

JOBS CREATION IN THE ENVIRONMENTAL INDUSTRY IN ARIZONA AND THE UNITED STATES

Prepared By

Roger H. Bezdek
Robert M. Wendling
Management Information Services, Inc.
Washington, D.C.
www.misi-net.com
202-889-1324

For The

Building Diagnostics Research Institute
Chevy Chase, Maryland
www.buildingdiagnostics.org
301-951-5951

This report is a project of the Jobs and Environment Initiative, a pilot program of research, policy analysis and public education. The Arizona report is part of a series of state-based and national reports on current jobs creation in the environmental industry, including in manufacturing, and further jobs potential inherent in environmental management and stewardship. Other reports completed examine jobs creation and the environmental industry in Connecticut, Florida, Michigan, Minnesota, North Carolina, Ohio, and Wisconsin and are available on the above websites.

Contact: Paula DiPerna, 212-688-0042
Roger Bezdek, 703-620-4120

March 2005

TABLE OF CONTENTS

LIST OF TABLES	iv
LIST OF FIGURES	iv
EXECUTIVE SUMMARY	v
I. INTRODUCTION	1
II. BACKGROUND: 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 ARIZONA ECONOMY IN 2003	19
V. THE ENVIRONMENTAL INDUSTRY AND JOBS IN ARIZONA	23
V.A. Summary of the Environmental Industry and Jobs in Arizona	23
V.B. Environmental Jobs in Arizona by Industrial Sector	23
V.C. Environmental Jobs in Arizona by Occupation and Skill	26
V.D. The Environmental Industry as an Economic Driver for Arizona	31

TABLE OF CONTENTS
(Continued)

VI.	SUMMARY PROFILES OF SELECTED ARIZONA ENVIRONMENTAL COMPANIES	33
VI.A.	AMEC	33
VI.B.	Coe & Van Loo Consultants, Inc.	36
VI.C.	Entranco, Inc.	37
VI.D.	Environmental Support Solutions	38
VI.E.	Hydro Geo Chem, Inc.	39
VI.F.	Kyocera Solar, Inc.	40
VI.G.	Logan Simpson Design, Inc.	41
VI.H.	MMLA, Inc.	42
VI.I.	Southwest Windpower, Inc.	44
VI.J.	Stirling Energy Systems, Inc.	45
VI.K.	SWCA Environmental Consulting	46
VI.L.	Terracon	47
VII.	OPPORTUNITIES IN ARIZONA STATE GOVERNMENT PROGRAMS FOR ENCOURAGING ENVIRONMENT-RELATED JOBS	49
VII.A.	Governor's Initiatives	49
VII.A.1.	Governor's Strategic Partnership for Economic Development	50
VII.A.2.	Governor's Council on Innovation and Technology	51
VII.A.3.	Governor's Council on Workforce Policy	52
VII.A.4.	Climate Change Advisory Group	52
VII.B.	Arizona Department of Commerce	52
VII.B.1.	Arizona Job Training Program	52
VII.B.2.	Commerce and Economic Development Commission	53
VII.B.3.	Waste Reduction Assistance Program	53
VII.B.4.	Rural Economic Development Initiative	54
VII.B.5.	Municipal Energy Management Program	55
VII.B.6.	Enterprise Zone Program	55
VII.C.	Arizona Department of Environmental Protection	56
VII.C.1.	Jobs Through Recycling Grants	56
VII.C.2.	Pollution Prevention Incentives	57
VII.C.3.	The Arizona Water Protection Fund	57
VII.C.4.	Waste Reduction Grants	58
VII.C.5.	Water Revolving Funds	58

TABLE OF CONTENTS
(Continued)

VII.D. Solar Energy Advisory Council	58
VII.E. Arizona Association for Economic Development	59
VIII. SUMMARY OF MAJOR FINDINGS	61
BIBLIOGRAPHY	65
APPENDIX: U.S. COMMERCE DEPARTMENT ESTIMATES OF THE ENVIRONMENTAL INDUSTRY IN ARIZONA	74
ABOUT THE JOBS AND ENVIRONMENT INITIATIVE	79
ABOUT MANAGEMENT INFORMATION SERVICES, INC.	79
ABOUT THE BUILDING DIAGNOSTICS RESEARCH INSTITUTE, INC.	79
BIOGRAPHICAL INFORMATION	80

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, 2004_____	17
3.	Typical Employee Profile of a 250-person Wind Turbine Manufacturing Company, 2004_____	18
4.	Earnings by Industry of Employment in Arizona and the U.S. in 2004_____	22
5.	Jobs in Arizona in 2004, by Industry, Including Environmental Employment_____	24
6.	Environmental Jobs Generated in Arizona in 2004, by Selected Occupations_____	27
7.	Summary of the Select Arizona Environmental Companies Profiled_____	34
A.1.	U.S. Department of Commerce Estimates of the U.S. and Arizona Environmental Industries, 1999_____	75
A.2.	U.S. Department of Commerce Estimates of the Arizona Environmental Industry by Metropolitan Statistical Areas, 1999_____	76
A.3.	Pollution Abatement Costs and Expenditures Estimates for Arizona and the U.S. From the Census MA200 Survey, 1999_____	77

LIST OF FIGURES

1.	The Environmental Job Spectrum_____	13
2.	Selected U.S. Jobs Created in 2004 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 Arizona, 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 Arizona 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 Arizona in 2004
- Estimates the jobs created in Arizona in 2004 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 Arizona, 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 Arizona
- Discusses how encouraging environmental and related industries in Arizona 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 2004 protecting the environment generated \$320 billion in total industry sales, \$21 billion in corporate profits, 5.1 million jobs, and \$46 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 (2004 dollars) will increase from \$320 billion in 2004 to \$397 billion in 2010, \$439 billion in 2015, and \$486 billion in 2020; environmental employment will increase from 5.1 million jobs in 2004 to 5.9 million jobs in 2010, 6.2 million jobs in 2015, and 6.9 million jobs in 2020.

Environmental protection created over five million jobs in the U.S. in 2004, 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 Arizona, and MISI estimates that in 2004:

- Sales generated by the environmental industries in Arizona totaled \$6.9 billion.
- The number of environment-related jobs totaled 90,500.
- The environmental industry in Arizona comprised 3.6 percent of gross state product.
- Arizona environmental industries accounted for about two percent of the sales of the U.S. environmental industry.

- With nearly two percent of the nation's population, employment earnings in the Arizona manufacturing sector account for 1.3 percent of manufacturing earnings nationally.
- Environment-related jobs comprised nearly four percent of Arizona employment.
- Environment-related jobs in Arizona comprised nearly two 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 Arizona 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 Arizona

Environmental jobs in Arizona are widely distributed through all occupations and skill levels, and requirements for virtually all occupations are generated by environmental expenditures. Thus, in Arizona 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 Arizona, 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 Arizona 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 Arizona comprises only about four percent of total employment, in 2004 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 Arizona 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 manufacturing, remediation, IT, engineering, research, testing, monitoring, analysis, etc.; and they include some of the most sophisticated, high-tech firms in the state. Many of these firms have created significant numbers of new jobs

over the past six months, at a time when Arizona has been concerned about jobs, especially for highly skilled, well-paid, technical and professional workers

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

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 Arizona -- 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 Arizona are concentrated within a number of sectors, including manufacturing and professional, scientific, and technical services. This is significant because Arizona is seeking to modernize and expand its high-tech industrial and manufacturing base. Environmental protection offers a means of doing this, and investments in the environment can aid in this objective.

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 Arizona – 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 Arizona -- 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, perhaps most important, this study demonstrates that environmental protection can form an important part of a strategy for Arizona based on attracting and

retaining professional, scientific, technical, high-skilled, well paying jobs, including manufacturing jobs. There is no inherent institutional impediment in Arizona 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 Arizona economy and labor market
- Chapter V -- Size, employment, and industrial and occupational composition of the environmental industry in Arizona
- Chapter VI – Profiles of typical environmental firms in the state
- Chapter VII -- Arizona Policy Context, Opportunities and Gaps; 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 Arizona in 2004
- Estimate the jobs created in Arizona in 2004 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 Arizona, 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 Arizona

- Discuss how encouraging environment and related industries in Arizona 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 2004 dollars) from \$40 billion per year in 1970 to \$320 billion per year by 2004 -- increasing more rapidly than GDP over the same period. As shown in Table 1:

- In 1970, environmental protection expenditures totaled \$40 billion (2004 dollars).
- In 1980, environmental protection expenditures totaled \$125 billion (2004 dollars).
- In 1990, environmental protection expenditures totaled \$210 billion (2004 dollars).
- In 2004, environmental protection expenditures totaled \$320 billion (2004 dollars).

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

	Expenditures (billions of 2004 dollars)	Jobs (thousands)
1970	\$40	704
1975	79	1,352
1980	125	2,117
1985	163	2,838
1990	210	3,517
1995	235	4,255
2004	320	5,104
2010	397	5,861
2015	439	6,207
2020	\$486	6,913

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 2004 EP expenditures (\$320 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 2004 environmental protection created 5.1 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 Arizona -- 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 (2004 dollars) increased from \$40 billion in 1970 to \$320 billion in 2004. 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 1989 MISI assessed the economic and jobs impacts of acid rain control legislation and found that, contrary to what was then widely believed, such legislation would actually create 3,000 more jobs in Arizona than it would imperil. See Roger H. Bezdek and Robert M. Wendling, "Acid Rain Abatement Legislation – Costs and Benefits," *International Journal of Management Science*, Vol. 17, No. 3 (1989), pp. 251-261. 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 (3,800) in Arizona. See Roger H. Bezdek and Robert M. Wendling, "Potential Long-term Impacts of Changes in U.S. Vehicle Fuel Efficiency Standards," *Energy Policy*, Vol. 33, No. 3 (February 2005), pp. 407-419.

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 2004 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 \$79 billion to \$125 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 \$38 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 \$210 billion to \$242 billion -- 15 percent.
- Between 2000 and 2004, while U.S. economic and job growth was generally anemic, the EP industry expanded continuously, growing to \$320 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 2004 EP expenditures totaled \$320 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 2004 protecting the environment generated:

- \$320 billion in total industry sales
- \$21 billion in corporate profits
- 5.1 million jobs
- \$46 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 processes 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 definitions 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 (2004 dollars) will increase from \$320 billion in 2004 to:

- \$397 billion in 2010
- \$439 billion in 2015
- \$486 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 5.1 million jobs in 2004 to:

- 5.8 million jobs in 2010
- 6.2 million jobs in 2015
- 6.9 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 over five million jobs in the U.S. in 2004, 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 about a firm in Arizona that produces emissions control equipment for power plants in Utah? It seems clear that the jobs in the Arizona company should be considered green or environmental jobs, even though the user of the equipment in Utah may cause pollution in Arizona.

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).

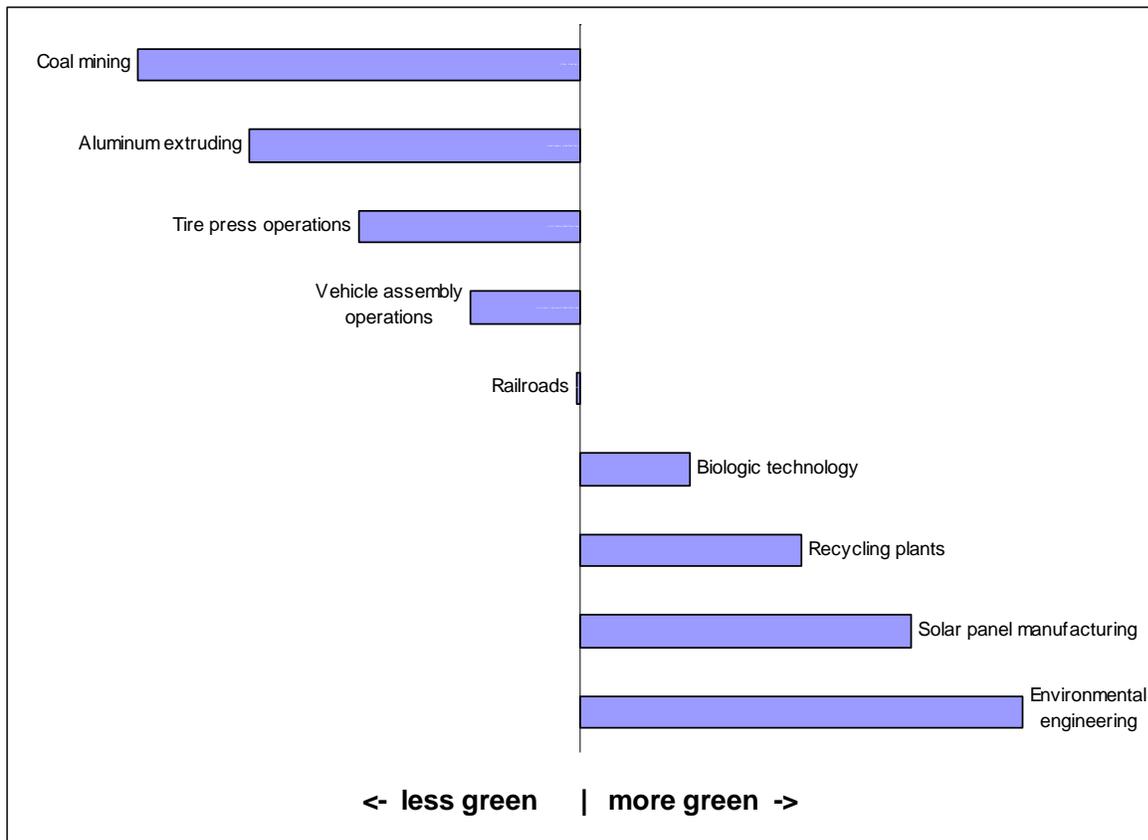
Using the spectrum concept, MISI defines environmental industries and green jobs as those which, as a result of environmental pressures and concerns, have produced the development of numerous products, processes, and services, which specifically target the reduction of environmental impact. Environment-related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

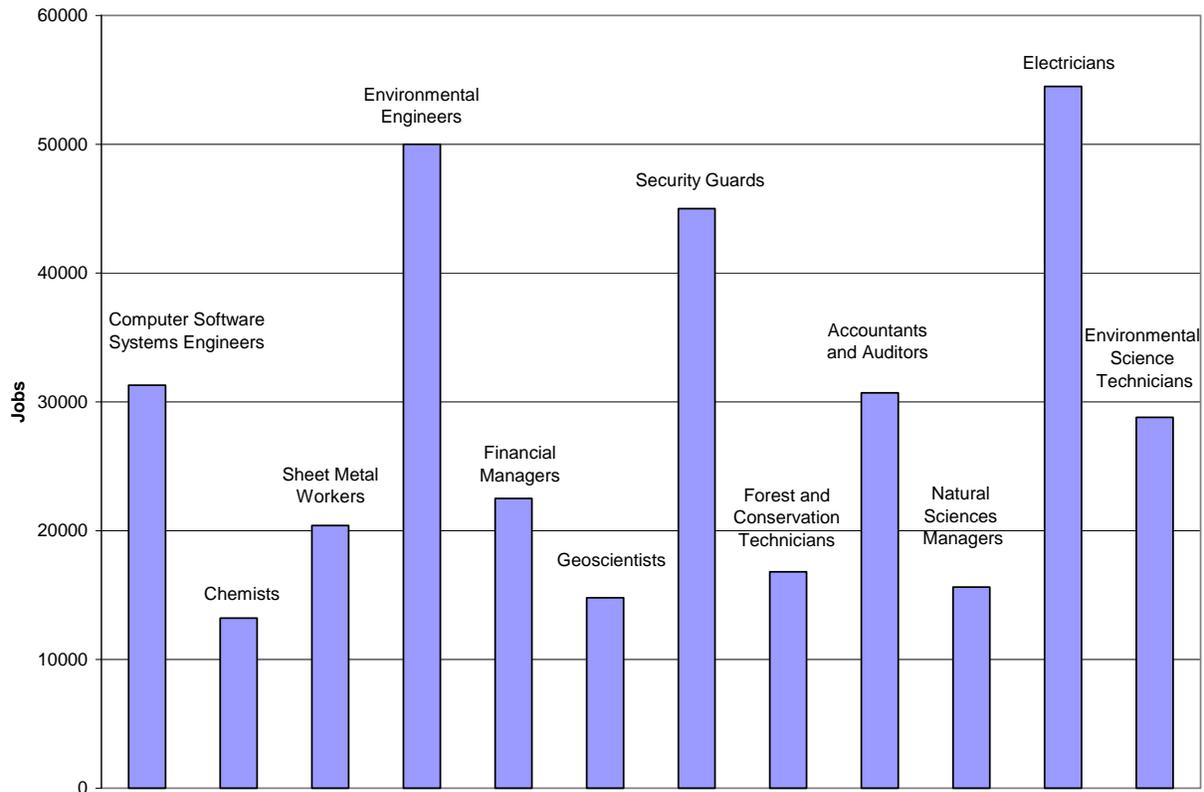


Source: Management Information Services, Inc., 2005.

For example, as illustrated in Figure 2, in the U.S. in 2004, environmental protection created:

- More jobs for electricians (55,000) than for environmental engineers (50,000)
- More jobs for accountants and auditors (31,000) than for geoscientists (15,000)
- More jobs for sheet metal workers (20,000) than for forest and conservation technicians (17,000)
- More jobs for financial managers (23,000) than for chemists (13,000)

Figure 2
Selected U.S. Jobs Created in 2004 by Environmental Expenditures



Source: Management Information Services, Inc., 2005.

- More jobs for computer software systems engineers (31,000) than for natural sciences managers (15,000)
- More jobs for security guards (45,000) than for environmental science technicians (29,000)

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 2004 occupational job distribution and employee earnings of a typical environmental remediation services company.
- Table 3 shows the 2004 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, 2004

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	100	\$39,621

Source: Management Information Services, Inc., 2005.

Table 3
Typical Employee Profile of a 250-person
Wind Turbine Manufacturing Company, 2004

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	250	\$42,726

Source: Management Information Services, Inc., 2005.

IV. THE ARIZONA ECONOMY IN 2004

The Arizona economy performed quite well in 2004, growing at an estimated 7.0 percent rate compared to the national average of 5.3 percent. Since 2000, the state has seen its personal income increase at rates exceeding the national rate by between one and two percentage points every year. Arizona per capita income increased in 2004 to almost \$29,000, but remains well below the national per capita income level of just over \$33,000. Gross state product has steadily increased over the past four years and reached \$195 billion in 2004. The state's contribution to national GDP has risen every year since 2000, and now accounts for 1.7 percent of the national total. Arizona's population has increased well over 10 percent since the last decennial census, a rate over twice the nation's 4.1-percent growth rate. The state's population exceeded 5.7 million in 2004 and Arizona climbed from being the 20th most populous state in 2000 to the 17th most populous in 2004, now accounting for almost 2.0 percent of the nation's total.

The general labor force and employment situation also improved in 2004. The Arizona labor force grew slightly from 2003 levels, reaching 2,794,000 in October 2004, the highest level in the state's history. State employment kept pace with the expansion in the labor force, growing to an all-time high of 2,661,000 during the year. With employment rising at a rate slightly higher rate than the expansion in the labor force, the state experienced reductions in unemployment, with the number declining an average of around 22,000 to just over 115,000 by December 2004. Arizona's unemployment rate decreased from 2003, falling to 4.2 percent of the civilian labor force by December. The state's monthly unemployment rate remained from 0.5 to 1.0 percentage points below the nation's average throughout the year.

Arizona's current economic structure still includes the proverbial Five C's of cotton, cattle, citrus, copper, and climate, but is now augmented by electronics and other tech industries, aerospace, and back-office administrative services that expand the state's employment and production base. Of the Five C's, only climate-related industries currently provide any dynamism to the state economy. Financial services, business services, and production of missiles and space equipment round out the industries providing dynamism and economic growth in recent years. Electronics, aircraft, federal government, and agriculture have added stability to Arizona's economy over the past decade, and mining's role in the state economy continues to diminish as the economy expands. Further, while Arizona's economy has created new jobs at a remarkable pace, its current structure has failed to keep per capita income equal to the national average or to significantly improve poverty rates.

Arizona has a number of economic advantages; these include⁶:

⁶Sources: Economy.com, *Arizona's Economic Future*, report prepared for the Arizona Department of Commerce, August 2002; "Arizona Ready to Catch the Next Big Technology Wave," Arizona Department of Commerce, April 2004; "Arizona Economic Conditions," Economy.com; Robert Franciosi, *Assessing Arizona's Economy: Boom or Bust?*, Goldwater Institute, June 2002.

- The second fastest growing population among all states – after Nevada
- Continued in-migration of a skilled workforce
- Business costs near average for the U.S. and below those of California
- Costs of living below most competing centers of technology
- A proven presence of research and innovation
- Ample capacity at its major airport
- High exposure to export trade
- Extensive forest, farmland, and scenic resources
- Proximity to southern California markets
- Benefits from NAFTA
- Major center for low-cost, high-tech manufacturing and back-office operations
- Growth rates of residents with college and advanced degrees higher than the national averages

However, Arizona ranks near the bottom with respect to a number of critical measures of comparative economic advantage, and this indicates a need for further investment and policy considerations in the years to come.⁷ For example:

- Workforce quality is of particular concern. While Arizona is able to attract skilled workers from outside the state, the local workforce does not measure up. Arizona ranks last for the rate of high school completion and nearly last for the share of high school graduates continuing on to college. Eighth-grade proficiency test results are below average and vary widely across the state's regions.
- State per capita spending ranks nearly last for K-12 education and 41st for higher education.
- Its prized quality of life is offset by a crime rate that consistently ranks among the top five states.

⁷Ibid.

- The quality and distribution of infrastructure is problematic. Many outlying areas are not well served by telecommunications and water systems, highways face capacity constraints, and aging road surfaces on older highways are in need of rebuilding.
- Innovative businesses face a dearth of venture capital, which ranks last relative to the size of Arizona's economy when compared to competing tech-related states.
- The state's tax structure is weighted toward business taxes and away from personal taxes, and thus deters expanding firms from considering Arizona.
- Per capita personal income in Arizona is only about 90 percent of the national average. This is due to Arizona's relatively unskilled labor force, workers' willingness to sacrifice some pay to live in a warm climate, and the relatively smaller accumulation of human and physical capital compared with other states.
- The state exceeds the nation in the growth rate of residents who have not finished high school.
- Arizona's economy is unbalanced within the state, with personal income in the fastest growing county expanding at a rate nearly three times that of the lowest-growing county. Some Arizona counties are highly dependent on a certain sector of the economy -- usually the government.
- The state has a traditional boom-bust economy.
- The state has relatively high poverty rates compared to most other states.

Table 4 shows the earnings by industry of employment in Arizona and how these compare to the U.S. averages. This table shows that Arizona ranks relatively low with respect to sectors such as mining, information, educational services, and manufacturing. However, this illustrates that the state ranks high with respect to several sectors: Specifically, with 1.8 percent of the nation's population:

- Employment earnings in the Arizona construction sector account for 2.3 percent of total earnings nationally in that sector.
- Employment earnings in the Arizona real estate and rental sector account for 2.3 percent of total earnings nationally in that sector.

- Employment earnings in the Arizona administration, management, and support sector account for 2.4 percent of total earnings nationally in that sector.
- Employment earnings in the Arizona accommodations and food services sector account for 2.0 percent of total earnings nationally in that sector.

Table 4
Earnings by Industry of Employment in Arizona and the U.S. in 2004

	Arizona (mill.\$)	Arizona Share of U.S.	Arizona Share of Earnings	U.S. Share of Earnings	Arizona Index
Personal Income (including adjustments)	\$160,831	1.7%	-	-	-
Agriculture, Forestry, Fishing and Hunting	1,329	1.6%	1.1%	1.1%	96
Mining	699	1.1%	0.6%	0.8%	68
Utilities	1,188	1.5%	1.0%	1.0%	92
Construction	10,794	2.3%	8.7%	6.1%	142
Manufacturing	12,831	1.3%	10.4%	13.2%	78
Wholesale Trade	6,383	1.7%	5.2%	5.1%	100
Retail Trade	10,152	2.0%	8.2%	6.7%	123
Transportation and Warehousing	3,868	1.6%	3.1%	3.2%	96
Information	3,115	1.1%	2.5%	3.9%	64
Finance and Insurance	8,514	1.5%	6.9%	7.6%	90
Real Estate and Rental and Leasing	4,576	2.3%	3.7%	2.7%	139
Professional, Scientific, and Technical Services	9,622	1.4%	7.8%	9.1%	85
Management of Companies and Enterprises	1,660	1.0%	1.3%	2.1%	63
Administrative/Support/Waste Management/Remediation Services	6,617	2.4%	5.3%	3.6%	148
Educational Services	1,165	1.2%	0.9%	1.3%	72
Health Care and Social Assistance	11,791	1.7%	9.5%	9.4%	101
Arts, Entertainment, and Recreation	1,386	1.7%	1.1%	1.1%	104
Accommodation and Food Services	4,130	2.0%	3.3%	2.8%	121
Other Services	3,351	1.5%	2.7%	3.0%	91
Public Administration	20,648	1.7%	16.7%	16.0%	104

Source: Management Information Services, Inc., 2005.

V. THE ENVIRONMENTAL INDUSTRY AND JOBS IN ARIZONA

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

MISI estimates that in 2004:

- Sales generated by environment-related industries in Arizona totaled \$6.9 billion.
- The number of environment-related jobs totaled 90,500.
- The environmental industry in Arizona comprised 3.6 percent of gross state product.
- Arizona environmental industries accounted for 2.1 percent of the sales of the U.S. environmental industry.
- Environment-related jobs comprised 3.9 percent of Arizona employment.
- Environment-related jobs in Arizona comprised 1.8 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 Arizona by Industrial Sector

Table 5 shows the industrial distribution of total employment and of environmental employment in Arizona in 2004.

Comparison of the industrial sector distribution of environment-related jobs in Arizona 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 Arizona 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 Arizona is more manufacturing intensive than other average private sector activity in the state:

Table 5
Environmental-Related Jobs in Arizona in 2004, by Industry

Industry	Establishments	Total Employment	Environmental Employment	Environmental Jobs (percent)
Agriculture, Forestry, Fishing and Hunting	230	4,980	272	5.5
Mining	182	3,320	275	8.3
Utilities	288	11,500	2,086	18.1
Construction	14,779	193,300	5,271	2.7
Manufacturing	4,542	172,600	6,709	3.9
Wholesale Trade	6,567	92,500	1,458	1.6
Retail Trade	18,567	286,400	2,482	0.9
Transportation and Warehousing	2,737	65,400	543	0.8
Information	1,965	46,600	1,301	2.8
Finance and Insurance	8,557	118,100	802	0.7
Real Estate and Rental and Leasing	6,722	43,500	783	1.8
Professional, Scientific, and Technical Services	14,498	106,400	11,019	10.4
Management of Companies and Enterprises	826	21,600	366	1.7
Administrative/Support/Waste Management/Remediation Services	7,155	200,500	13,099	6.5
Educational Services	1,801	38,100	1,235	3.2
Health Care and Social Assistance	13,311	219,500	1,628	0.7
Arts, Entertainment, and Recreation	1,629	29,800	251	0.8
Accommodation and Food Services	10,174	204,900	1,956	1.0
Other Services	10,527	87,300	1,014	1.2
Public Administration	-	400,200	37,939	9.5
State Total	125,056	2,346,500	90,492	3.9

Source: Management Information Services, Inc., 2005.

- 13 percent of private sector jobs in the environmental industry are in manufacturing, compared to nine percent in manufacturing among all private sector industrial activities in Arizona.
- 21 percent of private sector environmental jobs are in professional, scientific, and technical services, compared to five percent of all private sector jobs in the state.
- 25 percent of private sector environmental jobs are in administrative, support, and waste management services, compared to 10 percent of all private sector jobs in the state.

- 2.4 percent of private sector environmental jobs are in educational services, compared to 1.9 percent of all private sector jobs in the state.

Conversely, there are relatively few private sector environmental jobs in other parts of the Arizona economy:

- 4.7 percent of private sector environmental jobs are in the retail trade sector, compared to 14 percent in retail trade among all private sector jobs in the state.
- 1.5 percent of environmental jobs are in the finance and insurance sector, compared to six percent among all private sector jobs in the state.
- 3.1 percent of environmental jobs are in the health care and social service sector, compared to 11 percent among all private sector jobs in the state.
- One percent of environmental jobs are in the transportation and warehousing sector, compared to 3.2 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 90,500 environmental jobs account for 3.9 percent of the total 2.3 million jobs in Arizona. However, this distribution is uneven among industry sectors:

- 18 percent of employment in the utilities sector consists of environmental jobs, primarily water, waste treatment, sanitation, and related facilities.
- More than nine percent of public administration employment in the state consists of environmental jobs.
- More than 10 percent of Arizona jobs in the professional, scientific, and technical services are environmental jobs.
- **Four percent of the state's manufacturing employment is environment-related**
- Only very small portions of total state employment in sectors such as food services, entertainment, real estate, transportation, 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 three percent of total state employment, the industrial sector composition of environmental employment is highly skewed in favor of certain sectors. For example, nearly 13 percent of private sector environmental jobs are in manufacturing, compared to 8.5 percent of all private sector employment, and one-fifth of private sector environmental jobs are in professional, scientific, and technical services, compared to 5.2 percent of all private sector jobs in the state.

This indicates that investments in the environment will provide a greater than proportionate assist to Arizona's high-tech and manufacturing sectors. As noted in Chapter IV, Arizona is seeking to modernize and expand its high-tech industrial and manufacturing base. Table 5 indicates that the environmental industry can aid in this objective.

Similarly, **environmental investments generate, proportionately, more than four times as many jobs in professional, scientific, and technical services as the state average.** Jobs in this sector are the high-skilled, high-wage, technical and professional jobs that Arizona – 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 Arizona by Occupation and Skill

Environmental employment in Arizona can be disaggregated by specific occupations and skills, and this information for 2004 for selected occupations is given in Table 6. This table illustrates that environmental jobs in Arizona are widely distributed among 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 Arizona in 2004 within selected occupations. This table shows that in 2004 environmental protection generated in Arizona generated:

Table 6
Environmental Jobs Generated in Arizona in 2004, by Selected Occupations

Occupation	Jobs
Accountants and Auditors	595
Bookkeeping and Accounting Clerks	762
Cashiers	1,668
Carpenters	653
Civil Engineers	1,191
Computer Software Engineers	1,047
Conservation Scientists	144
Customer Service Representatives	1,209
Electricians	983
Electronics Engineers	727
Environmental Engineers	854
Environmental Science and Protection Technicians	144
Environmental Scientists and Specialists	876
Executive Secretaries and Administrative Assistants	1,008
Financial Managers	456
Forest and Conservation Technicians	626
Geoscientists	107
Graphic Designers	138
Hazardous Material Removal Workers	195
Inspectors, Testers, and Sorters	186
Janitors and Cleaners	1,480
Laborers	1,038
Management Analysts	1,069
Marketing Managers	288
Mechanical Engineers	237
Medical Scientists, Except Epidemiologists	108
Natural Science Managers	212
Office Clerks	1,492
Plumbers, Pipefitters, and Steamfitters	250
Security Guards	939
Septic Tank Servicers and Sewer Pipe Cleaners	443
Sheet Metal Workers	430
Stock Clerks	836
Training and Development Specialists	262
Truck Drivers	1,308
Welders and Solderers	169

Source: Management Information Services, Inc., 2005.

- More jobs for sheet metal workers (430) than for geoscientists (107)
- More jobs for office clerks (1,492) than for environmental engineers (854)
- More jobs for executive secretaries (1,008) than for forest and conservation technicians (626)
- More jobs for janitors (1,480) than for natural science managers (212)
- More jobs for cashiers (1,668) than for civil engineers (1,191)
- More jobs for accountants and auditors (595) than for medical scientists (108)
- More jobs for truck drivers (1,308) than for septic tank servicers (443)
- More jobs for financial managers (456) than for conservation scientists (144)
- More jobs for management analysts (1,069) than for environmental engineering science and protection technicians (144)
- More jobs for computer software engineers (1,047) than for hazardous material removal workers (195)

Thus, many workers in Arizona 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, conservation scientists, environmental science protection technicians, refuse and recyclable material collectors, and environmental engineering technicians, virtually all of the demand in Arizona 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 is also generated by environmental protection. Recalling that, on average, environment-related employment in Arizona comprises only 3.9 percent of total employment, in 2004 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:

- Biochemists and biophysicists
- Chemists
- Civil engineers
- Computer software engineers
- Electrical and Electronics engineers
- Geoscientists
- Landscape architects
- Medical scientists
- Natural sciences managers
- Occupational, health, and safety specialists
- Surveyors
- Urban Planners

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 Arizona comprises only 3.9 percent of total employment, in 2004 environmental protection generated jobs for as much as ten percent or more of many highly skilled, technical occupations in the state, including:

- Architectural and civil drafters
- Biological technicians
- Civil engineering technicians
- Control and valve installers and repairers
- Electrical and electronics engineering technicians

- Electrical and electronics equipment assemblers
- Electrical and electronics drafters
- Forest and conservation technicians
- Heating, air conditioning, and refrigeration mechanics and installers
- Industrial engineering technicians
- Sheet metal workers
- Surveying and mapping technicians
- Technical writers

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 that Arizona -- 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 Arizona generated by environmental protection are close to the average of 3.9 percent of total employment; including:

- Accountants and auditors
- Brickmasons
- Chemical laboratory technicians
- Computer support specialists
- Construction managers

- Executive secretaries and administrative assistants
- Financial managers
- Graphic designers
- Human resource assistants
- Industrial engineers
- Inspectors and testers
- Interviewers
- Machinists
- Medical and health information technicians
- Mobile heavy equipment mechanics
- Network and Computer systems Administrators
- Plumbers and Pipefitters
- Purchasing agents
- Security guards
- Stock clerks
- Training and development specialists
- Truck drivers
- Welders

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

This study demonstrates that environmental protection can form an important part of a strategy for Arizona 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 Arizona. For example:

- This study demonstrates that, at present in Arizona, environmental protection is creating more than 90,000 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 for the Energy Foundation estimated that an aggressive strengthening of U.S. Federal Corporate Average Fuel Economy (CAFE) standards would create 3,800 jobs in Arizona. Thus, contrary to what many believe, the production of more fuel-efficient vehicles would create substantial numbers of jobs in Arizona, not reduce them.⁸
- A 1999 study sponsored by the World Wildlife Fund and the Energy Foundation estimated that a strategy to address global warming in the U.S. would create nearly 12,000 jobs in Arizona.⁹

Given the multiplier effect of environmental spending and investment, it is likely that substantial numbers of jobs could be created through a systematic program to develop the environmental industry. Our findings show this is especially true in Arizona, which currently has a thriving, job creating environmental industry, currently generating more than 90,000 jobs in the state, to a large extent unbeknownst to most state residents 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. This finding is consistent with the results derived for other states such as Connecticut, Florida, Ohio, Minnesota, North Carolina, Wisconsin, and Michigan.¹⁰

⁸Management 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. See also Bezdek and Wendling "Potential Long-term Impacts of Changes in U.S. Vehicle Fuel Efficiency Standards," op. cit.

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

¹⁰See www.misi-net.com for those reports.

VI. SUMMARY PROFILES OF SELECTED ARIZONA ENVIRONMENTAL COMPANIES

We conducted a survey of existing environmental companies in Arizona, 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 manufacturing, engineering, remediation, testing, monitoring, analysis, etc.
- Include some of the most sophisticated, innovative, high-tech firms in the state

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

VI.A. AMEC

AMEC is international project management and services company with offices in Mesa, Tempe, Phoenix, and Tucson, and its Earth and Environmental Division is one of the world's leading earth and environmental consulting businesses. The company employs a wide range of staff, including scientists, technical and environmental consultants, financial experts, engineers, project managers, and support personnel. It has over 45,000 employees throughout the world, included 1,150 in the U.S. and 115 in Arizona, and has hired eight new employees in the state in the past six months. About half of its clients are industrial and half are government, and all of its Arizona business is domestic.

AMEC advises its customers on everything from planning, funding, and design – through regulatory and environmental compliance, to project management and delivery. It has office networks in three main territories: Continental Europe, the UK, and the Americas. AMEC is headquartered in London with regional head offices in Paris and Washington.

Table 7
Summary of the Select Arizona Environmental Companies Profiled

Company	Location	Products/Services	Jobs
AMEC	Mesa, Tempe, Phoenix, Tucson	A world leading earth and environmental consulting businesses	US: 1,150 AZ: 115
Co & Van Loo	Phoenix	Environmental remediation and water resources services and planning	US: 225 AZ: 155
Entranco	Phoenix, Tucson	Environmental engineering and consulting	US: 300 AZ: 100
Environmental Support Solutions	Tempe	Environmental, Health, and Safety and Crisis Management IT and software	US: 120 AZ: 50
Hydro Geo Chem, Inc.	Tucson, Scottsdale	Environmental remediation and restoration	US: 24 AZ: 24
Kyocera Solar	Scottsdale	Sales and installation of photovoltaic solar cells and systems	US: 4,000 AZ: 60
Logan Simpson Design, Inc.	Tempe, Tucson	Natural resource-based landscape architecture and environmental planning and services	US: 70 AZ: 63
MMLA	Tucson	Environmental engineering and consulting	US: 78 AZ: 78
Southwest Windpower	Flagstaff	World's leading manufacturer of wind generators used to produce electricity for rural applications	US: 54 AZ: 54
Stirling Energy Systems	Phoenix	Utility-scale renewable energy power plants and distributed electric generating systems	US: 30 AZ: 10
SWCA	Flagstaff, Phoenix, Tucson	Environmental planning, ecological research, and regulatory compliance services	US: 350 AZ: 110
Terracon	Tempe, Tucson	Geotechnical, environmental, and materials engineering and services	US: 1,600 AZ: 75

Source: Management Information Services, Inc., 2005.

The Earth and Environmental Division provides multi-disciplined solutions covering all aspects of environmental services, geotechnical engineering, infrastructure, materials testing and engineering, and water resource services. AMEC's expertise is delivered in four general areas -- environmental, geotechnical, materials, and water resources, and the firm combines these services to focus on the specific needs of different client sectors: Commercial, consumer and industrial products; energy, oil and gas; forest industry; transportation infrastructure; mining and metals; pharmaChem, and public.

AMEC staff provide a wide range of specialist environmental services: Human environments specialists assess the socio-economic impact of client operations, marine environment experts analyze toxins to protect water species, regulatory experts ensure compliance with air quality standards in pharmaceutical facilities, and civil engineers map and design flood control systems. In materials consulting, AMEC tests construction materials and its geotechnical engineers use technologies to survey human impacts on geological terrains.

AMEC's consulting services encompass all aspects of planning and permitting, construction, project design, operation, maintenance, and remediation, including:

- Assessment of current environmental performance, evaluating its impact on the local environment and any risks it poses to employees and local communities
- Development of environmental programs and management systems
- Monitoring and audit of client compliance against industry regulations and sustainability targets
- Implementation of systems and training and the running of public participation programs
- Advice on hazardous waste management and provision of remediation solutions

AMEC understands the environmental obligations of different industries and organizations; for example, it has:

- Provided services for remediation, restoration, technical and management-support at 30 US Air Force bases for the Air Force Center for Environmental Excellence
- Surveyed the Colorado River to support work on a 1,900 foot bridge as an alternative crossing over the steep-walled Black Canyon, bypassing the Hoover Dam

- Provided a management plan for a specialty chemical manufacturer that highlighted the advantages and disadvantages of reducing emissions below regulatory thresholds
- Worked on a number of operational scenarios to be factored into the development of a permitting strategy

VI.B. Coe & Van Loo Consultants, Inc.

Coe & Van Loo Consultants, Inc. (CVL) is an environmental services and planning company headquartered in Phoenix, with affiliate offices in Denver and Las Vegas. The firm has 225 employees, including 155 in Arizona, and has hired two new staff in the past six months. Its employees include engineers, environmental scientists, water resource specialists, landscape architects, urban planners, project managers, and administrative staff. About half of its clients are industrial and half are government, and all of its Arizona business is domestic.

CVL was established in 1958 as a company committed to providing cost-effective solutions, and it integrates seven disciplines to assist in managing multiple projects. The disciplines include:

- *Land planning.* CVL provides a variety of land planning services, including urban planning, master land use plans, feasibility studies, site plan development, subdivision design, zoning, and rezoning, general and comprehensive plan amendments, and hillside development – including 2-D imaging and 3-D modeling.
- *Civil Engineering.* Civil engineering services include commercial site development, industrial subdivision development, residential subdivision development, master planned community infrastructure, city improvement districts, public works facilities, and parks.
- *Water Resources.* CVL provides a variety of water resources engineering services, including master drainage planning, storm drainage and flood control, flood studies and river mechanics, watershed erosion and scour analysis, channelization and bridge hydraulics, water resource management, dam safety studies, floodplain modifications, dam break analysis (emergency action plan), and water resources environmental permitting.
- *Environmental Sciences.* The firm provides a variety of environmental services, including wastewater collection, treatment, disposal, and reuse systems, water supply, distribution, and treatment, rate analysis/expert witness, water and wastewater master planning, and operation and maintenance instruction.

- *Landscape Architecture.* Landscape architecture services include city park and recreation, master plans/urban designs, parks and recreational amenities, creative thematic and character studies, open space planning and design, downtown redevelopments, athletic facilities, revegetation projects, streetscapes, model complexes, roadside buffering concepts, resort hotels, bicycle trail design, hardscape, water features, and decorative pavement.
- *Land Survey.* CVL provides a variety of land survey services, including A.L.T.A. surveys, topographic surveys, aerial mapping, construction staking, legal descriptions, and horizontal and vertical controls.
- *Construction Services.* CVL provides a variety of construction services projects, including bid specifications, project scheduling, construction observation, construction certification, and construction administration.

VI.C. Entranco, Inc.

Entranco is an environmental consulting and engineering firm with headquarters in Phoenix and a branch office in Tucson. It has 300 employees nationwide, including 100 in Arizona, and has hired two new staff in the state within the past six months. Its employees include engineers, consultants, technicians, and support personnel. Its clientele is 50 percent industrial and 50 percent government, and all of the business of its Arizona operations is domestic.

Entranco was founded in 1961 as a two-person engineering firm in Bellevue, Washington and has evolved into a mid-sized, multi-disciplinary environmental engineering and consulting firm. It has more experienced specialists than large generalist operations, and more resources than boutique firms. Entranco originally focused on environmental and transportation consulting -- hence the name, Entranco. The firm currently provides professional engineering and consulting services that preserve and enhance the environment and quality of life. Entranco provides services for both the public and private sectors, and is competent in small and large projects.

Services offered include:

- Environmental
- Transportation
- Construction
- Site Civil

- Survey
- Water Resources

VI.D. Environmental Support Solutions (ESS)

Environmental Support Solutions (ESS) is headquartered in Tempe and provides Environmental, Health, and Safety and Crisis Management services. The firm has 120 employees nationwide, including 50 in Arizona, and its employees include environmental and IT specialists and administrative and support staff. Its clientele is 50 percent industrial/institutional and 50 percent government, and all of the business of its Arizona operations is domestic.

ESS is one of the leading U.S. providers of Environmental, Health and Safety (EH&S) and Crisis Management solutions and services and, in addition to its Tempe headquarters, it has major offices in Denver and the Washington, DC, area. The firm has more than 35,000 software licenses in effect at businesses, government, and military facilities, healthcare organizations, power utilities, chemical manufacturers, and educational institutions worldwide.

The majority of the ESS team consists of professionals and staff members who are involved in the technical aspects of the operation. They include recognized compliance management domain experts in every specialty, along with implementation and business process specialists.

ESS offers a comprehensive framework with an array of off-the-shelf and customizable modules that assure compliance, improve accuracy, reduce costs, and build corporate visibility. ESS's software takes a holistic, integrated approach to EH&S and Crisis Management throughout organization, and transforms them into powerful drivers for sustainable growth.

ESS software transforms EH&S and Crisis Management data into the information needed to support regulatory reporting and business enhancing performance metrics to reduce business-related operational expenses. The company's solutions accommodate existing procedures with little disruption, and the EES browser-based performance management structure automates the process of collecting, analyzing, and reporting data on a vast array of compliance, emergency and strategic goals and requirements. The ESS *Essential Suite*[™] and *Compliance Suite*[™], two flexible and fully integrated solutions, are the most comprehensive and cost-effective EH&S and Crisis Management software infrastructure offerings on the market.

VI.E. Hydro Geo Chem, Inc.

Hydro Geo Chem, Inc. is an Arizona-based environmental consulting and remediation corporation with offices in Tucson and Scottsdale. The firm has 24 employees, all in Arizona, and has hired three new employees within the past six months. Its employees include engineers, technicians, and administrative support staff. Its clientele is 90 percent industrial and 10 percent government, and all of its business is domestic.

Hydro Geo Chem has extensive nationwide experience in providing expert responses in multiple areas of environmental science and technology and environmental restoration, and has pioneered specific technologies for site characterization and remediation. Over the last 20 years, the firm has developed a philosophy for environmental restoration that has minimized its clients' environmental liabilities and saved them millions of dollars.

The firm's experience and services include:

- Site Characterization and Assessment
- Remedial Feasibility Assessment
- Remedial System Design and Construction
- Remedial System Operation and Maintenance
- Negotiation with Regulatory Agencies
- Expert Consulting and Testimony on Environmental Matters.

The firm's expertise includes:

- Soil Vapor Extraction (SVE)/Bioventing
- Modeling
- Mining Services
- Landfill Services
- Expert Witness Testimony Services
- Water Resources
- Lanfill Services

- Water Rights Adjudication

VI.F. Kyocera Solar, Inc.

Kyocera Solar is a solar energy sales and installation company with offices in Scottsdale. Kyocera Corporation has over 5,000 employees in North America, including 60 in Arizona, and has hired three new employees within the past six months. Its employees include engineers, technicians, sales personnel, installers, and administrative support staff. Its business is 80 percent with government and distributors and 20 percent direct to consumers, and all of its Arizona business is domestic.

Kyocera Corporation, the parent company of the global Kyocera group, was founded in 1959 in Kyoto, Japan as a start-up venture by Dr. Kazuo Inamori and seven colleagues. Kyocera's founders shared a vision of creating a company dedicated to the successful manufacture and sale of innovative, high-quality products based on advanced materials and components. Over the past five decades, this vision has resulted in a highly successful and widely diversified global enterprise.

Kyocera's North American operations were founded as a two-person office in 1969 in Silicon Valley and have contributed strongly to the company's overall success. These operations have since expanded to more than 5,000 employees engaged in the manufacture and sale of a broad range of state-of-the-art, high-technology products in the United States, Canada, and Mexico. Kyocera's environmental businesses include:

- *Solar Energy.* Since Kyocera entered the solar energy field in 1974, its expertise with crystal-forming technology has helped the firm become a world-leading producer of photovoltaic solar cells -- with 2002 shipments of 60 megawatts and 2003 capacity of 72 megawatts. Over the years, Kyocera has expanded its solar energy business to provide reliable renewable power in more than 60 nations. The firm's solar products are available through Kyocera Solar, Inc. of Scottsdale, which has more than 1,000 dealers worldwide.
- *Ceramic Engine Components.* Kyocera's advanced ceramics possess a number of physical properties that are shared by no other known material, including extreme levels of hardness, wear resistance, heat resistance, physical stability, and chemical inertness. Kyocera's ceramics are helping engineers solve long-standing technical challenges that have historically limited the performance of automotive engines. By allowing engines to operate at higher temperatures and burn fuel more efficiently, Kyocera's ceramics are helping to reduce the exhaust pollution that contributes to acid rain and other environmental problems.

- *Cartridge-Free Document Solutions Equipment.* Kyocera's advanced ceramics provide the "cartridge-free" technology for the revolutionary Ecosys document imaging systems. These copiers and printers use a durable print drum with a super-hard material coating to provide up to 350,000 pages of printing. This contrasts sharply with conventional laser printers, which require users to buy a new print cartridge when the toner runs out. Kyocera's Ecosys printers are never sent into landfills -- and they save money as they help the environment.

Through these applications and others under development, Kyocera continually focuses its engineering resources to create products that help preserve the environment.

VI.G. Logan Simpson Design, Inc.

Logan Simpson Design Inc. (LSD) is a landscape architecture and environmental planning firm with offices in Tempe and Tucson. It has 70 employees, including 63 in Arizona, and has hired 18 new employees within the past six months. Its employees include landscape architects, urban and regional planners, technicians, and administrative support staff. Its clientele is 97 percent government and three percent industrial, and all of its Arizona business is domestic.

LSD provides professional services in natural resource-based landscape architecture and environmental planning services for client agencies in all regions of Arizona. The firm's services fall into five categories -- Environmental planning, landscape architecture, 404 permitting/resource surveys, public participation/ graphic design, and construction administration:

- *Environmental Planning.* LSD deals with the natural, cultural, and physical resources found throughout Arizona. It offers a full range of environmental planning services, including resource assessments, management plans, environmental impact statements, environmental assessments, categorical exclusions, and environmental overviews, and has established working relationships with federal, state, and local resource and regulatory agencies throughout Arizona.
- *Landscape Architecture.* The firm offers a full range of landscape architectural services, including site analysis, design charrettes, ecologically-based site planning, hardscape design, streetscape design, traffic calming, art and artist coordination, planting design, irrigation design, revegetation, constructed wetlands, and habitat restoration. Landscape architecture requires integration of the natural environment with built facilities, and LSD views its

responsibility as meeting the client's programmatic requirements and enhancing the project's aesthetics, while integrating the facility into the natural environment.

- *404 Permitting/Resource Surveys.* As part of LSD's environmental planning services, its cultural resource specialists conduct surveys, testing, and recovery of cultural (prehistoric and historic) resources, and the firm's biologists perform surveys for federally-listed threatened, endangered, and sensitive species. LSD's 404 specialists have completed jurisdictional delineations, Nationwide and Individual Section 404 permits, 401 Water Quality Certifications, Section 404 Training, mitigations plans, and monitoring.
- *Public Participation and Graphics.* LSD seeks to obtain specific direction from public interactions, and has developed creative methods and techniques for achieving participation objectives. Clear, professionally prepared, "public friendly" graphics are required to foster communication, and LSD's graphics professionals assist clients in developing materials that communicate their message.
- *Construction Administration.* Services provided include the management and inspection of construction activities. Acting as a liaison between contractors and owners, LSD's construction administration staff facilitates project meetings, conducts inspections, reviews and approves pay applications and project submittals, and insures compliance with the project documents.

VI.H. MMLA, Inc.

MMLA, Inc. is an Arizona-based environmental consulting and engineering corporation located in Tucson. The firm has 78 employees, all in Arizona, and has hired six new employees within the past six months. Its employees include urban and regional planners, engineers, water resource specialists, technicians, and administrative support staff. Its clientele is 50 percent industrial and 50 percent government, and all of its business is domestic.

MMLA was founded in 1985 and is a multi-disciplinary consulting firm offering professional services in the areas of land planning, civil engineering, land survey, transportation engineering, water resources, and construction management. The firm has successfully completed projects ranging in scope from planning and engineering of 10-acre subdivisions to the master planning of 6,000-acre communities; from designing city street extensions and bridges to improving city storm sewer systems; from

designing sanitary sewer lines to photo control surveying for extensions of major transportation corridors for the Arizona Department of Transportation.

MMLA offers a full range of professional engineering and consulting services to the private sector, government agencies, municipalities, institutions, and school districts. Its services are divided into the following disciplines:

- *Land Planning* -- master development plans, specific plans, land use studies, site investigations/feasibility studies, entitlement studies, subdivision design and review processing, cost estimate preparation, neighborhood and area plans, project strategic planning, and rezoning services
- *Civil Engineering* -- sensitive design in difficult terrain, golf course/residential communities, educational facility planning and design, constraints maps, site concept studies and plans, hydrology and hydraulic reports, tentative and final plats, cost estimates, off-site and on-site grading plans, off-site and on-site sewer plans, off-site and on-site water plans, and off-site and on-site street designs
- *Land Survey* -- ALTA surveys, boundary surveys, topographic surveys, right-of-way surveys, legal descriptions, construction staking, as-built surveys, GIS data mapping, hydrographic surveys, geodetic surveys, civil site improvement, and drawings and specifications
- *Traffic Engineering* -- traffic impact analyses, highway capacity analyses, intelligent transportation systems, traffic control and signal studies, facility operations studies, network simulation and modeling, access management, and travel demand forecasting
- *Transportation Engineering* -- corridor studies, advance planning reports, design concept reports, urban arterials and collector streets, highways, subdivision streets, environmental design mitigation reports, pavement design, and alignment studies
- *Water Resources* -- floodplain/floodway analysis, hydrologic/hydraulic studies, NPDES permitting, Section 404 permitting, drainage channel and structure design, bank protection design, detention/retention basin planning and design, area wide basin management plans, floodplain development assessments, and FEMA map revision studies

- *Construction Management* -- plan and specification review, private improvement agreements, bidding and bid analysis, pre-construction meetings, construction progress meetings, construction supervision/observation, construction documentation, contractor progress payments, final inspection, and as-built plan preparation

VI.I. Southwest Windpower, Inc.

Southwest Windpower, Inc. is an Arizona-based wind energy company located in Flagstaff. The firm has 54 employees, all in Arizona, and has hired four new employees within the past six months. Its employees include machinists, assemblers, machine tool operators, inspectors, lathe machine operators, engineers, welders, electricians, production managers, technicians, and sales and administrative support staff. About ten percent of its sales is to government and 90 percent is to distributors, and 50 percent its business is international.

Southwest Windpower, is the world's leading manufacturer of the wind generators used to produce electricity for rural applications such as remote homes and water pumping, and for reducing the monthly electrical bill for homes connected to the electric grid. More than 80,000 of its 400-3,000 watt wind generators can be found in over 120 countries. Its product line includes the following wind energy systems: Whisper Link, Air X, Air X Marine, AIR 403, Air Marine, Whisper H40, Whisper H80, Whisper 175, Air Industrial, and Tower Kits.

The U.S. Department of Energy (DOE) has issued Southwest Windpower the "Outstanding Research and Development Partnership" award – one of four such awards per year DOE issues for outstanding contributions to advancing the mission of its wind energy research and development program. These awards recognize the program's outstanding contributions each year in the areas of research and development partnerships, individual research efforts, leadership, and technology acceptance. Southwest Windpower was chosen from a field of over forty industry and university partners involved in the DOE Wind Energy Program portfolio of research and development activities, currently funded at over \$40 million per year. This award specifically recognizes the outstanding contribution that the company has made to the federal program's mission of advancing U.S. wind energy technology through effective partnership with a national laboratory.

In 2000, Southwest Windpower received a development partnership contract from the National Renewable Energy Laboratory to develop an innovative residential wind turbine that reduces or reverses a consumer's electrical meter. The new wind turbine will be available to the general public by the end of 2005, and is expected to offer substantial improvements in cost effectiveness, ease of installation and use, and quietness for small wind turbines.

VI.J. Stirling Energy Systems, Inc.

Stirling Energy Systems, Inc. (SES) is a renewable energy engineering corporation with headquarters in Phoenix. The firm has 30 employees, including ten in Arizona, and its staff includes engineers, technicians, project managers, and support staff. All of its business is currently domestic.

SES is a systems integration and project management company that is developing equipment for utility-scale renewable energy power plants and distributed electric generating systems ("gensets"). SES is teamed with Kockums Submarine Systems, NASA-Glenn Laboratories, the U.S. Department of Energy (DOE), and the Boeing Company for solar power plants, and with Vestas Wind Systems -- the premier provider of wind turbine technology for wind systems. The firm is positioned to become a premier worldwide renewable energy technology company to meet the global demand for renewable electric generating technologies through the commercialization of its own Stirling cycle engine technology for solar and genset applications, and utilization of Vestas Wind Systems. SES will also be participating in the biogas and hydrogen markets.

SES was founded in 1996 and, although its headquarters is in Phoenix, its engineering and technical team is located in Tustin, California. SES also has a demonstration test site and training facility at University of Nevada, Las Vegas. The firm recently engaged in a joint venture program with Eskom Enterprises, located in Johannesburg, South Africa.

SES holds two key patents on the solar concentrator system that were initially filed by McDonnell Douglas (now the Boeing Company) to manufacture this solar concentrator system, as well as six of the original solar concentrator systems that were fabricated in the 1980s. SES also acquired all of the intellectual properties, including significant trade secrets regarding technical and manufacturing aspects of the solar concentrator system. SES was granted a licensing agreement with Kockums, a major Swedish defense company, to manufacture, market, and sell the Kockums 4-95 Stirling engines.

SES is positioning itself to be a premier provider of renewable energy solutions on a global scale. The company is enhancing the economics of renewable energy power plants and making them competitive with other electrical power generation technologies. Several important teaming relationships augment the SES management team and staff and provide the firm with significant engineering and technical support and marketing and project development assistance. These strategic partners include:

- *Schuff Steel Company* employs certified craftsmen and field-seasoned managers who know their industry and craft and provide clients with the highest quality workmanship available. As SES continues to grow with the future demand for solar energy technology, Schuff will become an important strategic partner providing the steel components to manufacture the concentrator.
- *Kockums Submarine Systems* granted SES an exclusive license to manufacture and market its solarized Stirling engine in North America, and a non-exclusive license elsewhere in the world. Kockums continues to provide SES with technical support on Stirling engines.
- *Vestas Wind Systems* granted SES rights to develop wind projects and serve as a distributor of its wind turbine systems in the United States.
- *NASA-Glenn Laboratories* has been involved in Stirling engine research and development for the past 15 years, and has provided technical support to SES.
- *U.S. Department of Energy (DOE)* provides additional research and development support of the Dish Stirling System under an ongoing government contract.
- *Chafin Resources, LC* (Chafin), located in Dallas, Texas, is an energy development firm that has been developing projects for over 30 years. SES and Chafin have entered into a joint development agreement and formed a Wyoming limited liability company, FAME, LLC, to develop, market, operate, and maintain certain wind resources.

VI.K. SWCA Environmental Consulting

SWCA Environmental Consulting is an environmental and regulatory compliance consulting company with offices in Phoenix, Flagstaff, and Tucson. It has 350 employees in the U.S., including 110 in Arizona, and has hired six new employees within the past six months. Its employees include engineers, technicians, biologists, archaeologists, planners, and support staff. The firm's clientele is 50 percent government and 50 percent industry, and all of its Arizona business is domestic.

SWCA Environmental Consulting has been in the environmental consulting industry for 20 years, and has 12 regional offices that allow their staff reach the most remote project locations. The firm has experience coast to coast and specializes in environmental regulatory compliance and natural and cultural resource management.

The services SWCA provides include:

- Regulatory Compliance
- Ecological Research
- Environmental Planning
- Cultural Resource Management
- Environmental Mediation and Facilitation
- Spatial Information Services
- Wind Power Services
- Paleontological Services

VI.L. Terracon

Terracon is a geotechnical, environmental, and materials engineering company with offices in Phoenix and Tuscon. It has 1,600 employees in the U.S., including 75 in Arizona, and has hired six new staff in the past six months. Its employees include engineers, scientists, materials specialists, technicians, and support personnel. Half of its business is public sector and half is private sector, and all of its Arizona business is domestic.

Terracon is an employee-owned consulting firm of engineers and scientists providing geotechnical, environmental, construction materials, and related services from more than 60 offices nationwide. Since its founding in 1965, the firm's network of offices has provided local expertise backed by extensive national resources to service local, regional, and national clients.

Terracon is a leading provider of geotechnical, environmental, construction materials, and related services, and has completed projects of all sizes for clients in a variety of industries nationwide. Areas of specialties include:

- *Environmental.* Major environmental services provided include site assessments and investigations; remedial design and implementation; brownfield and site redevelopment; natural resources, wetlands delineation and mitigation; health and safety; industrial hygiene, mold, indoor air quality; asbestos and lead; regulatory compliance; environmental management systems; and solid waste planning and design.

- *Geotechnical.* Design and construction of functional and cost-effective structures require a thorough understanding of local soil, rock, and groundwater conditions. Terracon provides a wide range of services to support all phases of a project, from preliminary design through completion of the building process.
- *Services.* From the ground up, Terracon provides practical solutions to geotechnical, environmental, construction materials, and related engineering challenges. Its national network of over 60 offices provides local expertise backed by national resources to get the job done cost effectively and efficiently. On both small and large projects, Terracon's experienced professionals work closely with clients to achieve success, on time and on budget.
- *Construction Materials.* Proper selection, quality, and workmanship of construction materials play a vital role in ensuring that buildings and infrastructure perform adequately over long time periods. Terracon works with clients to minimize material replacements, reduce the likelihood of deterioration, avoid potential failures, and investigate and evaluate construction materials related problems and failures when they do occur.

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

There are a number of state government programs and initiatives that could be used to stimulate environment-related industries and jobs in Arizona. 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.A. Governor's Initiatives

VII.A.1. Governor's Strategic Partnership for Economic Development

The Governor's Strategic Partnership for Economic Development was formed in 1992 for the purpose of implementing Arizona's plans for economic development. The GSPED strategy focuses on cluster-based economic development, which involves targeted marketing to attract and sustain industries that create quality, high-paying jobs and benefit the economy.

GSPED defines an economic cluster as a geographic concentration of interdependent competitive firms in related industries that do business with each other. Each cluster includes companies that sell inside and outside of the region as well as support firms that supply raw materials, components, and business services. Clusters create large, diverse pools of experienced workers, attract suppliers who end to congregate in their vicinity for increased efficiency, and foster a competitive spirit that stimulates growth and innovative strategic alliances. GSPED has identified 11 key clusters in Arizona: Bioindustry; Environmental Technology; Food, Fiber, and Natural Products; High Technology; Minerals and Mining; Optics; Plastics and Advanced Composite Materials; Senior Industries Development; Software; Tourism; and Transportation and Distribution.

The Environmental Technology cluster focuses on businesses that create and provide products and services that utilize technology. Technology, under this cluster, is defined as that used to monitor, eliminate, control, treat, and prevent pollution as well as conserve and restore natural resources.

Although the GSPED has identified Environmental Technology as a vital cluster, more attention could be focused on the environmental industries and jobs in Arizona and make them a higher priority in the future.

VII.A.2. Governor's Council on Innovation and Technology

The Governor's Council on Innovation and Technology was formed by Executive Order of the Governor as a catalyst for creating new economic development strategies, focusing primarily on improving Arizona's knowledge-based economy. The Council consists of 31 members from industry, each of whom is appointed by the Governor.

As the Governor's principal advisory group for innovation and technology, the council has set the following goals and objectives:

- Develop and periodically update a blueprint for technology-based economic development in Arizona through the creation of a long-term strategic plan
- Stimulate technology transfer among and within higher education institutions and industry, including transfers of information available from federal agencies
- Provide the framework, and a forum for ideas, to enable Arizona to become a global leader in innovation and technology research, product development, and creation
- Monitor changes in global economic conditions that may justify a re-orientation of Arizona's technology programs
- Identify fields of science and technology that offer potential for application in Arizona
- Improve the state's competitiveness in attracting new science and technology businesses
- Create reasonable policies that attract and leverage private sector venture capital investment

The Governor's Council is in the unique position to identify industries which could improve the state's competitiveness and can be used to help attract environment-related industries and jobs to Arizona.

VII.A.3. Governor's Council on Workforce Policy

The Governor's Council on Workforce Policy was established by Executive Order to develop a coordinated and comprehensive approach to workforce development that incorporates the state's economic development goals and strategies using federal, state, and local resources. The Executive Order establishing the Council recognized that the need for a strong workforce capable of attracting and sustaining quality industries and promoting economic growth is dependent upon a quality education, training, and apprenticeship system. The Council consists of 35 members from business, labor, public education, higher education, economic development, youth activities, employment, and training, as well as the Legislature.

The responsibilities of the GCWP are to:

- Provide policy guidance and review for all workforce development programs in the state
- Review the operations conducted in each local workforce investment area and the availability, responsiveness, and adequacy of state workforce development services and make recommendations to the Governor, appropriate chief elected officials, local workforce investment area boards, and the public with respect to ways to improve the effectiveness of such programs or services
- Establish goals for the development and implementation of performance measures relating to applicable federal, state, and local workforce development programs
- Assist the Governor in developing, reviewing, and submitting written comments on the state plan
- Review and modify this plan, before its submission to the U.S. Secretary of Labor, including review and submission of written comments on each local plan submitted to the Governor by any local workforce investment area
- Establish goals for the development and implementation of Arizona's Job Training and Apprenticeship programs

The GCWP is in the unique position to influence the state's policies on training Arizona's workforce for existing and emerging industries. Such policies could be used to help build environment-related industries and jobs by ensuring that the labor pool in Arizona is well suited for the industry.

VII.A.4. Climate Change Advisory Group

In February 2005, Governor Napolitano signed an Executive Order creating a Climate Change Advisory Group for the state. The governor charged the group with developing recommendations to reduce Arizona's greenhouse gas emissions, culminating in the submission of a Climate Change Action Plan by June 2006. The advisory group will also produce an inventory of Arizona's greenhouse gas emissions. The governor will appoint representatives to the advisory group from state government, industry, the tourism sector, and non-governmental organizations.

The Climate Change Advisory Group represents a unique opportunity:

- It is in the process of being formed, and the opportunity thus exists to give it a strong jobs focus.
- Arizona already has a strong base of industries that produce products and services that address the climate change issue.
- A Governor's advisory group offers the high profile required to emphasize the jobs and environment nexus in Arizona.

VII.B. Arizona Department of Commerce Programs

VII.B.1. Arizona Job Training Program

The Arizona Job Training Program supports the design and delivery of training plans that meet unique industry standards and challenges. Under the "Net New Hire" portion of the grant program, grants are issued to businesses to return up to 75 percent of the costs of training net new employees in jobs that meet wage criteria. The "Incumbent Worker" portion of the grant program allows for training that upgrades the skills of existing employees and can reimburse employers up to a maximum of 50 percent of allowable training costs. During FY 2003, Commerce reported that it awarded 67 new grants, totaling over \$12 million, to train nearly 21,000 workers.

The new rules have been finalized for the Arizona Job Training Program to assist in the creation and retention of higher paying jobs that support emerging and base industries in every region of the state. These changes make grants easier to manage for all recipients and easier to access for small and rural businesses. They also make it easier to utilize this program to benefit renewable energy and environment-related industries in the state.

VII.B.2. Commerce and Economic Development Commission

The Commerce and Economic Development Commission was established in 1989 as the state's economic policy and planning board. Nine commissioners govern the CEDC: The Director of the Department of Commerce serves as the chair and eight members are appointed by the Governor for three-year terms. The Commission is responsible for developing the state's 10 year economic strategy and it administers the CEDC Fund, which provides financial assistance to support the state's economic development efforts. The CEDC is funded through the Arizona Lottery; 21.5 percent of two scratch games provide continuous, reliable funding.

To ensure high-quality, high-paying jobs for Arizona in the future, the CEDC is developing a 10-year strategic economic plan for Arizona. Several economic planning efforts will be integrated to produce *Arizona 2012*, a coordinated, strategic vision. The 10-year plan will be based primarily on the *Statewide Economic Study*, a public-private effort to analyze the economy and identify compelling opportunities for Arizona's regional economies over the coming decade.

The *Statewide Economic Study* concluded that Arizona is comprised of diverse economic regions and communities. Different areas of the state have different economic characteristics and, therefore, have different long-term opportunities and constraints. Some communities are growing and are vital; others are experiencing slow or even declining growth and economic conditions. This implies that there is no single policy or strategic approach that will maximize the opportunities for all parts of Arizona. However, even with limited resources, economic development and fiscal policies can be designed to encourage positive changes in each region of the state.

Thus far, there appears to be little focus on the environmental industry in the Arizona Job Training Program or the Commerce and Economic Development Commission, but such a focus could strategically leverage the benefits of environmental protection for workforce development. Both the AJTP and the CEDC could be used to assist Arizona firms in environmental industries to expand and to upgrade the skills of their workers.

VII.B.3. Waste Reduction Assistance Program

Waste Reduction Assistance program funding is awarded to projects devoted to waste reduction, recycling, and composting. WRA projects may include new recycling collections, household hazardous waste collections, electronics recycling programs, mulching or composting operations, material processing operations and manufacturing facilities that use recycled material as a feedstock. Capital improvements to expand existing programs of these types may also be proposed, and eligible applicants include private companies, non-profit organizations, and political jurisdictions of Arizona communities that contribute to the recycling fund through landfill disposal fees.

VII.B.4. Rural Economic Development Initiative

In 1987, the Arizona legislature created the Rural Economic Development Initiative (REDI) program to “promote economic development in rural areas and communities of the state.” The Arizona REDI program provides direct assistance to rural communities in organizing an economic development program or effort, and in evaluating community resources. Qualified rural economic development programs and organizations with an on-going commitment to economic development can be recognized through REDI accreditation. The REDI program provides both technical and matching fund assistance.

REDI assists communities in:

- Increasing basic job opportunities and investment in community growth
- Developing a plan to become more attractive for capital investment and industrial and business locations while preserving and maintaining existing business and industry
- Encouraging expansion of the existing employment and tax base
- Effectively managing an economic development program
- Evaluating community resources
- Targeting effective strategies to enhance community attractiveness
- Providing an effective, locally generated program of activities and focused state assistance enabling communities and tribal authorities to better facilitate economic development
- Providing public recognition to communities and regions making the effort to facilitate economic development
- Providing the Arizona Department of Commerce and other industry-recruiting organizations with a current and accurate inventory of REDI communities’ marketable assets, to bring to the attention of prospects seeking new location sites or other beneficial investment opportunities

Thus far, environmental industries and jobs have not been a focus of the REDI program. However, there is no reason why the program cannot be enhanced to include a jobs and environment focus.

VII.B.5. Municipal Energy Management Program

The Municipal Energy Management Program encourages and assists in the development and implementation of energy management programs by facilitating the planning process and providing the necessary basic tools, staff training, and technical assistance. As part of MEMP, the Energy Office makes funds available for energy saving projects. Those eligible to apply include incorporated Arizona cities, towns, counties, improvement districts, and Indian tribes with populations under 70,000.

The MEMP approach to energy conservation is a simple and direct step-by-step approach:

- The first step is to understand where energy is being consumed and how much it costs, based on utility bill analysis and audits
- The second step identifies strategies for lowering energy costs
- The third step assists in incorporating energy management into future development through an energy management plan.

MEMP represents an important vehicle for bringing jobs and the environment issues to the forefront in the state:

- It is a high priority statutory state program.
- It leverages unique state resources and expertise.
- It focuses on energy efficiency and energy conservation.
- It is amply funded.

VII.B.6. Enterprise Zone Program

The primary goal of the Arizona Enterprise Zone program is to improve the economies of areas in the state with high poverty or unemployment rates, and the program enhances opportunities for private investment in certain areas that are called enterprise zones. These zones are designated by the Arizona Department of Commerce, and increased investments in such areas tend to strengthen property values (or keep property values from falling), encourage job creation, and promote the vitality of the local economies.

There are two state benefits provided by the Enterprise Zone program:

- *Income or Premium Tax Credits.* Arizona statutes provide for an income and premium tax credit for net increases in qualified employment positions at a site located in an enterprise zone -- except for those at a business location where more than 10 percent of the activity is the sale of tangible personal property at retail.
- *Property Tax Benefits.* Property reclassification is available for qualified manufacturing businesses locating or expanding facilities in an enterprise zone. A manufacturer in an Enterprise Zone is eligible for an assessment ratio of five percent on all personal and real property (for primary tax purposes only) in the zone for five years.

VII.C. Arizona Department of Environmental Protection

VII.C.1. Jobs Through Recycling Grants

In 1994, the U.S. Department of Environmental Protection partnered with the Arizona Department of Environmental Quality to provide over \$114,000 in funding via a grant to help increase jobs through recycling related projects in Arizona. The JTR grant created 672 new recycling-oriented jobs and attracted \$200.5 million in recycling business investments. Arizona's recycling material capacity expanded by 758,000 tons per year, and the program resulted in a 40 percent growth in end use over three years. The accomplishments were attributed to the use of strategic planning, flexibility, and program evolution when efforts were ineffective.

The U.S. EPA awarded another JTR grant to Arizona in April 1996. This project was entitled "Project for a Sustainable Arizona," and its main goal was to create long-term job opportunities in rural and tribal areas of Arizona, focusing on forestry and timber industry wastes.

Arizona DOC received its third JTR grant in late 1998 for the Rural Recycling Business Initiative. This project worked closely with the Arizona Department of Environmental Quality to provide the information necessary to establish recycling businesses in rural and tribal areas of the state. Specific development tools included geographic information databases and online and printed media that help identify and link regional waste streams, eco-industry sites, and sources and users of recyclable materials. Tools were posted on the Internet and marketed to assist local economic developers, attract new industries, and help mentor similar efforts across the country.

The Jobs Through Recycling Grants program can serve as a model for other environment-related jobs programs in Arizona, and such an expanded program could contain similar elements and:

- Provide the information necessary to establish environment-related businesses and jobs in rural and tribal areas of the state
- Develop geographic information databases and online and printed media to facilitate development of environmental industries and jobs
- Have tools posted on the Internet and marketed to assist local economic developers and attract new environmental industries and create environment-related jobs

VII.C.2. Pollution Prevention Incentives

Each year, the U.S. EPA, Region 9's Pollution Prevention Team offers funding to state, tribal, local, business, and community partners for Pollution Prevention projects. Many organizations partner with others to build pollution prevention capabilities.

Pollution Prevention Grants for States is one type of funding offered by the Pollution Prevention team. This funding is aimed at building and supporting state and tribal pollution prevention capabilities as well as encouraging the testing and innovation of pollution prevention approaches and methodologies. Funds awarded must be used for programs that prevent the transfer of pollutants across all environmental media -- air, water, and land. Funded activities can include agricultural P2, P2 for children's health, P2 focused on persistent, bioaccumulative and toxic (PBT) source reduction, and sector P2 (metal finishing, auto repair, fleet maintenance, hospitals). Award amounts can total up to \$200,000 and require 50 percent matching.

VII.C.3. The Arizona Water Protection Fund

In 1994 the Arizona legislature created a Water Protection Fund administered by a 15-member Commission. The Fund, which is administered by the director of ADWR and the State Land Commissioner, is earmarked for supporting projects that will enhance riparian areas. Up to \$5 million is available annually through grants.

Grants may be made to both public and private bodies, including natural resource conservation districts for various projects. They may include restoration or protection of rivers, promotion of water conservation activities outside AMAs, and research and public awareness programs for water and riparian protection and enhancement.

Statutory limitations on how the funds can be spent include: No purchases of land can be made from the Heritage Fund, no more than \$100,000 per year can be spent on research, and no more than \$100,000 per year can be spent on water

conservation projects, which must be located outside the state's five Active Management Areas.

VII.C.4. Waste Reduction Grants

The Waste Reduction Assistance grant provides funding assistance to projects that will divert significant amounts of solid waste materials from landfills through reducing, reusing, and recycling methods. The Waste Reduction Initiative Through Education grant provides funding assistance to projects that promote the education of Arizona citizens concerning issues related to the proper disposal of solid waste, source reduction, recycling, buying recycled content products and composting. Both grants are typically available to public, private, and non-profit organizations.

VII.C.5. Water Revolving Funds

The Clean Water Revolving Fund is awarded to public jurisdictions to plan, engineer, and construct wastewater treatment, water reclamation, and water quality projects. There is no dollar limit on funding, but the project must qualify on the Project Priority List. The Drinking Water Revolving Fund is awarded to publicly held and investor-owned drinking water utilities to plan, engineer, and construct drinking water facilities. There is no dollar limit on funding, but the projects must also qualify on the Project Priority List.

VII.D. Solar Energy Advisory Council

The Solar Energy Advisory Council represents a wide range of expertise in solar and renewable energy and a broad spectrum of knowledge in other fields. The Council consists of members from government, academia, and private-sector appointees who are knowledgeable on specific solar energy technologies, or representative of private industry involved in the application of solar energy commercial, industrial, or residential use.

The council's responsibilities are to:

- Assist and advise the director on matters relating to the development and use of solar energy and other renewable energy resources, including recommendations for the utilization or disbursements of federal and state funds for solar purposes
- Encourage efforts by research institutions, local government institutions, and homebuilders in obtaining technical and financial support from the federal government for their activities in solar and advanced alternate energy systems

- Identify and describe the solar energy technologies that are feasible and practical in terms of short-term application of retrofit, new construction, and conservation projects within five years
- Identify and describe long-range programs that are feasible and require significant technological development. Programs having similar technology gradients shall be formulated to encompass the period of time from the present through the year 2020.
- Encourage the cooperation and direct involvement of academic, business, professional, and industrial sectors that have special expertise or knowledge of solar energy technology
- Make recommendations to the director on standards, codes, certifications, and other programs necessary for the orderly and rapid commercialization and growth of solar energy use in Arizona for consideration by the appropriate jurisdictional bodies

While the Solar Energy Advisory Council currently has little focus on jobs, it nevertheless, represents an excellent vehicle for bringing jobs and the environment issues to the forefront in the state:

- It has high visibility.
- It can leverage unique state resources and expertise.
- It has the express goal of creating high-tech renewable energy jobs and businesses.
- It has secure funding.

VII.E. Arizona Association for Economic Development

The Arizona Association for Economic Development was originally formed as the Arizona Association for Industrial Development (AAID) in 1974 by a small group of economic development professionals and business leaders dedicated to expanding the industrial and economic base of Arizona. This group came together to discuss issues affecting Arizona's economic development, to promote economic development in the state through an interchange of information and educational opportunities among its members, to act as a liaison with outside groups having the same objectives, to influence legislation affecting economic development, and to continually improve working relationships among its diverse membership. In 1991, the membership of AAID

voted to change the organization's name to Arizona Association for Economic Development (AAED) to better reflect its broader mission.

In 2004, the AED teamed with the Governor and the Arizona Department of Commerce to conduct the Governor's Rural Development Conference. The focus of the conference was on drawing individual community strengths together to build teams that benefit broader regions within Arizona. Following the success of the 2004 conference, additional conferences are being planned for 2005 and 2006.

The AED could team with the Governor, the Arizona Department of Commerce, other state agencies and private industry to hold a "Governor's Jobs and the Environment Conference." This conference would explore ways to leverage the existing Arizona environmental and renewable energy industries to expand them and facilitate creation of new companies and environment-related jobs in the state.

VIII. SUMMARY OF MAJOR FINDINGS

This report presents information about jobs creation and the potential of the environmental industry in the state of Arizona, 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 2004 protecting the environment generated:

- \$320 billion in total industry sales
- \$21 billion in corporate profits
- 5.1 million jobs
- \$46 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 (2004 dollars) will increase from \$320 billion in 2004 to:

- \$397 billion in 2010
- \$439 billion in 2015
- \$486 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 5.1 million jobs in 2004 to:

- 5.9 million jobs in 2010
- 6.2 million jobs in 2015

- 6.9 million jobs in 2020

Environmental protection created more than five million jobs in the U.S. in 2004, 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 Arizona and Arizona’s Environmental Industry

We found that environmental protection is a large and growing industry in Arizona. MISI estimates that in 2004:

- Sales generated by the environmental industries in Arizona totaled \$6.9 billion.
- The number of environment-related jobs totaled 90,500.
- The environmental industry in Arizona comprised 3.6 percent of gross state product.
- Arizona environmental industries accounted for 2.1 percent of the sales of the U.S. environmental industry.
- Environment-related jobs comprised nearly four percent of Arizona employment.
- Environment-related jobs in Arizona comprised 1.8 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 two and three percent annually.

Most of the environment-related jobs in Arizona 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 Arizona are widely distributed among 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 Arizona 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 Arizona, 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 Arizona 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 Arizona comprises less than four percent of total employment, in 2004 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 Arizona revealed a wide range of firms, located throughout the state and across sectors. 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 manufacturing, engineering, remediation, testing, monitoring, analysis, etc.
- Include some of the most sophisticated, innovative, high-tech firms in the state; for example:
 - AMEC (Mesa, Tempe, Phoenix, Tuscon) is a world leading earth and environmental consulting businesses
 - Environmental Support Solutions (Tempe) is one of the leading U.S. providers of Environmental, Health and Safety and Crisis Management IT and software.
 - Kyocera Solar (Scottsdale) is a major U.S. provider of solar photovoltaic systems

- Southwest Windpower (Flagstaff) is the world's leading manufacturer of wind generators used to produce electricity for rural applications
- Stirling Energy Systems (Phoenix) provides utility-scale renewable energy power plants and distributed electric generating systems
- SWCA (Phoenix, Flagstaff, Tucson) is a major environmental and regulatory compliance consulting company.
- Terracon (Phoenix, Tucson) is one of the largest U.S. geotechnical, environmental, and materials engineering companies.

A number of these firms, as well as Co and Van Loo (Phoenix), Entranco (Phoenix, Tucson), Hydro Geo Chem (Tucson, Scottsdale), Logan Simpson Design (Tempe, Tucson), and MMLA (Tucson), have created significant numbers of new jobs over the past six months.

We identified a number of existing state agencies and initiatives that could be used to maximize the jobs creation benefit and potential of the environmental industry. These include the Governor's Strategic Partnership for Economic Development, the Governor's Council on Innovation and Technology, the Governor's Council on Workforce Policy, the Climate Change Advisory Group, the Arizona Job Training Program, the Commerce and Economic Development Commission, the Waste Reduction Assistance Program, the Rural Economic Development Initiative, the Municipal Energy Management Program, the Enterprise Zone Program, the Jobs Through Recycling Grants program, Pollution Prevention Incentives, the Arizona Water Protection Fund, Waste Reduction Grants, Water Revolving Funds, the Solar Energy Advisory Council, and the Arizona Association for Economic Development. Of these, the Governor's Strategic Partnership for Economic Development, the Governor's Council on Innovation and Technology, the Governor's Council on Workforce Policy, the Climate Change Advisory Group, the Arizona Job Training Program, the Commerce and Economic Development Commission, the Jobs Through Recycling Grants program, the Solar Energy Advisory Council, and the Arizona Association for Economic Development are especially notable and hold considerable promise.

We suggest policy options that could maximize the jobs benefits of the environmental industry in Arizona, with no institutional impediment. Such initiatives should be encouraged and expanded. This study demonstrates that environment-related initiatives can create substantial numbers of jobs in Arizona, a state that is currently seeking new ideas for employment generation, stable good jobs, and workforce development.

BIBLIOGRAPHY

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.

American Federation of State, County, and Municipal Employees. *Thinking Creatively About Welfare-To-Work Job Creation*. Washington, DC, July 1998.

American Petroleum Institute. *A Reconstruction and Reconciliation of Administration Estimates*, July 1998.

Arizona Association for Economic Development, www.aaed.com.

Arizona Department of Commerce, www.commerce.state.az.us.

Arizona Department of Environmental Quality, www.azdeq.com.

"Arizona Economic Conditions," Economy.com.

Arizona Government Information Technology Agency, www.auditorgen.state.az.us.

Arizona Governor Takes Action on Climate and Clean Energy, PEW Center on Global Climate Change www.pewclimate.org/what_s_being_done/in_the_states/news.cfm.

Arizona Job Training Program. <http://www.commerce.state.az.us/jobtraining/default01.asp>

"Arizona Solar Energy Advisory Council." <http://www.commerce.state.az.us/energy/SolarEnergyAdvCouncil.asp>

"Arizona Statewide Economic Study." <http://www.commerce.state.az.us/prop/ses/sesreports.asp>

"Arizona Ready to Catch the Next Big Technology Wave." Arizona Department of Commerce, April 2004.

Arizona Water Protection Fund. <http://www.awpf.state.az.us/about/desc.html>

Arizona Water Resource. *Water Protection Fund Commission Formed*, ag.arizona.edu/AZWATER/awr/sept94/fundcomm.html, September 1994.

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.

Australian Conservation Foundation, Australian Council of Trade Unions, and the Commonwealth Department of Employment, Education, and Training. *Green Jobs in Industry -- Research Report*. Melbourne, May 1994.

Baily, Wallace K. "Local Area Personal Income, 1982-97." *Survey of Current Business*, May 1999, pp. 50-67.

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

Barnow, Burt. *The U.S. Experience with Public Service Employment Programs*. Johns Hopkins University Institute for Policy Studies, Baltimore, MD, September 1994.

Bartch, Charlie and Christine Anderson. *Matrix of Brownfield Programs by State*. Northeast-Midwest Institute, September 1998.

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*, Arlington, Virginia, March 1995, pp. 65-79.

_____. "Environmental Protection: A Recession-Proof Industry?" *Virginia's Environment*, February 1994, pp. 10-16.

_____. "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. "Fuel Efficiency and the Economy." *American Scientist*, Volume 93 (March-April 2005), pp. 132-139.

_____. "Potential Long-term Impacts of Changes in U.S. Vehicle Fuel Efficiency Standards." *Energy Policy*, Vol. 33, No. 3 (February 2005), pp. 407-419.

_____. "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 Buses for Kids School Bus Diesel Retrofit Program. www.cleanbusesforkids.com.

Cropper, Maureen L. and Wallace E. Oates,. "Environmental Economics: A Survey." *Journal of Economic Literature*, Vol. 30, No. 2 (June 1992), pp. 12-36.

Current Developments, State Conservationist Message, February, 2001, www.info.usda.gov.

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.

DRI. "Potential Benefits of Integration of Environmental and Economic Policies: An Incentive-Based Approach to Policy Integration." Report prepared for the Commission of the European Communities, Luxembourg, 1994.

Economy.com. *Arizona's Economic Future*. Report prepared for the Arizona Department of Commerce, August 2002.

ECOTEC. "The Employment Impact of Environmental Policies." Discussion Paper No. 2 in the series "Sustainability, Employment, and Growth," ECOTEC, Birmingham, England, 1993.

Electronic Industries Alliance, International Cooperative for Environmental Leadership, and World Resources Institute. *Taking a Byte Out of Carbon: Electronics Innovation for Climate Protection*, July 1998.

Enterprise Zone Program. <http://www.commerce.state.az.us/business/ez%20home%20page.asp>

Environmental Law Institute. *Barriers to Environmental Technology Innovation and Use*. ELI Research Report, February 2000.

_____. *Innovation, Cost, and Environmental Regulation: Perspectives on Business, Policy and Legal Factors Affecting the Cost of Compliance*. Environmental Law Institute, May 1999.

Franciosi, Robert. *Assessing Arizona's Economy: Boom or Bust?* Goldwater Institute, June 2002.

Greenwald, Judith M. *Labor and Climate Change: Getting the Best Deal for American Workers*. Progressive Policy Institute, October 1998.

Green Jobs Project. *Environment and Employment in Spain*. Spanish Report, April 1998.

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's Council on Innovation and Technology. <http://www.gcit.az.gov/>

Governor's Council on Workforce Policy. <http://www.commerce.state.az.us/jobtraining/workforcepolicy.asp>

Governor's Strategic Partnership for Economic Development. <http://www.commerce.state.az.us/gsped/>

Governor of Arizona Website, www.governor.state.az.us.

Hoerner, J. Andrew and James Barrett, *Smarter, Cleaner, Stronger: Secure Jobs, a Clean Environment, and Less Foreign Oil*, Redefining Progress, Oakland, California, 2004.

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.

International Institute for Sustainable Development. *Making Budgets Green: Leading Practices in Taxation and Subsidy Reform*. Winnipeg, 1994.

International Labour Office. *Employment and Training Implications of Environmental Policies in Europe*. ETIEPE, Geneva, 1989.

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 Through Recycling. <http://www.epa.gov/jtr/docs/az/az.htm>

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.

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.

Management Information Services, Inc. *Job Creation in the Environmental Industry in Minnesota and the United States*. Report prepared for the Building Diagnostics Research Institute, September 2004.

_____. *Job Creation in the Environmental Industry in Wisconsin and the United States*. Report prepared for the Building Diagnostics Research Institute, September 2004.

_____. *Jobs in the Environmental Industry in Michigan and the United States.* Report prepared for the Building Diagnostics Research Institute, July 2004.

_____. *Jobs in the Environmental Industry in Ohio and the United States.* Report prepared for the Building Diagnostics Research Institute, May 2004.

_____. *Survey of Jobs and the Environment Issues in Six Midwestern States: Identifying Policy Challenges and Opportunities.* Report prepared for the Joyce Foundation, Chicago, Illinois, 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.

_____. *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.

_____, and 20/20 Vision. *Fuel Standards and Jobs: Economic, Employment, Energy, and Environmental Impacts of Increased CAFE Standards Through 2020.* Report prepared for the Energy Foundation, San Francisco, California, July 2002.

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

Most Livable States, 2004, www.infoplease.com.

"Municipal Energy Management Program." <http://www.commerce.state.az.us/energy/municipal.asp>

Organization for Economic Cooperation and Development. *Environmental Policies and Employment*. Paris, 1997

Pollution Prevention Grants. <http://www.epa.gov/region09/p2/grants.html>

Proceedings of the Conference on Cost, Innovation, and Environmental Regulation: A Research and Policy Update. Environmental Economics Report Inventory, June 1, 1999.

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.

Resource Data International. *The Economic Risks of Reducing the U.S. Electricity Supply*, November 1997.

_____. *Energy Choices in a Competitive Era: The Role of Renewable and Traditional Energy Resources in America's Electric Generation Mix*. April 1995.

"Rural Economic Development Initiative." <http://www.commerce.state.az.us/rural/redi.asp>

Tellus Institute. *America's Global Warming Solutions*, August 1999.

Travel Industry Association of America. *Tourism Works for America, 12th Annual Edition 2003*. Washington, D.C, December 2003.

Small Cities Development Program, Fact Sheet. www.dted.state.ct.us.

State of Arizona, Office of the Auditor General Report No. 03-08. *Eliminate, Transfer, or Modify Functions*, www.auditorgen.state.az.us/Reports/State_Agencies/Agencies/Commerce,%20Department%20of/Performance/03-08/03-08Highlights.pdf.

Unemployment Data for U.S. and Arizona. www.dted.state.az.us.

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

University of Arizona. *2005 – 2006 Economic Outlook.* <http://ebr.eller.arizona.edu/AzEconomyIssues/AEWinter05.pdf>

U.S. Congressional Budget Office. *Environmental Regulation and Economic Efficiency.* Washington, D.C., 1985.

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

U.S. Office of Technology Assessment. *Industry, Technology, and the Environment: Competitive Challenges and Business Opportunities*. OTA-ITE-586, U.S.GPO, Washington, DC, 1994.

Vest, Marshall. *Arizona's Economy, 2005 – 2006 Economic Outlook*, ebr.eller.arizona.edu/AzEconomyIssues/AEWinter05.pdf, December 1, 2004.

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.

Water Infrastructure Finance Authority of Arizona, www.azwifa.com.

Water Revolving Funds. <http://www.azwifa.gov/cleanwaterrevolvingfund/cleanwaterrevolvingfund.html>

WEFA, Inc. *Global Warming: The High Cost of the Kyoto Protocol*, June 1998.

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 ARIZONA

There are two historical sources of information about the environmental industry in Arizona. 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.

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.

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 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 Arizona. The ITA estimated that, in 1999, Arizona accounted for about 1.1 percent of the U.S. industry, and that the number of environmental jobs in the state totaled about 15,000.

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

		Arizona	U.S.	Arizona Share of U.S.
Revenues	(millions)	\$2,213.3	\$196,465	1.1%
Jobs	(number)	14,873	1,389,638	0.9%
Companies	(number)	1,451	115,030	1.0%
Exports	(millions)	\$200.6	\$21,310	1.2%

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

The ITA report disaggregated the Arizona industry by metropolitan statistical area (MSA) – see Table A.2. In Arizona, this consisted of the Phoenix-Mesa MSA. This MSA accounted for 63 percent of the industry in the state and about 9,400 environment-related jobs.

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

Phoenix- Mesa, AZ

Revenues	(millions)	\$1,395.9
Jobs	(number)	9,380
Companies	(number)	915
Exports	(millions)	\$126.5
MSA Average Share of Arizona		63%

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 Arizona and the United States from the most recent survey, for 1999. Pollution abatement costs in these selected Arizona industries included \$58 million of capital expenditures and \$71 million for operating costs. Together with \$26 million in operating costs for disposal and recycling activities and other categories of economic activity, the PACE estimates for Arizona in 1999 totaled \$194 million. This represented 0.6 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 Arizona
and the U.S. From the Census MA200 Survey, 1999
(million dollars, except where noted)

	Arizona		U.S.		Arizona Share of U.S.	
Pollution abatement						
Capital expenditures	58.4		5,809.9		1.0%	
Non-hazardous		18.7		4,497.8		0.4%
Hazardous		39.7		1,312.0		3.0%
Air	39.6		3,463.7		1.1%	
Non-hazardous		14.0		2,644.7		0.5%
Hazardous		25.6		819.0		3.1%
Water	16.7		1,801.9		0.9%	
Non-hazardous		3.0		1,488.2		0.2%
Hazardous		13.7		313.7		4.4%
Solid Waste	2.0		361.9		0.6%	
Non-hazardous		1.7		245.5		0.7%
Hazardous		0.3		116.4		0.3%
Multimedia	0.1		182.3		0.1%	
Non-hazardous		-		119.4		-
Hazardous		0.1		62.9		0.2%
Operating Costs	70.9		11,864.4		0.6%	
Non-hazardous		47.2		8,924.9		0.5%
Hazardous		23.7		2,939.5		0.8%
Air	43.5		5,069.1		0.9%	
Non-hazardous		27.3		3,941.2		0.7%
Hazardous		16.2		1,127.9		1.4%
Water	18.0		4,586.5		0.4%	
Non-hazardous		13.4		3,511.8		0.4%
Hazardous		4.5		1,074.6		0.4%
Solid Waste	8.8		2,013.3		0.4%	
Non-hazardous		6.4		1,320.4		0.5%
Hazardous		2.5		692.9		0.4%
Multimedia	0.6		195.5		0.3%	
Non-hazardous		0.1		151.5		0.1%
Hazardous		0.5		44.0		1.1%
Disposal and recycling						
Capital expenditures	0.4		398.7		0.1%	
Disposal		0.3		267.2		0.1%
Non-hazardous		0.3		218.0		0.1%
Hazardous		(D)		49.2		(D)
Recycling		0.1		131.5		0.1%
Operating costs	26.2		4,923.6		0.5%	
Disposal		18.0		3,680.9		0.5%
Non-hazardous		8.3		2,466.2		0.3%
Hazardous		9.7		1,214.7		0.8%
Recycling		8.3		1,242.7		0.7%

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

	Arizona	U.S.	Arizona Share of U.S.
Pollution prevention	5.9	2,767.9	0.2%
Other expenditures	25.1	3,154.5	0.8%
Site cleanup	4.0	1,039.3	0.4%
Remediation	1.4	827.3	0.2%
Replacement	1.9	83.1	2.3%
Other	0.7	128.8	0.5%
Habitat protection	(D)	155.2	(D)
Monitoring/testing	4.6	599.5	0.8%
Administration	16.4	1,360.4	1.2%
Other payments			
Payments to government	7.4	959.1	0.8%
Permits/fees	4.9	816.6	0.6%
Fines/penalties/charges	0.3	116.3	0.3%
Other	2.2	26.2	8.4%
Tradeable permits - bought	-	20.2	-
Tradeable permits - sold	-	23.7	-
Tradeable permits - other	-	12.6	-
Total	194.3	29,934.6	0.6%

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

ABOUT THE JOBS AND ENVIRONMENT INITIATIVE

The Jobs and Environment Initiative, founded in 2004 by Paula DiPerna, is a pilot program of research, policy analysis and public education. The objective of the Initiative is to examine and demonstrate the links between jobs creation in all sectors of economic activity, including manufacturing, and all aspects of environmental management. The Initiative seeks to describe and analyze current jobs benefits of environmental investment and stewardship; bring further public and policy attention to the strength and scope of the environmental industry; examine potential for further jobs creation; highlight policy opportunities, and improve understanding of the positive contributions of environmental management to economic growth and employment generation, at the local, state, regional, national and international levels. The Initiative conducts state-based and national reports and other inquiries, and is a collaboration between Management Information Services, Inc. (www.misi-net.com) and the Building Diagnostics Research Institute (www.buildingdiagnostics.org). For information contact Paula DiPerna at 607-547-8356

ABOUT MANAGEMENT INFORMATION SERVICES, INC.

Management Information Services, Inc. (MISI) is an economic research firm with expertise on a wide range of complex issues, including energy, electricity, and the environment. The MISI staff offers expertise in economics, information technology, engineering, and finance, and includes former senior officials from private industry, federal and state government, and academia. Over the past two decades MISI has conducted extensive proprietary research, and since 1985 has assisted hundreds of clients, including Fortune 500 companies, nonprofit organizations and foundations, academic and research institutions, and state and federal government agencies including the National Academy of Sciences, the U.S. Department of Energy, the U.S. Environmental Protection Agency, the Department of Defense, and the Energy Information Administration.

For more information, please visit the MISI web site at www.misi-net.com.

ABOUT THE BUILDING DIAGNOSTICS RESEARCH INSTITUTE

The Building Diagnostics Research Institute, Inc. (BDRI) is a Section 501(c)(3) not-for-profit organization dedicated to providing the highest level of research, education and training, and public outreach on issues related to the effects of building performance on health, safety, security, and productivity. The Institute's mission is to leverage more than 25 years of building diagnostics experience in order to enhance health, safety, security, and productivity, and it is implemented by conducting basic and applied research, providing education and training for health and building professionals, disseminating knowledge, and serving as an advocate for the general public. BDRI's basic and applied research, its education and training, and its public outreach are

carried out by an interdisciplinary team of staff and external scientists and professionals representing a variety of disciplines, including chemistry, industrial hygiene, engineering, microbiology, and law and public policy.

For more information, please visit the BDRI web site at www.buildingdiagnostics.org.

BIOGRAPHICAL INFORMATION

Paula DiPerna, founder of the Jobs and Environment Initiative, served formerly as President of the Joyce Foundation, and Vice-President for International Affairs for the Cousteau Society and is a widely published author and public policy analyst.

Roger H. Bezdek, Ph.D., is President of Management Information Services, Inc. He has 30 years experience in consulting and management in the environmental, energy, economic forecasting, and regulatory areas, serving in private industry, academia, and the Federal government. He has served as a consultant to the White House, Federal and state government agencies, environmental organizations, and various corporations and research organizations. Dr. Bezdek, is an internationally recognized expert in economic forecasting and environmental analysis, and is the author of four books and of 200 articles in scientific and technical journals. He received his Ph.D. in Economics from the University of Illinois (Urbana).

Robert M. Wendling is Vice President of Management Information Services, Inc. He has 28 years experience in consulting and management in the energy, environmental, statistical/econometric modeling, and regulatory areas. He has served in industry as corporate CEO and president and as corporate vice president and in senior positions in the U.S. Department of Commerce and the Department of Energy. He is the author of 75 reports and professional publications on energy and environmental topics and lectures frequently on various energy, forecasting, regulatory, and economic modeling topics. He received an M.A. in Economics from George Washington University.

James E. Woods, Ph.D. is CEO of the Building Diagnostics Research Institute. He has 35 years experience in management and consulting in the environmental industry, serving in academia, industry, and as an advisor to DOE, EPA, NIST, and the National Academy of Sciences. He has extensive experience in end-use demand in the residential, commercial, and industrial sectors, environmental factors, and energy modeling, has managed 20 large scale energy and environmental research projects, and is the founder of the Building Diagnostics Research Institute. He received a Ph.D. in Mechanical Engineering from Kansas State University.