of Ohio coal, and supports the coal R&D applications of Ohio enterprises seeking funding from the Federal government or other sources.

A key policy goal, then, could be for Ohio to view its environmental industry as at least as important for investment and development as its coal industry. In addition, opportunities to highlight "clean coal" could also be maximized. (See Table 5 for relative sales and employment in Ohio's mining industry, including coal.)

VII.D. Examples of State Assistance to Environment-Related Industries

In Ohio, there are relevant examples of using state assistance to foster environment-related industry and jobs, albeit mainly from the traditionally green end of the jobs-environment spectrum. However, these could certainly be replicated and expanded. Two of these are summarized below.

VII.D.1. Fuel Cells

Ohio is making an aggressive effort to support development of a commercial fuel cell industry.

The state has established the Ohio Fuel Cell Coalition (OFCC), a consortium of industry, academic, and government leaders from throughout Ohio that is designed to facilitate Ohio's fuel cell industry. Coalition members work to ensure Ohio's presence in the growing fuel cell industry, both regionally and nationally, through world-class research and development, an entrepreneurial environment that encourages innovation and supports commercialization, strategic advocacy to increase federal and state resources to create a globally competitive industry in Ohio, and promotion of the benefits and value of fuel cell technology.

In May 2002, the state launched the Ohio Fuel Cell Initiative, a \$103 million program designed to position Ohio as a national leader in the fuel cell industry and to help facilitate economic growth and job creation in Ohio. The Initiative is a key component of the Third Frontier Project (discussed above), it is designed to make Ohio

a national leader in the discovery and commercialization of fuel cell innovations, and its goal is to position Ohio among the top three states in the nation in the rapidly expanding fuel cell industry. The fuel cell market is predicted to grow to \$10 billion by 2010, fuel cell technology is on the verge of becoming a viable, high-growth industry, and Ohio is positioning itself to play a significant role in its emergence.

The growth of the fuel cell industry could have a substantial impact on a number of core industrial sectors in which Ohio is already a leader, including advanced materials, advanced manufacturing, and instruments, controls, electronics and components. The Fuel Cell Initiative is designed to build upon existing industry and academic strengths of R&D, advanced manufacturing, advanced materials (polymers, ceramics, catalysts, precious metal chemistry, surface and coatings technology, nanotechnologies) components (sensors, electronics), and services (precious metals management and recycling) to advance the integration of a coordinated, robust fuel cell infrastructure.

Thus, advanced materials suppliers in Ohio, such as NexTech Materials, OM Group, and Ferro can provide the catalysts and electrolytes that facilitate the electrochemical process for fuel cells. Ohio's polymer companies will also benefit through the use of advanced polymers as an electrolyte in the growing field of Proton Exchange Membrane fuel cell devices. The creation and rapid implementation of novel polymers could also make Ohio's fuel cell effort extremely competitive.

The state's Advanced Manufacturing sectors will benefit as fuels cells evolve from concept to mass production. Ohio is uniquely positioned to "make things" at production scale that are globally competitive based on cost and quality. Industries involved in metal, polymer, and electronics fabrication, material joining, factory automation, and system design and integration will be critical to the scale-up of fuel cell production. Instruments, controls, electronics, and components companies can provide the sensors, controls, and electrical elements that help complete the fuel cell energy system. Ohio companies that could assist in these areas include Parker Hannifin, Keithly Instruments, Dana Corporation, and Delphi.

These core industry sectors, in conjunction with Ohio's robust R&D resources and skilled, productive workforce, can help drive the success of the fuel cell industry in the state. Ohio has core industry and research strength in the power and propulsion technology sector, including engines, advanced propulsion systems, batteries, power storage, and fuel cells, as well as in polymers, advanced materials and advanced manufacturing.

Jobs and Fuel Cells

As a relevant, direct job-creating example, in June 2003, Stark State College of Technology received \$2 million in Wright Capital Project Funds to support the research, development, and commercialization of fuel cells by establishing the Fuel Cell Prototyping Center. Collaborators on the project include SOFCo-EFS Holdings of

Alliance and Case Western Reserve University's Advanced Power Institute. The project is building a state-of-the-art facility to serve as a learning center for the public for the purpose of fuel cell awareness, job creation, and industry attraction. The Center is expected to create 300 high-paying jobs for Stark County by 2010. This grant was in addition to \$18 million that has been awarded to Case Western Reserve University and a team of four other universities and 21 business partners. The jobs benefits of this investment could be more specifically highlighted for the public, policy makers and potential out-of-state investors.

VII.D.2. Photovoltaics

As another relevant example, in March 2004 First Solar, a leader in the development and manufacture of high-energy yield solar modules (profiled in Chapter VI) received \$5 million of funding from the state in the form of a low interest loan. This funding is being applied to the expansion project underway to increase manufacturing capacity fourfold, from 6 Megawatts (MW) in 2004 to 25MW in 2005. First Solar has earmarked the loan proceeds to purchase machinery and equipment that will help the company achieve high-volume, low-cost manufacturing capabilities and improve production processes, and the plant expansion is scheduled for completion in late 2004.

First Solar's expansion of its solar module production will create new technology jobs in Ohio and assist in the goal of achieving economically viable renewable energy. As Governor Taft noted, "The state's partnership with First Solar is a win-win for jobs, the economy, and the environment."

In sum, many other "win-wins" are ripe in Ohio if policy incentives are reviewed with the jobs-environment link in mind, which would also enable environmental firms to more successfully compete for state and Federal seed and start-up funds.

VIII. SUMMARY of MAJOR FINDINGS

VIII. Major Findings

This report presents information about jobs creation and the potential of the environmental industry in the state of Ohio, as well as background information on the jobs impact of the environmental industry in the nation as a whole. The report finds that the environmental industry is a major player in both the state and national economy, and that the direct and indirect jobs creation potential of the environmental industry is significant, multi-sectoral, under-appreciated, and could be maximized for broad socio-economic and environmental benefit.

Jobs and the National Environmental Industry

The report summarizes MISI findings on the national environmental industry. MISI research has found that over the past four decades, protection of the environment has grown rapidly to become a major sales-generating, profit-making, job-creating U.S. industry. This “industry” ranks well above those in the top of the Fortune 500, and MISI estimates that in 2003 protecting the environment generated:

- \$301 billion in total industry sales
- \$20 billion in corporate profits
- 4.97 million jobs
- \$45 billion in Federal, state, and local government tax revenues

It is likely that the environmental industry will continue to grow significantly for the foreseeable future, and MISI forecasts that in the U.S. real expenditures (2003 dollars) will increase from \$301 billion in 2003 to:

- \$357 billion in 2010
- \$398 billion in 2015
- \$442 billion in 2020

Environmental protection generates large numbers of jobs throughout all sectors of the economy and within many diverse occupations, and MISI forecasts that U.S. employment created directly and indirectly by environmental protection will increase from 4.97 million jobs in 2003 to:

- 5.39 million jobs in 2010

- 5.76 million jobs in 2015
- 6.38 million jobs in 2020

Environmental protection created nearly five million jobs in the U.S. in 2003, and these were distributed widely throughout all states and regions within the U.S. The vast majority of the jobs created by environmental protection are standard jobs for accountants, engineers, computer analysts, clerks, factory workers, truck drivers, mechanics, etc. In fact, most of the persons employed in these jobs may not even realize that they owe their livelihood to protecting the environment.

Firms working in the environmental and related areas employ a wide range of workers at all educational and skill levels and at widely differing earnings levels. Even in environmental companies, most of the employees are not classified as “environmental specialists.” Rather, most of the workers are in occupations such as laborers, clerks, bookkeepers, accountants, maintenance workers, cost estimators, engine assemblers, machinists, machine tool operators, mechanical and industrial engineers, welders, tool and die makers, mechanics, managers, purchasing agents, etc.

Jobs in Ohio and Ohio’s Environmental Industry

We found that environmental protection is a large and growing industry in Ohio. MISI estimates that in 2003:

- Sales of the environmental industries in Ohio totaled \$12.2 billion.
- The number of environment-related jobs totaled more than 176,000.
- The environmental industry in Ohio comprised 3.2 percent of gross state product.
- Environment-related jobs comprised 3.3 percent of Ohio employment.
- Ohio environmental industries accounted for 4.1 percent of the sales of the U.S. environmental industry.
- Environment-related jobs in Ohio comprised 3.5 percent of the total number of environment-related jobs in the U.S.
- Environment-related employment in the state has been increasing in recent years between one and two percent annually.

Most of the environment-related jobs in Ohio are in the private sector, and these are heavily concentrated in several sectors, including manufacturing, professional, scientific, and technical services, and educational services.

Environmental jobs in Ohio are widely distributed through all occupations and skill levels and, while the number of jobs created in different occupations varies substantially, requirements for virtually all occupations are generated by environmental spending. Thus, in Ohio as in the U.S. generally, the vast majority of the jobs created by environmental protection are standard jobs for all occupations.

Nevertheless, we found that, in Ohio, the importance of environmental protection for jobs in some occupations is much greater than for others. For some occupations, such as environmental scientists and specialists, environmental engineers, hazardous materials workers, water and liquid waste treatment plant operators, environmental science protection technicians, refuse and recyclable material collectors, and environmental engineering technicians, virtually all of the demand in Ohio is created by environmental protection activities. This is hardly surprising, for most of these jobs are clearly identifiable as “environmental” jobs.

However, for many occupations not traditionally identified as environment-related, a greater than proportionate share of the jobs are also generated by environmental protection. While, on average, environment-related employment in Ohio comprises only 3.3 percent of total employment, in 2003 environmental protection generated jobs for a greater than proportionate share of many professional, scientific, high-tech, and skilled workers in the state.

Our survey of existing environmental companies in Ohio revealed a wide range of firms, located throughout the state and across sectors, including manufacturing. These firms:

- Are located throughout the state, in major urban centers, suburbs, small towns, and rural areas.
- Range in size from small firms of 25 employees to large firms employing thousands
- Are engaged a wide variety of activities, including remediation, manufacturing, testing, monitoring, analysis, etc.
- Include some of the most sophisticated, high-tech firms in the state; for example:
 - Forry, Inc. (Chargin Falls) is the largest supplier of end use particulate process controls in the U.S.
 - Venture Lighting (Solon) is a world leader in the manufacture of energy efficient metal halide lighting systems.

- Wastequip (Cleveland) is North America's leading manufacturer of waste control products.
- YSI, Inc. (Yellow Springs) is a leading provider of environmental sensors, monitoring, and data products.
- First Solar, LLC (Perrysburg) is a leading U.S. manufacturer of solar photovoltaic modules.
- Aqua-Tech Environmental Laboratories, Inc. (Marion) is one of the nation's foremost environmental testing and analysis companies.
- Environmental Quality Management, Inc. (Cincinnati) is a leading U.S. environmental engineering and remediation firm.

A number of these firms, including Venture Lighting, Forry, and Gelles Laboratories (Dublin) have created significant numbers of new jobs over the past six months, and First Solar is in the process of quadrupling its manufacturing capacity at a time when Ohio has been hemorrhaging jobs, especially in manufacturing.

We found that in Ohio, as elsewhere, there is a general perception that environmental protection and economic development/job creation may be incompatible, despite significant empirical data and evidence to the contrary

Nevertheless, we identified a number of existing state initiatives that could be used to maximize the jobs creation benefit and potential of the environmental industry. These include the Third Frontier Project, the Research and Development Investment Loan Fund, the Clean Ohio Fund, the Edison Technology Centers, the Innovation Ohio Loan Fund, the Technology Investment Tax Credit Program, the Energy Efficiency Skills for Professionals program, and others.

We suggest policy options that could maximize the jobs benefits of the environmental industry in Ohio, with no institutional impediment. Such initiatives should be encouraged and expanded, and this study and others demonstrate that environment-related initiatives can create substantial numbers of jobs in Ohio.

BIBLIOGRAPHY

"A Changing Great Lakes Economy: Economic and Environmental Linkages, State of the Lakes Ecosystem Conference. August 1995, www.epa.gov.

"Advanced Manufacturing Center." www.epa.state.oh.us.

Allison, G. *Are Jobs Really the Price of a Clean Environment?* Washington, D.C., League of Women Voters, 1977.

American Council for an Energy Efficient Economy. *Energy Innovations: A Prosperous Path to a Clean Environment*, July 1997.

Arnold, Frank S. *Environmental Protection: Is it Bad for the Economy? A Non-Technical Summary of the Literature*. EPA Economy and Environment, July 10, 1999.

Banzhaf, Spencer. "Accounting for the Environment," *Resources*, Issue 151 (Summer 2003), pp. 6-10.

Bauer, Brad. "Candidates: Clean Air, Jobs Can Coexist." *Marietta Times*, February 24, 2004.

Berman, Eli and Linda Bui. *Clearing the Air: The Impact of Air Quality Regulations on Jobs*. Economic Policy Institute Study, 1997.

Bezdek, Roger H. "The Environmental Protection Industry and Environmental Jobs in the U.S.A.," in Leal Filho and Kate Crowley, eds., *Environmental Careers, Environmental Employment, and Environmental Training: International Approaches and Contexts*. Frankfurt am Main: Peter Lang Publishers, pp. 161-179, 2001.

_____. "State of the Industry: Jobs and Sales Created by Environmental Protection." *New England's Environment*. Vol. 1, No. 8 (August 1999), pp. 12-16.

_____. "The Net Impact of Environmental Protection on Jobs and the Economy." Chapter 7 in Bunyan Bryant, editor., *Environmental Justice: Issues, Policies, and Solutions*, Washington, D.C.: Island Press, 1995, pp. 86-105.

_____. "The Economy, Jobs, and the Environment." *Proceedings of GEMI '95: Environment and Sustainable Development*, 1995, pp. 65-79.

_____. "Environment and Economy: What's the Bottom Line?" *Environment*, Vol. 35, No. 7 (September 1993), pp.7 – 32.

_____. "The Economic and Employment Effects of Investments in Pollution Abatement and Control Technologies." *Ambio*, Vol. XVIII, no.3, (1989), pp. 274-279.

_____, and Robert M. Wendling. "The Economic and Employment Effects of Increasing CAFE Standards." Forthcoming in *Energy Policy*, 2004.

_____, "Acid Rain Abatement: Costs and Benefits." *International Journal of Management Science*, Vol. 17, No. 3 (1989), pp. 251-261.

Blodgett, John E. "Environmental Protection: How Much It Costs and Who Pays," *Congressional Research Service Report for Congress*, No. 97-459 ENR, April 1997.

California State Department of Conservation. *Green Business: Growing Jobs and Profits*. Sacramento, CA, July 1995.

Campbell, M. and W. Glenn. *Profit From Pollution Prevention*. Toronto: Pollution Probe, 1982.

Clark, Lyman. *The Environmental Industry in the United States*. Report to the Economic Analysis and Research Branch, Office of Regulatory Management and Evaluation, Environmental Protection Agency, Washington, D.C., January 1991.

Clean Ohio Fund. "Implementation White Paper." www.odod.state.oh.us

Cook, Alvin and Jerome Rosenberg. "The Ohio Story: The Economic and Employment Benefits of Controlling Acid Rain." *Amicus Journal*, Vol. 8, No. 2, 1986

Council of Economic Advisors. *2004 Economic Report of the President*. Washington, D.C., February 2004.

Creating Jobs and Clean Energy for Ohio. Ohio Clean Energy Business Council, November 2003.

Darmstadter, Joel. "Greening the GDP: Is It Desirable? Is It Feasible?," *Resources*, Issue 135 (Spring 2000), pp.11-15.

DiPerna, Paula. *Creating Jobs and Sustainable Livelihoods Through Agenda 21 and Other Environmental Policies: A Critical Catalyst for Implementation*. Report Prepared for UNDP, October 1997.

"Edison Center Incentive Program (ECIP)." *Resource Ohio*, March 23, 2001, www.resourceohio.com.

Employment Research Associates. *Biomass Resources: Generating Jobs and Energy*. Great Lakes Regional Biomass Energy Program, September 30, 1999.

Environment Ohio. www.epa.state.oh.us

George H. Alber Enterprise Center, A Center for Collaborative Economic -- Community Enhancement at The Ohio State University at Marion, Center for Excellence in Manufacturing Management. www.marion.ohio-state.edu.

Green Legislative Agenda. Ohio Environmental Council, Columbus, 2003.

Goodstein, E.B. "Jobs or the Environment? No Trade-off." *Challenge* (January-February 1995), pp. 41-45.

_____. *Jobs and the Environment: The Myth of a National Trade-Off*. Economic Policy Institute, Washington, D.C., 1994.

"Governor Announces Plans for Wright Centers of Innovation." News release, September 23, 2003, Office of the Governor.

Harris, Michael, and Iain Frasier. "Natural Resource Accounting in Theory and Practice: A Critical Assessment," Department of Economics and Finance, LaTrobe University, Melbourne, Australia, November 2001.

Hoerner, J. Andrew, Alan Miller, and Frank Muller. "Promoting Growth and Job Creation through Emerging Environmental Technologies." *Global Change* (Electronic Edition), April 1995.

Interlaboratory Working Group on Energy-Efficient and Low-Carbon Technologies. *Scenarios of U.S. Carbon Reductions: Potential Impacts of Energy Technologies by 2010 and Beyond*. Washington, D.C.: U.S. Department of Energy, 1997.

Jacobs, M. *Green Jobs? The Employment Implications of Environmental Policy*. WWF Report, Lancaster/Brussels, 1994.

Jaffe, A.B., Peterson, S.R., Portney, P.R., and R.N. Stavins. "Environmental Regulation and the Competitiveness of US Manufacturing." *Journal of Economic Literature*. Vol. XXXIII (March 1995), pp. 132-163.

Jobs and Progress Plan. Ohio Department of Transportation, August 2003.

Jobs and Prosperity: Ohio's Strategy for the Third Frontier. Office of the Governor of Ohio, October 2002.

Jobs Bill 2004. Office of the Governor, 2004.

Jorgenson, Dale, Richard Goettle, Daniel Gaynor, Peter Wilcoxon, and Daniel Slesnick. *The Clean Air Act and the U.S. Economy: Final Report of Results and Findings*. Environmental Economics Report Inventory, August 27, 1993.

_____, and Peter Wilcoxon, "Environmental Regulation and U.S. Economic Growth." *RAND Journal of Economics*, Vol. 21, No. 2, Summer 1990, pp. 153-167.

Kennickell, Arthur B., Martha Starr-McCluer, and Annika E. Sunden. "Family Finances in the U.S.: Recent Evidence from the Survey of Consumer Finances." *Federal Reserve Bulletin*, Volume 83, No. 1, January 1997, pp. 1-24.

Laitner, Skip, John DeCicco, Neal Elliott, Howarfd Geller, Marshall Goldberg, Robert Morris, and Steven Nadel. *Energy Efficiency and Economic Development in the Midwest*. American Council for an Energy-Efficient Economy, April 1995.

_____. *Energy Efficiency as an Investment in Ohio's Economic Future*, American Council for An Energy-Efficient Economy, Washington, D.C., November 1994.

Larrick, Don. *The 1998 Ohio Poverty Report, Office of Strategic Research*. Ohio Dept. of Development, December 1999.

Management Information Services, Inc., *Survey of Jobs and the Environment Issues in Six Midwestern States: Identifying Policy Challenges and Opportunities*. Report prepared for the Joyce Foundation, Chicago, July 2001.

_____. *Assessing The Impact Of Environmental Protection On Job Creation, Protection, And Enhancement, And On Workforce Development And Training For The Poor, Underemployed, And Unemployed In Indiana*. Report prepared for the Joyce Foundation, July 2000.

_____. *Potential Effects on the Coal Industry and Related Industries of the Kyoto Protocol*, March 1999.

_____. *Federal Subsidies and Incentives for the Energy Industries*. September 1998.

_____. *Costs Incurred by Electric Utility Companies Due to Federal Air Pollution Control Requirements*. Report prepared for the Edison Electric Institute, 1996.

_____. *Anticipating the Labor Markets of the 21st Century*. Report prepared for the American Management Association, 1994.

_____. *Potential Economic and Employment Impact on the U.S. Economy of Increased Exports of Environmental and Energy Efficiency Technologies Under NAFTA*. Report prepared for the White House, 1993.

_____. *Environment and Employment in Canada: Final Report of the Symposium*. Prepared for the Canada Employment and Immigration Advisory Council, 1992.

_____. *The Net Costs and Benefits to Each State and to the Nation of Acid Rain Abatement Legislation.* 1987.

_____. *Simulation of the Economic Impact of Pollution Abatement and Control Investments: Methodology, Data Base, and Detailed Estimates.* 1986.

_____. *Economic and Employment Benefits of Investments in Environmental Protection.* 1986.

Management Information Services, Inc. and 20/20 Vision Education Fund. *Fuel Standards and Jobs: Economic, Employment, Energy, and Environmental Impacts of Revised CAFE Standards Through 2030.* Washington, D.C., 2002.

Morgenstern, Richard D., William A. Pizer, and Jhih-Shyang Shih. *Are We Overestimating the Real Economic Costs of Environmental Protection?* Resources for the Future Discussion Paper 97-36-REV, June 1997.

Nordhaus, William D. and Edward C. Kokkelenberg, eds. *Nature's Numbers: Expanding the National Economic Accounts to Include the Environment,* National Research Council, Washington, D.C.: National Academy Press. 1999.

"NCIC Capital Fund." *Resource Ohio.* www.resourceohio.com.

"Ohio and U.S. Employment Situation." Ohio Department of Job and Family Services News Release, February 26, 2001.

"Ohio Coal Development Program." *Resource Ohio.* www.resourceohio.com.

Ohio Department of Development. *Executive Budget for FYs 2002 and 2003.*

Ohio Department of Job and Family Services. "Labor Market Information." Imi.state.oh.us.

Ohio Department of Job & Family Services Core Planning Document. July 1, 2000.

Ohio Environmental Protection Agency. *Executive Budget for FYs 2002 and 2003.* 2001.

_____. *Draft Long Term Goals: Goals 2001 and Strategies.* June 12, 1998, www.epa.state.oh.us.

_____. *Strategic Planning/Tactical Management Structure.* www.epa.state.oh.us

_____. "Working Together." www.epa.state.oh.us.

Ohio Environmental Protection Agency, Office of Environmental Education. www.epa.state.oh.us.

Ohio Environmental Protection Agency, Small Business Assistance Office. *Small Businesses Affected By Environmental Regulations*. www.epa.state.oh.us.

Ohio Department of Development, Technology Division. www.odod.state.oh.us.

Ohio Department of Job and Family Services. *Helping Ohioans*. www.state.oh.us.

_____. *Ohio Job Outlook to 2008*. www.state.oh.us.

“Ohio Manufacturing Summit.” Bricker & Eckler, LLP, January 2004.

“Ohio State Parks to Turn Teens Green.” Ohio Department of Natural Resources News Release, February 15, 2001, www.dnr.state.oh.us.

The Ohio State University Environmental Policy Initiative First Annual National Policy National Policy Conference, Environmental Policy in an Era of Devolution, April 16-18, 2001, www.agecon.ag.ohio-state.edu.

Ohio State University. *Environmental Policy Initiative*. www.agecon.ag.ohio-state.edu.

Ohio Third Frontier Project: Creating Jobs for Ohioans. Office of the Governor, 2003.

Ohio Urban Revitalization: Policy Agenda & Task Force Report. Prepared for the Governor of Ohio, June 2000.

“Ohio Workforce Connection.” www.ohioworkforce.org.

“Ohio’s First Commercial Wind Turbine Installed in 2003.” Greenenergyohio.org

“Ohio to Build World’s Largest Compressed-Air Energy Plant.” Environmental News Network, May 31, 2001.

“Ohio’s Thomas Edison Program.” Ohio Department of Development, 2003.

“Reflecting on Ohio’s Environmental Accomplishments in 1996.” Ohio EPA News Release, December 27, 1996, www.epa.state.oh.us.

Regional Economics Applications Laboratory. *Job Jolt: The Economic Impacts of Repowering the Midwest*. University of Illinois, Chicago, 2002.

Renner, M. *Jobs in a Sustainable Economy*. Worldwatch Paper 104. Washington, D.C.: Worldwatch Institute, 1991.

Repowering the Midwest: The Clean Energy Development Plan for the Heartland. Environmental Law and Policy Center, Chicago, February 2001.

Schill, Katherine B. *Ohio's Economically Disadvantaged Areas: Are We Matching Resources with Need?* Ohio Legislative Budget Office, 2000.

Schweke, William, Carl Rist, and Brian Dabson. *Bidding for Business: Are Cities and States Selling Themselves Short?* Washington, D.C.: Corporation for Enterprise Development, 1994.

Sustainable Energy for Economic Development, Renewable Energy Development Benefits, www.me3.org.

"Technology Action Fund." *Resource Ohio*. www.resourceohio.com.

Tellus Institute and Stockholm Environment Institute, *America's Global Warming Solutions*, Boston, August 1999.

"Testimony of Christopher Jones, Director, Ohio Environmental Protection Agency. February 6, 2001, Before the House Finance Committee.

"Testimony of Christopher Jones, Director, Ohio EPA, House Bill 3, Before the House Energy and Environment Committee." March 1, 2001,

United Nations, European Commission, International Monetary Fund, Organisation for Economic Co-operation and Development, and World Bank. *Integrated Environmental and Economic Accounting 2003*, A Handbook of National Accounting, 2003.

U.S. Department of Commerce, Bureau of the Census. *Statistical Abstract of the United States*. 2004.

_____. *County Business Patterns*. Annual Series, 2004.

_____. *Survey of Environmental Products and Services*. February 1998.

_____. *Population Projections: States: 1995 – 2025*. 1998.

_____. *Current Population Reports*. Various issues.

_____. *Current Population Survey, Annual Demographic Study*. Annually.

_____. *Pollution Abatement Cost and Expenditures: 1999*. MA200(99), November 2002.

U.S. Department of Commerce, Bureau of Economic Analysis. *State Personal Income, Quarterly Series*. 2004.

_____. *Gross State Product, Annual Series*. 2004.

U.S. Department of Commerce, Office of Technology Policy. *Meeting The Challenge: U.S. Industry Faces the 21st Century - The U.S. Environmental Industry*. September 1998.

U.S. Department of Labor, Bureau of Labor Statistics. *Employment and Wages, Annual Series*, 2004.

_____. *Local Area Unemployment Statistics*. Monthly Series, 2004.

_____. *Occupational Employment and Wage Estimates*. Annual Series, 2004.

_____. *State and Area Employment, Hours, and Earnings*. Monthly Series, 2004.

U.S. Department of Commerce, International Trade Administration, Office of Environmental Technologies Industries. *Environmental Industry of the United States*, a USDOC/ITA web-accessible briefing generated by Environmental Business International, Inc. for 1999

U.S. Department of Energy. *The Jobs Connection: Energy Use and Local Economic Development*. www.eren.doe.gov.

U.S. Department of Energy. *U.S. Carbon Reductions by 2010 and Beyond: The Potential Impact of Energy-Efficient and Low-Carbon Technologies*. September 1997.

U.S. Department of Labor. *Impact of Federal Pollution Control and Abatement Expenditures on Manpower Requirements*. Bulletin 1836. Washington D.C., 1975.

U.S. Environmental Protection Agency. *The Benefits and Costs of the Clean Air Act, 1970 to 1990*. Report prepared for the U.S. Congress, October 1997.

U.S. Environmental Protection Agency, Office of Policy, Planning, and Evaluation. *The U.S. Environmental Protection Industry: A Proposed Framework for Assessment*. EPA 230-R-95-011, September 1995.

_____. *Environmental Investments: The Cost of a Clean Environment*. EPA-230-11-90-083, November 1990.

Wagner, Gernot. "The Political Economy of Greening the National Income Accounts," *AERE Newsletter*, Association of Environmental and Resource Economists, Vol. 21, No. 1 (May 2001), pp.14-18.

World Resources Institute. *U.S. Competitiveness is Not at Risk in the Climate Negotiations*. October 1997.

APPENDIX: U.S. COMMERCE DEPARTMENT ESTIMATES OF THE ENVIRONMENTAL INDUSTRY IN OHIO

There are two historical sources of information about the environmental industry in Ohio. Unfortunately, they only address certain segments of the industry, do not focus on jobs, and were conducted for 1999. These are briefly summarized below.

International Trade Administration

One estimate of the size of the environmental industry is available through the U.S. Department of Commerce.¹¹ The Department's International Trade Administration (ITA), Office of Environmental Technologies Industries estimated, for 1999, the world market for environmental products and services and the size of the U.S. market, including estimates at the state and metropolitan statistical area levels. In this example of environmental accounting, the environmental industry is defined to include:

- Environmental-related services
 - Environmental testing and analytical services
 - Wastewater treatment works
 - Solid waste management
 - Hazardous waste management
 - Remediation/Industrial services
 - Consulting and engineering

- Environmental equipment
 - Water equipment and chemicals
 - Water equipment and chemicals
 - Instruments and information systems
 - Air pollution control equipment
 - Waste management equipment
 - Process and prevention technology;

- Environmental resources:
 - Water utilities
 - Resource recovery
 - Environmental energy sources.

ITA estimated that the 1999 U.S. environmental market totaled \$189 billion, almost 38 percent of the global \$499 billion market. In meeting the demands of those markets, the U.S. environmental industry was estimated to have generated \$196 billion

¹¹See U.S. Department of Commerce, International Trade Administration, Office of Environmental Technologies Industries, *Environmental Industry of the United States*, a USDOC/ITA web-accessible briefing generated by Environmental Business International, Inc. for 1999.

of revenues. ITA also estimated the U.S environmental trade balance for 1999. It estimated that the U.S. exported \$21 billion worth of environmental products and services and imported \$14 billion, thus generating a positive net U.S. exports balance of just over \$7 billion in environmental-related goods and services.

The ITA U.S. industry estimates were disaggregated by state, and Table A.1 lists the estimated industry revenues, jobs, the number of companies, and the exports of the industry in Ohio. The ITA estimated that, in 1999, Ohio accounted for about 4.4 percent of the U.S. industry, ranking it between sixth and eighth among the states. ITA estimated that the number of environmental jobs in the state totaled almost 61,000 in 1999.

Table A.1
U.S. Department of Commerce Estimates
of the U.S. and Ohio Environmental Industries, 1999

		Ohio	U.S.	Ohio Share of U.S.
Revenues	(millions)	\$8,443	\$196,465	4.3%
Jobs	(number)	60,745	1,389,638	4.4%
Companies	(number)	5,022	115,030	4.4%
Exports	(millions)	\$957	\$21,310	4.5%

Source: U.S. Department of Commerce (ITA) and Environmental Business International; 1999.

The ITA report disaggregated the Ohio industry by metropolitan statistical area (MSA) – see Table A.2. In Ohio, these areas include the Cleveland-Lorain-Elyria MSA, the Cincinnati MSA (including counties in Kentucky and Indiana), and the Columbus MSA. Cleveland accounted for one-fifth of the industry in the state and almost 12,000 environmental-related jobs. The Cincinnati MSA accounted for about 14 percent of the state's environmental industry, but the in-state portion of the MSA would be substantially less. The Columbus MSA accounted for 13 percent of the industry in Ohio and almost 8,000 jobs.

Table A.2
U.S. Department of Commerce Estimates of the Ohio
Environmental Industry by Metropolitan Statistical Areas, 1999

		Cleveland OH	Cincinnati OH-KY-IN	Columbus OH
Revenues	(millions)	\$1,666	\$1,221	\$1,117
Jobs	(number)	11,986	8,783	8,038
Companies	(number)	991	726	664
Exports	(millions)	\$189	\$138	\$127
MSA Average Share of Ohio		20%	14%	13%

Source: U.S. Department of Commerce (ITA) and Environmental Business International; 1999.

Census Bureau -- Pollution Abatement Costs and Expenditures (PACE)

The Census MA200 survey has been one of the more respected sources for information on the U.S. environmental industry.¹² This report was not available for a number of years after 1994, but was revived for the year 1999. The results of the survey are not consistent with previous reports for a number of reasons, but they do present a snapshot of major portions of the environmental industry with information available by detailed North American Industry Classification System (NAICS) industry and geographically, by state. However, the survey's biggest weakness is that it only covers the mining (NAICS 21), manufacturing (NAICS 31-33), and electric power generation industries (NAICS 22111). Clearly, the U.S. agricultural, services, transportation, and government sectors have pollution abatement costs and expenditures that contribute to and help define the U.S. environmental industry, but they are not included in the PACE survey. Therefore, while the survey estimates are of sufficient quality, they lack comprehensiveness and describe only a small fraction of the environmentally-related business activities in the U.S.

Table A.3. lists the pertinent information for Ohio and the United States from the most recent survey, for 1999. Pollution abatement costs in these selected Ohio industries included over \$271 million of capital expenditures and \$948 million for operating costs. Together with almost \$465 million in operating costs for disposal and recycling activities and other categories of economic activity, total PACE estimates for Ohio in 1999 totaled just short of \$2.0 billion. This represented 6.6 percent of the overall PACE estimates in the United States.

¹²See U.S. Department of Commerce, Economic and Statistics Administration, Census Bureau, *Pollution Abatement Cost and Expenditures: 1999.*, MA200(99), November 2002.

Table A.3
Pollution Abatement Costs and Expenditures Estimates for Ohio
and the U.S. From the Census MA200 Survey, 1999
(million dollars, except where noted)

	Ohio		U.S.		Ohio Share of U.S.
Pollution abatement					
Capital expenditures	271.5		5,809.9		4.7%
Non-hazardous		239.9		4,497.8	5.3%
Hazardous		31.6		1,312.0	2.4%
Air	155.7		3,463.7		4.5%
Non-hazardous		136.5		2,644.7	5.2%
Hazardous		19.3		819.0	2.4%
Water	111.1		1,801.9		6.2%
Non-hazardous		100.2		1,488.2	6.7%
Hazardous		11.0		313.7	3.5%
Solid Waste	3.4		361.9		0.9%
Non-hazardous		2.4		245.5	1.0%
Hazardous		1.0		116.4	0.9%
Multimedia	1.3		182.3		0.7%
Non-hazardous		0.8		119.4	0.7%
Hazardous		0.5		62.9	0.8%
Operating Costs	947.9		11,864.4		8.0%
Non-hazardous		787.5		8,924.9	8.8%
Hazardous		160.4		2,939.5	5.5%
Air	541.8		5,069.1		10.7%
Non-hazardous		471.4		3,941.2	12.0%
Hazardous		70.4		1,127.9	6.2%
Water	295.6		4,586.5		6.4%
Non-hazardous		233.0		3,511.8	6.6%
Hazardous		62.7		1,074.6	5.8%
Solid Waste	106.3		2,013.3		5.3%
Non-hazardous		80.3		1,320.4	6.1%
Hazardous		26.0		692.9	3.8%
Multimedia	4.1		195.5		2.1%
Non-hazardous		2.8		151.5	1.8%
Hazardous		1.3		44.0	3.0%
Disposal and recycling					
Capital expenditures	33.6		398.7		8.4%
Disposal		30.7		267.2	11.5%
Non-hazardous		30.0		218.0	13.8%
Hazardous		0.7		49.2	1.4%
Recycling		2.9		131.5	2.2%
Operating costs	464.6		4,923.6		9.4%
Disposal		381.1		3,680.9	10.4%
Non-hazardous		290.8		2,466.2	11.8%
Hazardous		90.3		1,214.7	7.4%
Recycling		83.5		1,242.7	6.7%

(continued)

Table A.3 (Continued)
Pollution Abatement Costs and Expenditures Estimates for Ohio
and the U.S. From the Census MA200 Survey, 1999
(million dollars, except where noted)

	Ohio	U.S.	Ohio Share of U.S.
Pollution prevention	85.8	2,767.9	3.1%
Other expenditures	133.3	3,154.5	4.2%
Site cleanup	48.3	1,039.3	4.6%
Remediation	43.5	827.3	5.3%
Replacement	1.5	83.1	1.8%
Other	3.3	128.8	2.6%
Habitat protection	1.1	155.2	0.7%
Monitoring/testing	22.6	599.5	3.8%
Administration	61.3	1,360.4	4.5%
Other payments			
Payments to government	44.2	959.1	4.6%
Permits/fees	35.8	816.6	4.4%
Fines/penalties/charges	7.8	116.3	6.7%
Other	0.6	26.2	2.3%
Tradeable permits - bought	5.3	20.2	26.2%
Tradeable permits - sold	0.5	23.7	2.1%
Tradeable permits - other	0.0	12.6	0.0%
Total	1,986.7	29,934.6	6.6%

Source: U.S. Department of Commerce (ESA/Census Bureau), 2002.

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