

Technology²¹

Innovation and Technology in the 21st Century
Creating Better Jobs For New Mexicans

A Science and Technology Roadmap for New Mexico's Future

*New Mexico Governor Susana Martinez' Office
and
New Mexico Economic Development Department*

Foreword

“New Mexico is a state rich in science and technology assets and capabilities. With more than 50,000 high tech workers, science and technology jobs form an important sector of our economy. I look forward to working with our national laboratories, universities, business community and other stakeholders to ensure that our technology economy continues to thrive.”

-- Governor Susana Martinez

The original charge in developing this plan was to provide a prioritized assessment of the opportunities that exist or could be developed that would drive technology-based economic development (TBED) in New Mexico.

In order to achieve that goal, the Plan needed to identify a sustainable process by which the State could make investments that would provide full oversight and accountability and a pathway towards achieving a significant return on its investments. Finally, the Plan must address Science, Technology, Engineering, and Mathematics (STEM) education as that lays the foundation for the workforce development that is essential to driving economic development in New Mexico.

The Plan that is described in this document – Technology21 - is meant to provide a *roadmap* of where the State should be going in encouraging and driving innovation and defining the means for reaching those goals. There have been many previous studies that have dealt with aspects of the State’s S&T resources, none has been comprehensive enough. This plan is not meant to supplant those efforts, but rather to draw on them, extensively, as we complete the task of integrating all of the elements into a single plan.

The State owes a debt of gratitude to the many people who generously volunteered their time and effort in developing this plan. It is through their efforts that all of New Mexico will benefit as we begin a coordinated journey towards leveraging our considerable resources that will draw on the S&T strengths in New Mexico to drive long-term, sustainable technology-based economic development.

Although originally published in 2009, this plan is a living document. This iteration includes additional detail on our aerospace cluster in the appendices. While the analysis of the state’s core assets and opportunities is unlikely to change significantly over time, particular action strategies will necessarily need to be revisited and the detailed information on specific research programs will need to be updated periodically. When significant revisions are needed, a public process will be initiated to review the plan, solicit current input and make any changes required.

Acknowledgements

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Table of Contents

Foreward	2
Acknowledgements	3
1. Overview	
a. Introduction	5
b. New Mexico's Future	6
c. Recommendation	8
d. The TICenter	9
e. New Mexico's Major Technology Clusters	9
f. Funding the TICenter	11
g. Conclusion	11
2. Basis for the Plan	
a. Purpose of the Plan	12
b. Goals of the Plan	13
c. Development of the Plan	14
d. Science, Engineering, and Technology Strengths	15
e. Competition from other states	15
f. A critical success factor: Time	16
3. The Five Innovation Clusters	
a. Aerospace	17
b. Bioscience	21
c. Energy/Environment/Water	24
d. Information Technology	29
e. Nanotechnology	34
4. Economic Development	
a. Overview	37
b. Technology as a Driver for Clean Growth	38
c. The Federal R&D Investment in New Mexico	38
5. Education and Workforce Development	
a. Education	40
b. IDEAL New Mexico	41
c. New Mexico Project 2012	41
d. Education Working Group	41
e. Workforce Development	43
f. Portrait of New Mexico	43
g. Education and Workforce Development Reform	43
6. Recommendations	45
7. Summary	47

Overview

1a. Introduction

New Mexico is a state with a wealth of human capital - a place where innovation and modern technology combine to create new ideas and new opportunities. It is also a state with age-old traditions that have guided our commercial and business life for generations. It is this very combination and the synergy that results from an occasional friendly clash of cultures that makes us a vibrant investment site for science and technology (S&T) companies.

Our S&T assets are many and varied, but reside physically in our research universities and our Federal laboratories (the latter contribute \$6.0 billion, annually, to the State's economy). This financial underpinning has enabled us to consolidate and focus on specific scientific research and attract new companies to our state. These new commercial relationships have helped us become a world leader in many S&T disciplines.

New Mexico's success is rooted in a top-down and bottom-up support for science. Our Governor and our Congressional delegation have steadfastly supported our State's efforts to leverage those assets while our technologists and researchers continue to distinguish themselves through their discoveries.

Through a strong mix of Federal Grants and local incentives, New Mexico has attracted significant investment and created many new technology-based jobs. In fact, it is expected that technology-based economic development (TBED) will be the principal driver of economic growth in New Mexico for several decades to come.

In this respect, we are very similar to many states, and that similarity makes us competitors as well as potential collaborators.

Technology, like investments, goes where it can grow... fastest and best.

In order for New Mexico to retain its competitive edge and insure its attractiveness as a future investment site, we must have a plan to support and capitalize on the development of high-potential technologies. The plan must also have a set of realistic goals and a strategy to achieve them if we are to leverage and maximize our resources.

Technology21 defines the way in which the State can most effectively promote science and technology in the 21st century to drive high-tech-based economic development, create more high-paying jobs for New Mexicans, and to ensure we are fully competitive in the knowledge economy. Technology21 is meant to serve as a *roadmap* that identifies specific S&T opportunities the State should support along with a sustainable mechanism to provide that support. The Plan also addresses our many needs in the areas of science education, capital formation, workforce development, and public-private sector cooperation - all essential to creating the workforce that will drive our innovation economy forward. It also speaks to the need for establishing a New Mexico Technology Innovation Center to better coordinate and manage our many State projects and science and technology relationships.

1b. New Mexico's Future

New Mexico is a land of diversity of thought, culture, and people. Unfortunately, our economy is not so diverse. Government is the largest employer and most of the rest are retail, tourism-related, or healthcare jobs. We are facing a serious workforce crisis in New Mexico: while we have relatively low unemployment, our per capita income is one of the lowest in the country.

We cannot compete in the new world economy if our jobs are still in the old world economy. We must find new ways to stimulate high technology-based job growth so that we become a magnet for attracting new investment to the State. We must lead instead of follow. If we see ourselves as leaders in science and technology development then we must confront some sobering realities. We face four challenges:

Challenge #1 Addressing rising energy costs

In the past, we have been able to compete because of our low labor costs, low cost of living, Federal government revenue, and a vast storehouse of energy reserves, among other factors. Our future will be different. All costs will rise, especially those associated with energy and transportation. Growing our technology will become more expensive with each passing year. As we see this year, our budget surpluses from fossil fuels are not sustainable. We will switch from being an oil-exporting state to becoming an oil-importing state in 2015. The demands from our society for more energy, improved infrastructure, more evenly distributed healthcare and better social services will be impossible to meet unless we act now to grow our economy.

To address rising costs, we must develop economically competitive sources of renewable clean energy. Technologies emerging from our labs and universities have the potential to revolutionize the energy sector. Growing algae in the desert using our untapped sources of saline water could make New Mexico a major provider of transportation fuels for the country. Our immense solar resources, coupled with new technologies being developed in New Mexico could position us to be the most important state for solar energy. The New Mexico Green Grid Initiative can make New Mexico a national leader in implementing the Smart Grid with renewable energy. While we have the natural resources and scientific resources necessary to make this happen, we also need to provide the means to transition these possibilities into reality. Technology21 will do just that.

Challenge #2 Using technology for clean growth

Technology as a Driver for Clean Growth

Our future depends on finding new technology solutions to the nation's most pressing energy and water issues. The economic future also relies on our ability to develop new businesses in areas such as aerospace, biotechnology, information technology, and nanotechnology. We must grow our base of technology jobs, expand new technology-driven company start-ups, and recruit more out-of-state firms. This is vital if we are to firm up and diversify our economic base and provide a bright and sustainable future for all New Mexicans.

To expand our economic base, we must dedicate a relatively small but consistent portion of our budget to move our discoveries from the laboratory to the people. This requires a commitment to creating a Technology Innovation Center (the core of Technology21) that will support or coordinate promising *commercializable* technologies in four areas: energy, water, supercomputing, and technology innovation. Similar centers have been created by other states

for the same purposes, and the vast majority of them have profited from the economy of scale and coordination that these centers have provided.

Challenge #3 Profiting from Federal Investments

Our science and technology advantage over other states has been our unique Federal government relationship with our national laboratories. With over \$6.0 billion in annual revenue derived from the Federal government to operate its many facilities here, we are fortunate but also vulnerable to Washington's changing priorities. New policy decisions could lead to base closures or substantial reductions of missions for the national laboratories.

To avoid such losses and the subsequent economic impact on New Mexico, we must forge stronger and more flexible relationships with the labs that focus on commercial technology transfer and retaining Intellectual Property (IP) and human capital. We must draw on our scientific resources to provide solutions to energy problems and to produce the technologies needed to create better-paying jobs in rural and urban New Mexico. Technology21 provides the means for us to most effectively meet those challenges.

Challenge #4 Producing more technologists to satisfy projected workforce needs

We have not graduated or retained enough qualified workers to keep pace with company growth. The lack of preparation of our students in Science, Technology, Engineering, and Mathematics (STEM) areas, coupled with the large percentage of high school and college dropouts, is a significant barrier to growing businesses in New Mexico. In turn, this prevents us from improving the standard of living of New Mexicans. The need to act is critical and immediate in order to break the vicious cycle that traps our young people in a lifetime of minimum wage jobs.

Addressing this challenge requires us to substantially improve the performance of students in STEM areas that are of relevance to grow high-tech business. New Mexico Project 2012 (a joint Public and Higher Education initiative) is designed to advance our students to the forefront in STEM areas, nationally. Technology21 will support Project 2012 through initiatives such as the supercomputing center and will work with the Departments of Economic Development and Workforce Solutions to ensure that our educational system and business community become full partners in developing the right mix of commercially-relevant curricula.

Building the three-legged stool of success: Technology-Based Economic Development, Workforce Development, and Education

No state has been successful in achieving technology-based economic development without solving its workforce and educational problems. New Mexico is no different. We are faced with a potential 'Catch 22' situation. Currently, there are not enough specialized technology workers to satisfy the demand for them, and we won't get more investment until we graduate more of them. The solution to this problem requires a coordinated effort between high-tech economic development and education and workforce development. Technology21 provides the means to achieve that coordination.

We must act quickly to improve STEM education, increase our graduation rates, and develop specialized training programs to train workers needed for the future workforce. If we don't address this crisis quickly, we will lose companies as they move out of state to find the workforce they need; we will lose more of our most talented graduates to attractive out-of-state jobs and would leave those remaining graduates with only a selection of poor-paying jobs. A continuing lack of a qualified and educated workforce places us at risk of losing venture capital investments and a subsequent loss of our ability to attract high-tech companies to New Mexico.

All of the solutions have one thing in common; they cannot be achieved by one government department or by the private sector alone. They demand a coordinated approach and on-going cooperation from all New Mexicans, but especially by policy-makers, legislators, state agencies, and the 'implementers' on the ground. Technology21 provides the best way possible to provide the coordination needed to meet these challenges.

1c. Recommendation

The State Science and Technology plan has taken over 18 months to complete. Over 100 people representing the academic, scientific, business, government and non-profit communities from all parts of the State worked on it. The outcome of this effort concluded that meeting the needs identified in the S&T Plan can be met by implementing the following recommendation:

Establish and fund the New Mexico Technology Innovation Center (TICenter)

Technology21 is a roadmap that charts a course for economic and technological development that is integrated with educational and workforce development initiatives. It builds on the experiences of other states' plans, but is specific to New Mexico.

The TICenter is essential to bring all sectors of the S&T community together - a place where programs, activities, and grants can be monitored, coordinated and supported. It is also a place where a state-sponsored Technology Development Fund could be administered and directed towards commercializable technologies to meet market pull and help emerging technologies prosper with the State's help. The TICenter would be the principal liaison between all New Mexico state government departments, community-based technology programs, federal labs, universities and colleges, and private sector companies. At its core, the TICenter would administer or help coordinate four funds that would be used to support emerging technologies: the New Mexico Computing Applications Center, Technology Innovation Fund, the Water Innovation Fund, and the Energy Innovation Fund. Absent a positive decision on this recommendation, the State will not have the necessary resources to effectively implement and coordinate the technology development that is critical to improving the standard of living of New Mexicans across the entire state.

1d. The TICenter

The TICenter would have reporting responsibility and accountability to the Department of Economic Development, the Governor's Office, and the State Legislature. It would be a nonprofit organization with an executive board as well as a technical advisory committee of subject matter experts. It would have the flexibility to contract for R&D services, provide funding for technology development, create initiatives to respond to market opportunities, form partnerships with any combination of public, private, and government entities, and create and commercialize new intellectual property. It would oversee and administer the Technology Innovation Fund and serve to coordinate the Supercomputing, Energy, and Water Innovation Funds that are currently administered by other state agencies. Finally, it is designed to ultimately achieve self-sustaining operation through its ability to attract Federal and private funding and through the intellectual property it develops. This structure would allow the TICenter to be able to respond most effectively to market opportunities. This full range of capabilities is critical in addressing the pressing needs that exist in New Mexico to make technology-based economic development a driving force in improving the quality of life for all citizens.

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1e. New Mexico's Major Technology Clusters

Technology21 has targeted five major clusters for support: Aerospace, Bioscience, Energy/Environment/Water, Information Technology and Nanotechnology. The reasons for their selection are explained in detail later in this report, but are based on our state's current concentration of investment, both in terms of research and development, actual company presence as well as on the data and recommendations of all five industry advisory groups. All are expected to post significant gains in the coming years due to industry's own projected growth and by the adoption of Technology21. The working groups made specific recommendations to advance Technology-Based Economic Development in these clusters as well as in education and workforce development:

Aerospace: Driving economic growth in aerospace requires *a statewide clearinghouse for aerospace technology development that also provides a mechanism for private aerospace companies to participate in and gain access to funded research.* The absence of a mature, full-spectrum aerospace engineering department in the State is a weakness that must be addressed. Without the appropriate education and training of students, professionals and technicians, the State will not be able to convince medium-to-large sized aerospace businesses to locate to New Mexico and remain here. In addition, New Mexico has a great opportunity to capitalize on Spaceport America, which can be a platform for innovation and TBED.

Bioscience and Health: New Mexico has world-class capabilities in specific areas of bioscience and biotechnology that could serve as the basis for increased economic growth. *These are in the areas of biofuels, genomics, neuroscience, health research, and development of diagnostics and sensors.* Biotechnology has seen rapid growth in New Mexico and is a prime source of high-tech economic development. Investments are needed to provide an even broader base of bioscience-related jobs in bioenergy, human health, animal health, and agriculture.

Energy/Environment/Water: These three areas are inextricably tied together such as in the area of fossil fuels, where more water than fuels is extracted from the ground and which has a significant environmental impact. *The growth and sustainability of the energy sector is tied to environmental issues and is dependent on predictable supplies of water.* In the area of renewable alternative energy, we have enormous opportunities to develop solar energy, algal-based biofuels, and "Green Grid" technologies. Greater emphasis must be placed on shortening the time from the testing to production stage and investing in high-potential commercializable technologies if the State is to compete on a national level with a broader mix of energy sources.

Information Technology: *This is an area where New Mexico has tremendous strengths such as in high performance computing, remote sensing networks, and digital media.* The State's supercomputing initiative (the New Mexico Computational Applications Center or NMCAC) promises to position New Mexico as a national leader in the area of IT-based economic development. The opportunities for strong growth in the areas of digital media and homeland security are considerable. Continued legislative support is critical to its success.

Nanotechnology: This area has great potential. New Mexico ranks third in nanotech intensity in the country. *Significant Federal investment, most recently in the Center for Integrated Nanotechnology at Los Alamos and Sandia National Laboratories, positions the State to capture increased revenues in this emerging field.* More must be done to transfer technologies such as ultra-short pulse lasers out of the labs and universities into the commercial sector and to inform companies of the advantages of locating to a state with a diverse platform of nanotechnology.

Economic Development, Education, and Workforce Development: It is essential to keep several overarching requirements at the forefront of science and technology development decision-making. They are: to assure that all new State S&T investments be based on 'market pull' (commercializable R&D and applications); to spread investment in rural as well as urban New Mexico whenever possible; to focus on the inseparable nature of education and workforce development to economic and S&T development; and to match the business community's commercial curricula needs with those of the universities' capabilities.

1f. Funding the TICenter

A small staff would be associated with the TICenter to provide the coordination and oversight of the programs for which the TICenter has responsibility. The technology development funding that the TICenter would oversee or coordinate falls into four categories:

1. New Mexico Computing Applications Center (NMCAC). Complete the effort started in FY08 to bring the Supercomputing Center fully on line with major business partners. Provide support for targeted areas in economic and workforce development. Support the Center goals in education, telehealth, and community development. Implement gateways in combination rural/urban New Mexico. The NMCAC was established with state funding and designed to transition to self-sufficient operation over a five-year period. As state funding is reduced in the out years, that funding can be applied to help ramp up the Technology Development Fund.
2. A Technology Development Fund to support innovation and commercializable technologies in the areas of Aerospace, Biotechnology, Information Technology, and Nanotechnology. This will provide the diverse high-tech economic base that is essential if New Mexico is to achieve a healthy and sustainable economic future. This program needs to increase to a reasonable level over several years as an ongoing effort that will ultimately (within 15 years) transition to self-sustaining operation through the Intellectual Property it will hold. The initial focus will be the New Mexico Green Grid Initiative.
3. An Energy Innovation Fund program to support innovation in energy technologies that are important to New Mexico and offer the prospect of significant return on investment. This will drive our State's efforts to achieve a clean and sustainable energy future where clean energy is an important economic factor. This program needs to be an ongoing effort supported by the State.
4. A Water Innovation Fund program to support innovation in water technologies that are important to New Mexico. This will provide novel means of conserving water and developing new sources of usable water that are essential if we are to grow. This program needs to be an ongoing effort supported by the State.

1g. Conclusion

This plan provides the basis for the State to optimally capitalize on the science and engineering resources that exist in New Mexico. It provides a process that will assure commercial and scientific groups, associations, institutions, companies and government leaders can collaborate in a more highly-targeted, focused way along well-defined technology lines. It provides well-defined priorities within the five cluster areas identified in which New Mexico can compete effectively on national and international scales. As a result of the collective statewide efforts that have gone into this plan, we have provided, for the first time ever in New Mexico, a roadmap for how the State can most effectively significantly increase the number of high-value, high-tech jobs for citizens across all of New Mexico. We have the natural and intellectual resources to realize the vision of this plan. It is now up to us to act to carry out the recommendations made in the plan.

2. Basis for the Plan

New Mexico is rich with opportunities that provide the basis for moving the State to the forefront in innovation and TBED. It has tremendous potential for producing renewable energy (primarily wind and solar) along with excellent prospects for large-scale production of biodiesel. We have a remarkably strong and robust basic research and development foundation, driven by more than \$6.0 billion of annual Federal investments. We have all the ingredients necessary for New Mexico to become a national leader in innovation and technology-based economic development. What is now required is a plan that effectively harnesses these resources and integrates our efforts to turn this enormous potential into reality.

2.a. Purpose of the Plan

The New Mexico Science and Technology (S&T) Plan was developed as a roadmap rather than a vision of what we would like to achieve. While it does lay out the strengths of existing technology and suggests synergies with emerging technologies, it is meant primarily to provide guidance to the State by identifying a proposed set of paths for New Mexico's private and public sector to further develop current S&T capabilities and create new ones that will move New Mexico to the forefront in innovation and Technology-Based Economic Development. In addition to identifying opportunities, the Plan provides recommendations for an enduring and sustainable process that will enable us to:

1. implement the steps required for New Mexico to become preeminent in several, new, important technology sectors;
2. support the development of new, local, technology companies;
3. retain existing companies, patents and IP in the State;
4. recruit non-New Mexican technology firms to the State;
5. grow the State's workforce through the creation of commercially-relevant technology-based curricula at both the intermediate and college level;
6. stimulate investment in rural as well as urban New Mexico.

National Rankings

New Mexico ranks 1st in per-capita PhD scientists and engineers

New Mexico ranks 2nd in R&D intensity.

New Mexico ranks 2nd in Federal Laboratory and Campus funding

New Mexico ranks 6th in science and engineering graduate students.

New Mexico has over 1,000 high-tech companies and ranks 11th in R&D.

New Mexico high-tech industry accounts for over 45,000 jobs with an annual payroll of over \$3.0 billion with average annual salaries of \$47,665.

2.b. Goals of the Plan

The overarching goal of this Plan is to coordinate and integrate State investments in technology development with the Federal investments in basic research through technology maturation to commercialization. This will drive strong growth of a technology-based economy in New Mexico resulting in the creation of high-paying, high-tech jobs for New Mexicans across the entire state.

It is the remarkable intellectual assets at our national laboratories, universities, and high-tech businesses that differentiates New Mexico and provides the basis for us to significantly expand in the knowledge economy. Since New Mexico has a small population and a smaller economy than many other states, we must carefully prioritize how we use state funding for innovation. Any investment made must provide significant return to New Mexico in economic and workforce development and address important issues in the State in energy, water, environment, health, and other key areas. This Plan provides the basis for determining priorities in the five cluster areas defined. Those priorities are not meant to be an intrinsic comparison of the relative merits of one cluster area over another. Rather the priorities are determined primarily by market opportunities and by the urgency with which particular issues of importance to New Mexico must be resolved.

The second overall goal is to increase the amount of commercially-relevant research and development and seed capital/venture capital funding to create a strong platform for technology-based economic development to take root and have the financial means to grow and compete. This provides the means to grow our technology-based economy through the recruitment of out-of-state companies, the creation of new in-State ones (from commercialization of patents and IP), and retain current S&T companies (to stop *technology bleed* to other states)

Given the high level of Federal investment in basic R&D in New Mexico and the growing level of venture capital (VC) in the State (including the investments made by the State Investment Council), the greatest need is in the area of technology maturation. This is not unique to New Mexico, but is widely recognized as a problem for R&D businesses to cross the “valley of death” that exists between the point of proof-of-principle for a new technology to the developmental stage at which VC firms would be interested. It is essential that we find a way to help close this critical gap. The processes proposed in this Plan for State investments in technology development are aimed at providing a bridge between early-stage R&D and commercialization. Additional detailed recommendations can be found in *Growing New Mexico’s Clean Tech Economy: Strategies to Strengthen Technology Commercialization*, released in September 2010. While focused on the energy, environment and water cluster, the recommendations of this report apply broadly to all five clusters.

The third overall goal of this Plan is to recommend ways to effectively support Science, Technology, Engineering, and Mathematics (STEM) initiatives in New Mexico. This is critical if we are going to develop the highly skilled workforce that is required for the TBED this Plan will create. While each of the working groups (described below) was charged with providing recommendations for support of STEM education in their areas, we also created a separate

Education/workforce Development Working Group tasked with considering statewide approaches to supporting STEM education and workforce development.

An important aspect of this Plan is developing a model for how investments should be made through a coordinated and sustained investment by the State based on the State's needs and market pull (with some technology push). The model developed here is transparent and meets all the criteria for success. An important part of the Plan is that it provides accountability, metrics, and return on investment.

As stated in the Executive Summary, the State's S&T Plan is meant to be a *roadmap*, indicating the paths New Mexico should take to reach its destination of increasing long-term sustainable high-wage employment; stimulating new, high-tech company growth and expansion and retention of existing New Mexican companies. Following this roadmap will require a steadfast commitment and belief that the decisions to be taken are sound and timely. Implementing those decisions will require resolve, cooperation, coordination and communication by the stakeholders.

2.c. Development of the Plan

The elements of this Plan were developed by seven working groups that obtained input from a wide variety of sources. Five of those groups are discipline-oriented in areas of S&T strength in New Mexico. Those groups focused on opportunities in Aerospace, Bioscience, Energy/Environment/Water, Information Technology, and Nanotechnology. There were also two cross-disciplinary working groups that dealt with crosscutting issues in economic development and education/workforce development. The input from these working groups was consolidated by a core team that included representatives from the State, economic development groups, universities, and the national laboratories.

This Plan has been prepared following interviews and roundtable conversations with science, technology, academic, business and financial professionals across the state. It has been formulated by integrating input from all of the above-mentioned groups. The Plan's recommendations are based on that input and on a survey of the current S&T capabilities of New Mexican companies and institutions as well as on an assessment of the level and sophistication of technologies now in use in the State. In addition, the plan draws on several historical documents that addressed various aspects of a State S&T Plan, for example in the area of hydrogen, biotechnology and micro/nanotechnology.. This Plan provides information on possible individual projects as examples of the opportunities that exist in New Mexico. It does not, however, address funding for individual projects or potential private sector partners. Instead, it provides an assessment of the likely directions technology will take (based on market needs and forces); the likely funding required; and the commercial potential. Most importantly, it provides a process to respond to those opportunities, and the mechanisms that are proposed include a process for review of individual projects and partners.

In the following sections, we will address the opportunities that exist or could be created in New Mexico that could serve as the basis for strong TBED. In each discipline area, we provide an overview, followed by an analysis of opportunities and issues. Recommendations for the path forward are also provided in each area. We will then present the crosscutting issues in economic

development and education/workforce development. Finally, we will present a proposed process for realizing those opportunities.

2.d. Science, Engineering, and Technology Strengths

New Mexico is a national leader in Federal support for basic and applied research. This is largely due to the presence of two national laboratories, military research facilities, and research universities located in the State. In addition, over the last several years, New Mexico has worked successfully to significantly increase the amount of venture capital in the State. As a result, we are well positioned to draw on our resources:

New Mexico ranks second in the nation in R&D intensity

New Mexico ranks second in Federal laboratory/campus funding

New Mexico ranks second in Federally performed R&D expenditures per capita

New Mexico has a planned commitment of more than \$200 million in state funds to be invested with resident venture capital firms. The total fund capital of New Mexico residents VC firms is over \$1.1 billion. Over a dozen VC firms are located here and the number of firms is increasing.

New Mexico has over 1,000 high-tech companies and is ranked eleventh in the nation in R&D.

New Mexico high-tech industry accounts for over 45,000 jobs with an annual payroll of over \$3.0 billion with average annual salaries of \$47,665.

New Mexico ranks first in PhD scientists and engineers as a percentage of the workforce and sixth in the nation in science and engineering graduate students.

Following the creation of the national laboratories and the location of military research installations in New Mexico after World War II, five core areas of R&D strength have emerged in the State. In the following sections, we describe the resources and opportunities available in each of those five areas and discuss what is necessary to effectively use them to stimulate the growth of sustainable, high-wage industries and businesses as well as satisfy their workforce requirements.

2.e. Competition from other states

After reviewing science plans from several other states, we found that wherever a single entity was formed to fund new commercially-viable technology, coordinate the state's grants and monitor R&D projects, the experience was almost universally positive. Economies of scale were achieved by bringing together seemingly disparate elements of the states' S&T activities under one operating entity.

According to a study done by the Kauffman Foundation and the Information and Technology & Innovation Foundation entitled, "The 2007 State New Economy Index," New Mexico ranks 33rd in overall ranking among all 50 states. The study used 26 indicators divided into five categories: knowledge jobs, globalization, economic dynamism, transformation to a digital economy, and technological innovation capacity. There were only three western states among the top ten ranked states: California (#5), Colorado (#9) and Washington (#4). All the remaining seven of the top ten were eastern seaboard states. The highest-ranked state was Massachusetts, which invests 5% of its state budget in R&D. With its concentration of software

companies, hardware and biotech firms, not to mention its world-class universities, Massachusetts enjoys a significant advantage over the competition.

Other states like Colorado have more in common than just their high-tech firms; they have a high concentration of managers, professionals and college-educated residents working in knowledge jobs. With one or two exceptions, these states' manufacturers tend to be more geared toward global markets both in terms of export orientation and the amount of foreign direct investment. According to the study, "The IT revolution gives companies and individuals more geographical freedom, making it easier for businesses to relocate or start up and grow in less densely populated states farther away from existing agglomerations of industry and commerce."

Venture capital (VC) continues to be one of the critical factors for states' success. Venture-backed firms were an important source of national job growth, adding 600,000 jobs between 2000-2003 (6.5% increase), while overall employment at private firms decreased by 2.3%. The study said that, "The majority of investments continue to take place in a handful of traditionally strong states. In 2005, 79% of investments went to the top ten states, up from 69% in 2000."

The top five states for venture capital as a percentage of worker earnings in 2007 were: Massachusetts, California, Washington, Colorado and Utah, which tracks closely with the level of innovation and technology development that those states have supported. While New Mexico has strong VC growth, the total dollar amount of VC investment is still small. By supporting late-stage commercializable R&D through Technology21, we can give New Mexico a distinct advantage in attracting VC investments.

The bottom line is that those states that have enacted programs similar to Technology21 have reaped the benefits and are now among the highest performing states in the country.

2.f. A critical success factor: Time

Timing is one of the most obvious factors in achieving success, but there are a number of factors that have created a window of opportunity for New Mexico:

- The global economy is investing in high-tech business at unprecedented levels. This is driven in large part by energy demand and production.
- Our package of business incentives makes us an attractive investment site for new technology-based companies.
- Our 'critical mass' of R&D at the Federal labs and at our research universities is a very strong draw for businesses to locate here.
- Our Federal labs and universities are focusing more strongly than ever before on technology transfer.
- We have strong Congressional, executive, and legislative leadership.

3. The Five Innovation Clusters

3.a. Aerospace

Description

The State of New Mexico is at the forefront of a burgeoning but still nascent aerospace industry. State and Federal technology development initiatives are dispersed throughout the State and are under the auspices of many funding agencies. Key clusters within aerospace are the photonics and satellite industries.

New Mexico has a strong tradition of performing advanced space research, and one of its main strengths is its diverse character. One of our main weaknesses, however, is the general lack of focus on the interrelation and collaboration of such research. There are numerous related technologies that are tied together (aerodynamics, small satellite development, space situational awareness and control, space electronics, propulsion, etc.). However, no top-level technology roadmap or organization exists that would help coordinate this journey toward to a coherent aerospace business plan. An organization such as a clearinghouse would permit entrepreneurs both inside and outside New Mexico to obtain the necessary data and business intelligence on which to base their business decisions.

The State receives significant federal funding through the Department of Defense (DOD) in Aerospace through the Air Force Research Laboratory, Space and Missiles Center, and the newly established Operationally Responsive Space Office. However, over 60% of the funds entering the state through these organizations leave the State to industries outside of New Mexico. Efforts to attract small, medium and large space industries to establish here by the Phillips Technology Institute have met with limited success. When assessing the issues, the main obstacle is the lack of workforce available to the relocated industry through the local universities as well as the lack of aerospace education programs necessary to continually develop and maintain their workforce.

There are opportunities, however. The 2006 Base Realignment and Closure (BRAC) Commission determined that 210 Air Force Research Laboratory positions at Hanscom Air Force Base will be moved to the Kirtland Air Force Base location. These positions are part of the Space Vehicles Directorate in the Battlespace Environment Division. New, state-of-the-art facilities will be built to accommodate them. Current personnel will be relocated, and highly technical positions will need to be filled. Currently, the education programs in the State do not specialize in the space sciences and space environment. The function being moved is a critical national capability and is the nation's center of excellence in space weather. Again, a key aspect to the

New Mexico receives significant federal funding through the Department of Defense through the Air Force Research Laboratory, Space and Missiles Center and the newly established Operationally Responsive Space Office...

However, over 60% of these funds leave the State to industries outside New Mexico!

success of the move is having the right education programs in aerospace engineering and space sciences.

Advisory Group Recommendation - Strengthen and develop relevant aerospace and space science education programs.

The State should focus on strengthening and developing much-needed aerospace and space science education and training programs for the three State research universities. By bolstering and supporting these programs, we would be better positioned to attract and sustain aerospace related businesses to the State. It is imperative that companies have a skilled workforce as well as excellent school systems.

The need for a full spectrum Aerospace Engineering Department must be addressed. New Mexico State University has made a great start on an Aerospace Engineering program, but still needs support. A multi-institutional plan for aerospace education should be pursued where strengths from each school can be optimized. This is definitely a role for the State to facilitate and make happen. Without the appropriate education and training of students, professionals and technicians, the State will not be able to convince aerospace businesses to locate in New Mexico or remain here.

Other areas of State expertise include reconfigurable systems that cover a large effort in reconfigurable computing for space applications, such as the Field Programmable Gate Arrays (FPGA) and radiation hardened electronics for space applications. UNM has several experts who cover the areas of computer engineering, control systems, signal processing, optical and microwave systems (all integral components to any telecommunication system including space). Finally, UNM has an internationally-recognized effort in the area of plasma science with applications to space weather and communications.

Advisory Group Recommendation - Establish a public-private clearinghouse to disseminate information.

In addition to emphasizing the need for enhancing space education, the establishment of a public-private partnership should also be pursued. This type of arrangement could serve to unify, influence, and direct the development of the aerospace industry in New Mexico. This partnership could assess the industry's needs in order to grow the aerospace industry and develop a unified plan for business development and education programs for the State. A clearinghouse is also needed for private aerospace companies to participate in - and gain access to - funded research such as federal funds through Small Business Innovation Research (SBIR) program funds. This business model should include a mechanism that would quickly transfer space technology into the private and public sectors to facilitate TBED.

Many programs exist in the Aerospace sector. They are located at: Kirtland Air Force Base, Air Force Research Laboratories, Sandia National Laboratories, University of New Mexico, New Mexico State University, New Mexico Tech, Los Alamos National Laboratories, Holloman AFB, White Sands Missile Range, NASA White Sands Test Facility, Spaceport America, Space Development and Test Wing, Operationally Responsive Space Office, Eclipse Aviation, and other aerospace industry partners. The New Mexico Aerospace Capabilities Assessment lists the

extensive aerospace capabilities available within the state from the federal laboratories, industry and universities.

Spaceport America



The New Mexico Spaceport Authority is building the world's first purpose-built inland, commercial spaceport, Spaceport America, in southern New Mexico.

The complex will be capable of accommodating the activities of both vertical and horizontal takeoff space launch vehicles. It will serve as the base for pre-flight and post-flight activities with a modern spectators' center. It will be a catalyst for regional economic development opportunities and be a key component in the State's effort to attract space-related business here and create partnerships with third parties to develop support facilities for the Spaceport.

The U.S.-based Virgin Galactic, part of the Virgin Group founded by British entrepreneur Sir Richard Branson will be the Spaceport's anchor tenant. Virgin Galactic will locate its primary launch and operational activities and its worldwide headquarters in New Mexico. The Virgin Galactic connection coupled with our unique location advantages, expert technical support from White Sands Missile Range, and a long local heritage of space-related activity, all help New Mexico positioned itself as a pioneering leader of the new commercial space industry.

Spaceport America aims to become a world-class tourism destination. It has been designed as a sustainable development that will serve as an international model of environmentally sensitive site design and construction. The Spaceport is intended as a catalyst for dramatic economic development and one of the primary objectives of the project is to attract space-related and other high-tech industry to the state, with the goal of creating R&D “clusters” in space commercialization, pharmaceuticals, and renewable energy sectors. Several private companies involved in space vehicle design, fabrication, testing and R&D have already signaled their intent to move or expand operations to New Mexico upon completion of the Spaceport, and dozens more, including governmental entities such as NASA and Kirtland AFB ORS, have expressed strong interest in doing the same.

Even in its infancy, the global commercial space transportation business is currently valued by the FAA at over \$139 billion, and by welcoming the next phase of this emerging industry to the State of New Mexico, the region around Spaceport America has the potential to become this century’s next world-class high tech cluster. According to an NMSU study, Spaceport America is estimated to generate more than 2,250 jobs and over \$1.0 billion in related economic activity for New Mexico in the first five years of operation.

The economic impact from tourism associated with Spaceport America and related regional attractions will additionally facilitate the development of leisure and hospitality jobs and supporting infrastructure. Also worth noting is that even before becoming operational, Spaceport America will provide nearly \$200 million dollars of investment in New Mexico and more than 500 construction jobs simply through the build out alone.

Spaceport America will be a diversified business with distinct lines of activity that act synergistically together and rely on the entire New Mexico aerospace industry to accomplish successfully.

[Advisory Group Recommendation](#) - Spaceport America should be a unifying link in a broad-based state aerospace industry strategy encompassing all state aerospace assets dedicated to driving economic activity in New Mexico.

Aerospace Industry Association statistics indicate that 60% of the aerospace industry workforce is 45 years old or older, highlighting the impending aerospace labor crisis as the scientists and engineers drawn to the profession during the 'Space competition and 'Cold War' retire. Education and workforce development are essential to Spaceport America’s two-fold plan of inspiring the next generation of Americans to pursue studies in science, technology, engineering, and math (STEM), and of helping to create domestic high-tech, high wage career opportunities for New Mexican youth. In order to help supply the incoming businesses with a skilled, ready workforce, NMSA intends to partner with the foremost educational institutions in the state, including all three major research universities, UNM, NMSU, and NMT, on methods to bolster fledgling aerospace departments and to increase enrollment in STEM disciplines.

[Advisory Group Recommendation](#) - Strengthen and develop relevant aerospace and space science education programs.

(See Aerospace appendix for more detailed information.)

3.b. Bioscience and Health

Description

The bioscience and health cluster is perhaps the broadest and most inclusive of all the clusters discussed in this Plan in that it covers health sciences, genomics, and touches the energy and environmental sectors as well. Its relationship to nanotechnology is also expected to be significant in the years to come as each technology crosses the other's R&D boundaries. New Mexico's bioscience sector is characterized by a great diversity of capabilities and is poised to make significant contributions in a wide range of areas with the potential to dramatically impact bioeconomy industries. Some of those industries are: bioenergy, agriculture, animal health, personal healthcare (new drug discovery, neuroscience, cancer self-immunization technologies), biothreat reduction, and the development of new biologically inspired and assembled technical materials of unprecedented strength per unit mass.

The sector has been growing due to major investments within the State's universities, research centers, and national laboratories. This growth and strength within New Mexico, will require focused investments for future acceleration and growth in our bioeconomy.

It has been shown that well placed strategic investments in research and development initiatives, e.g., university centers, leaders in key areas, and state-of-the-art infrastructure can evolve into new jobs and gains with five to ten times multipliers. The State of New Mexico has the opportunity to affect the outcome of bioscience and biotechnology research and development and therefore, the overall standing of the State in commercial investment and federal grants.

What follows are some opportunities for key investments for the State in: 1) Economic Development; 2) Energy, Environment and Water; and 3) Health initiatives. The portfolio represents a broad set of objectives with investment requirements in key infrastructure and personnel in the State's universities and major research centers. These investments should translate into further industrial collaborations and investments in the State, new business startups based on New Mexican-owned IP, improved health capabilities and establishment of the State in the bioenergy corridor.

On a national level, the bioscience sector remains strong. It currently employs 1.2 million people in the U.S. It has an annual growth rate of 2.9% in research, testing, and medical laboratories projected through 2014. Similarly, the drug and pharmaceutical industry projects an annual growth rate of 2.6% through 2014. In New Mexico, bioscience-related jobs are high-paying with an average salary of \$51,700 compared to \$30,000 in the rest of the private sector. Furthermore, the number of jobs grew 25% from 4,700 to 5,900 from 2001 to 2004.

Bioscience employs 1.2 million people in the USA. It has an annual growth rate of 2.9% in research, testing and medical laboratories, projected out to 2014.

In New Mexico, bioscience-related jobs pay an average of \$51,700 compared to \$30,000 in the rest of the private sector.

There are national programs that address our energy health and that offer specific approaches to mitigating our energy dependence on liquid fuels. Our physical health is also impacted by pandemic diseases, and there is already considerable work being done on both a national and international level with significant federal funding. More is needed, however. The bioscience industry is considered a generally clean industry that fits well within the environment of New Mexico. It is also able to provide alternative approaches to ground water utilization through the use of nontraditional water supplies. This is a very important issue as we project a decrease in the Oglalla aquifer of 25% by 2030.

We have a number of large institutions offering strong programs and resources within this sector, including: research universities like UNM, NMSU, and NM Tech; two, state-of-the-art research institutions, NCGR and the MIND Institute; and our national laboratories, Sandia and Los Alamos. These institutions have created a wealth of research capability that is nationally and internationally recognized. Research involving genomics is driving efficient biofuel production and detection and therapeutic interventions for agriculture and public health applications. These institutions also conduct research in pandemic disease detection, modeling and mitigation; energy and water applications; and neural imaging and the understanding of brain functions.

Finally, the New Mexico Bioscience and Biotechnology Association (now NMBIO) has more than 100 participating companies, providing a strong base for connecting to the biomedical industry for commercialization of technologies developed within NM.

Advisory Group Recommendations -

Our recommendations for future investments in the bioscience and health sectors would follow our plans for growth in economic development, energy diversity, environmental (and water) protection; and public health.

1. In the areas of Energy, Environment, and Water, we fully support the alternative energy project to develop biofuels from microalgae through the construction and operation of pilot scale commercial demonstration algal biofuel process. The use of microalgae as a biofuel feedstock has the potential to make biofuels a viable replacement for significant quantities of fossil fuels, thereby supporting state initiatives and state laws, reducing American dependence on foreign oil, and reducing net global CO₂ emissions. It could also provide the State with a significant return on investment.

2. We recommend supporting the New Mexico Bioeconomy Infrastructure Initiative (NM-BII), to be led by the New Mexico Consortium and its Institute for Advanced Studies in close collaboration with the Biosciences Division of Los Alamos National Laboratory. We expect it to catalyze rapid economic development by leveraging existing innovation in the State by establishing a technical infrastructure focused exclusively on the needs of bioeconomy industries. This initiative would start by developing an economic agro-business “template” for rational alternative fuel infrastructure investment and the viability of investments in other biotechnology infrastructure.

3. We advocate for the creation of a New Mexico Center for Biotechnology Enterprises to assist with commercializing the new biotechnologies being created in the UNM Clinical and Translational Science Center and other components of the UNM Health Science

Center. This center will provide a significant initiative in improvement of healthcare technologies and development of new biotechnology commercial efforts within New Mexico.

4. In Public Health, we recommend the completion of construction and build-out of facilities for the New Mexico Center for Isotopes in Medicine (NMCIM – a consortium of UNM HSC, LANL, Lovelace Respiratory Center, and several companies) to position the State as a prime competitor for attracting the \$1.0 billion plus radiopharmaceutical industry in the U.S. In partnership with private industry and the UNM Cancer Research and Treatment Center, the NMCIM would build-out a short-lived positron production facility (cyclotron), a state-of-the-art radiopharmacy, and a novel imaging and therapy suite that would directly benefit the health of New Mexicans and create jobs.

Other areas worth supporting are:

Genome New Mexico, which aims to enroll 20,000 New Mexicans in a bio-repository to carry out genome sequencing studies to identify causal variants associated with the top one hundred diseases and traits in New Mexico populations. Diagnostics and therapeutics would be developed with the goal of creating one or more personalized medicine companies in New Mexico. This project will provide solutions to the major healthcare problems of New Mexico's citizens, creating a vibrant biotechnology industry in the State, and substantially enriching the research ranking of our research universities.

The New Mexico Center for Research on Emerging Infectious Diseases to integrate and supplement the existing research strengths at the major research institutions in the State through investigation of environmental drivers of disease emergence; monitoring the evolution of designated populations of pre-pathogens; identifying and monitoring routes of pathogen introduction; and using data from the field studies to develop novel control strategies such as vaccines, antivirals, antifungals and antibiotics. The center would positively affect New Mexicans through improved health, increased security of the agricultural and recreation industries, increased federal funding of research, and enhanced technology transfer. Finally, we would support further development of capabilities at the Mind Research Network (MRN), improving the diagnosis of mental illnesses, brain disorders, and brain injuries. This would require funding the recruitment of leaders in neurodiagnostic and neuroimaging fields who would help build upon MRN's core competencies of research and training, ultimately making New Mexico one of the largest neuroscience research hubs in the world as well as a leader in neurodiagnostic research.

The development of the collaborative virtual environment called Flatland under the program called Project Touch (Telehealth Outreach for Unified Community Health), which is developing visualization and virtual environment tools employing scenarios as virtual models to make learning of critical concepts relevant and translatable to real-life application. These simulation systems will allow medical personnel and teams to train within a virtual environment.

(See Bioscience appendix for more detailed information.)

3.c. Energy/Environment/Water

Introduction

Energy, Environment, and Water are inextricably tied together in this Plan and in our world. This is clearly demonstrated when you look at the production of fossil fuels, where more water is extracted from the ground than fuel and where the impact on our environment is significant. Renewable fuels also impact our flora and fauna as they often require enormous amounts of water. Our use of water affects our health as more than 90% of diseases are waterborne. It also affects our economic growth as business often competes with new residential users as communities expand. Finally, no environmental, energy, or water plan can survive the 21st century without conservation.

Addressing Rising Energy Costs

In the past, we have been able to compete because of our low labor costs, low cost of living, Federal government revenue, and a vast storehouse of energy reserves, among other factors.

Our future will be different. All costs will rise, especially those associated with energy and transportation. Growing our technology will become more expensive with each passing year. As we see this year, our budget surpluses from fossil fuels are not sustainable. We will switch from being an oil-exporting state to becoming an oil-importing state in 2015. The demands from our society for more energy, improved infrastructure, more evenly distributed healthcare and better social services will be impossible to meet unless we act now to grow our economy.

To address rising costs, we must develop economically competitive sources of renewable clean energy. Technologies emerging from our labs and universities have the potential to revolutionize the energy sector. Growing algae in the desert using our untapped sources of saline water could make New Mexico a major provider of transportation fuels for the country. Our immense solar resources, coupled with new technologies being developed in New Mexico could position us to be the most important state for solar energy. The New Mexico Green Grid Initiative can make New Mexico a national leader in implementing a Smart Grid with renewable energy. While we have the natural resources and scientific resources necessary to make this happen, we also need to provide the means to transition these possibilities into reality. Technology21 will do just that.

On energy: If no viable alternatives to traditional energy production are found, by the year 2015, New Mexico will cease being a net exporter of energy, but instead be transformed into a net importer of energy.

On water: Our use of water affects our health as more than 90% of diseases are waterborne.

On the environment: We are working for a clean energy future in which greenhouse gas emissions are halved by 2025.

New Mexico's Energy Present

New Mexico enjoys significant fossil fuel resources (coal, gas, and oil) along with strong potential for renewable energy including some of the highest quality wind and solar resources in the country. Additional renewable energy resources include geothermal and biomass along with the potential for hydrogen fuel cells and the hydrogen economy, and, to a lesser degree, hydro. In addition, New Mexico has large reserves of uranium ore. While there are no nuclear power plants in New Mexico, the Public Service Company of New Mexico (PNM) owns a share of the Palo Verde nuclear power plant in Arizona. In addition, a uranium enrichment plant is under construction in southeastern New Mexico.

New Mexico's Energy Future - Energy and Environment

New Mexico has an opportunity to build a clean energy future for our State. Our Congressional delegates are supporters in promoting renewable energy here, and in the entire USA. Home to two Department of Energy (DOE) national laboratories, several universities and additional public and private research facilities, New Mexico has substantial intellectual and research capabilities. We are engaged in developing innovative technologies in clean coal, biomass, solar, and carbon sequestration. We have the physical, political, intellectual, and financial resources to move New Mexico into a national leadership position in energy production.

A principle tenet in achieving these goals must be energy efficiency and conservation. Thus, we recommend an statewide goal of 40% reduction in non-transportation energy use per capita from 2005 levels by 2025.

By maintaining environmental stewardship we can move to an integrated system of recycling and use of organic waste materials for energy production. Thus, we recommend development of a recycling program in New Mexico with a goal of recycling 40% of all non-organic materials and producing energy from 40% of waste materials by 2030.

Clean Energy Production

In order for us to achieve a clean, sustainable energy future for New Mexico we must develop new sources of clean and renewable energy. New Mexico is, in fact, already energy independent in electrical power, as we produce more electricity than we consume. A goal for New Mexico is to take an “all of the above” approach to developing advanced forms of energy.

Our first recommendation for clean energy production in New Mexico is to produce as much electricity by 2025 from advanced energy sources as we presently use from fossil fuels.

Our second recommendation for clean energy in New Mexico is to develop and implement cost-effective storage of wind and solar energy with a capacity factor of 80% by 2030.

Advisory Group Recommendation - Establish and fund the TICenter with a primary focus on achieving a clean energy future for New Mexico.

Transition from Fossil Fuels to Biofuels

New Mexico is a significant producer of transportation fuels, and as with electrical power, we are a net exporter of these fuels. Natural gas production in New Mexico is relatively flat and will become increasingly important to New Mexico's energy future during the transition to renewable fuels. This is particularly true since natural gas is a much cleaner fuel than coal, gasoline, or diesel. However, our oil production in the State is declining while total usage is increasing. Based on current trends, we estimate that New Mexico total usage will equal production in 2015. Thus, our challenge is to quickly transition to clean and renewable forms of fuels.

Our first recommendation for transportation fuels is to reduce our per capita usage of gasoline and diesel by at least 10% from 2005 levels by 2012 and 20% from present levels by 2020.

Our second recommendation for transportation fuels is to switch from petrodiesel to 100% use of biodiesel in New Mexico by 2030.

Achieving the goals laid out above requires the development of new technologies in energy production. On the Federal side, there is support for hydrogen fuel cell development. In 2007 the State created an Energy Innovation Fund designed to drive late-stage, precommercialization energy R&D into the commercial sector. This effort has been focused largely on algal biofuels, concentrating solar power, and conversion of dairy waste into electricity and could be expanded to include other areas such as hydrogen fuel cells, photovoltaic cells, and geothermal. This program has been highly successful - a state investment of \$4M to date has resulted in venture capital investments of almost \$50M. To drive the transition to a clean energy economy, we would recommend that the Energy Innovation Fund be significantly strengthened over the next five years to support the growth of new renewable alternative energy technology in the State and to strengthen the link between clean energy production and conservation.

[Advisory Group Recommendation - Increase support for the Energy Innovation Fund with particular emphasis on supporting algal biofuel efforts in New Mexico.](#)

The New Energy Economy in New Mexico

New Mexico possesses extraordinary potential for wind and solar power generation along with lesser potential for geothermal and biomass energy. If sufficient capital investments were made, New Mexico could export large amounts of renewable energy by 2025 (primarily in the form of electricity from wind and solar energy) to the primary markets of Arizona and California.

We recommend as a goal for a clean energy economy in 2025: Provide 1000 MW of renewable energy electrical power for export to other states by 2020 and 3500 MW of renewable energy electrical power for export to other states by 2040. By developing 3500 MW of exportable renewable energy by 2040, New Mexico would be able to meet a significant part of the projected demands for import of renewable energy from other states in the West.

Green Grid

The New Mexico Green Grid Initiative is the first effort in the United States to take a full systems-integration approach to implementing the next-generation smart grid with renewable energy sources in moving towards energy independence for the Nation. While many efforts are

underway to develop smart appliances and control systems, energy storage, renewable energy production, transmission and distribution, none of these efforts joins all aspects of what is required to implement a full, large-scale Green Grid system.

Technology development is crucial to the Green Grid Initiative as it provides the basis for clean energy export and manufacturing and enables the build out a full-scale Green Grid in New Mexico. This would provide an opportunity to grow New Mexico businesses and attract new businesses to the State to manufacture the equipment required for the Green Grid. This would result in the creation of high-paying, high-tech jobs for equipment manufacture and also for its installation and on-going operation. As we install additional electricity generation from solar, wind, and possibly geothermal and biomass, we would optimally position New Mexico to grow our economy by exporting clean energy to markets in the Southwest and West.

The ultimate goal of the New Mexico Green Grid Initiative is to transition New Mexico from a fossil fuel based economy to a clean energy economy with a focus on renewable energy. The impact of the New Mexico Green Grid Initiative will be national, by providing a flexible, scalable architecture that can be used in all 50 states. In this way, New Mexico will be a transformation leader in to an advanced energy economy and the prosperous future that brings.

[Advisory Group Recommendation - Implement the New Mexico Green Grid Initiative as a primary initial focus of the TICenter.](#)

New Mexico's Water Future

Water is a critical issue for the future of New Mexico. While we are primarily an agricultural state, demand for water is increasing as our urban areas are growing at about 1.6% per year. The drought of recent years, together with climate variations, highlight the likelihood that the Southwest has enjoyed unusually high levels of precipitation during the last several decades. As a result, our interstate water compacts are based on what may be *higher-than-average* levels, and we are likely facing a serious and enduring water shortage in the near future as a result of these factors and our projected growth.

In addition to our water supplies, we also face quality issues with our water. Contamination of both surface and ground waters is an issue all across the State. This contamination ranges from high levels of total dissolved solids (TDS) that impact marine life (in particular endangered species) to high levels of arsenic in ground waters, to biological contamination due to organic wastes and effluents.

Research on water issues, including data collection, analysis, and modeling and simulation of water issues using the State supercomputer Encanto are vital components of addressing New Mexico's water future. Development of new technologies to address those issues is of equal importance, if not even greater, importance.

Promoting conservation and the efficient use of water

At present, even during periods of average water supply, demand in many parts of the State would exceed supply if all water rights and permits were fully exercised. As New

Mexico's population grows and demands for water increase, more conservation and efficient use of water will be necessary to meet the State's present and future needs for water. Thus, New Mexico's water conservation programs must be strengthened and adequately funded.

Water Quality

About 90% of New Mexico's population depends on ground water for drinking, and it is the only source of potable water in many areas of the state. Therefore, protection of ground water is important for public health and welfare. The quality of ground water in New Mexico varies widely. Mountain aquifers, recharged by recent rain and snow melt, often yield high quality water. A tremendous amount of fresh water resides in the basin-fill aquifers along the Rio Grande, stretching from Colorado to Texas. Ground water in New Mexico, however, often contains naturally occurring minerals that dissolve from the soil and rock that it has flowed through. Some ground water in the southern part of the state is too salty to be used for drinking. High levels of natural uranium, fluoride, and arsenic occur in various areas around the state. Because all water eventually moves through the entire water cycle, pollutants in the air, on land, or in surface water can reach any other part of the cycle, including ground water. The shallow sand-and-gravel aquifers of the river valleys are most vulnerable to contamination. Septic tanks are currently a major source of contamination in these aquifers.

Implementation Strategies

Advanced technical and scientific approaches to water resource management, supply assessment, measurement, alternative water supplies, enhanced water production and salvage, and water quality and treatment will be necessary to meet the present and future needs of the State. The resources of public and governmental research bodies can be harnessed to assist the State in meeting the present and future needs of New Mexico.

Advisory Group Recommendation - Support the Water Innovation Fund

The Water Innovation Fund is being established to drive innovation of clean water technologies in New Mexico. We expect that the State will benefit through the increased production of usable water here, including: efficient use of produced water; cost-effective desalination; increased precipitation through weather modification; improved techniques for cleaning up water; improved water conservation technologies; reduction of evaporative losses of water; providing technologies to deal with community water issues and meeting the water needs of the state in a manner that retains our agricultural use of water while also allowing urban development.

(See Energy, Environment, and Water appendix for more detailed information.)

3.d. Information Technology

Description

Scientific supercomputing is rapidly becoming an essential element of innovation and competitiveness. Computer-based methods and the solutions they bring now play a central role in all areas of economic development, education, and research. In fact, the states that choose to move their science and technology forward rely heavily on computational analysis, modeling, and simulation to stay competitive. Supercomputing is also essential to New Mexico's success in the education field. To grow our students' science skills, we must offer them 21st century tools that will enable them to pursue their career ambitions in a highly information-intense world.

By setting up the New Mexico Computing Applications Center (NMCAC or the 'Center'), we have catapulted the State into the top rankings of states with supercomputing capabilities. (In fact, New Mexico now has the fastest non-Federal computer in the world.) The Center will provide a nationwide fabric of scientists and institutions - including leading-edge industrial partners - that will work together (in New Mexico) on issues important to our State and the Nation.

The vision of the Center is to create high-paying jobs and new job opportunities while training and equipping New Mexico's youth to be more competitive for those jobs. This is the only supercomputing center in the country (or the world) whose focus is primarily on driving economic and workforce development.

The Center will be a magnet for business growth. It will elevate our business profile both nationally and internationally. By setting up remote 'gateways' throughout the State, the NMCAC will extend computing capabilities along with 3-D stereo visualization and high-definition video conferencing collaboration across New Mexico. These gateways, which will be set up at universities and colleges (ultimately 40), will enable long distance learning, telehealth, and economic development.

In education, it will connect classrooms and create economies of scale by combining classrooms electronically, thereby allowing small numbers of students around the State to join together and take courses that might not have been possible had the supercomputer not connected the virtual classrooms. Finally, it will also support our educational initiatives while attracting more students into science and technology, thus positioning New Mexico at the forefront of the Knowledge Economy.

Establishment of the New Mexico Computing Applications Center provides a partnership between scientists, institutions, and industry in the State.

It will create high paying jobs and new job opportunities while training and equipping New Mexico's youth to be more competitive for those jobs.

The Center will have a positive impact on rural New Mexico by extending capabilities that will impact education, healthcare, and economic development.

The establishment of the New Mexico Computing Applications Center provides an engine of growth to drive science and high-tech industry in New Mexico. Our state is ideally suited for such a facility due to the existing world-class expertise in scientific computing that exists at our universities, national laboratories and industry. With an initial State investment of \$14M, a 172 Teraflop Altix ICE supercomputer was procured from SGI and Intel in November 2007, at which time it was the third fastest computer in the world. The investment requested from the State over 6 years will provide the basis for self-sustaining operation of the Center, thus moving New Mexico to a position of national importance in commercial applications of supercomputing.

Advisory Group Recommendation - Complete the 6-year funding request to bring the NMCAC up to its full capabilities.



Encanto, the NMCAC Supercomputer

Areas of Economic Growth

A complete market analysis was carried out in conjunction with the University of New Mexico's Anderson School of Business to identify those areas of strength in which New Mexico could compete favorably in high performance computing on a national and international scale. To be considered a target area, it must meet the criteria of having potential paying customers, complex problems requiring supercomputing and a current or developing New Mexico capability.

The three primary focus areas will be on the energy; health, medical, and bio med/tech; and the digital and film media industry. These were chosen for their robust market dynamics and for the resident professional expertise in the state. Secondary markets for the NMCAC reflects needs and strengths in the State of New Mexico. The energy and environment market sector and in

particular alternative energy, oil and gas, water, and electricity transmission hold promise for a high performance computing resource. Other potential markets include nanomaterials, remote sensing networks, and the financial investment sector. In the following sections, we provide some representative examples of high performance computing applications within three of the primary focus areas of the NMCAC: renewable energy, digital media, and genomics.

Renewable Energy

Algal Biofuels

Efforts are underway in New Mexico to determine the economic viability of bio-diesel produced from algae as a major new fuel source for the country. Algae is of interest as it has up to 100 times higher oil yield per acre than any other crop. New Mexico has the assets for growing algae on a large scale: large amounts of unused, flat land; high degree of sunshine; and large, deep saline aquifers. Making bio-diesel from algae competitive with petrodiesel will require genetic engineering of the algae strains. The most efficient way to engineer the algae is through computer modeling of changes to the genetic structures responsible for stimulating algae growth and the amount of oil contained in algal cells. If successful, this could lead to a new multi-\$B clean energy industry in New Mexico.

Green Grid

The goal of the Green Grid initiative is to develop and successfully demonstrate the next generation of commercially scalable electric grid using renewable energy sources such as solar and wind. Modeling and simulation will be central to designing, optimizing and ultimately operating the Green Grid. The State of New Mexico is uniquely poised to tap the expertise of national laboratories and state universities as well as the resources such as the New Mexico Computing Applications Center (NMCAC) to lead these efforts. High performance computing will address critical issues in the areas of modeling renewable energy storage and production, determining optimal routing of transmission lines, simulating electrical use by the consumer, and optimizing innovative control and communication systems.

Digital Media

New Mexico has made an important commitment to expanding the digital media industry. What started as incentives for the film industry has expanded to include an acknowledgment that film is a small part of a much larger and growing media industry. It is also an industry that matches the State's strengths in arts and technology.

The State has attracted several major companies to locate here, and each of them supports digital efforts in post-production and animation. In addition, many smaller companies in the interactive game, simulation, and animation are either here or in the process of moving here. One characteristic of the digital media industry is the need for high performance computing. New Mexico has a long history of involvement with simulation, primarily through Sandia, Los Alamos, and White Sands Missile Range. The field is undergoing revolutionary changes due to the advances in commodity graphics hardware. Simulations that formerly required expensive specialized workstations now use commodity graphics cards whose designs are based on the demands of interactive game users. Consequently, the simulation and game industries have merged, and we see the National Labs being heavily involved in game development.

Advisory Group Finding: Education must be part of any IT planning for digital media.

Unlike the film industry where programs such as the Film Crew Training Program (supported by the State at community colleges like CNM, SFCC) can train people from scratch, the media industry needs a highly educated pool to draw from. Most will be college graduates. Educational programs that will produce the necessary workforce will have to start with K-12.

Healthcare

Within the next ten years, the medical profession will see a revolution with the advent of personalized medicine. This will be based on the ability to carry out sequencing of the genome of individual patients. At present, the cost to sequence an individual is a few tens of \$K and takes a few weeks, but within a few years that is expected to come down to under \$1K and to be done in a few hours. When that is possible, doctors will be able to determine a patient's genetic susceptibility to a whole range of diseases as well as the response of the patient to different drugs. This will allow doctors to be proactive in early detection of cancer and other diseases, as well as the ability to tailor prescriptions to the body chemistry of each patient.

One of the greatest challenges in developing personalized medicine is the ability to analyze the extremely large data sets that result from sequencing the DNA of patients. Each person contains about 30,000 genes with about 3 billion base pairs of amino acids. Variations in the type and location of the amino acids in the DNA determines what a person looks like, their genetic disposition to disease, and their response to drugs. High performance computing is essential in analyzing and decoding the information in the genes. The intellectual property associated with knowledge of which genes are expressed in cancer, learning disabilities, and other health problems that can be genetically based will be a significant economic driver in health care. New Mexico is well positioned with work at the national laboratories, the National Center for Genomics Research in Santa Fe, and the NMCAC to develop the intellectual property for personalized medicine.

Homeland Security

The area of homeland security is one of intrinsic interest in New Mexico, given that this is one of the primary missions of our national defense laboratories. It is also a promising area for economic growth in New Mexico. While some aspects of homeland security fall under bioscience (biothreats) and other areas, much of homeland security issues are connected with information technology:

- Detection of chemical, biological, radiological, nuclear, and explosive threats
- Detection of networks (physical, social, ...)
- Remote sensing of infrastructures (buried structures, ...)
- Secure Border Initiative
- Protection of networks (cyber, electric grid, ...)
- Protection of infrastructures (perimeter security, cyber systems, ...)

The Information Technology aspects of homeland security issues fall generally into two categories:

- Development and testing of electronic sensors

- Computer modeling and simulation

In the first category, significant work is being carried out at Los Alamos and Sandia National Laboratories, Air Force Research Laboratory at Kirtland Air Base, White Sands Missile Range, New Mexico Tech, New Mexico State University, and a number of R&D businesses in New Mexico.

In the second category, significant work is being carried out at Los Alamos and Sandia National Laboratories, and New Mexico Tech.

New Mexico is in a relatively unique position to benefit from homeland security initiatives. New Mexico is one of only four states that share a border with Mexico, we have two national security laboratories, two R&D military installations, Fort Bliss (a test center for Future Combat Systems), and a number of military R&D businesses. As a result, we are in a prime position to translate late-stage military R&D into the commercial sector.

A large variety of data from satellites, networks of sensors, highly specialized detectors, the internet, human intelligence, and other sources result in massive, heterogeneous data sets that need to be analyzed to determine both natural and engineered threats. New Mexico is optimally positioned to develop the capabilities required for this type of analysis with the presence of the national laboratories, military R&D bases, the NMCAC, and R&D businesses in New Mexico.

(See Information Technology appendix for more detailed information.)

3.e. Nanotechnology

Description

Many economists, strategists and policy makers predict that nanotechnology and other small technologies will be the basis for the next economic revolution. These technologies present current and potential commercial solutions for numerous industries — so much so, it is difficult to find even one industrial segment that nanotechnology will not soon impact.

New Mexico could be a world leader, modeling how to leverage nanotechnology and small tech-led economic development. Our State has already undergone a formative period in which we built our infrastructure and developed our investment capacity. We now have world-class scientific and engineering knowledge and research centers. Yet despite many strong efforts, other states and international regions are recognized leaders in the field of nanotechnology. The next step is for New Mexico to leverage its strength to create opportunities in nanotechnology while keeping in mind the weaknesses in our State and the threats of competition from others.

New Mexico is uniquely positioned to take a leading role in nanotechnology and indeed in all small technologies. We are recognized for our world-class scientific and engineering knowledge and as a leading research center, including the Microsystems and Engineering Sciences Application complex at Sandia National Laboratories and the Center for Integrated Nanotechnologies at Sandia and Los Alamos National Laboratories. Largely because of these capabilities, New Mexico is ranked third nationally in R&D intensity in nanotechnology. While these and our nanotech efforts at our universities and businesses are strengths, our weakness is due to the overall loose coordination and disparate missions of the R&D organizations in New Mexico.

New Mexico is in a period where the infrastructural and investment capacity development has been building itself out. This growth has gradually filled in gaps, but not in a coordinated manner. The New Mexico Science & Technology Planning Task Force's Nanotechnology Group is proposing the following solutions, institutions, and programs. Combined with our existing organizations, these efforts will put us in a strong position to effectively leverage our potential:

Advisory Group Recommendation - Establish a State-Level Innovation Center, Infrastructure, and Funding

New Mexico is uniquely positioned to play a leading role in nanotechnology and indeed in all small technologies.

We are recognized for our world-class scientific and engineering knowledge and as a leading research center.

The next step is for New Mexico to leverage its strength to create opportunities in nanotechnology while keeping in mind the weaknesses in our State and the threats of competition from others.



CINT core facility at Sandia National Laboratories

It's vital that the State establish a New Mexico State Technology Innovation Center that oversees our science & technology investments, multi-technology strategy, high technology workforce development and overall science-based economic development coordination. This Center should have oversight over New Mexico State Technology Development programs for businesses and grand challenges; the coordination, collaboration on science and technology marketing and communication - within and without - the State and serve as the agent for the bundling of intellectual property from among the State's Research universities.

Advisory Group Recommendation - Establish a State-supported Small Tech Institute

A Small Tech Institute, linked to a New Mexico nano initiative would work with and through the Technology Innovation Center (as mentioned above). Such an institute would carry out New Mexico specific activities assisting New Mexican Small Tech public awareness, marketing, investment, partnering, commercialization, and workforce development stakeholders to improve statewide communication, collaboration, and networking. It would serve as a place for networking and product development, matchmaking with New Mexican biotechnology, energy, water and environment, and computing technology communities. Additionally, it would connect New Mexico's micro-nano interests with the larger worldwide networks of Small Tech researchers and commercial enterprises to accelerate matchmaking, partnering and investment. It would also initiate and maintain a public awareness and education campaign to inform and build excitement among New Mexico's citizenry about the importance of the Small Technology Revolution. Finally, it would market to and assist in recruiting a workforce from among the public and the State's education institutions and be an agent to help commercialize small technologies from research universities. In order to fulfill this mandate it would require a State-funded endowment for Small Tech economic development.

Given the above considerations, we propose that an initiative be launched in the area of nanoscience and nanotechnology transfer to accelerate the development of reliable, cost effective efficient and renewable energy. The State of New Mexico would establish an initiative for Nanotechnology for Efficient and Renewable Energy (NEARE) that will leverage the large

federal investment in S&T made at New Mexico's federal laboratories Sandia, Los Alamos, and the AFRL, and the state's investment in S&T at its institutions of higher education. The focus of the initiative would be on nanomaterials to achieve greater efficiencies and performance. The development and insertion of cutting edge science and technology would enable a constellation of efficient solutions to the nations energy problems, that will also capture the attention of industry in photovoltaics, solid state lighting, refrigeration and insulation, electricity transmission, and electrical energy storage. The initiative will result in thousands of new jobs for the state.

Some specific projects of the Small Tech Institute could include:

- 1) The creation of a state initiative in Nanotechnology for Efficient and Renewable Energy (NEARE), that would leverage federal investments in S&T in NM based on a nascent state industrial presence in photovoltaics, solid state lighting, refrigeration, and other nanomaterials for energy applications. The goal would be to help transfer emerging technology to large and small businesses in the state, spurring economic development and the growth of high-wage jobs. This aligns with the Governor's energy focus, harnesses expertise at the labs and universities that is not available in other states.
- 2) A project called *Frontera Del Sol* focusing on commercial solutions for the taxing problems associated with border, energy, environmental, and economic security issues.
- 3) A grand challenge to leverage New Mexico assets to develop a far-reaching Small Tech professional and technical workforce development infrastructure with specific goals oriented to dramatically increasing the diversity of the STEM workforce by 2020.
- 4) A Federal Technology Transfer Program to provide matching grants for Federally-Funded R&D Center scientists to assist businesses with technology development,
- 5) The creation of a state supported small business development fund to act as an incentive to innovative start-up firms to locate all portions of their operations in New Mexico. This fund, much like the New Mexico Small Business Assistance Program, would provide funding for prototyping helping firms cross "the Valley of Death".
- 6) The creation of an Innovation Access Incentive Program to act as an incentive to innovative start-up firms to take risks in product development that they might otherwise shun due to cost of accessing federal facilities and technical expertise.
- 7) The creation of an evergreen funding mechanism for the Administrative/ Management, Marketing/Sales and Production jobs that are created to insure these jobs are also retained in the state over time.

(See Nanotechnology appendix for more detailed information.)

4. Economic Development

Overview

If implemented successfully, the Science and Technology Plan will compliment the efforts of economic developers across the entire State, many of whom have been pursuing their own separate programs of technology-based economic development.

More often than not their efforts have been company or industry-related rather than technology related. Their recruiting efforts have been based on assessments of local resources, local infrastructure and local community needs. Whenever the New Mexico Department of Economic Development (EDD) was involved, the view expanded to include the entire State and its infrastructure/resources. The EDD's Office of Science and Technology has worked closely with the Office of the Governor, and in particular, the Governor's Science Advisor, to develop this S&T Plan. Our efforts were supported by several other State departments, the two federal labs, military testing facilities, the three State research universities and countless private sector volunteers who served on advisory committees.

There can be no doubt that the coming decades will see rapid growth in technology-based economic development, both here and throughout the world. Much of this growth will be dictated by necessity as we are compelled to adapt to new market and environmental conditions. These conditions will demand a move from more traditional paths to those supporting newer technologies. Many of the economic decisions we will make will be defensive in nature and based on the acceptance of ever-dwindling resources and increased competition. Others will be proactive like formulating strategies that marry conservation with marketplace realities to affect a healthier and more robust economic future.

Here in New Mexico, we are fortunate to have ample human capital and natural resources, diversity of thought and culture, an enviable concentration of research institutions and the ability and the leadership to move technology forward.

From an economic development point of view, these are all the important and necessary ingredients for success. We are pleased to support the Executive Recommendations in this Plan and stand ready to implement them.

Technology as a Driver for Clean Growth

Our future depends on finding new technology solutions to the

**"New Mexico is uniquely positioned to be a leader in development and commercialization of new technology. Our department believes in working with our partners to doing what we can to assist this important industry for our state."
*Cabinet Secretary
Jon Barela***

To move us forward towards creating more technology-based economic development we need a Technology Innovation Center that can mobilize all segments of the science and technology community.

nation's most pressing energy and water issues. The economic future also relies on our ability to develop new businesses in areas such as aerospace, biotechnology, information technology, and nanotechnology. We must grow our base of technology jobs, expand new technology-driven company start-ups, and recruit more out-of-state firms. This is vital if we are to firm up and diversify our economic base and provide a bright and sustainable future for all New Mexicans. To expand our economic base, we must dedicate a relatively small but consistent portion of our budget to move our discoveries from the laboratory to the people. This requires a commitment to creating a Technology Innovation Center (the core of Technology21) that will support or coordinate promising *commercializable* technologies in four areas: energy, water, supercomputing, and technology innovation. Similar centers have been created by other states for the same purposes, and the vast majority of them have profited from the economy of scale and coordination that these centers have provided.

The Federal R&D Investment in New Mexico

Our science and technology advantage over other states has been our unique Federal government relationship with our national laboratories. With over \$6.0 billion in annual revenue derived from the Federal government to operate its many facilities here, we are fortunate but also vulnerable to Washington's changing priorities. New policy decisions could lead to base closures or substantial reductions of missions for the national laboratories.

To avoid such losses and the subsequent economic impact on New Mexico, we must forge stronger and more flexible relationships with the labs that focus on commercial technology transfer and retaining Intellectual Property (IP) and human capital. We must draw on our scientific resources to provide solutions to energy problems and to produce the technologies needed to create better-paying jobs in rural and urban New Mexico. Technology21 provides the means for us to most effectively meet those challenges.

Advisory Group Recommendation - Establish and fund the Technology Innovation Center (TICenter)

The TICenter is the essential element in a strategy to bring all sectors of the S&T community together - a place where programs, activities and grants can be monitored, coordinated and supported. It is also a place where a State-sponsored Technology Development Fund could be administered and directed towards commercializable technologies; to support market pull and help emerging technologies prosper with the State's help. The TICenter would be the State's 'voice of technology,' promoting and cross-promoting New Mexico's R&D and companies. It would be the principal liaison between all State Departments, community-based technology programs, federal labs and private sector companies and multipliers. Absent a positive decision on this recommendation, the State will not have the necessary resources to oversee or implement the other recommendations. That is why we strongly support the TICenter initiative.

5. Education and Workforce Development

Education

Education is the key to the 21st century, both in terms of economic prosperity and personal achievement. Today's new economy is knowledge-based, entrepreneurial, and globally competitive to an extent that was almost unimaginable even a decade ago. Addressing our challenges in per-capita income, health care, and crime is dependent on a high level of achievement in education. Yet New Mexico students lag significantly in many measures of K-20 academic success, thus imperiling our prospects.

New Mexico is faced with a potential 'Catch 22' situation. Currently there are not enough specialized technology workers to satisfy the demand for them. This means we cannot attract new high-tech companies to New Mexico to create more and better paying jobs without having the necessary base of skilled workers. Conversely, until we grow the high-tech job market, we cannot interest students in investing the time and effort required to go into STEM (Science, Technology, Engineering, and Mathematics) careers.

At the heart of this issue is having a talented and highly-trained set of teachers who have the abilities to effectively teach students in STEM subjects while inspiring them to work towards STEM careers. A vital part of the equation is educating parents about the importance of their children performing well in math and science.

The S&T Plan that is laid out in this document cannot succeed in promoting high-tech workforce development without the State having a strong and solid base of students that are well prepared in technical areas. Thus, in developing the S&T Plan, we have been working closely with educators, state leaders, educational organizations, economic development groups, and the New Mexico Departments of Economic Development and Workforce Development to ensure that the State S&T Plan and efforts underway to improve STEM education are fully aligned.

What is called for is more opportunities by offering New Mexicans a pathway to meaningful employment through continuing education and vocational training. A number of efforts are underway to achieve this: IDEAL-NM (Innovative Digital Education and Learning in New Mexico); New Mexico Project 2012; Project GUTS (Growing Up Thinking Scientifically), STEM education efforts of the New Mexico Computing Applications Center, and others.
[IDEAL New Mexico](#)

Education is the foundation for improving the standard of living of New Mexicans. Strong science and math education is essential to achieving high-tech based economic development and the higher-paying jobs in the high-tech sector.

New Mexico can significantly improve our student's performance by implementing the plans laid out by our Public and Higher Education Departments. We conclude that those efforts are essential in achieving the goals of the State S&T Plan.

New Mexico is the first state in the nation to create a statewide eLearning system that from its inception encompasses all aspects of learning from traditional public and higher education environments to teacher professional development, continuing education and workforce education. IDEAL-NM provides eLearning services to New Mexico P-12 schools, higher education institutions, and government agencies. It reduces geographic and capacity barriers to educational opportunity while increasing the digital literacy skills students need to participate in a global economy.

New Mexico Project 2012

The goal of New Mexico Project 2012 is simple yet dramatic: that in five years New Mexico K-12 students will be among the nation's leaders in math and science achievement. While recognizing that this is a very ambitious goal, we believe it is a strong motivating force for positive change.

The strategic components of NM2012 are to: (1) increase student interest, participation, and achievement in math and science; (2) raise public support and awareness of the importance of science and math to New Mexico's economic health and security; and (3) to establish effective collaborations with internal and external partners.

The seven components of NM Project 2012 are:

- Increase the number of highly-prepared math and science teachers graduating from college
- Expand professional learning opportunities for K-12 math and science teachers
- Align the strategies used for teaching math and science to focus on inquiry-based learning, problem solving ability, and writing and literacy acquisition;
- Provide quality distance-learning opportunities for New Mexico's students via IDEAL-NM, the NMCAC, and related projects
- Draw on the extensive math and science expertise of New Mexico's very large community of engineers, mathematicians, and scientists to assist teachers
- Build a statewide STEM2 education community of students, parents, teachers, school administrators, institutions of higher education, state and local governments, and the business community to insure that New Mexico's young people are well prepared
- Create an effective public awareness campaign promoting math and science education

Education Working Group

The education working group identified a number of goals and strategies that should be implemented in conjunction with the State S&T Plan. While there is strong alignment between these goals and strategies with those of the New Mexico Project 2012 Plan, there was additional focus on the role of higher education in preparing students for a high-tech workplace and providing for the high-tech jobs needed to retain our students in New Mexico. Thus, the goals and strategies of the education working group are included here to amplify on some of the recommendations made by the Math and Science Advisory Council in formulating the Project 2012 Plan.

Goal I: Build coalition of business, industry, and government installations and labs to take ownership and provide coherence in statewide advancement of STEM education and workforce development.

- *Strategy 1: Create P-20 Council, including industry, business, national labs, education, etc. (chaired by Gov and top 10 CEOs in the state)*
- *Strategy 2: Create an HED STEM Bureau in collaboration with Governor's Office and P-20 Council*

Goal II: Build a seamless and coherent P-20 strategy that provides P-12 students increased access to STEM education

- *Strategy 1: Create statewide programs based on successful STEM programs that bring additional P-12 students onto campuses, national labs and businesses to prepare them for entering STEM fields.*
- *Strategy 2: Recruit and retain diverse faculty (women, minorities, faculty with disabilities) into Higher Education faculty and researcher positions. STEM HED staff representing increased diversity (STEM Bureau)*
- *Strategy 3: Double number of teachers certified in STEM fields with advanced preparation in the science, technology, engineering, and mathematics disciplines (program with salary supplements and scholarships for (pre-service teacher education*
- *Strategy 4: Provide opportunities for in-service teachers to increase knowledge and qualifications for teaching STEM subjects. (in-service strategies). Work collaboratively with PED k-12 math/science plan*
- *Strategy 5: Develop five5 STEM high school academies in diverse regions of the state with academic focus in strategic areas such as aerospace, nanotechnology, digital arts, robotics, energy, bioinformatics, etc.*
- *Strategy 6: Collaborate with P-12 to align curricula between P-12 system and higher education and enrich both institutions*
- *Strategy 7: Focus on role of school counselors in guiding students to STEM fields (prestige, opportunities, higher expectations—bring counselors to university campuses for STEM workshops/showcases)*

Goal III: Provide additional state funds for higher education STEM efforts

- *Strategy 1: Fund strategic hires of women and minority faculty in STEM fields to provide role models to increase recruitment and retention of diverse students*
- *Strategy 2: Increase by 50% funding for number of GRAs and fellowships for graduate students majoring in STEM fields*
- *Strategy 3: Increase by 50% scholarships for undergraduate students to major in STEM fields including Science or math teaching credentials*
- *Strategy 4: Match R&D—joint public-private partnerships between higher ed and industry*
- *Strategy 5: Provide matching funds for federal grants (NSF, NIH, DOE, ED, etc.)*
- *Strategy 6: Providing funding for mentored research opportunities for undergraduates*

Goal IV: Increase capital investments in identified NM areas of strength

- *Strategy 1: Increase facilities development for critical areas of scientific research*
- *Strategy 2: Fund Equipment upgrade and purchase in strategic STEM areas*

Workforce Development

Workforce development goes hand in hand with education. We need to both graduate students who are qualified for the high-tech jobs that will provide for a rewarding career and lifestyle while we also provide the high-tech jobs in New Mexico needed to keep our talented graduates in the state. This "Catch 22" situation is exacerbated by the challenges that we face in improving student performance and growing and attracting high-tech businesses to New Mexico.

Portrait of New Mexico

The New Mexico workforce system is faced by many challenges. New Mexico is a state marked by a high degree of poverty. According to the 2007 Kids Count report, New Mexico ranks 47th in the nation for the percent of children living in poverty (income below \$19,806 for a family of two adults and two children). In 2007, the New Mexico department of public education reported that approximately 59% of New Mexico's students were classified as low-income and qualified for free and reduced price meals. The effect of these statistics on New Mexicans has a lasting and dramatic impact on the access to and achievement in education and success in the work place. A large percentage of New Mexico students lag significantly in most measures of academic success, thus imperiling both their individual prospects and those of the state. According to the 2007 "The Emerging Policy Triangle: Economic Development, Workforce Development and Education" report, New Mexico is ranked 44th in the nation for public high school graduation rates. The state is ranked 47th in the nation for overall results on a career pathway pipeline, the transition and completion rates from 9th grade to completion of college. 28% of New Mexican adults ages 25 to 34 have an associates degree or higher.

Education and Workforce Development Reform

New Mexico has made great strides in implementing systemic education and workforce development reform. Paramount to these reform efforts is collaboration among state agencies and key stakeholders. In 2003 the New Mexico departments of higher education and public education were created. In 2004, the Governor's Workforce Coordination and Oversight Committee was established. Members of this committee include seven New Mexico agency heads, several private-sector representatives, public-sector leaders, representative from labor organizations and representatives of the New Mexico State Legislature.

During the 2007 legislative session, the New Mexico State Legislature passed the High School Redesign Act. This act increases opportunities and expectations at the middle and high school levels to align with national policy recommendations for college and career success.

In the summer of 2007, the New Mexico Department of Workforce Solutions (DWS) was developed through the integration of the state's Department of Labor and Office of Workforce Training and Development.

In the fall of 2007, the DWS received a WIRED (Workforce Innovation for Regional Economic Development) grant from the United States Department of Labor. The New Mexico WIRED project provides additional linkages among workforce development, economic development and education entities. Many of the partners involved in the New Mexico WIRED project represent workforce development, economic development and educational entities focused on the

development of a high tech workforce in the following industries: advanced manufacturing, construction, renewable energies, aerospace, micro-electronics and optics. Key activities of the project are dependent upon cross entity collaboration. In early 2008, the New Mexico department of workforce solutions was selected to participate in the shared youth vision mentee/mentor program by the United States Department of Labor.

State leaders recognize that connecting education to local and global economies is necessary to ensure a healthy workforce and a stable economic future for New Mexico. With the support from the Carl D. Perkins Vocational and Technical Federal Fund, industry recognized certifications aligned to the career clusters increased from 91 to 148 in the 2006 - 2007 school year. In addition, 12 high schools in 11 of the state's 89 school districts are participants in the High Schools That Work (HSTW) program that focuses on continuous school improvement and increasing career and technical opportunities by incorporating ten key instructional practices including career-technical studies.

Advisory Group Recommendation - Implement the recommendations of the New Mexico Project 2012 strategic plan.

Advisory Group Recommendation - Coordinate the efforts in economic development, education, and workforce development to maximize the creation of high-tech jobs for New Mexicans.

(See the Education and Workforce Development appendices for additional information.)

6. Recommendations

Given the challenges and opportunities that lay ahead of us, it is the opinion of the Working Groups that one single initiative be adopted and become the foundation of the State's S&T five-year Plan. While there are several other activities and recommendations, all are enabled by the:

Establishment of a Technology Innovation Center (TICenter)

The TICenter is the essential element in a strategy to bring all sectors of the S&T community together - a place where programs, activities and grants can be monitored, coordinated and supported. It is also a place where a State-sponsored Technology Development Fund could be administered and directed towards commercializable technologies; to support market pull and help emerging technologies prosper with the State's help. The TICenter would be the State's 'voice of technology,' promoting and cross promoting New Mexico's R&D and companies. It would be the principal liaison between all State Departments, community-based technology programs, federal labs and private sector companies and multipliers. Absent a positive decision on this recommendation, the State will not have the necessary resources to oversee or implement the other recommendations.

More specifically, legislation is requested to remove the Technology Research Collaborative (TRC) from statute and create the Technology Innovation Center (TICenter). This change will result in improving our ability to transition basic research supported by Federal funding at the universities and laboratories into the commercial sector. The TRC was focused primarily on technology push from the universities and laboratories in which one seeks to find a business application for new technology that is developed. The TICenter will have a primary focus on market pull in which technology development is driven by identified needs in the market place. Experience in other states has shown this approach to be much more effective in leveraging Federal Research and Development (R&D) investments into the commercial sector.

The TICenter will have reporting responsibility to the Department of Economic Development, the Governor's Office (through the Governor's Science Advisor) and the State Legislature. It will have an executive board with the Chair appointed by the Governor. The TICenter will also have the authority to hire an executive director and other personnel as appropriate. It will also appoint a technical advisory committee of subject matter experts to aid it in responding most effectively to opportunities.

The New Mexico TICenter would be responsible for developing a business plan, metrics, and performance assessment process that will ensure accountability and return on the state's investment. It will have the ability to contract for R&D services, provide funding for technology development, create initiatives to respond to market opportunities, form partnerships with any combination of public and private organizations, and create and commercialize new intellectual property. This full range of capabilities is critical in addressing the pressing needs that exist in New Mexico to make technology-based economic development a driving force in improving the quality of life for all citizens of New Mexico.

Initiatives that would fall within the scope of Technology21 are:

- New Mexico Computing Applications Center (NMCAC). Complete the effort started in FY08 to bring the Supercomputing Center fully on line with major business partners. Provide support for targeted areas in economic and workforce development. Support education and telehealth goals. Locate core facility in Albuquerque and implement 20 gateways in combination rural/urban New Mexico. Oversight by the Department of Information Technology and the Economic Development Department.
- The creation of a technology development effort. This would support the development of targeted technologies in the five cluster areas defined in this plan. Those efforts could be individual projects that are aligned with state interests and have good prospects for return on investment to specific initiatives such as a biotech or nanotech center. The State Legislature would have to review and approve large projects such as centers that involve significant state funding over several years.
- On-going Energy Innovation Fund program. Grow funding over several years to support innovation in energy technologies that are important to New Mexico and offer prospect of significant return on investment. Will drive New Mexico efforts to achieve a clean and sustainable energy future in which clean energy is an important economic factor. Model on program created in FY08, but make it an on-going effort. Oversight by Energy, Minerals, and Natural Resources Division.
- On-going Water Innovation Fund program. Support innovation in water technologies that are important to New Mexico. Providing novel means of conserving water and developing new sources of usable water is essential if New Mexico is to grow. Model on energy innovation program created in FY08, and make it an on-going effort. Oversight by the Office of the State Engineer.

Other initiatives that could be included within the scope of Technology21 are:

- Improve environment for workforce development through active private/public sector programs such as supporting STEM education and the development of new commercially-relevant training programs/curricula.
- Support high technology associations by having the Technology21 Center work with the associations in fulfilling the S&T Plan and working with the New Mexico Partnership in representing and advocating for their industries and the State.
- Review all State incentives and tax policies to attract high-technology companies coupled with a concerted effort to attract 2-3 of the major venture capital companies to New Mexico through a series of planned, carefully coordinated events.
- Establish a special High Technology Advisory Group comprised of membership from both legislative houses for the purpose of information exchange with the Governor's Science Advisor and the Technology21 Center.

7. Summary

The State Science and Technology Roadmap has taken over 18 months to complete. Over 100 people representing the academic, scientific, business, government and non-profit communities from all parts of the State worked on it. The outcome of this effort concluded that meeting the needs identified in the S&T Plan can be met by implementing the following recommendation:

Establish and fund the State of New Mexico Technology Innovation Center

Technology21 is a roadmap that charts a course for economic and technological development that is integrated with educational and workforce development initiatives. It builds on the experiences of other states' plans, but is specific to New Mexico.

Creating the Technology Innovation Center (TICenter) and providing sufficient funding to leverage the remarkable Federal investments in Research and Development in New Mexico is the most direct way to drive the technology-based economic development that will create high-paying high-tech jobs for New Mexicans across the state. These jobs are essential in addressing the significant issues that New Mexico faces in low per-capita income, health care, and crime.

Achieving the goals of the State S&T Roadmap requires a highly skilled and prepared workforce. We are not currently producing the number of graduating students with the necessary skills. To ensure the success of the S&T Roadmap requires a committed effort to improve the performance of our students in STEM disciplines. While New Mexico has made progress in the last several years and is a national leader in setting standards for our students, we need to focus on improving the math and science skills of our students. A number of efforts are underway to do just that and the most promising approach is the comprehensive one laid out in the New Mexico Project 2012 Strategic Plan. Implementing the recommendations of that Plan would dramatically further our ability to drive technology-based economic development across New Mexico.

Implementing the recommendations of the S&T Roadmap will position us to recover more quickly from the current national economic crisis and to be in a position of strong economic growth in the future. It provides a highly effective way for the state to address the important issue of the rising cost of energy and of using our technology base to drive growth. It contains all the elements required for success.

Following a two-year effort to assess what is required to address the pressing need for more better-paying jobs for New Mexicans, we conclude that:

**The State S&T Roadmap provides
a highly effective way to grow New Mexico's economy.**