New Mexico
Clean Energy Economy Roadmap

Growing Jobs through Clean Energy Development

North American Intelligent Manufacturing Initiative

&

New Mexico State University

Innovation and Commercialization
for a Regional Energy Workforce

North American
Intelligent Manufacturing
Initiative

Executive Summary

The Clean Energy Economy Roadmap, developed by the North American Intelligent Manufacturing Initiative (NAIMI) in conjunction with New Mexico State University (NMSU), is the result of the U.S. Economic Development Administration grant for the Innovation and Commercialization for a Regional Energy Workforce (i-CREW) effort awarded to NMSU in 2019. The grant identifies three critical phases of the Roadmap:

- Collect information on the status of clean energy technologies, workforce and economic development efforts in NM and adjacent states
- Conduct a needs and issues assessment and asset mapping
- Develop actions needed in K-20 education and workforce training programs, and growing business in New Mexico around the availability of clean energy

The advent of the Roadmap was the enactment of the New Mexico Energy Transition Act (ETA) in 2019, which established a goal of carbon free electricity for New Mexico by 2045. The ETA provides New Mexico with a unique opportunity to lead the country in a clean energy economy,

The Roadmap takes a holistic approach based on the impact on business growth due to a range of issues. The Roadmap lays out the recommendations and actions needed to grow a clean energy economy. The Roadmap is designed to bring together a collaboration of government, education, and business while coordinating efforts to make NM very business friendly and integrating these elements with addressing infrastructure needs. The Roadmap lays out specific actions, timelines, and priorities along with the best business areas to focus on for job growth in a Clean Energy Economy.

The Roadmap was developed with input and feedback during two statewide Town Hall meetings, from twelve Regional Advisory Groups that included over 300 leaders in business, workforce and economic development, education, nonprofits, and local and state government, from leaders of two clean energy trade organizations and two large renewable energy companies operating in NM, and obtained useful information from a number of plans that provide ties with state and national strategies.

Recommendations

The Roadmap identifies Foundational Issues that are critical in growing a Clean Energy Economy. The Foundational Issues fall into four areas of **Process**:

1. Ease the transition from fossil fuels to clean energy
2. Connect with opportunities in the Hydrogen Economy, Electric Vehicles,
3. Make regulatory processes more business friendly
4. Increase technology transfer and commercialization of our universities and national laboratories

There are also four areas of **Infrastructure** that need to be addressed:

1. Enhancing Clean Energy Infrastructure in electricity transmission, energy storage, electric vehicles, thre hydrogen economy, and the environment.
2. Improving Broadband access, speed, and cost across the state.
3. Increasing Cybersecurity Capabilities and jobs in New Mexico.
4. Improving Transportation with well-maintained roads, highways, and railways

The Roadmap identifies three areas for job sector growth in a Clean Energy economy:

<u>Clean Energy – Sustainable Economic Growth and the Environment</u>

- Production of Clean Energy, Energy Efficiency, and Environment
- Large-scale Possibility of clean hydrogen production
- Fuel cell and hydrogen powered transportation

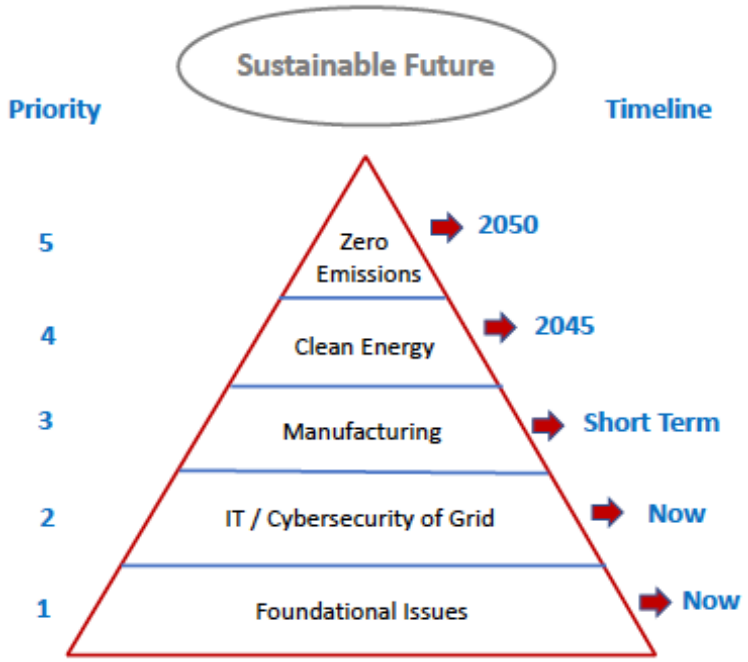
<u>Intelligent Manufacturing</u>

- Reshoring, Nearshoring, and Greenshoring manufacturing
- Building intelligence into manufacturing lines

<u>IT and Cybersecurity</u>

- Making the electric grid cybersecure
- Increasing concerns and job opportunities in cybersecurity

The Roadmap identifies the Goals, Method, and Process steps that are required to grow jobs in each of the three sectors. These are meant to be the first steps in an ongoing program to achieve a sustainable future. The Roadmap provides specific actions to be taken during the next five years to grow a Clean Energy Economy and to move to a zero emissions sustainable future by 2050.



Finally, the Roadmap provides actions that need to be implemented to grow the Workforce that is needed for a Clean Energy Economy. This includes convening a working group of EMNRD, EDD, ENV, and DWS that includes representation from NM colleges and universities, the national laboratories, and business and industry leaders to adopt and continuously evolve a strategy with specific action items that identify and match both short-term and long-term business and industrial needs.

Contents

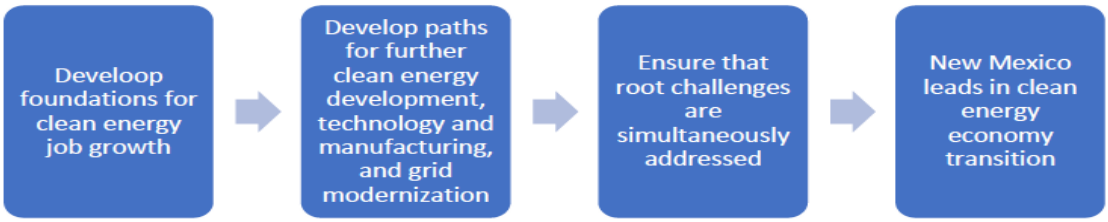
I. Roadmap Process 5
II. Connection to Other Plans 8
III. Challenges Identified for Economic Development 9
IV. Roadmap Focus Areas 12
V. Sustainable Clean Energy & the Environment 13
V.1 Overview 13
V.2 Clean Energy Status in New Mexico 13
V.3 New Mexico's Renewable Energy Potential 14
V.4 Electric Grid Transmission 15
V.5 Energy Storage 16
V.5.I Hydroelectric Storage 16
V.5.2. Kinetic Power 16
V.5.3. Smart Grid and Demand Side Management 17
V.6. The Hydrogen Economy 17
V.7. The Environment 20
VI. Intelligent Manufacturing 22
VII. Information Technology & Cybersecurity 25
VII.1 Information Technology 25
VII.2. Cybersecurity 28
VIII. Clean Energy Economy Roadmap Perspective 33
IX. Implementing the Roadmap 34
IX.1 Process 35
IX.2 Infrastructure 38
IX.3 Workforce 42
IX.4 Roadmap Focus Areas 44
X. CONCLUSION 51
APPENDIX 52
ACRONYMS 77

I. Roadmap Process

The Roadmap team engaged in a variety of discussions and events to get feedback on the potential for New Mexico's clean energy economy. The Covid-19 pandemic prevented any in-person interactions, so all engagement was conducted virtually.

The Roadmap is designed to be a bottoms-up rather than top-down effort. The Roadmap started with gathering information on the current status of efforts in clean energy and jobs related to clean energy. We then went on to form 12 Regional Advisory Groups across the State to gather input and feedback from a wide range of leaders; NAIMI and NMSU hosted two statewide Town Hall meetings that provided broad critical input to the Roadmap.

The overarching problem statement that led discussions was how do we create and grow jobs in New Mexico by creating clean energy jobs in a state that will continue to have a gas and oil industry that contributes to New Mexico's bottom line.



NAIMI gathered information from a wide of sources:

- NM State University
- 12 Regional Advisory Groups
- Entrepreneurs and businesses
- Local, State, and Federal agencies
- Colleges and universities
- National laboratories
- Economic/Workforce development groups
- Council on Competitiveness
- NM nonprofits
- Roosevelt Project
- Utilities
- Oil and gas companies
- Interested individuals

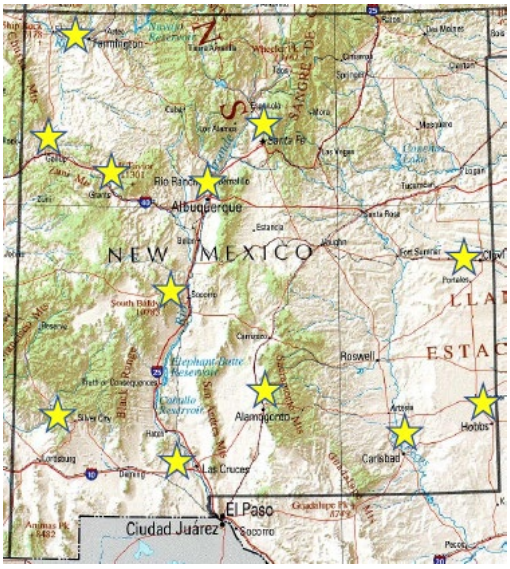


Figure 1 Location of Advisory Group

The EDA grant for the i-CREW project is for three years, commencing July 1, 2019. The Roadmap will provide recommendations and action items required to grow a Clean Energy Economy over a period of five years. Some of the actions recommended were

initiated in 2020 and the period of activity required to implement the recommendations extends to 2025.

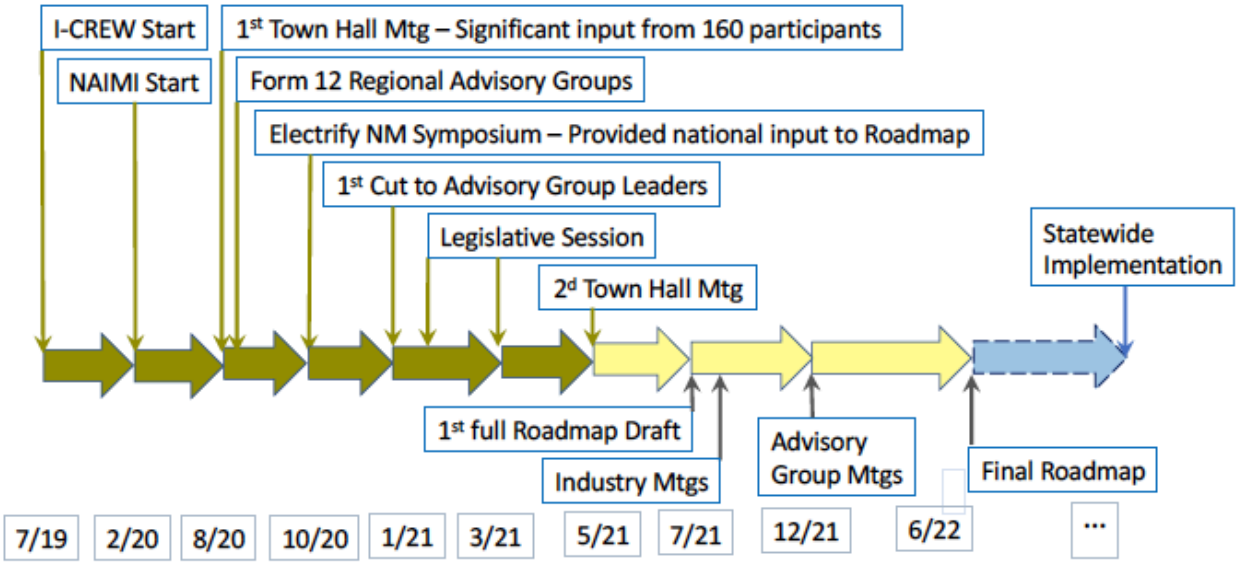


Figure I.2. Timeline for Developing the Roadmap.

Town Hall Meetings

NAIMI and ICREW hosted two virtual Town Halls (Appendix 1) to both ascertain interest and increase awareness of the clean energy economy as well as get participant feedback. Participants represented a variety of interests and industries including legislators, wind and solar developers, private industry, investor owned, cooperative and municipal utilities; educational institutions; trade associations; state, local and tribal government representative, and nonprofit and advocacy organizations.

The first Town Hall August 5, 2020 with participation by 160 leaders from around the State briefly described the purpose of the Clean Energy Roadmap and featured speakers on efforts that pertain to New Mexico in a variety of areas including: beneficial electrification, workforce solutions, projects and policies related to a clean energy economy, and opportunities for manufacturing in the state. Breakout sessions led by subject matter experts worked to get valuable feedback from attendees in several key areas including economic development and entrepreneurship, workforce development, grid modernization, energy policy and technology innovation.

NAIMI participated with assistance from NMSU in the symposium with the Beneficial Electrification program on October 14, 2020, that had 150 participants (Appendix 4). The meeting demonstrated the value of replacing fossil fuel use with electricity in a way that reduces overall emissions and energy costs. NMSU and NAIMI agreed to work with the national group to provide a means of benefitting NM with this approach.

The May 18, 2021, Town Hall had participation of 126 leaders and discussed national strategies on the transition to a clean energy economy and how New Mexico could benefit from the national work. In addition, state officials provided updates on current

and future clean energy policy strategies, private sector representatives provided perspective on opportunities and challenges of building a clean energy economy in the state, and entrepreneurs shared their experiences in how they have benefitted from the transition to a clean energy economy.

NAIMI and NMSU also participated in the Energy Summit on July 29-30, 2021, and in the I-WEST Meeting on September 24, 2021 (Appendix 4.)

Regional Advisory Groups

NAIMI organized 12 Regional Advisory Groups across New Mexico (Figure 2.1) that included over 300 leaders in business, workforce and economic development, education, nonprofits, and local and state government. NAIMI hosted virtual meetings with the Advisory Groups to obtain feedback on building a clean energy economy for New Mexico. The purpose of these regional meetings was to identify specific challenges and opportunities related to a clean energy economy in those specific regions. NMSU co-partnered output of the Regional Advisory Groups. The input from the Advisory Groups is a critical element in developing the Roadmap.

The Regional Advisory Groups are located in:

Alamogordo	Hobbs
Albuquerque	Las Cruces
Carlsbad	Portales
Farmington	Santa Fe
Gallup	Silver City
Grants	Socorro

We note that there are important differences of issues and recommendations that come from the different regional advisory groups. For example, broadband connectivity is not an issue for Roswell, but surprisingly is for Socorro. This makes for important distinctions in developing the Roadmap recommendations and actions to be taken in creating a Clean Energy Economy. In some cases, we note that there are essentially universal concerns, such as the availability of an adequately trained workforce, and the desire of communities to have clean energy projects in their region as New Mexico works to diversify its economy. In other cases, our recommendations in areas such as transportation have different needs and requirements in different regions.

Specific challenges and opportunities raised by the Regional Advisory Groups are discussed in Section IV – Challenges Identified for Economic Development and are provided in more detail in Appendices 2a (Challenges) and 2b (Opportunities). Challenges and Opportunities that are specific to each region are presented in Appendix 2c. In Section VIII – Implementing the Roadmap, we have worked to identify universal issues and the actions to be taken in addressing them. In specific cases, we make note the issues that are of importance to specific regions. Given the diversity of needs, issues, and recommendations that are contained in hundreds of pages of information we have received in developing the Roadmap, it is simply not possible to

provide all the detailed actions needed for specific regions. That task falls to implementing the Roadmap, not developing it. We expect to receive support to begin implementing the Roadmap, at which point we will break out specific actions needed for specific regions in the detail needed to actually implement the Roadmap.

Other Organizations and Individuals

NAIMI worked with a range of other organizations in New Mexico including ReNewMexico, Climate Change Leadership Council, EPSCoR, NM Partnership, NM EDD, NM EMNRD, NM ENV, NM SLO, UNM Rainforest, NMSU Arrowhead Center, LANL Feynman Center, Sandia National Laboratories, Roosevelt Project, Manufacturing Extension Partnership, and the Council on Competitiveness.

Industry Conversations

NAIMI also interviewed leaders of two clean energy trade organizations and two large renewable energy companies operating in NM to assess the gaps and opportunities related to building a clean energy economy in New Mexico.

The input from Industry identified challenges including clean energy workforce, outdated rules, inconsistent permitting, and complicated and delayed processing of renewable energy tax credits. A number of opportunities were also identified including the ability to recruit more companies that want to take advantage of our RE resources, diversifying the clean energy economy workforce with more women and representation from all New Mexico communities, and capitalizing on the benefits of operating a renewable energy company in New Mexico. Appendix 3 provides more detailed information.

NAIMI also received valuable input from the electric utilities and electric cooperatives including Public Service of NM, El Paso Electric, Tristate, Kitt Carson Electric Coop, and Los Alamos Public Utilities.

II. Connection to Other Plans

Ties to State and National Strategies

The Roadmap ties directly to state and national priorities and strategies. At the Federal level, NAIMI has included findings from the National Council Report Competing in the Next Economy and the Infrastructure and Investment Jobs Act of 2021 that stress the importance of technology development, workforce training, infrastructure investment and addressing the climate crisis (Appendix 5). NAIMI has also included the impact of actions taken by the NM Legislature (Appendix 6) and benefitted from other plans that have relevance to growing a Clean Energy Economy. (Appendix 7).

Legislative Actions

For the past 15 plus years, the New Mexico legislature has passed a host of clean energy pieces of legislation that help the state transition to a clean energy economy (Appendix 6). NAIMI worked with members of the Legislature and Committees during

the 2021 and 2022 Sessions of the Legislature to support passage of a range of legislative action that help grow a Clean Energy Economy.

There were two bills passed by the Legislature that addressed infrastructure issues identified by the Regional Advisory Groups Senate Bills 93, the Omnibus Broadband Bill, and Senate Bill 121 -Transportation Improvement Bonds.
Other bills passed that are relevant to growing a Clean Energy Economy were House Bill 15, Sustainable Buildings Tax Credit, and Senate Bill 84, Community Solar Act. NAIMI supported the passage of these bills as they generally support the goals of the Clean Energy Economy Roadmap.

Other Related Plans
In developing the Roadmap, NAIMI took benefitted from other plans have relevance to growing a Clean Energy Economy. The other plans that NAIMI drew from are described in Appendix 7.

III. Challenges Identified for Economic Development

Process

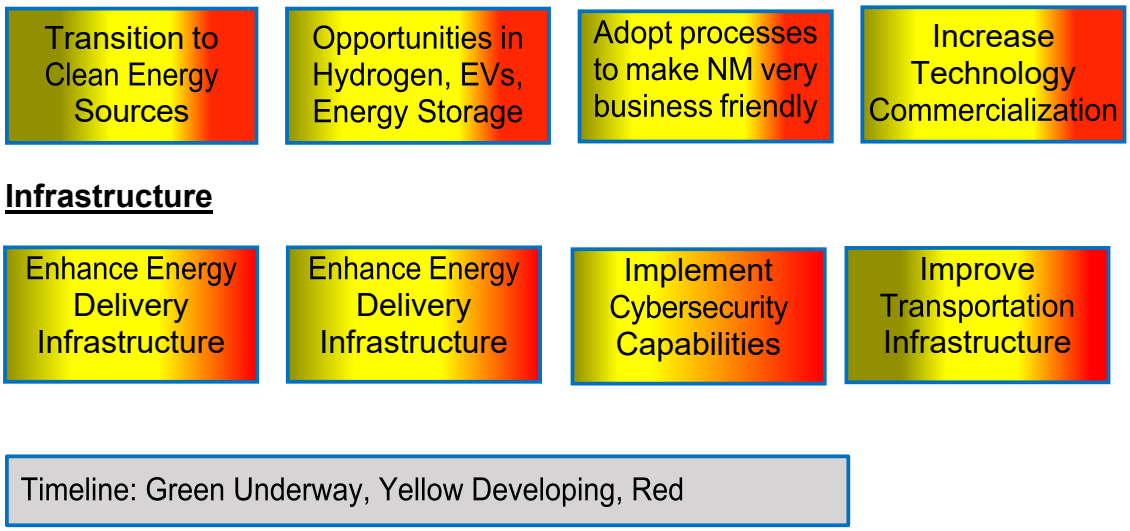


Figure III.1. Foundational Issues.

Using the inputs from the broad range of sources described above, NAIMI identified a set of three ‘Foundational Issues’ that are widely perceived as critical elements that must be in place to support any kind of economic development. The two ‘Foundational Issues’ are Process and Infrastructure.

The Roadmap identifies **four Process areas** where improvements are needed:

1. **Ease the transition from fossil fuels to clean energy**
    - Fossil fuel industries constitute the largest source of revenue for NM[1], making it increasingly important to provide opportunities for workforce transition as NM diversifies its economic base as it moves to a clean energy economy.
2. **Connect with opportunities** in the Hydrogen Economy, Electric Vehicles, Energy Storage, and the Environment
    - This requires coordinated planning and execution of training and educational programs with needs of specific NM job sectors that are primed for growth.
3. **Make regulatory processes more business friendly**
    - NM should strive to be competitive with adjacent states in the ease with which business can be done. This is an important element in getting businesses to locate and stay in NM that want to take advantage of the low cost of our RE
4. **Increase technology transfer** and commercialization of our universities and national laboratories.
    - NM ranks first in R&D intensity in the U.S.[2], providing a prime opportunity to grow high-tech businesses in NM. Both Los Alamos and Sandia National Laboratories have strong clean energy programs that can provide increased clean energy capabilities that can be commercialized.

The Roadmap identifies **four Infrastructure areas** that require efforts and investments to provide the elements needed to grow a Clean Energy Economy:

1. Enhancing Clean Energy Infrastructure is important since clean energy is a draw for NM as we have significant Renewable Energy resources and the lowest cost of RE in the U.S. Clean Energy Infrastructure falls into several sectors:
    - Transmission has challenges in siting of new lines that may take decades to overcome without improvements in the review and approval process
    - Energy Storage is central to growing a Green Grid and need to go beyond battery storage for utility-scale projects.
    - Electric Vehicles require statewide charging stations in NM to become a viable source of transportation.
    - Hydrogen Economy has resources in NM that make it possible for NM to become a Hydrogen Hub.

[1] [NMTRI] New Mexico Tax Research Institute. 2021. State and Local Revenue Impacts of the Oil and Gas Industry: Fiscal Year 2021 Update.
[2] [ITIF] Information Technology & Innovation Foundation. 2017. The 2017 State New Economy Index: Benchmarking Economic Transformation in the States. p. 47.

- Environment must be a prominent factor in any and all efforts to grow a Clean Energy Economy.
- A coordinated process needs to be put in place that provides the ability to address issues across all the clean energy sectors in a timely fashion.
  - *NAIMI appreciates that Governor Lujan Grisham has appointed Martin J. Chavez (former Albuquerque Mayor) as the state's new infrastructure advisor to work with communities to determine priorities, including $3.7B of funding from President Biden's Infrastructure Plan.*

2. **Broadband** must provide cost-effective, high-speed internet for individuals, businesses, communities, and government for all socio-economic groups.
   - High-speed broadband is an essential part of being able to monitor and control the electric grid, especially as we move towards more and more distributed generation due to solar panels on residences and businesses.
   - High-speed, affordable broadband is also an integral part of any effort to attract and grow business for the Clean Energy Economy
   - NM ranks in the bottom ten of all rankings of how states perform wrt broadband coverage, speed, and price access. A widely used assessment provided by BROADBNDNOW RESEARCH on November 5, 2021.

Rank	State	Terrestrial BBD Access	Wired Internet at Low Price	Avg Speed Mb/sec	#ISPs
14	CO	88.8%	87.7%	347.0	254
20	AZ	88.4%	86.1%	396.1	176
21	TX	84.9%	87.0%	425.9	550
45	NM	79.14%	71.6%	288.7	144

3. **Cybersecurity Capabilities** requires both the public and private sector in NM to implement cybersecurity software and hardware to protect our resources
   - The electric grid is a critical infrastructure that is central to virtually every aspect of our lives. It is essential that it be well protected against cybersecurity attacks that could damage or destroy the grid.

4. **Transportation** that provides well-maintained roads, highways, and railways
   - Reliable transportation is a critical element in transitioning to a carbon-free environment as we install large solar and wind facilities along with additional transmission and storage on the electric grid.
   - Manufacturing cannot be grown in New Mexico without adequate transportation infrastructure.

IV. Roadmap Focus Areas

The Roadmap found three areas offer good prospects for creating jobs:

Sustainable Clean Energy and the Environment

- Increasing Renewable Energy and Energy Efficiency programs
- The Hydrogen Economy
- Pumped hydroelectric storage for the electric grid

Intelligent Manufacturing

- Greenshoring – Environmentally friendly manufacturing in NM
- Reshoring – Bringing manufacturing back to the US
- Nearshoring – Working with Mexico and Canada to achieve efficiencies

Information Technology and Cybersecurity

- Modernizing the electric grid
- Implementing IT capabilities in networked environments
- Implementing cybersecurity of the grid and important systems in NM
- Increasing job opportunities in cybersecurity

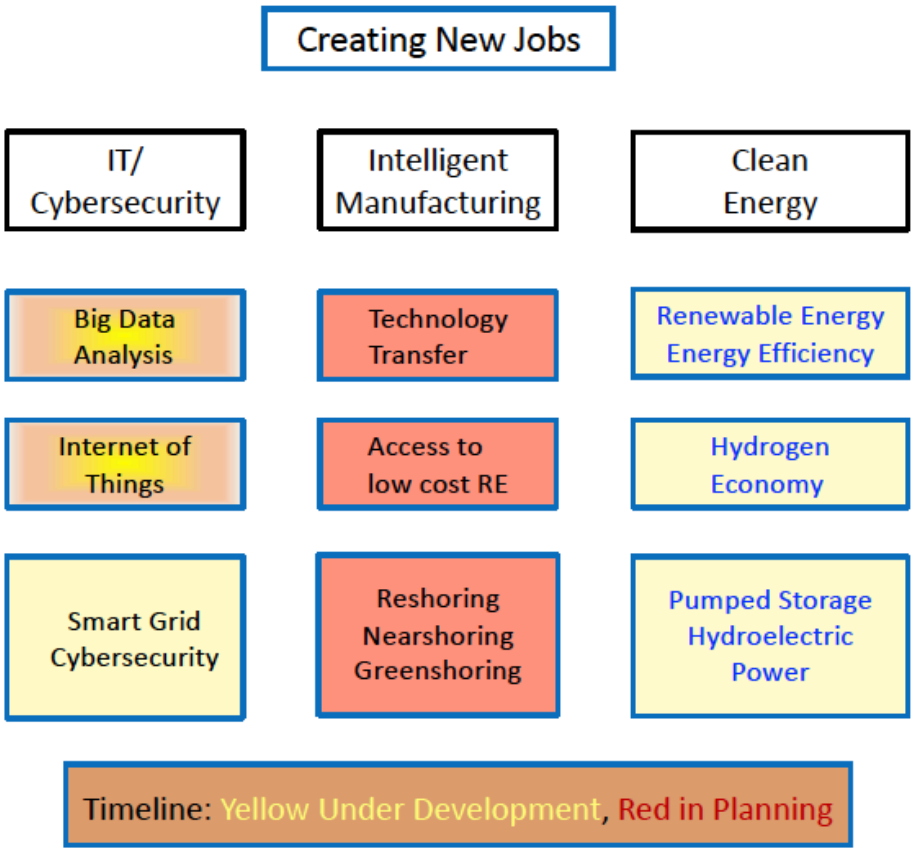


Figure IV.1. Roadmap sectors identified as opportunities for job creation.

V. Sustainable Clean Energy & the Environment

V.1 Overview

The wide scope of the Clean Energy/Hydrogen Economy/Water/Environment area is a reflection of the fact that Climate Change is rapidly becoming accepted as a serious threat to the U.S. The world must take into account the full range of issues in growing out clean energy and enabling a clean energy economy. The Biden Administration is pushing this approach and we can hope that Congress will come to some agreement on Federal support. Certainly, the efforts of Gov. Lujan Grisham and her cabinet along with the State Land Office have adopted this holistic approach.

- Clean Energy is a draw for bringing companies to NM as we have significant Renewable Energy resources and the lowest cost of RE in the U.S.
- Transmission has challenges in siting of new lines that may take decades to overcome without improvements in the review and approval process
- Energy Storage is central to growing a Green Grid and need to go beyond battery storage for utility-scale projects.
- Electric Vehicles require statewide charging stations in NM to become a viable source of transportation.
- Hydrogen Economy has resources in NM that make it possible for NM to become a Hydrogen Hub.
- Environment must be a prominent factor in any and all efforts to grow a Clean Energy Economy.

V.2 Clean Energy Status in New Mexico

The NM Energy Transition Act (ETA), requiring utilities to be carbon neutral by 2045, is driving changes to energy plans. PNM's Integrated Resource Plan serves as a proxy of the plans of all electric utilities in New Mexico customers though some do plan wind power additions. These plans call for fossil fuel generation to be retired and replaced by renewables, storage, load management, hydrogen fired turbines and nuclear.

	Technology	2021	2022	2023	2024	2025
Additions	Solar	99	650	50	190	-
	Wind	-	-	-	-	-
	Battery Storage	-	300	123	100	-
	Pumped Storage	-	-	-	-	
	H_2-Ready CTs	-	-	160	-	120
	DSM	20	35	20	24	24
Retirements	Nuclear	-	-	-104	-10	-
	Coal	-	-497	-	-	-200

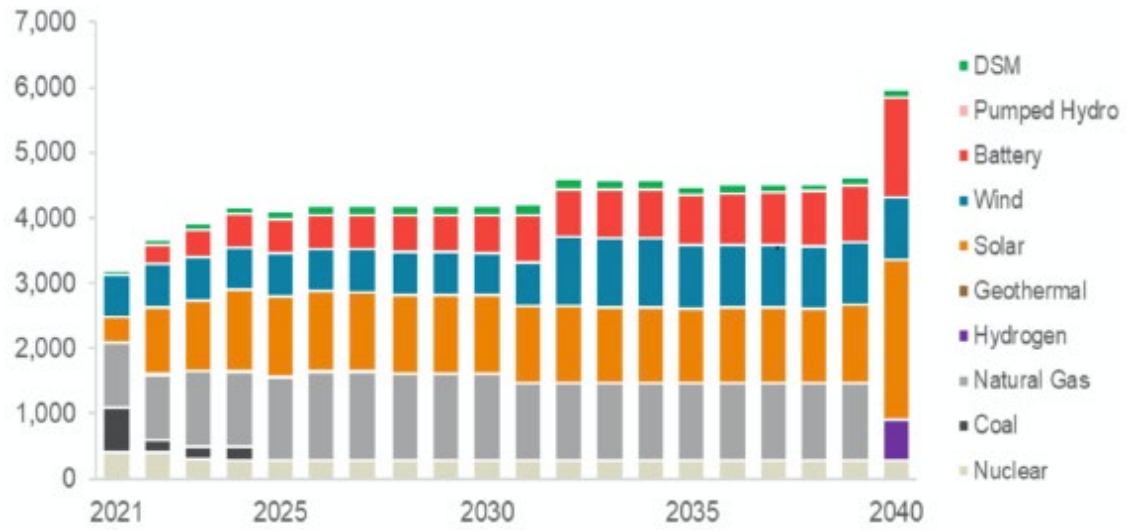


Figure V.1. Table from PNM's IRP showing transition to clean energy.

V.3 New Mexico's Renewable Energy Potential

With passage of the ETA, New Mexico has taken a leadership role in our nation's conversion to carbon neutral electricity generation. Although our coal, oil and natural gas have historically provided tax revenues and highly paid jobs, our abundant solar and wind resources are a substitute for those fossil resources and make New Mexico an attractive location for businesses with demands for large amounts of clean energy.

The New Mexico Renewable Energy Transmission Authority (NMRETA) completed a study in 2020 that identified the abundant solar and wind resources in New Mexico[3]. The abundance and diversity of both and the high-capacity factor of renewable resources in our state give New Mexico the potential to be one of the lowest cost producers of renewable energy in the nation.

The NMRETA study made several important findings:

- By removing transmission barriers, New Mexico could expand from 2,500 to 11,500 MW of renewable capacity by 2030.

[3] New Mexico Renewable Energy Transmission and Storage Study. 2020. Available from: https://nmreta.com/wp-content/uploads/2020/10/NM_RETA_Transmission_Study_June2020v2.pdf

- The study identifies 137,000 MW of highest quality wind, and 824,000 MW solar potential on State Trust and private lands.
- Significant investments in transmission infrastructure are required to make both wind and solar available for New Mexico's load centers and for export.

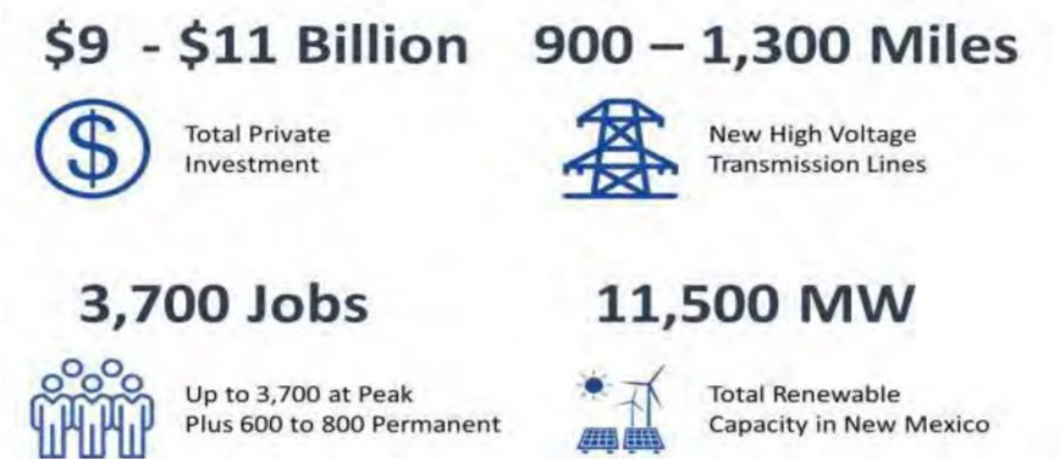


Figure V.2. Potential impact of full adoption of clean energy in NM.

The 11,500 MW would more than satisfy New Mexico's clean energy goals. This consists of 2,500 MW existing, 3,100 MW under development, and 5,900 MW of new wind and solar projects. (By comparison, the 4-Corners, San Juan, and Escalante coal generating plants total approximately 3,500 MW of capacity.)

V.4 Electric Grid Transmission

The Clean Energy Economy Roadmap recognizes the challenges in siting new transmission. For now, utility-scale wind and solar resources and long-duration storage provide the shortest and least expensive route to carbon free electric production.

New Mexico's transition to RE requires a reasonable process for building the infrastructure required to deliver that energy and support for energy storage needed to maximize utilization of transmission infrastructure. We need to be aware that the barriers to constructing those facilities may take decades to overcome. *(For example, developers of the proposed Sun-Zia transmission project have spent 14 years and approximately $110 million and have yet to obtain approval to construct.)* [4]

Policy makers must recognize those barriers, seek to reduce or remove them, and develop alternate paths for the development of renewable energy. Relying on building new transmission could prolong our state's reliance on fossil generation.

[4] Markowitz C. 2020. A Seriously Long-Term Investment: Inside SunZia's Transmission Adventure. Clean Energy Finance Forum. Available from: https://www.cleanenergyfinanceforum.com/2020/12/08/seriously-long-term-investment-inside-sunzias-transmission-adventure

V.5 Energy Storage

Storing electric energy could provide a path to developing renewable generation without transmission by increasing the utilization of existing infrastructure. Hydro-electric storage is efficient, effective and has a strong track record, opportunities for deployment are limited. Other technologies are simply too new to have developed a history.

As intermittent renewable energy generation is added to the grid, there will be a demand for reliable inexpensive energy storage. Early adopters of smart grid technology are installing lithium-ion battery systems such as the Tesla PowerWall. Although lithium-ion batteries have become more affordable, the cost is still substantial.

V.5.I Hydroelectric Storage

Pumped storage hydroelectric power is a proven technology for storing energy with load following capability; the ability to instantaneously vary output to match changes in load.

The required elements are water, proximity to electric transmission lines and geography. Although water is essential in the process, consumption is limited to evaporation. The investment in infrastructure though is substantial. For this reason, economies of scale are important.

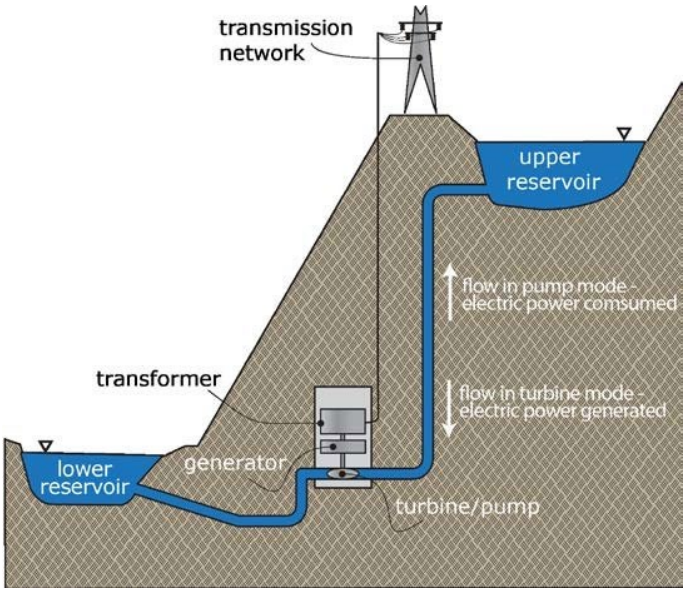


Figure V.5. 1. Hydroelectric Power Storage

V.5.2. Kinetic Power

Kinetic Power is developing New Mexico's renewable energy potential as a firm resource. Their plan would transition existing transmission lines from exporting coal-fired electricity from the Four Corners region and combined that with new pumped storage facilities built on the Navajo Nation at Beclabito to provide 6,000 MW of firm power 24/7/365. Kinetic Power projects that there would be 2400 construction jobs, 4700 operations jobs (over 100 years), and 450 jobs every 25 years to refurbish the facility. (Appendix 9).

This project has the potential to stabilize the electric grid over the entire Four Corners region while also creating jobs and economic advantage in attracting companies to New Mexico that want to utilize the lowest cost of renewable energy in the U.S.

(See Appendix 7 for more detailed information.)

V.5.3. Smart Grid and Demand Side Management

A smart grid adds communication capability and equipment to the grid that allows utilities and customers to respond to grid conditions in real time. When renewables are abundant and prices low, owners of storage could buy and store power. When there are shortages of clean power, stored power could be sold to the grid. Demand Side Management (DSM) could provide benefits similar to energy storage by shifting use of energy from times of constraint to times of abundance. For example, an electric water heater could be programmed to remain off during times of peak electric demand.

The smart grid extends as well to energy efficiency – reducing use of electricity for lighting, designing and retrofitting buildings for improved ventilation and natural lighting, designing and constructing buildings that allow for demand side management, and retrofitting buildings to improve energy usage. The smart grid and demand side management includes increasing the usage of electric vehicles and increasing the number and availability of electric vehicle charging stations.

V.6. The Hydrogen Economy

The increasing concerns about global climate change, including those concerns of the private sector, are going to drive us towards a hydrogen economy. In addition, there have been technical developments recently that offer the promise of reducing the cost and availability of green hydrogen. (Produced hydrogen is described as green (produced using electrolysis using clean energy with no CO2 released, blue (produced from petroleum, but the CO2 is captured and sequestered), or gray (produced from petroleum and releases CO2).)

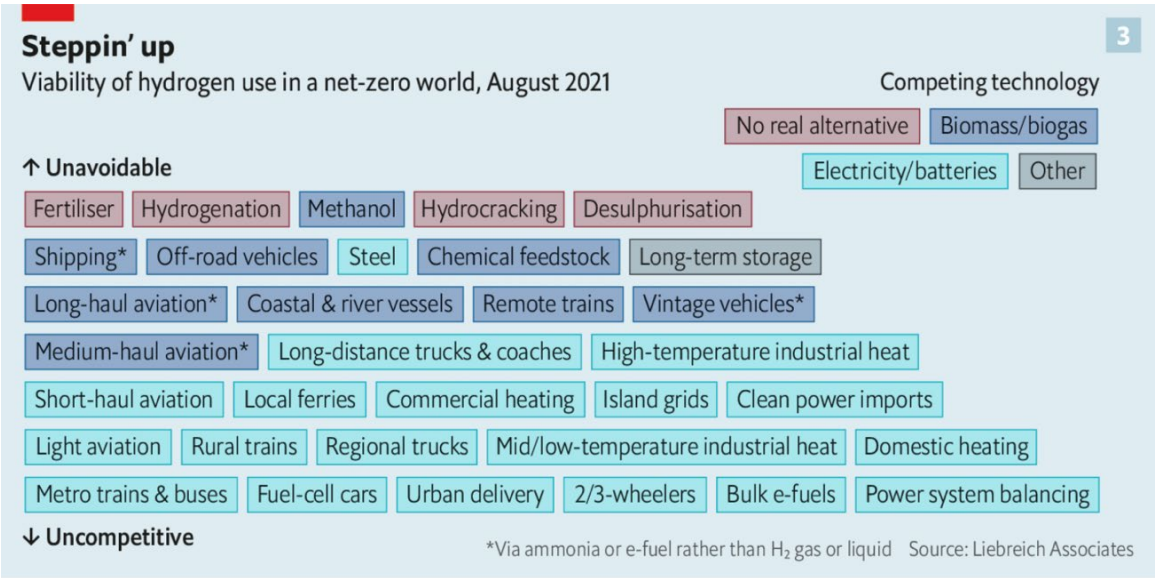


Figure V.6.1. Viability of Hydrogen Use[5]

[5] "The Economist". 9th October, 2021

The viability of hydrogen for various uses is hotly debated. Michael Liebreich, described as a clean energy guru by The Economist, has created a hydrogen ladder shown in Figure V.1 in which he ranks the use of hydrogen from uncompetitive to unavoidable and includes the competing technologies. It is absolutely clear that before any hydrogen project is undertaken that a full energy and carbon balance be worked out for the project.

The potential market for green hydrogen is huge, New Mexico has all the elements to be a major producer, and the Hydrogen Economy can be an important element of growing a Clean Energy Economy in New Mexico. Gov. Lujan Grisham has announced plans to make New Mexico a major producer, consumer, and exporter of clean hydrogen ('Bill lays out framework for a hydrogen economy in NM', ABQ Journal, 10-1-21). The Biden administration has a strong push to grow the hydrogen economy ('What Is the Role of Hydrogen In Biden's Infrastructure Plan', Forbes, 8-5-21). In June 2021 the Department of Energy announced a "hydrogen shot" initiative aimed in part to reduce the cost of green hydrogen to $1/kg by 2030.[6] There are efforts currently underway that have potential for the hydrogen economy:

BayoTech Inc.

BayoTech, a New Mexico company, is a full-service hydrogen supplier that offers modular, scalable, and rapidly deployable hydrogen generation that creates hydrogen from natural gas using a modular reformer technology developed at Sandia National Laboratories. Bayotech has the ability to build hundreds of hydrogen units to produce cleaner, lower-cost hydrogen. Producing hydrogen where it is needed reduces much of the expense of transporting this fuel by using existing gas pipelines. BayoTech recently announced that they are nearing completion of a hydrogen production facility in the North Valley that can produce 1,000 kg of hydrogen per day. The following is a graphic from the BayoTech web site illustrating the carbon intensity of various methods of producing hydrogen.

Escalante H2 Power

Escalante H2 Power provides a capability to transition existing coal-fired power plants to hydrogen-fueled power plants. The 253 MW, coal-fired Escalante Station near Prewitt, NM closed in August 2020. A partnership of Newpoint Gas LLC and Brooks Energy Company is working to transform Escalante into a hydrogen facility using a technology that separates hydrogen, water, and carbon from natural gas. The Escalante power plant could then be operated using either natural gas or hydrogen as the energy

[6] [DOE] Department of Energy. Available from: https://www.energy.gov/eere/fuelcells/hydrogen-shot

source.[7] The plant would also provide the capability to produce hydrogen for export and use of hydrogen as a base for manufacturing.

The new plant would provide high-quality, well-paying jobs for the underserved population displaced by closing of the Escalante power plant.

Hydrogen for Transportation

While hydrogen fuel may provide the means to stabilize renewable energy sources such as wind and solar, switching to hydrogen as a fuel faces challenges as it is not a direct replacement for natural gas. Hydrogen is less energy dense than petroleum and is more costly to transport and to store. In addition, burning hotter than natural gas, new turbines and boilers will be needed for hydrogen.

One aspect of the hydrogen economy is to develop fuel cells for vehicles. Fuel cells convert hydrogen directly into electricity, emitting only water and can be used to power electric vehicles. Although less efficient than modern battery technology, hydrogen powered vehicles can be refueled as quickly as a gasoline powered vehicle, overcoming the limitation of batteries of long recharge times. This limitation is severe for semitrucks and makes battery-operated electric semitrucks impractical.

An alternative to EVs is to power semitrucks with hydrogen fuel cells. These trucks would pull into a fueling station and refill their tanks with hydrogen in a few minutes similar to the way they pump gasoline into their tanks. Los Alamos National Laboratory is part of a five national laboratory 'Million Mile Fuel Cell Truck' effort that is funded for five years by the US Department of Energy. The goal of this R&D is to develop an efficient and cost-effective fuel cell that could be used by long-haul 18-wheelers and eventually by everyday vehicles.

There have also been technical developments recently that reduce costs and availability of green hydrogen for other forms of transportation Airlines and aircraft manufacturing companies are investing in both hydrogen-fueled propeller and jet aircraft. Bill Gates, Amazon, and British Airways recently provided $38M in funding to ZeroAvia, a CA startup developing hydrogen-electric technology to power aircraft. Germany is producing hydrogen-powered rail cars for the Eisenbahn. And advances in fuel cell technology are being carried over into the automotive sector by Bayotech in New Mexico.

[7] [EAI] Energy Analytics Institute. 2021. Clean Energy Project Proposed In NM. Available from: https://www.energy.gov/eere/fuelcells/hydrogen-shot

Six-seater Piper Malibu M350 first flight in Sept with ZeroAvia's hydrogen powertrain.

Germany's new hydrogen-powered train.

Figure V.6.1. Hydrogen-powered aircraft and trains.

V.7. The Environment

NAIMI has taken the position of supporting the findings and recommendations of the International Panel on Climate Change (IPCC). As such, clean energy becomes a prerequisite for supporting economic growth and the creation and growth of businesses in New Mexico.

The IPCC released their Sixth Assessment Report in August 2021 with an update in February 2022[8] in which they provided a very worrying outlook for Earth's future. The figure below highlights the impact of climate change in stark terms.

The headline of the IPCC report is specific: "The scientific evidence is unequivocal: climate change is a threat to human well-being and the health of the planet.

Any further delay in concerted global action will miss the brief, rapidly closing window to secure a livable future."

Given the critical nature of recommendations of the IPCC report, the relevance of the Clean Energy Economy Roadmap and transitioning to clean energy sources and creating jobs around the availability of clean energy becomes clear. Overall, it is clear that the elements, recommendations, and actions to be taken that are identified in the Roadmap and front and in developing a sustainable future for New Mexico.

The first focus area identified in the Roadmap (Clean Energy - Economic Growth, the Hydrogen Economy, and the Environment) fully supports a transition from fossil fuels to Clean and Renewable Energy and the Hydrogen Economy. From NAIMI's perspective,

[8] The Intergovernmental Panel on Climate Change. 2022. Climate Change 2022: Impacts, Adaptation and Vulnerability. 2022. Available from: https://www.ipcc.ch/report/ar6/wg2/

a Clean Energy Economy needs to include green hydrogen as the basis for a sustainable Hydrogen Economy.

Figure V7.1. Findings of the IPCC.

Water is a critical element for any and all human endeavors. New Mexico has been in a severe drought condition for many years. The State has taken action to assess water issues and solutions by appointing Matt Hamman as the state's water advisor. Hamman will work closely with federal, tribal, state, and local agencies to ensure the state's water infrastructure is prepared for and resilient to the effects of climate change and across industry and communities to develop policies that set New Mexico toward responsible and conservative water management practices. An integral piece of the state's strategy involves the development of a 50-year water plan, which Hamman will coordinate among the state's water agencies, complete, and implement. Hamman began work in his new role in January 2022. However, NAIMI notes that without strong and sustained actions to limit climate change there is little chance for New Mexico to be able to implement a sustainable water effort that meets the needs of our citizens.

VI. Intelligent Manufacturing

Introduction

Manufacturing in the U.S. has been undergoing significant and rapid change in the last 10 years driven largely by new technologies:

- Consumers drive manufacturing to make goods better, cheaper, faster, cleaner.1
- Responsive manufacturing allows consumers to quickly and cost effectively get goods produced to their specific requirements.3
- The Internet of Things (IoT) has made possible extensive, cost-effective, capabilities for monitoring and controlling equipment in manufacturing.
- Just-in-Time (JIT) manufacturing coordinates materials delivery to needs and optimizes distribution of manufactured goods reducing cost storage. Additive (3D) manufacturing has opened new sets of capabilities in producing goods.

Figure VI.1. An Intelligent Manufacturing System

Intelligent Manufacturing (IM) means taking a holistic approach to all elements of manufacturing from the initial product concept thru R&D thru supply chain to manufacturing to distribution to maintenance to disposal. IM includes intelligent process monitoring to identify inefficiencies that can be addressed using intelligent control systems. It can also include analysis of the large amounts of data generated during the entire process to identify where inefficiencies occur. Computer modeling and simulation of parts and products and processes can be done to optimize performance and characteristics. Finally, intelligent manufacturing means minimizing environmental impact.

Manufacturing Assets in NM

Technology Transfer / Commercialization

New Mexico has strength in the number of national laboratories and research universities that have strong technology transfer programs:

- Los Alamos National Laboratory
- Sandia National Laboratories
- Air Force Research Laboratory
- White Sands Missile Range
- New Mexico State University
- University of New Mexico
- New Mexico Tech

New Mexico has a number of technology commercialization centers that help businesses with technology commercialization and support them in crossing the 'Valley of Death':

- NMSU Arrowhead Center
- UNM Rainforest
- NM Partnership
- NM Manufacturing Extension Partnership
- Small Business Development Centers:
  - Albuquerque
  - Rio Rancho
  - NM Junior College – Hobbs
  - San Juan College – Farmington
  - Dona Ana Community College
  - UNM Los Lunas
  - Clovis Community College

New Mexico also has resources that businesses can use in developing new products:

- New Mexico Consortium
- LANL and SNL Centers for Integrated Nanotechnologies
- NMSU Physical Science Laboratory

New Mexico also supports innovation:

- Local Economic Development Act
- Technology Readiness Gross Receipts Tax Credit

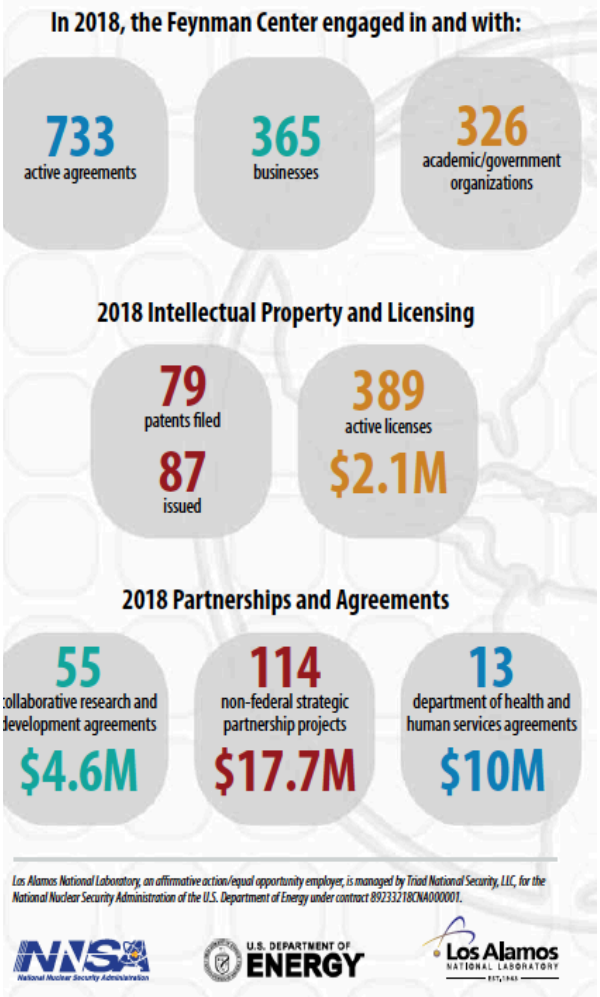


Figure VI.2. Feynman Center for Innovation – LANL.

Manufacturing Opportunities

Our country's economic security is reliant on the availability of manufactured goods at reasonable prices and high reliability on delivery. Most recently, COVID has demonstrated our vulnerability in depending on foreign suppliers for Protective Personnel Equipment (PPE), ventilators, and other medical supplies. This vulnerability resulted in shortages of critically needed goods and subsequent loss of American lives. (IM7) Similarly, the breakdown in foreign manufacturers providing integrated circuit chips has impacted the production and delivery of every digital device made, including phones, cars, hospitals, clean energy systems, and the smart grid. Disruption of our clean energy supply is also being recognized nationally for its vulnerability on foreign suppliers. The potential impact of disruption of the supply chain for our clean energy supply could affect virtually every aspect of our daily lives.

An area of importance for intelligent manufacturing is cybersecurity – ensuring that manufacturing of systems for the electric grid incorporate strong cybersecurity measures to ensure the grid is safe and secure from hacking, ensuring that proprietary information of the manufacturing process is not stolen by hackers seeking economic gain (ransomware or from the sale of valuable information to the highest bidder) or by foreign adversaries who wish to gain an advantage by stealing information that they can use to make themselves more competitive.

The growing interest in transitioning the U.S. to clean energy provides an opportunity for Greenshoring – namely manufacturing goods in the U.S. using clean energy and clean manufacturing processes. Such manufacturing can be applied to clean energy systems themselves as well as producing products that companies need to achieve a Zero Carbon Certification. New Mexico can be competitive in the Greenshoring arena as we have the lowest cost of Renewable Energy in the U.S.

The pressures denoted above provide an opportunity for Reshoring – namely U.S. companies moving manufacturing of their goods back to the U.S. Reshoring would most likely apply to goods that are considered critical to the health, safety, and livelihoods of Americans. One of those areas is clean energy – reshoring manufacturing of not only solar panels and wind turbines, but also control and monitoring systems for the smart grid, and energy transmission and storage components and systems.

An area of manufacturing that is particularly relevant for New Mexico is Nearshoring – namely manufacturing of some components needed for a product in the U.S. and some components in Mexico. Nearshoring has provided economic benefit to the U.S. states bordering Mexico for decades. As pressures mount to reshore manufacturing, some of that pressure can be relieved by nearshoring. Having parts made in Mexico close to the U.S-Mexico border would alleviate the supply chain issues that we are currently

experiencing due to COVID. This is an area in which NAIMI has had good experience in the past partnering with CIDESI in Mexico on a joint US-Mexico Intelligent Manufacturing Initiative.

A good example of nearshoring is the joint manufacturing work going on between McCallen Texas and Renosa Mexico. New Mexico could profit learning from this effort to expand cross-border manufacturing between Santa Teresa NM and Ciudad Juarez in Mexico.

The possibilities for NM in nearshoring in the Paso del Norte region (the intersection of New Mexico, Texas, Chihuahua) was developed in September 2014 at a summit meeting in San Diego of 100 leaders from the U.S. and Mexican border states that was sponsored by FUMEC (US-Mexico Foundation for Science).. The outcome of the summit was to form the Binational Intelligent Manufacturing Initiative (the antecedent of NAIMI). At the end of summit Thomas Guevara, Deputy Assistant Secretary, Office of Regional Affairs, U.S. Economic Development Administration, stated that the Intelligent Manufacturing Initiative proposed had the potential to create 1.5 million manufacturing jobs along the U.S.- Mexico Border. Scaling that for the level of cross-border manufacturing in the New Mexico-Chihuahua and including a growth factor of 7-8% per year, we estimate that Nearshoring of Intelligent Manufacturing could result in the creation of 15,000 manufacturing jobs in NM in the next 5 years. Just as important, such a nearshoring effort could support Greenshoring with companies taking advantage of NM having the lowest cost of RE in the US.

VII. Information Technology & Cybersecurity

VII.1 Information Technology

Overview

Information Technology (IT) is at the heart of the American way of life – from cell phones to laptops to our cars to our televisions, to our way of communicating using Zoom during COVID. It is difficult to envision modern life without the internet and computers. Many of the innovations that have brought new products to the marketplace have been developed in the U.S. Yet increasingly, other countries including Japan, South Korea, and China are working to take center stage in the IT arena. The US can retain its position of dominance only if we invest in innovation, entrepreneurship, and education.

Information Technology advances in the last decade with new capabilities such as the Internet of Things (IoT) have provided significant benefit to society and to our economy. With significant R&D resources at our universities, colleges, and national laboratories, NM has the highest level of R&D intensity in the U.S. with 6.9% of the share of the

State's GDP[9]. IT is a significant part of this share and offers an opportunity to grow companies.

Information Technology is both a foundational issue for economic growth and an opportunity to create jobs in a clean energy economy. In particular, implementing the latest advances in IT into the electric grid is important not only in terms of efficiency but also in terms of the ability to monitor and control the grid in real time. The importance of this can be seen in the impact of recent wildfires and severe storms on the ability of utilities to provide reliable power.

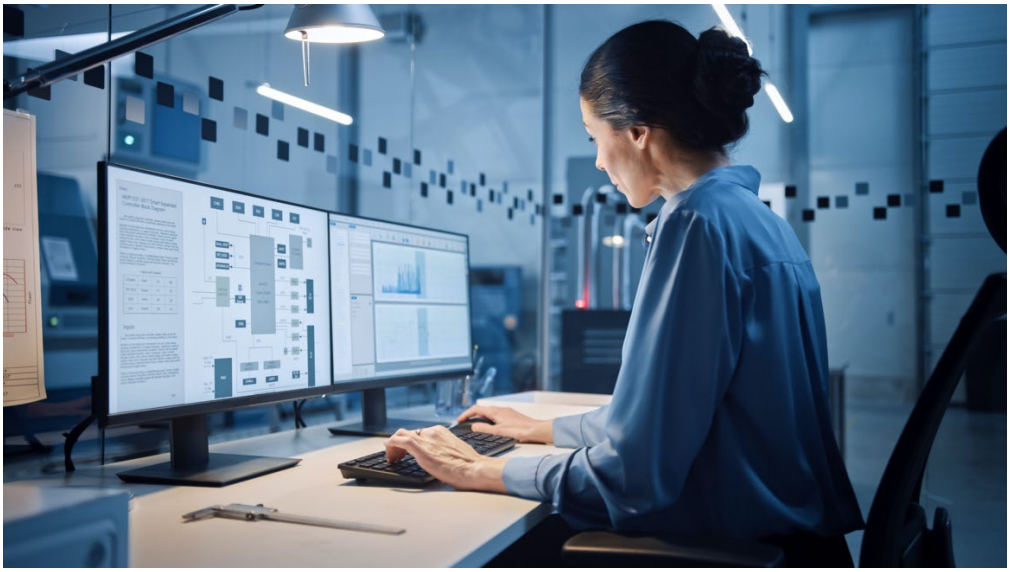


Figure VII.1. IT control of a CNC (Computer Numerically Controlled) System.

Current Assessment of IT Issues

NM faces some challenges in growing the IT world:

- Broadband connectivity is poor and without good broadband, it is impossible to attract and grow IT companies.
  - The U.S. ranks 10th in the world and NM ranks 45th in the U.S. with average speed of 30 Mbps and 80% coverage.[10]
- Limited availability of a trained workforce

[9] SSTI Weekly Digest. 2019. Available from: https://ssti.org/blog/useful-stats-overall-rd-intensity-state-2002-2016

[10] Cooper T, Tabnerk J. 2021. Best and Worst States for Internet Coverage, Prices and Speeds, 2021. Broadband Now Research. Available from: https://broadbandnow.com/research/best-states-with-internet-coverage-and-speed

IT Assets

NM has good resources in the IT world:

- Intel has its largest computer chip manufacturing center in Rio Rancho and recently announced it will make a $3.5B investment there to make it the center of their R&D program.[11]
- NM State University and its Arrowhead Center
- Los Alamos and Sandia National Laboratories have strong IT programs, including modeling and simulation as well as efforts in nanotechnology that have IT applications.
- Facebook opened a $1B data center in Los Lunas using 100% renewable energy.[12] The selection of Los Lunas was due in large part to New Mexico having the lowest cost of renewable energy in the U.S. and the incentives the city and State provided.

Figure VII.2 Facebook data center in Los Lunas

- Netflix bought Albuquerque Studios to provide a production center for their films and tv shows that employ a high degree of digital media.
- A cooperative agreement between the country of Japan and New Mexico resulted in a $57M investment by the Japanese government to develop a 1-MW

[11] Intel. 2021. Available from: https://www.intel.com/content/www/us/en/newsroom/news/new-mexico-manufacturing.html#gs.0wmz5h
[12] KRQE. 2020. Available from: https://www.krqe.com/news/new-mexico/study-facebooks-los-lunas-data-center-represents-1b-investment-in-new-mexico/

solar array with storage and a smart grid system in Los Alamos and a 0.5MW solar array and smart grid system at Mesa del Sol

- The University of New Mexico Institute for Digital Media trains students to be productive in Computer Generated Images (CGI).
- The Bigbyte secure campus and data center in Albuquerque houses computing and data storage systems.
- UNM Center of Digital Media
- $950K appropriation made by the NM Legislature in 2021 to the NM Department of Information Technology to create an Office of Broadband Access and Expansion charged with providing the Governor with a three-year statewide broadband plan by January 1, 2022.

Opportunities

There are opportunities to grow the IT sector in NM:

- Los Alamos and Sandia National Laboratories have new management that support their technology transfer/commercialization programs.
- NM can attract environmentally conscious IT businesses due to having the lowest cost of RE in the U.S.
- NM universities and colleges are working to support the IT workforce.
- The Biden Administration is proposing to support manufacturing in the U.S., including for the semiconductor industry.[13]
- Big Data – 84% of companies know Big Data analysis can improve their bottom line but only 16% know how to handle Big Data Cybersecurity Overview.

VII.2. Cybersecurity

Overview

Cybersecurity is both a foundational issue for economic growth and an opportunity to create jobs in a clean energy economy.

Cybersecurity events have recently come to the forefront with break-ins to companies that provide services to many government and business organizations including ransomware attacks like the Colonial Pipeline hack. There have been successful denial-of-service attacks on the US power grid. While those did not result in any damage, but

[13] The White House. American Jobs Plan. Available from: https://www.whitehouse.gov/wp-content/uploads/2021/04/American-Jobs-Plan-Master_Manufacturing.pdf. Fact Sheet: Biden-Harris Administration Bringing Semiconductor Manufacturing Back to America. Available from: https://www.whitehouse.gov/briefing-room/statements-releases/2022/01/21/fact-sheet-biden-harris-administration-bringing-semiconductor-manufacturing-back-to-america-2/

hackers could shut down the electric grid, and destroy equipment. Such an attack could take years to recover from and could result in numerous deaths.

Current Assessment of Cybersecurity

NM is well positioned to take advantage of the R&D efforts in cybersecurity at our national laboratories and with the cybersecurity education programs at NMSU, UNM, NMT, ENMU, and NAM and cybersecurity certificate programs at CNM, ENMU, and WNMU. With an estimated shortfall nationally of 358,000 unfilled positions in cybersecurity, NM is positioned to grow the number of NM workers in cybersecurity.

Cybersecurity events have recently come to the forefront with news of major cybersecurity break-ins to companies that provide services to many government and business organizations, to ransomware attacks like the Colonial Pipeline attack, cyberthefts, and attacks on the U.S. electric grid.

Figure VI.3. Continuous monitoring for cybersecurity intruders

Cybersecurity is rapidly garnering national attention due to recent cyberattacks:

- The SolarWinds attack by an organized group in a foreign country provided access to the networks of a number of businesses and Federal agencies that resulted in theft of valuable information, possible monetary impacts, and threats to the abilities of those attacked to perform their jobs.
- The ransomware attack by an organized group in a foreign country led to the shutdown of the Colonial gas pipeline that supplies a large fraction of the oil and natural gas to the East Coast of the U.S. This resulted in the payment of $4.4M

to the attackers (of which $2.3M was recovered) and the disruption of services to customers for a week.[14]

- The Annual Threat Assessment of the U.S. Intelligence Community published 4/9/2021 stated that:
    - "China presents a prolific and effective cyber-espionage threat, possesses substantial cyber-attack capabilities…"
    - "Russia will remain a top cyber threat…"
    - "Iran's expertise and willingness to conduct cyber operations make it a significant threat to the security of the U.S. …"
    - "North Korea's cyber program poses a growing espionage, theft, and attack threat."
- There have been a number of attacks on the electric grid, including one in which the hackers took control of part of the U.S. western electric grid (WECC) for 10 hours on March 5, 2019 hacking caused periodic "blind spots" for grid operators in the western US for 10 hours from a denial-of-service attack in Utah, Wyoming, California.[15] While the hackers did not cause physical damage to the grid, there are those in foreign countries who likely do have the capability to do extensive damage to the U.S. grid.

In general, businesses, organizations, and government agencies are becoming more aware of the potential for cyberattacks against them and are looking to find ways to implement better cybersecurity measures.

EERE Cybersecurity Multiyear Program Plan

In May 2021 the Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) provided a Cybersecurity Multiyear Program Plan to Congress. While the Plan was directed at the Federal sector using EERE technologies, its observations and recommendations apply equally well to the public sector and are relevant to the Roadmap cybersecurity effort. EERE observed:

- Sensors and controls that are connected to communicate through the Internet or other IT platforms are key to more affordable and efficient energy use.
- A reliable and resilient energy supply depends on improving cybersecurity defenses and mitigating the cyber vulnerabilities of these technologies.
- New renewable energy technologies, such as advanced solar inverters, must be designed with cybersecurity as a requirement.

[14] Romo V. 2021. How A New Team Of Feds Hacked The Hackers And Got Colonial Pipeline's Ransom Back. Available from: https://www.npr.org/2021/06/08/1004223000/how-a-new-team-of-feds-hacked-the-hackers-and-got-colonial-pipelines-bitcoin-bac

[15] [DOE] Department of Energy. 2019. OE-417 Electric Emergency and Disturbance Report. Available from: https://legacy-assets.eenews.net/open_files/assets/2019/04/30/document_ew_03.pdf

- Cyber threats present an immediate risk to the integrity and availability of energy infrastructure and other systems critical to the Nation's economy, security, and well-being.

EERE also noted that as operational technologies and IT networks evolve that engineers and managers are increasingly being asked to respond to cybersecurity challenges. These new responsibilities are not accompanied by the necessary tools, technology, and workforce development to train and respond to a rapidly evolving cyber threat. And the number of cybersecurity experts has not kept up with demand. According to a 2018 $(ISC)^2$ study[16], there is a significant number of open cybersecurity-related positions, almost 500,000 in North America alone. With 3.2 million Americans working in RE and clean energy jobs, these sectors will be requiring additional cybersecurity experts to detect and manage risk.

Connection of IT and Cybersecurity to Clean Energy

A reliable and resilient energy supply depends on improving cybersecurity defenses and mitigating the cyber vulnerabilities of new IT technologies. Sensors and controls that are connected to communicate through the Internet or other IT platforms are key to fully integrating new technologies to deliver on more affordable and efficient energy use. Yet the implementation of advanced IT capabilities provides new avenues for cybersecurity threats to attack our electric grid. As noted in the previous section of the Current Assessment of Cybersecurity, attacks on the electric grid have already occurred and can be expected to increase in frequency and potential damage. It is essential to address these cybersecurity threats. Cybersecurity threats to EV charging stations must also be addressed to identify, assess, and mitigate cyber-physical security vulnerabilities that exist in the interfaces between vehicles, chargers, and the grid.

Cybersecurity Connection of IT and Cybersecurity to Intelligent Manufacturing

Sensors and controls that are connected to communicate through the Internet or other IT platforms are key to fully integrating manufacturing technologies. Many semiconductor devices for sensors, controls, and power electronics in new technologies are identical or very similar, so it is important to address cybersecurity cohesively.

Digitization and automation have greatly increased the complexity and inherent risk of globally distributed cyber-physical supply chains in manufacturing. Advances in automation technologies, including sensors and controls, hold promise for increased performance, energy efficiency, and economic growth, but these technologies also present new cyber vulnerabilities.

[16] $(ISC)^2$. 2018. $(ISC)^2$ Cybersecurity Workforce Study.

Assets

NM has significant resources to address cybersecurity issues:

- Los Alamos and Sandia National Laboratories have a great deal of experience in protecting themselves from cyberattack. Although millions of hacking attempts are made every month, there has not been a single successful penetration.
- NMSU, NMT, and ENMU offer courses and degrees in cybersecurity
- NMT operates the Cybersecurity Education Center and the Cybersecurity Center of Excellence,
- LANL has developed and successfully demonstrated a quantum cryptographic control system for their electric grid that is impossible to hack into without knowing the attack has occurred.
- NMT has spun out cybersecurity businesses, most notably RiskSense

Cybersecurity Opportunities

NM is well positioned to take advantage of the R&D efforts in cybersecurity at our national laboratories and the cybersecurity education programs at NMSU, UNM, NMT, and ENMU and cybersecurity certificate programs at CNM, ENMU, and WNMU. NM is positioned to grow a strong cybersecurity industry to help fill the 358,0002 unfilled cybersecurity jobs in the U.S.

The US Bureau of Labor Statistics projects "information security analyst" will be the 10th fastest growing occupation over the next decade, with an employment growth rate of 31% compared to the 8% average growth rate for all occupations.[17]

CyberReady program – NM EDD received a grant from the Dept of Defense to pioneer a cybersecurity awareness and preparedness training initiative to help NM businesses become compliant with federal cybersecurity standards.[18]

Many cybersecurity efforts can be done remotely so that NM workers do not have to relocate to other states.

NM universities and colleges have realized the importance of educating students in cybersecurity and have put cybersecurity education programs in place.

NM has an FBI cybersecurity team located in Albuquerque.

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[17] U.S. Bureau of Labor Statistics. 2021. Available from: https://www.bls.gov/ooh/computer-and-information-technology/information-security-analysts.htm

[18] Tomar M. New Mexico Economic Development Department Office of Science and Technology. 2021. State-Led CyberReady Initiative will Assist Businesses with Cybersecurity Best PracticesAvailable from: https://ocedc.com/state-led-cyberready-initiative-will-assist-businesses-with-cybersecurity-best-practices/

NM has strong cybersecurity groups at our national labs and defense installations.

The EERE Plan is closely aligned with what the Roadmap sees as an essential element in growing a Clean Energy Economy – namely IT and Cybersecurity. There is clearly an increasing need for cybersecurity personnel that the Roadmap has identified for NM.

VIII. Clean Energy Economy Roadmap Perspective

In developing the Roadmap, NAIMI has taken a bottoms-up holistic approach in which input was received and evaluated from a very wide range of people, business industries, utilities, colleges and universities, and national laboratories:

- Statewide Townhall Meetings (Appendix 1) in August 2020 and April 2021
- 12 Regional Advisory Groups (Appendix 2) convened by NAIMI
- Input from industry (Appendix 3)
- Input from other Clean Energy meetings (Appendix 4)
- Ties to national strategies (Appendix 5)
- Legislative actions (Appendix 6)
- Other economic / workforce development and clean energy plans (Appendix 7)

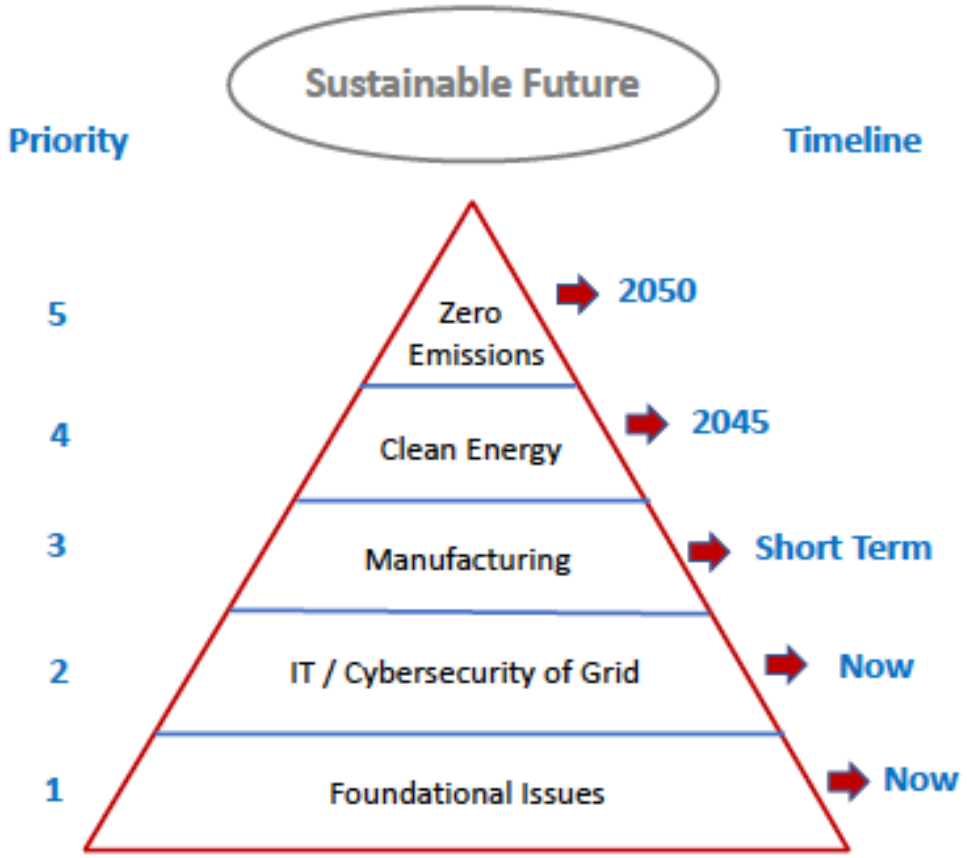


Figure VIII.1. Sustainable Future Pyramid

The pyramid reflects the transition to a sustainable future that includes addressing foundational issues and opportunities for economic development and job creation. The priority is largely based on the timeline to achieve a goal.

There are three areas of **"Foundational Issues"** that are essential needs that must be met to grow the economy:

- **Four Process Areas** that include easing the transition from fossil fuels to clean energy, connecting with clean energy opportunities, making policy and regulatory processes much more business friendly, and increasing technology transfer and commercialization of our universities and national laboratories.
- **Four Infrastructure Areas** that include energy delivery infrastructure, high speed broadband, cybersecurity capabilities, and improving transportation through well-maintained roads and railways.
- **Workforce** is a foundational issue that requires developing the Workforce to connect the labor force with specific industry training needs.

IX. Implementing the Roadmap

New Mexico can transition to a Clean Energy Economy only if we address issues that affect our ability to develop the workforce needed for a Clean Energy Economy and to recruit and grow businesses that want to take advantage of NM having the lowest cost of Renewable Energy in the country.

We feel it is important to be up front in saying that a transition to a Clean Energy Economy will not be possible without some movement of the workforce. Some jobs in the Clean Energy Economy can be done remotely, but some of the new jobs will involve not only retraining, but also relocation of people. This is particularly true of the oil and gas industries in the Permian Basin and Four Corners area.

The overall goal of the Roadmap is to develop a new Clean Energy Economy that provides an overall increase in the number, salaries, and benefits for New Mexican residents. In contrast to some other job development efforts, the Roadmap is taking a holistic approach that includes R&D, technology transfer and commercialization, supply of clean materials, intelligent manufacturing (described in Section VI), a highly trained workforce, distribution and maintenance. This approach involves a lot of issues that must be addressed in a coherent and coordinated fashion to ensure that the transition is done in a manner that allows minimal disruption of people's lives. Overall, the gain will outweigh the pain that will be experienced in transitioning to a Clean Energy Economy. The next step in addressing implementation of the Roadmap will be to develop a detailed plan for the workforce development needed and to start implementing those

actions. The timeline for the transition needs to take into account the current dependence of the New Mexico economy on oil and gas balanced by the need to transition away from oil in gas rapidly in order to ensure the impact of climate change is kept to a manageable level. This is not an easy or simple task, but it is a necessary one. The Roadmap is a step in the right direction to carry out this task.

In developing the Roadmap, NAIMI received significant input that identified several 'Foundational Issues' that must be addressed to grow the clean energy economy (Section IV). The issues fall into two categories: *Process and Infrastructure*.

IX.1 Process

The Roadmap identifies four process areas that are "Foundational Issues" where actions are needed to be able to grow the economy (see Section IV):

Actions are listed roughly in order of importance.

1. Ease the transition from fossil fuels to clean energy

GOAL 1:

Fully implement the requirements of the Energy Transition Act sooner than 2045 to be in line with the target date of 2035 set by President Biden.

GOAL 2:

Create jobs in a Clean Energy Economy that employ New Mexicans as they lose their jobs in the fossil fuel industry as NM transitions from fossil fuels to clean energy.

METHOD:

- To maintain stability of the economy in NM it is important to start retraining fossil fuel workers starting now to other jobs that are created around the availability of clean energy as we develop the clean energy economy.
    - A good example is the efforts in Hobbs to develop an EnergyPlex economy that includes the development of clean energy sources as a means to stabilize the economy of the Permian Basin.[19]

ACTIONS:

- Creating jobs in a transition to a Clean Energy Economy must be a joint effort of EMNRD, EDD, DWS, and our colleges and universities. The Legislature must be

[19] Todd L. 2016. In New Mexico, a way out of the boom-bust cycle?
Lea County tries a different formula for rural success. High Country News. Available from: https://www.hcn.org/articles/a-new-dawn-for-new-mexicos-energyplex

willing to appropriate the funding required for this effort. The Governor's office should direct this effort.

- EMNRD, EDD, and ENV must work with the Legislature and the Governor's Office to develop policies to attract and grow businesses who want to be green and who can benefit from NM having the lowest cost RE in the country.

2. Connect with Clean Energy Opportunities

GOAL:

- Take advantage of efforts underway to provide support to increase usage of electric vehicles, creation of significant amounts of RE storage, and the hydrogen economy.

METHOD:

- The NM Legislature, EMNRD, EDD, ENV, PRC, and the Governor's Office should work in concert to increase the number of electric vehicles and charging stations, implement large-scale energy storage, and the growth of green hydrogen in NM.

ACTIONS:

- Gov. Lujan Grisham should support enacting incentives to build out EV charging stations and to create a clean fuels energy standard.
- NM should support the Beclabito Pumped Storage Hydroelectric project
  - EMNRD should develop a plan that lays out State participation
  - The NM Congressional delegation and Gov Lujan Grisham should provide letters of support
- NM should support the Beclabito NM should support the conversion of the Prewitt coal-fired power plant to a hydrogen facility.
  - As in any initiative in the Hydrogen Economy, the energy and carbon balance of the conversion must be made and shown to be beneficial in addressing climate change before a project is supported.

3. Make policy and regulatory processes much more business friendly.

GOAL:

- Make NM more business friendly so NM can attract companies that are attracted to NM due to its business-friendly manner and low cost of RE Process.

METHOD:

- EDD, EMNRD, ENV, SLO, and the State Engineer need to develop an assessment of how well NM is doing compared to our neighboring states in attracting and growing clean energy-related businesses.
- The twelve NAIMI Regional Advisory Groups can provide invaluable input.

ACTIONS:

- The State should modify existing and implement new policies and regulatory processes that will make NM competitive with our neighboring states.
- The State should address specific policy and regulatory issues that are presented in Appendices 1 and 3.
- The State should assess policies that are outdated, inconsistent, or are too complex and modify them to be more business friendly.

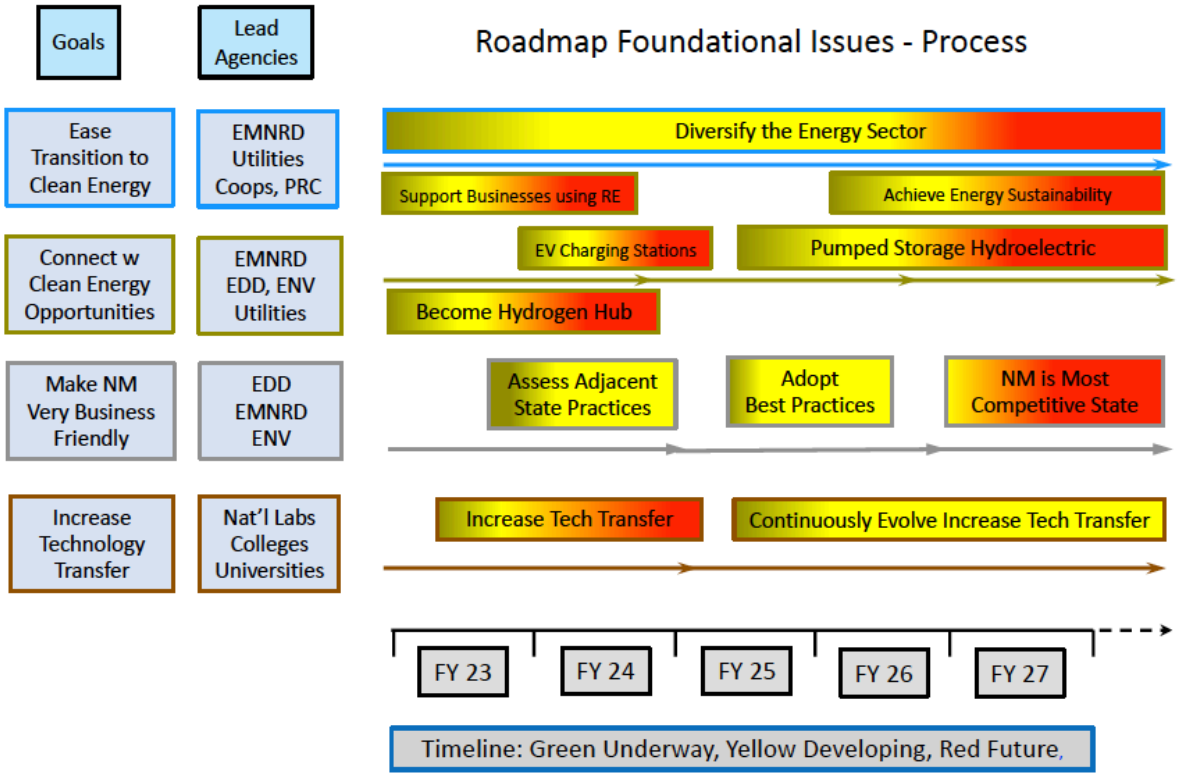


Figure IX.1. Timeline for Roadmap Foundational Issues Process Issues

4. **Increase technology transfer and commercialization of our universities and national laboratories.**

GOAL:

- Improve the connections between businesses and our research universities and national laboratories.

METHOD:

- EDD should support the efforts of communities outside the Rio Grande corridor to be able to draw on the capabilities of the research universities and national laboratories technology transfer and commercialization capabilities.
    - A possible means might be to have an organization like the NM Consortium set up to provide broader participation by business.

ACTIONS:

- State government must adopt the best models from across NM and neighboring states to develop a coordinated and collaborative strategy that makes NM regionally and nationally competitive in a Clean Energy Economy.

The timeline for Roadmap activities to address "Fundamental Process Issues" over the next five years is shown in Fig. 1X-1.

IX.2 Infrastructure

The Roadmap also identifies four infrastructure areas as "Foundational Issues" that require efforts and investments to be made for economic growth (see Section IV). Specifically:

<u>New Mexico's Renewable Energy Potential</u>

1. **Energy delivery infrastructure** includes not only electric grid transmission lines, but also distribution, smart grid, and energy storage as well as grid cybersecurity.

   GOAL:

   - Enhance energy delivery infrastructure to provide the full range of capabilities needed to take advantage of the increase in RE to support the growth of the Clean Energy Economy.

   METHOD:

   - The State should work to ensure coordination of all the elements that go into creating a full RE capability for NM.

ACTIONS:

- The Energy Conservation and Management Division (ECMD) of EMNRD should continue to use the Grid Modernization Program to coordinate the full range of efforts involved in developing the RE energy for a Clean Energy Economy.
- EMNRD needs to work with the Legislature, the PRC, and the SLO to identify priorities for new transmission lines.
- The Governor's office needs to work with the reformed PRC starting in 2023 to push forward changes to make the PRC approval process more efficient and more in line with meeting the needs of the public.

2. Implementing **Hi-speed Broadband** requires:

GOAL:

- Make NM competitive with neighboring states for broadband coverage, speed, and price access.

METHOD:

- For businesses, the most important factor is the ability to obtain high-speed internet at a reasonably low price.
- The State should work to increase wired internet coverage t low price by 3% per year for the next 5 years while also increasing average speed by 20 Mb/sec per year for the next 5 years.
    - This would provide 87% coverage with average speed of 408 Mb/sec, corresponding to 4% and 7% annual improvements in coverage and speed. This is sufficient to make NM competitive regionally. While adjacent bordering states will certainly continue to improve coverage and speed, this approach should be sufficient to put NM on a par with our neighboring states, allowing us to compete in creating and growing businesses more effectively.

ACTIONS:

- Develop a long-range plan to provide the required capabilities through coordinated planning involving NM telecom businesses, DoIT, and EDD.
- An effort has started with the passage of SB 93 in 2021 to create an Office of Broadband Access and Expansion which will provide the Governor with a three-year statewide broadband plan by January 1, 2022.
- The State should ensure the $130M funding for broadband provided by the Legislature are used effectively to support business growth.

    - NAIMI appreciates that Governor Lujan Grisham has appointed Matt Schmit as broadband advisor to the new state Office of Broadband Access and Expansion.
- A coalition of Internet Service Providers (ISPs) and state government must work in concert to develop a working relation in which the state provides some level of support for broadband expansion in return for ISPS making upgrades.
    - A previous effort demonstrated the possibility of such an arrangement.
- Any expansion of broadband service must necessarily include implementation of state-of -the-art cybersecurity measures.
- The State should ensure the funds for broadband provided by the Legislature are used effectively to support business growth.

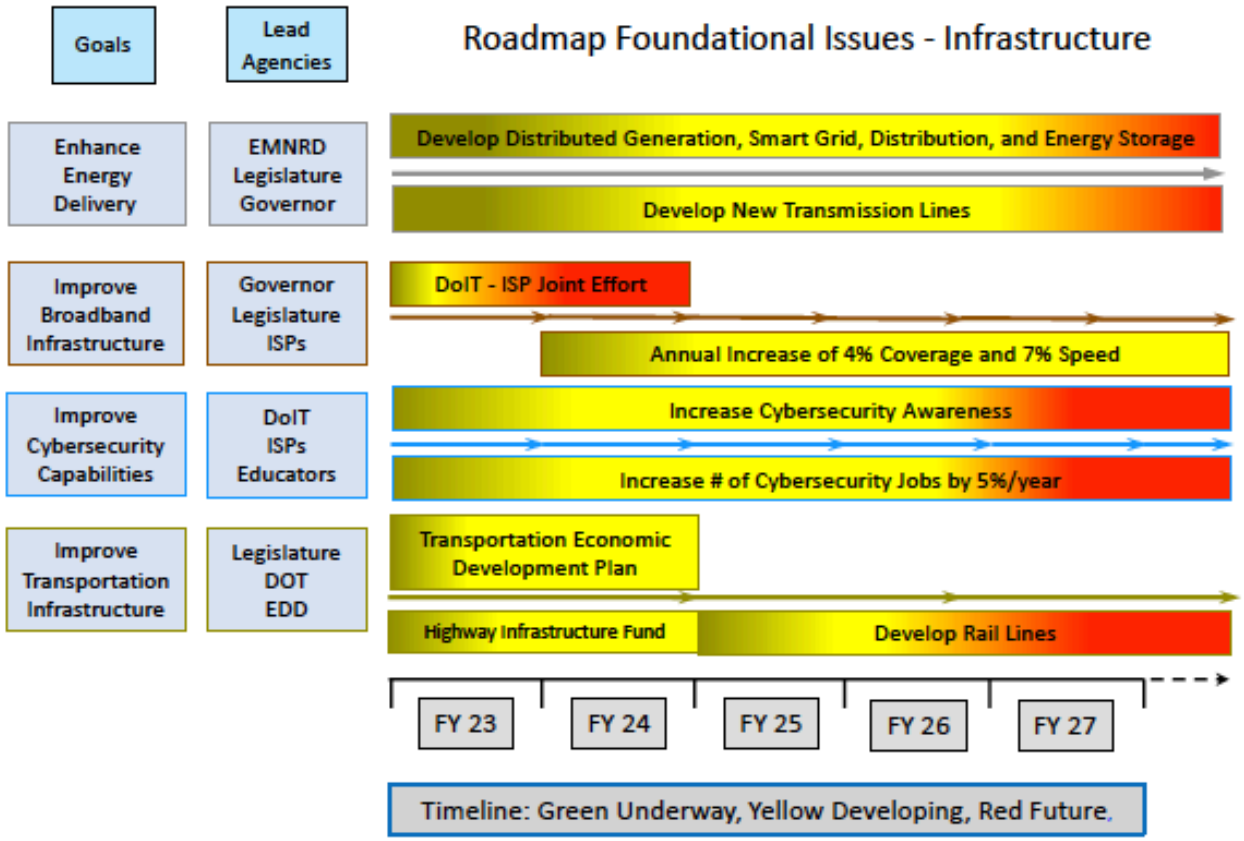


Figure IX.2. Timeline for Roadmap Foundational Issues Infrastructure Issues

3. Cybersecurity Capabilities

GOAL 1: Improve cybersecurity capabilities in NM tp a degree that provides robust protection against significant loss of critical capabilities of the electric grid, health and first responder capabilities, and economic losses.

GOAL 2: Increase number of cybersecurity jobs in NM by 5% per year

METHOD:

Goal 1 requires both the public and private sector in NM to implement cybersecurity software and hardware.

Goal 2 NM universities must work with cybersecurity businesses to address their workforce needs through increased enrollment for cybersecurity degrees.

ACTIONS:

Goal 1:

- Utilities and electric coops need to provide homeowners, businesses, and institutions with information on possible cyber threats and the means to prevent attacks to the electric grid and to health and economic sectors.
- DoIT needs to work with state agencies, the Legislature, schools, colleges and universities, ISPs, businesses, our national laboratories, and public groups to increase public awareness of cybersecurity threats and the means to protect against such threats.
- Utilities and electric coops mut implement the steps necessary to secure the electric grid.

Goal 2:

- Our research universities and national laboratories need to support the growth of cybersecurity companies in NM by working with EDD to provide cybersecurity resources and workforce to meet the needs of potential businesses and to support their subsequent growth.

4. **Improving Transportation through well-maintained roads and railways:**

GOAL:

- Ensure that roads and bridges in need of repair that are used for transporting supplies and goods needed to grow a Clean Energy Economy and to support Intelligent Manufacturing are prioritized on the worklist of DOT.

METHOD:

- A first step to address this need was taken with the passage of SB121 in 2021 that provides $234M for a ‘highway infrastructure fund’.
- A risk assessment needs to be developed by the DOT to identify roads, bridges, and railways that are in imminent danger of failure.

ACTIONS:

- Additional appropriations need to be provided each year to address the needs identified by DOT.
- A Statewide Plan needs to be developed by DOT in concert with EDD to identify where railways need to be improved to support economic growth.
- Appropriations need to be provided for railways that need to be extended to support growth of manufacturing in NM as part of a coordinated effort to create a Clean Energy Economy.

The timeline for Roadmap activities to address “Fundamental Infrastructure Issues” over the next five years is shown in Fig. 1X.2.

IX.3 Workforce

As noted earlier, transitioning to a Clean Energy Economy will involve some displacement of workers from the oil and gas industry to other locations in New Mexico where well-paying, clean energy-related jobs are made available.

In addition to addressing “Foundational Issues” for economic development, input received by NAIMI led to the clear understanding that there is one activity that forms the basis for all other activities in creating a Clean Energy Economy: Workforce. Developing the Workforce means connecting the labor force with specific industry training needs.

GOAL:

- Recruit and grow companies that want to take advantage of NM RE resources.

METHOD:

- Ensure the NM workforce is trained for the clean energy jobs that are currently going to out-of-state workers.
- Ensure that that a trained workforce is available in time to meet the projected needs of business and industry as they grow

ACTIONS:

- The State (and possibly the Legislature) should convene a working group of EMNRD, EDD, ENV, and DWS that includes representation from NM colleges and universities, the national laboratories, and business and industry leaders that meet quarterly to adopt and continuously evolve a strategy with specific action items that identify and match both short-term and long-term business and industrial needs by developing and implementing the courses and programs required at our colleges and universities to meet projected needs.

- The strategy needs to include providing incentives for businesses to locate and grow in NM.
- The working group needs to continuously evolve the strategy and incentives as market conditions change.

- Offer technical career education programs through PED and HED and apprenticeships through DWS to start building the STEM workforce.
- Have community colleges work with companies to provide training / internships.
- Address specific workforce issues that are provided in the workforce sections of the Town Hall meetings and Industry Conversations (Appendices 1 and 3).

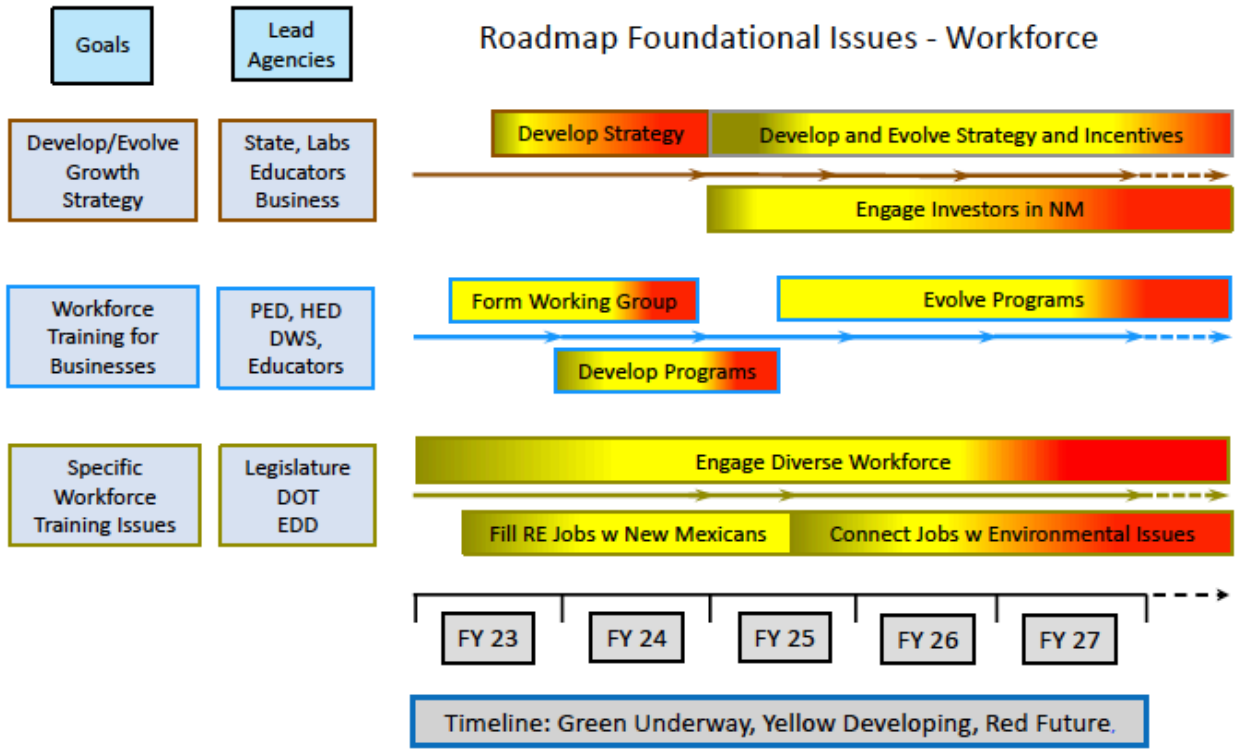


Figure IX.3. Timeline for Roadmap Foundational Issues Workforce Issues

The timeline for Roadmap activities to address “Fundamental Workforce Issues” over the next five years is shown in Fig. 1X.3.

IX.4 Roadmap Focus Areas

The Roadmap identifies three focus areas that offer the best prospects for growing jobs in a Clean Energy Economy:

1. Sustainable Clean Energy and the Environment
2. Intelligent Manufacturing
3. Information Technology and Cybersecurity

NAIMI has identified a number of action items that must be undertaken to create and grow jobs in these three sectors.

1. Growing Sustainable Clean Energy and the Environment:

1.1 Sustainable Clean Energy:

GOAL:

- Ensure that the growth of renewable energy is accompanied by the creation of a system of new electric transmission lines, energy storage, and smart grid/demand side management capabilities to make the increased RE available to communities and businesses to grow the Clean Energy Economy.

METHOD:

- Capitalize on the benefits of locating and/or growing a b in New Mexico – cost of living, rate of solar production, predictability in factors such as transportation times, good access to people who can make decisions.
- Coordinate efforts to simplify making increased RE available to communities and businesses for use in growing the Clean Energy Economy.

ACTIONS – Clean Energy:

- Increase awareness about all sources of clean energy and its positive impacts on the state's economy.
- NM PRC should encourage Time of Use Electric Rates.
- NM Colleges and Universities should partner with IBEW on effective training courses for electricians and technicians on DSM technologies.
- NM Construction Industries Division should coordinate with utilities and local governments to standardize interconnection and construction rules.
- Efforts to implement energy conservation technologies need to increase.
- Developing more geothermal energy, similar to what has been done in Iceland.
- Working to make distributed energy permitting consistent throughout NM

ACTIONS – Transmission:

- NM PRC should expedite their Transmission Study Update to include energy storage on transmission requirements.
- RETA and EDD should prepare a study of siting industrial facilities adjacent to RE production to reduce the need for new transmission lines.
- RETA should contract for a study of all barriers to transmission infrastructure additions with recommendations for overcoming those barriers.
- State Land Office (SLO) should include the potential for creating clean energy economy jobs when considering proposals for transmission lines.
- New Mexico should be part of a Regional Transmission Organization (RT) to help integrate more renewables and transmission onto the grid.

ACTIONS – Energy Storage:

- Support the Pumped Storage Hydroelectric (PSH) project at Beclabito.

ACTIONS – Smart Grid and Demand Side Management

- The ECMD of EMNRD should continue to use the Grid Modernization Program to drive increased implementation of the Smart Grid, Energy Efficiency, Demand Side Management, and Electric Vehicles.
- NM should enact a Clean Fuels Standard that would support increased usage of electric vehicle.
- EMNRD should propose incentives for installation of EV charging stations.

1.2 The Hydrogen Economy

GOAL:

- NM should develop a Hydrogen Economy.

METHOD:

- New Mexico should be a strong partner in the western states "Hydrogen Hub."

ACTIONS:

- EMNRD, ENV, and EDD should carry out a study and implement the findings to develop a green hydrogen capability in NM.
- EMNRD should propose incentives for hydrogen fueling stations in NM
- The State should support the efforts to turn the Escalante power plant into a hydrogen facility (pending an energy and carbon balance assessment)

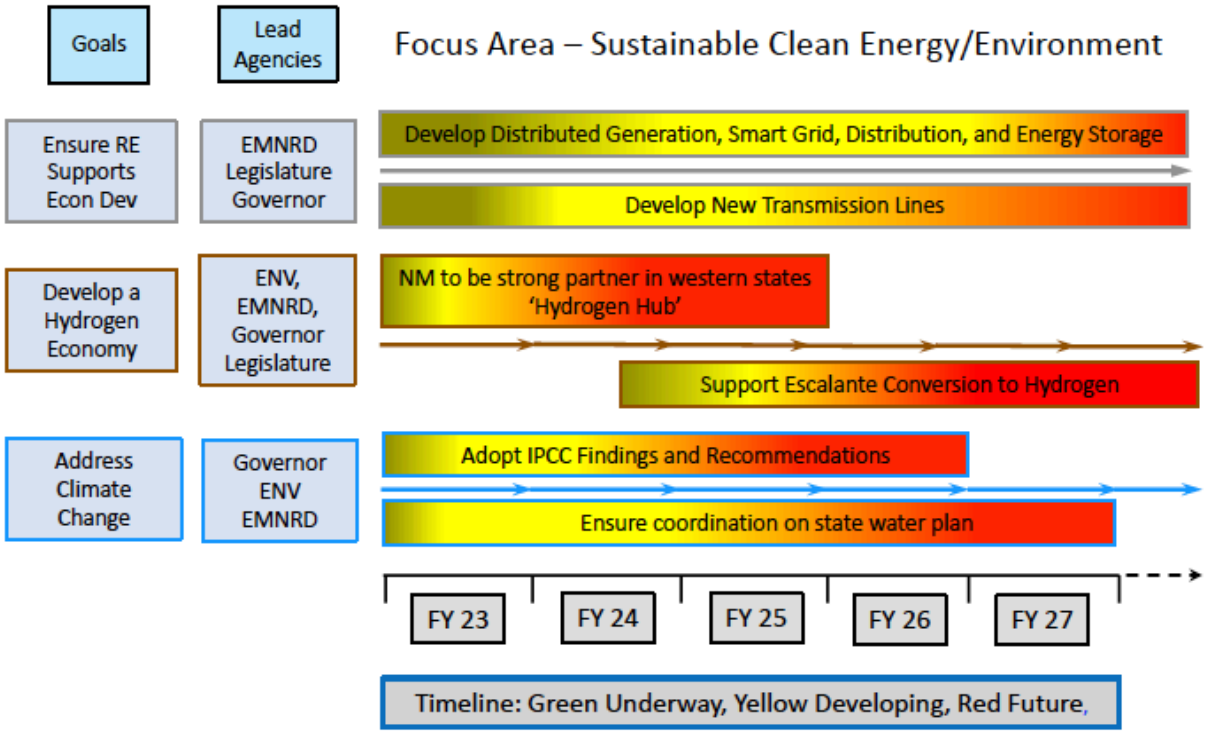


Figure IX.4.1. Timeline for Roadmap Sustainable Clean Energy/Workforce Growth

1.3 The Environment

- NM should formally adopt the findings of the International Panel on Climate Change and take actions to implement their recommendations
- The State should ensure that relevant departments work closely with the state water advisor to develop and implement a 50-year water plan.
- NAIMI appreciates that Governor Lujan Grisham has appointed Mike Hamman as the state's water advisor.
- The state infrastructure and water advisors need to work together to be effective in growing a clean energy economy.

GOAL:

- Develop a Clean Energy Economy that fully addresses climate change

METHOD:

- NM should formally adopt the findings of the International Panel on Climate Change and take actions to implement their recommendations

ACTIONS:

- The State should ensure that relevant departments work closely with the state water advisor to develop and implement a 50-year water plan.
    - NAIMI appreciates that Governor Lujan Grisham has appointed Mike Hamman as the state's water advisor.
    - The state infrastructure and water advisors need to work together to be effective in growing a clean energy economy.

The timeline for Roadmap activities to address Sustainable Clean Energy / Workforce growth over the next five years is shown in Fig. 1X.4.1.

2. Growing Intelligent Manufacturing

GOAL:

- New Mexico should create a strong intelligent manufacturing initiative.

METHOD:

- New Mexico should support the manufacture of parts needed by the clean energy industry including wind turbines, solar panels, transmission, smart grid systems, and power plant components.

ACTIONS:

- EDD and EMNRD should recruit more companies like Unirac and Array Technologies which have good products and can be used by NM RE providers.
- EMNRD and EDD should simplify regulations for companies wanting to grow or locate in NM
- The Governor should create a Green Jobs cabinet with membership from all state agencies that will answer the questions of companies concerning growth or locating in NM within two weeks from the date of receiving a request for answers.
- A previous effort demonstrated the possibility of such an arrangement
- DWS and HED need to coordinate workforce development and training/certification programs with projected needs of companies wanting to grow or locate in NM
- NAIMI should reestablish the Intelligent Manufacturing Initiative with CIDESI in Mexico.
- NAIMI should develop a Southwestern resource in NM that has broad connections that can match problems and needs with solutions.
- The Legislature should require the State Investment Council to use 10% of available funds for investments within NM

- Our national laboratories and R&D universities should expand the availability of access to their technology commercialization programs

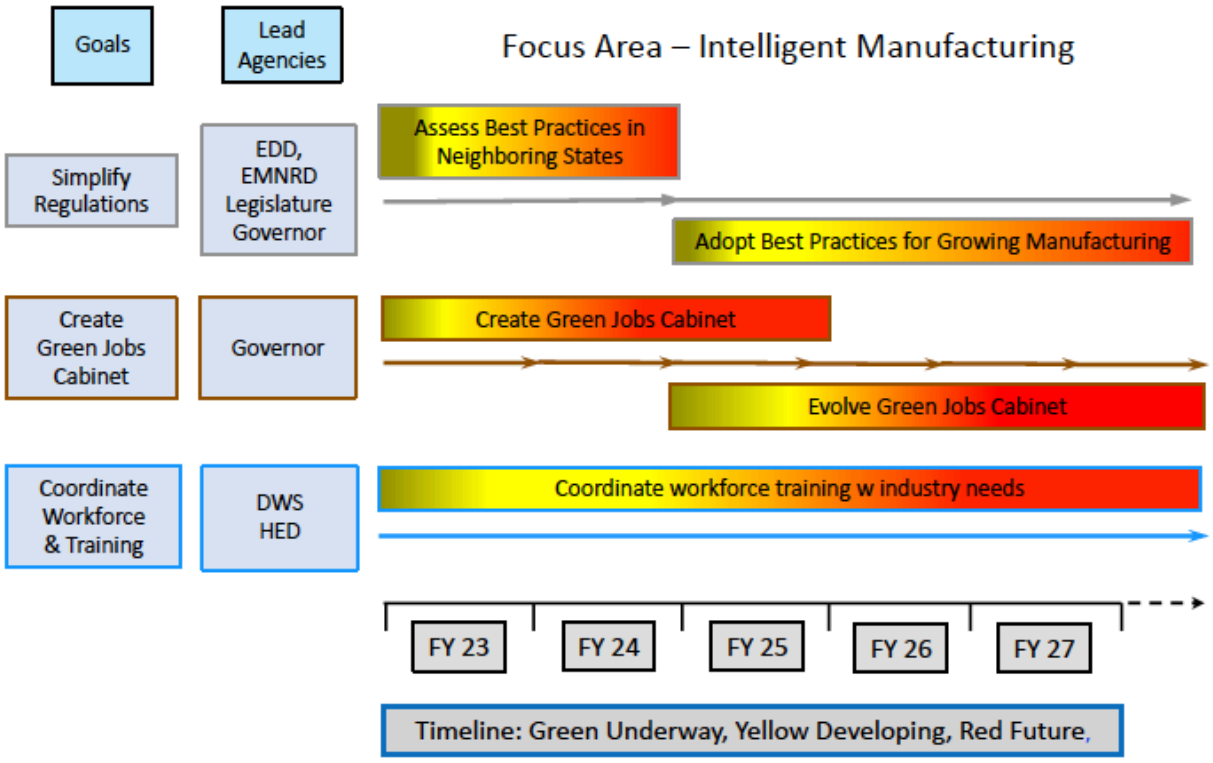


Figure IX.4.2. Timeline for Roadmap Intelligent Manufacturing Growth

The timeline for Roadmap activities to address Intelligent Manufacturing growth over the next five years is shown in Fig. 1X.4.2.

3. Growing Information Technology and Cybersecurity.

3.1 Information Technology

- Make cybersecurity a viable sector for job creation and growth in EDD.
- Support growth of IT businesses through access to Economic Development and Technology Based Economic Development (TBED) organizations.
- Fill positions in EDD to create an effective TBED program.
- Support the use of the NAIMI Regional Advisory Groups to establish a TBED membership forum across NM to connect businesses, organizations, and communities.

- Support the expansion of IT capabilities at Big Byte and elsewhere to support business growth.
- The State should ensure the funds for broadband provided by the Legislature are used effectively to support business growth.

GOAL:

- New Mexico should support the growth of a strong IT sector.

METHOD:

- Create a State IT resources center that can inform businesses, organizations, and communities of new IT capabilities as they are developed and assist them in growing the IT workforce.

ACTIONS:

- Support growth of IT businesses through access to Economic Development and Technology Based Economic Development (TBED) organizations.
- Fill positions in EDD to create an effective TBED program
- Support the use of the NAIMI Regional Advisory Groups to establish a TBED membership forum across NM to connect businesses, organizations, and communities
- Support the expansion of IT capabilities at Big Byte and elsewhere to support business growth
- The State should ensure the funds for broadband provided by the Legislature are used effectively to support business growth

3.2. Cybersecurity

GOAL 1:

- New Mexico should make cybersecurity an issue that everyone – individuals, organizations, companies, and businesses - is aware of.

GOAL 2:

- New Mexico should work to significantly increase its cybersecurity workforce.

METHOD:

- The State needs to create a strong cybersecurity awareness program.
- State agencies need to work together to grow the cybersecurity workforce.

ACTIONS:

- The Governor should appoint a Cybersecurity Czar
- DoIT should set up a cybersecurity awareness program for businesses, educators, and State agencies
- DoIT, EDD, DWS, the Legislature, and the Governor's Office need to support the growth of a strong cybersecurity industry in NM
- Make cybersecurity a viable sector for job creation and growth in EDD
- Cybersecurity education and training programs need to be matched with the demands for the cybersecurity workforce
    - HED and the Legislature should support and expand the cybersecurity education programs at NMSU, NMT, CNM, and other education institutions
- NM should investigate the possibility of joint NM-Mexico efforts on cybersecurity

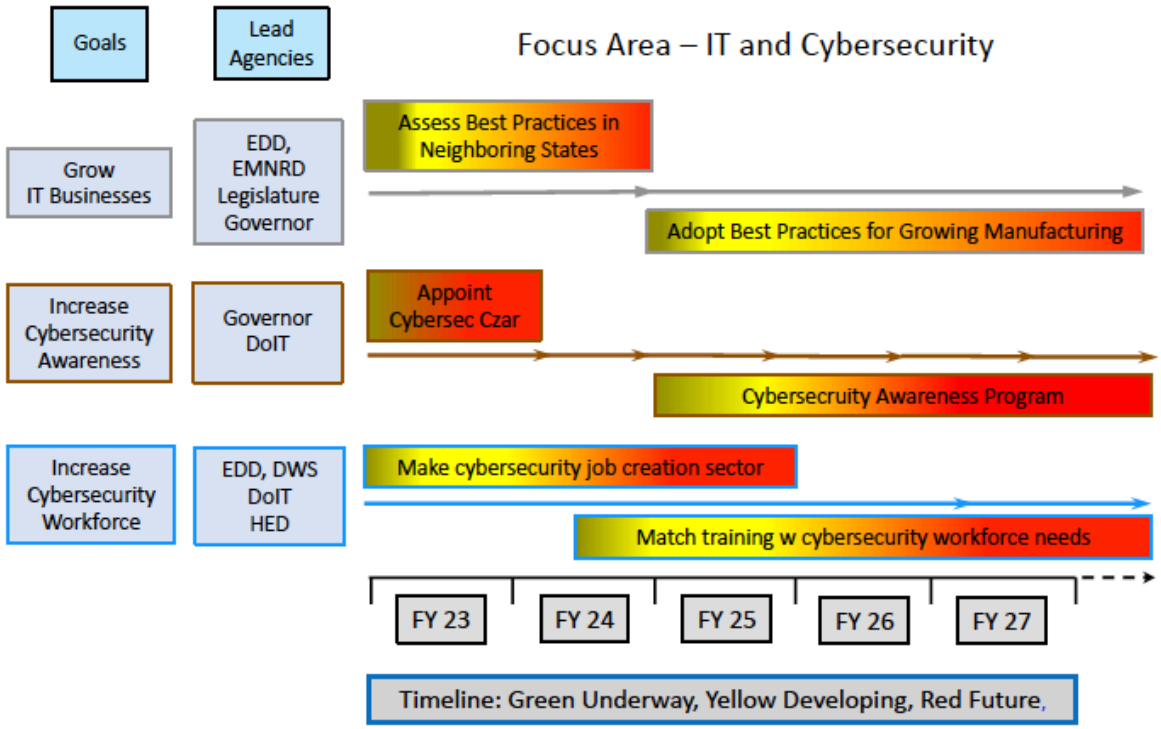


Figure IX.4.3. Timeline for Roadmap Intelligent Technology / Cybersecurity Growth

The timeline for Roadmap activities to address Intelligent Manufacturing growth over the next five years is shown in Fig. IX.4.2.

X. CONCLUSION

The Clean Energy Economy Roadmap is designed to provide direct guidance and actions that will result in the growth of a Clean Energy Economy. Recognizing that no Roadmap can be static, the initial effort is to define goals, methods, and actions that should be taken in the next 5 years to enable job growth and to establish NM as a leader in the Clean Energy Economy.

To that end, NAIMI, in collaboration with NMSU, has undertaken two statewide Town Hall meetings, formation of 12 Regional Advisory Groups, and has worked with industry, government, and a wide range of workforce and education groups to determine the best prospects for job growth that is tied to New Mexico having the lowest cost of Renewable Energy in the United States.

The Roadmap has identified goals and methods and lays out specific actions to be taken in the areas of Process, Infrastructure, and Workforce. In addition, the Roadmap has identified three areas as having the best prospects for job creation and growth in a Clean Energy Economy:

- Sustainable Clean Energy and the Environment:
- Intelligent Manufacturing
- Information Technology and Cybersecurity

These leads provide the best prospects for job growth in a Clean Energy Economy.

Finally, NAIMI is heartened to see that as the Roadmap was being developed that efforts on several of the action items that were identified were already being initiated, This demonstrates that the Roadmap is already proving of vallue.

APPENDIX

Appendix 1

Town Hall Meetings

NAIMI and ICREW hosted two virtual town halls to both ascertain interest and increase awareness of the clean energy economy. This ensured that the team could get grassroots feedback through a collective approach to addressing a clean energy transition in New Mexico. The Town Halls were open to anyone who wanted to register, and participants represented a variety of interests and industries including legislators, wind and solar developers, private industry, investor owned, cooperative and municipal utilities; educational institutions; trade associations; state, local, and tribal government representative, and nonprofit and advocacy organizations.

The first Town Hall in August 2020 briefly described the purpose of the Clean Energy Roadmap and featured speakers on efforts that pertain to New Mexico in a variety of areas including: beneficial electrification, workforce solutions, projects and policies related to a clean energy economy, and opportunities for manufacturing in the state. Breakout sessions led by subject matter experts worked to get valuable feedback from attendees in several key areas including economic development and entrepreneurship, workforce development, grid modernization, energy policy, and technology innovation.

The May 2021 Town Hall discussed national strategies on the transition to a clean energy economy and how New Mexico could benefit from the national work. In addition, state officials provided updates on current and future clean energy policy strategies, private sector representatives provided perspective on opportunities and challenges of building a clean energy economy in the state, and entrepreneurs shared their experiences in how they have benefitted from the transition to a clean energy economy.

Issues Surfaced in Town Halls

Needs and Opportunities	
Policies/Regulations	• Offering tax credits for geothermal heat pumps. • Permitting for solar installations is burdensome, opportunity to streamline multi-agency and community requirements. • Adopting and enforcing updated building codes. • Address how cost of transitioning to clean energy economy doesn't fall on ratepayers. • Adopting a clean fuel standard. • Tax incentives for energy storage. • Evaluating state level incentive models to allow low-income households to participate in and benefit from the clean energy economy.

	• Regulations impacting economic growth need to be uniform across the State.
Workforce Training	• Training New Mexicans in new skill sets for a clean energy industry, ranging from digital communications, power electronics to maintaining EV charging stations and cybersecurity for the energy industry. • The need for more electricians, electrical installers, and plan reviewers in the solar industry. • Educating New Mexicans about the importance of transmission in building out a clean energy economy. • Offering career technical education programs through PED in middle school and high schools to start building STEM workforce. • NM colleges' need for updated clean energy training equipment. • The need for community colleges to work with companies to provide tailored training and internships. • The need for huge capital investment to meet ETA targets. • Curricula in schools need to be standardized
Infrastructure	• Improving broadband infrastructure. • Nontraditional opportunities for funding like green banks and green bonds. • Improving governance of grid. • Exploration of microgrid opportunities. • Change NM's economy from "boom and bust" cycle to a stable diversified economy.
Technology Development/ Manufacturing	• Reshoring opportunities on the U.S. Mexico border. • Exploring bringing wind blade manufacturing to New Mexico. • Small communities in rural NM feeling left out of the opportunities related to clean energy. • Technology advancement in the clean energy industry. • Exploring how fossil fuels can benefit renewable economy • Exploring opportunities to use carbon capture for plastic product production

Appendix 2

Regional Advisory Groups

2.a. Issues Surfaced by Regional Advisory Groups

Challenges	
Political/Regulatory	• Regulatory challenges, especially with NMPRC. • Electricity is priced as to not create incentives to save energy. • New Mexico's anti-donation clause can be challenging
Planning and Permitting	• Economic development plans are not consistent among communities in the same region. • Local governmental entities easier to deal with than State of NM entities. • Permitting rules inconsistent among jurisdictions for solar industry.
Workforce Issues	• Workers need consistent work, not occasional project work. • Lack of workforce skills, sometimes drug testing issues.
Economic Diversification	• If and when gas and oil declines, how do we make up revenue with clean energy? • Though not equivalent to tax and oil, communities are seeing some benefits from clean energy projects – property tax, construction phase employment, gross receipts.
General Infrastructure	• Broadband – Communities feel that they cannot attract strong industry without good broadband. • Transportation/highways need work. • There is a need for more buildings in some communities to attract manufacturers.
Clean Energy Infrastructure	• The queue for Southwest Power Pool is problematic when it comes to adding additional renewable energy in eastern New Mexico. • Getting more transmission built, obtaining rights of way. • Challenges from military bases related to wind turbines

2.b. Opportunities Surfaced by Regional Advisory Groups

Opportunities	
Infrastructure	• Some communities in prime spot for transportation hubs for manufacturing, others need transportation improvements. • Lots of available land, both state and privately owned (especially to benefit farmers and ranchers) for clean energy projects.
Attracting New Investment and Employers / Workforce Training	• Potential with opportunity zones. • Manufacturing and storage at the border • Trade with Mexico. • Legalization of marijuana • Attraction of more data centers • Desire for the work of the national laboratories to benefit all communities in the state, not just the Rio Grande corridor. • Opportunities related to water – desalinization, produced water, making water "greener." • Replicating the "Facebook" model in other communities. • When life cycle of equipment is up, opportunities for repowering or recycling industries. • Development / attraction of start-ups in energy • Development / attraction of start-ups in agriculture • Strengthen community college and dual enrollment programs. • Regional Council of Governments – planning, federal grants, etc.
Clean Energy Technologies	• Rare earth minerals, byproducts of mining. • Hydrogen economy. • Geothermal as baseload energy. • Grid modernization • Microgrid development, placement of resources near communities. • Advanced metering infrastructure for utility customers. • Increased electrification for utilities, especially in transportation. • Grid modernization, Governor's climate exec order. • Growing distributed generation for residents, businesses, municipalities.

	• Creating more middle-class jobs through increased energy efficiency and demand response programs.

2.c. Regional Issues Surfaced by Regional Advisory Groups

Issues and Opportunities by Region	
Albuquerque	• Interest in getting more manufacturers that make clean energy products such as Unirac • Suggestion of New Mexico Green Shoring campaign such as NM True • Exploration of creation of clean fuels industry by use of byproducts of waste in NM, possible Clean Fuel Standard • Transmission and ability to export power out of state is important • New Mexico needs to market itself to clean energy companies, also incent homegrown, start-up work in clean energy technologies • AED has renewable energy companies as one if its target industries
Clovis/Eastern Plains	• Wind energy developments, such as Sagamore and Broadview, have been strong economic driver in the region through jobs, contractors, private landowner payments, property taxes, local business revenue, sponsorships. • Challenge -- Transmission and dealing with long time periods for projects being in the queue need to be addressed to help grow wind industry. • Companies are looking to work with local dairies on biomass projects.
Farmington	• Region is going through a lot of change with planned shutdown of San Juan Generating Station and ultimately Four Corners Power Plant. Needs to work on diversifying its economy away from fossil fuels. ETA is bringing large scale solar and storage to the area. • The area needs assistance, partnerships, resources to move its economy forward.

	• Challenges – no rail, broadband and fiber accessibility, regulatory processes that are too long and cumbersome, lack of broadband access, the region is not in agreement about where to head on the economy, need concerted regional effort to find common ground. (Government to government relationship building is critical). • Opportunities – solar, helium, geothermal, storage (especially hydro), existing transmission, transition role of natural gas.
Las Cruces	• Residential and large-scale solar projects are growing in the region. • Interested in opportunities related to job creation – manufacturing clean energy components at the border, jobs in research and development, other job growth areas such as advanced metering, energy efficiency, storage and electric vehicles, exporting energy to the West. • Pricing of electricity is critical to building clean energy future. Provide what works for customers to convert to clean energy while providing safety net for utilities. • Also, opportunities related to ag and clean energy synergies.
Alamogordo/Ruidoso	• Otero County getting a lot of solar, Lincoln County now getting wind. • Regional opportunities include potential for biomass, desal of brackish water, rare earth mineral production, more energy efficiency, battery storage. • Challenges include water, regulatory processes, broadband/fiber infrastructure.
Grants	• Area leaders not that interested in this process. Don't believe that clean energy can help their economic situation much. Disappointed that Escalante coal plant was shutting down. See it as a big hit after fall of uranium industry years ago. • Interested in manufacturing opportunities.

Lea County	• URENCO has large impact, was largest construction project in NM, $5 billion investment, gave opportunities for energy professionals in the area, hired locals, expanded horizon for young people for a type of job they could have in the area. • Challenges – broadband access, rail and highway access, feel state favors film industry over energy industry, Southwest Power Pool queue process, lack of value-added production, NM bureaucracy (Gas processing plant was going to be in southeastern NM due to red tape and bureaucracy, dealing with State Land Office, moved 2 miles over the border). • Opportunities -- diversifying economy due to ups and downs of oil and gas industry, more wind development, NM Junior College training programs, manufacturing, IT.
Santa Fe	• Lots of activity coming out of Northern NM College and Santa Fe Community College related to renewables, smart grid, student training, and EMNRD and State Land Office related to renewable expansion. • Opportunities – marijuana industry, renewables for the food production industry, supply chain rethinking, workforce being able to live and work where they are, community solar, microgrids, storage, energy efficiency for low-income families, electric transportation • Challenges – transmission, finding buyers for energy, lack of regional transmission organization for more thoughtful regional coordination among utilities, strong need for political will, need for clean rules and dependability in regulatory front.
Silver City Region	• Wind and solar have grown in the region. Also have geothermal. • Opportunities – Construction of Sun Zia line in region, more energy efficiency including job training in that area, green infrastructure related to water systems, • Challenges – Lack of transmission, trade with Mexico, manufacturing of carbon-based products,

	byproducts associated with mining, anti-donation clause presents barriers, workers need consistent work, kids need to learn about opportunities in clean energy trades.
Socorro	• Challenges – Broadband is huge challenge, local electric cooperative not cooperating to make this happen. Also lack of buildings and labor pool problems (lack of education, failure of drug testing, etc.) • Opportunities – Highway and rail access, ultimate construction of Sun Zia transmission line,

Appendix 3

Industry Conversations

Industry Challenges	
Legislative/Regulatory and Permitting	• Inconsistent regulatory and legislative environment. (Ex: PRC timelines, legislation proposed to tax renewable energy) • Outdated rules related to some renewables. Ex: renewable interconnection for distributed generation (they go back to 2008). Need to increase allowed capacity on distribution lines to accommodate more renewables. (This process is going on right now at the PRC). • Siting for renewable projects can be slow. • Inconsistent permitting for distributed generation across different jurisdictions, adding significant cost and complexity to doing business. Ex: outdated geothermal regulations written in late 1970s. • Complicated and delayed processing of renewable energy tax credits (large scale and individual) through the State of NM.
Workforce Issues	• Need for more workers at all levels, especially in the trades. Specifically mentioned were electricians, inspectors, heavy equipment operators and welders. • Many clean energy jobs in NM currently going to out-of-state workers. Firms also using temp hiring services to meet labor needs.
Workforce Growth	• Recruiting more companies that want to take advantage of our renewable energy resources. • Training more New Mexicans for the clean energy industry at high school and post high school institutions and through apprenticeships. • Diversifying the clean energy economy workforce with more women and representation from all New Mexico communities.
Community Support	• Many people want more renewables but won't support new transmission lines and delivery of power out of state.

Appendix 4

Clean Energy Meetings

Beneficial Electrification

NAIMI participated in a Beneficial Electrification meeting on October 14 that was organized by NMSU. The meeting was very productive and included national representation from the Beneficial Electrification group with 150 participants. The meeting demonstrated the value of replacing fossil fuel use with electricity in a way that reduces overall emissions and energy costs. NMSU and NAIMI agreed to work with the national group to provide a means of benefitting NM with this approach. I-WEST Meeting

I-WEST Symposium

I-WEST (Intermountain West Energy Sustainability & Transitions) is a consortium of the six western intermountain states, which is working to develop approaches to attaining carbon neutrality. NAIMI participated in the I-WEST Zoom meeting on September 24 on 'The Changing Face of Energy in New Mexico,' The meeting included useful presentations on various approaches to transitioning NM to clean energy and on carbon mitigation and hydrogen projects in NM. Many of the topics presented fit well into the Clean Energy Economy Roadmap as it involves creating jobs around clean energy.

NMT is the I-WEST lead organization for NM. Additional information can be found at iwest.org.

Energy Summit

The second annual Virtual Distributed Energy Summit for the NM EPSCoR SMART Grid Center was hosted by Santa Fe Community College's Smart and Micro-grid Training Center on July 29-30. Organization of the Summit was assisted by David Breecker and the Microgrid Systems Laboratory.

The Summit addressed the state's clean energy transition through three related themes: Economy, Technology, and Workforce.

The July 29 morning session focused on the Economy. NAIMI assisted the Summit by arranging to have NMSU Chancellor Dan Arvizu speak about the i-CREW project and the Clean Energy Economy Roadmap.

The afternoon of July 29 focused in part on the Grid Modernization Roadmap being developed by EMNRD. The session was hosted by EMNRD Cabinet Secretary Sarah Cottrell Propst with three speakers: Jon Hawkins – PNM Resources, Clay Doyle – El Paso Electric Company, and Luis Reyes – Kit Carson Electric Cooperative. Of direct relevance to the Clean Energy Economy Roadmap, when the speakers were asked about the importance of cybersecurity for the grid, all three responded that this was their biggest concern after meeting the technical needs of the future grid. Given the recent number of very disruptive cyberattacks, including one that shut down the Colonial Pipeline, which stopped distribution of 45% of the East Coast's fuel, it is critical that cybersecurity be a central element of the grid. New Mexico is well positioned to grow a

cybersecurity workforce due to the presence of the national laboratories, UNM, NMT, NMSU, our colleges and other efforts in place on cybersecurity. The comments of the three speakers highlights the importance of including IT and Cybersecurity as the third area of opportunity in the Clean Energy Economy Roadmap.

The day of July 30 was devoted to workforce development in clean energy. Santa Fe Community College was featured in presentations along with Northern New Mexico College and San Juan College. A tour of the facilities at Santa Fe Community College shows how clean energy has been implemented on campus and highlighted the ability to have sustainable agriculture using clean energy. NAIMI fully supports the efforts of the colleges to train students to meet the demands for a clean energy economy workforce.

Appendix 5

Ties to National Strategies

Former Sandia Laboratory Director Dr. Paul Hommert, who serves as a distinguished fellow at the National Council on Competitiveness, spoke about these synergies at a 2021 Clean Energy Roadmap Town Hall hosted by NAIMI and NMSU. The Council on Competitiveness Competing in the Next Economy report, released in late 2020, (www.compete.org), aims to create a national vision for U.S. competitiveness and innovation in the 21st century global economy and integrate policy development across federal departments and agencies in this domain. Several areas of the report connect with the findings and conclusions of the Clean Energy Roadmap team including the following:

- Developing and deploying critical dual-use technologies that will shape the industries of the future, national security, and global grand challenge. Included advanced microelectronics, advanced computing (supercomputing, quantum, artificial intelligence), biotechnology, advanced materials, climate, etc.
- Realigning federal, state, and local workforce development programs and training to enable a highly skilled beginning at the junior and high school levels
- Launching new community-based public-private partnerships to support students and entrepreneurs, by expanding invention and entrepreneurship curricula in pre-K through higher education.
- Establishing multidisciplinary engineering innovation centers and ecosystems in communities of dire economic and social need.
- Driving deployment – by federal, state, and local governments – of new technologies that make infrastructure smarter, safer, more sustainable, more efficient, and more responsive and resilient and establishing new sustainability curricula, innovation consortia, the “Patents for Planet” program, and new tax incentives or sustainability investments.

The Infrastructure and Investment Jobs Act, passed by Congress in August of 2021, also connects with the findings and recommendations of the Clean Energy Roadmap in the following areas:

- Addresses needed infrastructure investment in public transit, rail, highways, bridges, water infrastructure critical for economic development.
- Ensures all have access to reliable high-speed internet.
- Addresses the climate crisis by making large investments in clean energy transmission and electric vehicle (EV) infrastructure in history; electrifying thousands of school and transit buses across the country; and creating a new Grid Deployment Authority to build a resilient, clean, 21st century electric grid https://www.whitehouse.gov/briefing-room/statements-releases/2021/08/02/updated-fact-sheet-bipartisan-infrastructure-investment-and-jobs-act/

Appendix 6

Legislative Actions

For the past 15 plus years, the New Mexico legislature has passed a host of clean energy pieces of legislation that help the state transition to a clean energy economy (Appendix 6).

NAIMI worked with members of the Legislature and Committees during the 2021 and 2022 sessions of the Legislature to support passage of a range of legislative action that help grow a Clean Energy Economy.

During the 2022 30-day session of the NM Legislature passed one bill that is relevant for the Roadmap: HB 37 - Community Energy Efficiency Development Block Grant – Creates a grant program implement energy efficiency measures in low-income households.

Of noticeable exception in the 2022 session was the failure to approve HB 4 – the Hydrogen Hub Act. This bill proposed to support NM becoming a Hydrogen Hub, and thus be able to apply for $2B of Federal funding under the Infrastructure Law passed by the US Congress in 2021. The bill was strongly opposed by a number of conservation groups because, as proposed, it would use natural gas to create hydrogen.

There were two bills passed by the Legislature in the 2021 60-day session that addressed infrastructure issues identified by the Regional Advisory Groups:

- SB 93 - Omnibus Broadband Bill – Provides $950K appropriation to Dept of Information Technology to create an Office of Broadband Access and Expansion charged with providing the Governor with a three-year statewide broadband plan by January 1, 2022.

- SB 121 -Transportation Improvement Bonds – Provides $234M for a 'highway infrastructure fund' to improve roads in New Mexico.

Other bills passed during the 2021 60-day session that are relevant to growing a Clean Energy Economy were:

- HB 15 – Sustainable Buildings Tax Credit – Provides new incentives for energy efficient new buildings, enhanced energy efficiency for existing buildings with double the incentive for low-income housing.
- SB 84 – Community Solar Act - Prescribes requirements for community solar facilities, subscriber organizations and subscriptions; prescribes requirements for administration of a community solar program; directs the Public Regulation Commission to adopt rules to implement a community solar program.

NAIMI supported the passage of these bills as they generally support the goals of the Clean Energy Economy Roadmap.

In previous sessions of the Legislature, a number of bills were passed that are directly relevant to the Roadmap.

Legislation	Details	Legislative Benefits
Energy Transition Act (2019)	**Requires 50% renewable energy in New Mexico by 2030; 80% by 2040; and 100% carbon-free energy by 2045. M**andates are for our state's investor-owned utilities (PNM, El Paso Electric and Southwestern Public Service). Co-ops get five years longer to comply with the 100% requirement. Provides economic development and workforce training funds for the Four Corners area.	• Create jobs in renewable energy including wind and solar, as well as transmission lines. • Reduce greenhouse gas and other emissions that impact public health. • Fund workforce training and economic development projects to help the impacted area transition to clean energy jobs.
Efficient Use of Energy Act (updated in 2019)	Requires the state's public utilities to achieve 5% savings off 2020 retail sales by 2025, followed by higher savings targets the Public Regulation Commission will set through 2030. Authorizes up to a 66% increase in utility spending on energy-efficiency programs. Modifies the state's Efficient Use of Energy Act, enacted in 2005.	• Create more jobs in energy efficiency, one of the fastest growing job areas in the U.S. • Result in lower energy bills for residents and businesses so money can circulate to other parts of the economy. • Reduce greenhouse gas and other emissions that impact public health.
Solar Market Development Tax Credit (2020)	Provides a tax credit of 10% for small solar systems, including on-grid and off-grid photovoltaic	• Continues to retain and create jobs in NM's thriving solar industry.

	and solar thermal systems from March 2020 through December 2027. Cap of $8M tax credit to be issued each year on a first-come, first-serve basis.	• Results in lower energy bills for residents and businesses so money can circulate to other parts of the economy. • Reduce greenhouse gas and other emissions that impact public health.
Community Solar Act (2020)	The act creates a statewide 3-year community solar "pilot program", where up to 200 MW of energy can be sold through subscriptions to *certain customers* from localized 5-MW solar facilities. Authorized community solar projects in the state require that 30 percent of each community solar facility serves low-income households. The first three years of the program are capped at 200 megawatts of total generating capacity. This total does not include native community solar projects or rural electric distribution cooperatives.	•
Transportation Electrification Act	Directs investor-owned utilities to file transportation electrification plans for approval with the Public Regulation Commission on a regular basis.	• Create jobs in the EV infrastructure installation and repair industry. • Help incent fleet transitions. • Lower operations costs of cars and trucks in New Mexico. • Reduce greenhouse gas and other emissions that impact public health.

Appendix 7

Plans Relevant to a Clean Energy Economy

New Mexico First State of NM Energy Roadmap

More than 60 stakeholders gathered for meetings in 2018 to help develop an Energy Roadmap for the State of New Mexico, working with the NM Energy, Minerals and Natural Resources Department and New Mexico First. Focus areas of the plan included Energy Economy Diversification, Moving Energy, Transportation, Energy Efficiency and Workforce and Education.

Though an administrative change occurred after development of the Roadmap, which under the Martinez administration, work proceeded in several key areas related to goals outlined in the plan including increasing the Renewable Portfolio Standard through the Energy Transition Act, development of draft rules for the use of produced water in NM, state funding of the Renewable Energy Transmission Authority, increasing the amount of alternative fuel vehicles, especially electric vehicles, and the accompanying infrastructure, upgrading New Mexico building codes to 2018 codes, extending the Efficient Use of Energy Act, passage of the Electric Vehicle Infrastructure Act, and draft ozone rules to address methane issues in the State.

Other items mentioned in the report such as exploring promotion of alternative transportation fuels, upgrading the electric grid, and exploring microgrids and expanding energy storage capacity are still underway.

https://3w15yc3wrztt1b6yrc3ckujc-wpengine.netdna-ssl.com/wp-content/uploads/sites/230/2021/03/Natural-Resources-NM-Energy-Roadmap-Scenarios-and-Final-Report-2018.pdf

Grid Modernization Task Force Report

As a result of the passage of House Bill 233 (The Energy Grid Modernization Roadmap Act, the NM Energy Minerals and Natural Resources Department convened a Grid Modernization Advisory Group in 2020 to produce a series of action-oriented whitepapers to inform New Mexico's grid modernization Roadmap. Key recommendations included: establishing new rate design mechanisms to support grid modernization policy goals; strategically deploying battery and other energy storage on the New Mexico grid; developing low to moderate income customer programs to help modernize the grid; updating small scale renewable energy interconnection rules and manuals; creating and provide ongoing support for a statewide transmission planning group charged with delivering a statewide transmission modernization strategy; requiring utility Distribution System Plans (DSPs) to be submitted to the New Mexico

Public Regulation Commission (PRC); creating and providing support for a New Mexico Regional Transmission Operator (RTO) Task Force, and standardizing Integrated Resource Plan requirements across New Mexico electric utilities.

https://www.emnrd.nm.gov/ecmd/grid-modernization/

2020 New Mexico Chamber of Commerce Report – Driving New Mexico's Future, Empowering a Competitive Economy in a Post-Pandemic World

Though not energy specific, several other plans have been released in New Mexico in the last year that tie into building a clean energy economy.

A report released by the NM Chamber of Commerce in 2020 made several recommendations that directly align with the Roadmap recommendations related to building a clean energy economy. The Chamber sponsored a survey that included nearly 700 New Mexicans, augmented by discussions, and focus groups. Based on the results of the survey and discussions, recommendations included creating a Governor's office of regulatory reform, enacting enabling legislation authorizing public private partnerships for infrastructure, creating a rail spur economic development grant/loan program, creating a grant tuition program for community college students pursing a degree in STEM that agree to remain in NM for a specified time, The report also identified some key opportunities for New Mexico including capitalizing on the reshoring momentum.

2021 Albuquerque Economic Development Plan

The largest economic development organization in New Mexico, Albuquerque Economic Development, issued a report in early 2021 that also closely aligns with developing a clean energy economy in New Mexico. Diversifying the economy and increasing regional competitiveness are among the key strategic focus areas. The organization's plan has identified six clusters that it will focus on for job growth and capital investment including renewable energy, aerospace, biosciences, manufacturing, digital media and film, and corporate and professional services.

New Mexico Clean Energy Workforce Development Study (Center for Social Policy, Cradle to Career Policy Institute, Native American Budget & Policy Institute, Commissioned By: Center for Civic Policy / Power4NM Coalition

The 2020 UNM report was based on several forms of research including regional focus groups, research of clean energy workforce efforts in other states, practices, analysis of the state resources available to provide training in clean energy jobs including the higher education system and state workforce training programs and a broader survey of

1,700 New Mexicans. The survey indicated that the majority of New Mexicans indicated they felt that the state's economy needed to be diversified.

Key findings of the research included the following: New Mexico's existing structure for green workforce training and credentialing has strong foundations, especially among its two-year institutions; in some cases, training programs have outpaced their local job markets; there is limited public knowledge of the ETA and what it will mean for job growth in the clean energy industry; there is a perception that jobs available in this sector are limited to installation and do not pay high wages; the state lacks a set of statewide processes for helping students access high-quality training outside their immediate communities; prospective workers seeking training or retraining face a number of financial and logistical barriers; and there is concern across the state that the jobs that may come from this transition will be limited to those with advanced degrees and those who live in urban areas or come from out of state.

Recommendations included: Developing an aligned, comprehensive plan for clean energy workforce development that connects K-12 education, post-secondary education and regional workforce needs; creating incentives to bring jobs and clean energy industries to communities in alignment with training programs to ensure training leads to clear employment opportunities; ensuring that core industry competencies are included in curricula that prepare students to obtain industry-recognized credentials; stacking credentials so individuals can build careers with certificates and degrees that add marketable skills and enable promotion into higher wage jobs; supporting partnerships between colleges and universities that allow students statewide to take advantage of specialized training programs, through a combination of online and in-person coursework; investing in paid apprenticeships, internships, and stipends for students during retraining; providing incentives for programs to recruit students from underrepresented populations and communities; and implementing a statewide outreach program to educate the population on the timeline for the transition to clean energy, the jobs that will be created through this transition, and the skills and certifications that will be needed to access those jobs.

Diversifying Revenue on New Mexico's State Trust Lands, Headwater Economics, September 2021

An analysis from Headwaters Economics, an independent, nonpartisan research group, identifies four land management activities beyond oil and gas leasing on New Mexico's state trust lands that can generate revenues as the state's economy continues to diversify and grow. Headwaters Economics coordinated with the State Land Office (SLO), other agencies, and public land management experts to report on options that can help diversify revenues from state trust lands and secure the continued success of the LGPF. The report identifies four land management activities where new investments

can lead to additional revenues: 1) Renewable energy: Expanded renewable energy generation, transmission, and storage on state trust lands is already a priority at the SLO, but can be expanded; 2) Commercial development: Revenues from growing sectors such as space technology, renewable energy manufacturing, and film and media could be significant, particularly where trust lands have high real estate and development potential; 3) Outdoor recreation: Enhanced recreation opportunities and access could build on the substantial role this sector already plays in New Mexico's economy; and 4) Conservation: State lands contain significant ecological and cultural values, and tools to evaluate and monetize conservation activities can be an important part of revenue diversification efforts. The report also identifies several fiscal and management strategies, as well as new staffing capacities at the SLO, that are needed to fully take advantage of the potential behind revenue diversification efforts including strategic planning, pursuing active revenue models at the SLO, taking a portfolio management approach to optimize revenue, and expanding partnerships.

https://headwaterseconomics.org/tax-policy/new-mexico-state-land/

New Mexico Economic Development Department, Empower and Collaborate – New Mexico's Economic Path Forward, October 2021

In early 2021, the New Mexico Economic Development Department (EDD) determined the need for a guiding strategy that not only identified ways to jumpstart New Mexico's near-term recovery, but also the state's long-term transformation into a more diversified, resilient, and inclusive economy. EDD hired SRI International, which engaged with over 100 public, private, and non-profit organizations – and conducted extensive quantitative data analysis – to design an actionable, long-term economic development and diversification strategy. Obstacles to New Mexico's economic future were identified, including: lack of collaboration between economic development stakeholders; difficulty attracting and retaining talent in urban, rural, and tribal communities; misalignment between higher education and industry; disengagement of socioeconomically disadvantaged communities in planning processes; public-sector dominance in New Mexico's innovation ecosystem; and concentration of economy in a few key industries. With the following goal in mind – to build a diverse and robust economy that engages local talent, cultivates innovation, and delivers prosperity for all New Mexicans – key strategies were identified including: modernizing New Mexico's economic development system; strengthening New Mexico's communities; reimagining education and training; promoting equity through economic justice; enabling high quality, home grown innovation; and diversifying New Mexico's economy in key areas – aerospace, biosciences, cybersecurity, film and television, outdoor recreation, sustainable and

value-added agriculture, intelligent manufacturing, global trade and sustainable and green energy.

https://edd.newmexico.gov/statewide-strategic-plan/

The Santa Fe Institute, "The Energy Transition in New Mexico: Insights from a Santa Fe Institute Workshop," October 2020

In early 2020, The Santa Fe Institute gathered an interdisciplinary group of local, national, and international experts to discuss strategies for the deep decarbonization of New Mexico's economy. This report draws on discussions from the workshop and subsequent conversations with several New Mexico stakeholders. It focuses on areas of innovation that are well-suited for New Mexico and its communities.

Key takeaways included:

Job creation and economic recovery in areas such as deploying, integrating, and managing wind energy, solar energy, energy storage, and other clean energy technologies; methane monitoring, methane capture, and the plugging of abandoned wells; and scaled up weatherization and efficiency programs.

Decarbonization across the state's economy by setting specific, binding greenhouse gas reduction goals like those in the ETA for other major sectors, including transportation, heating, and oil and gas production can provide a platform for capturing several key innovation opportunities.

Embracing innovation to ensure grid stability while relying on variable sources of renewable power that achieves stability with weather-dependent renewable energy sources by combining energy storage, fast-response management of flexible demands, power electronics, and better regional interconnections.

Regional coordination to streamline the path towards New Mexico's energy transition by reducing overall costs, averaging weather conditions across the Southwest to smooth variations in the output of wind and solar power generators, balancing supply and demand, and sharing the costs of regional transmission and interconnections.

Supporting electrification of more energy services that meet customer needs, with the help of interconnected devices that communicate with grid operators to shift demand to hours when renewable energy is plentiful.

Innovation to achieve soft cost reduction including decreasing soft costs of these technologies, including design, permitting, installation, inspection, and interconnection

of distributed generation and streamlining permitting processes for both distributed and utility-scale generation.

Anticipate technological changes in regulation, encouraging both planners and regulators to incorporate the pace of technological change into current investment decisions. These changes can include declining costs, new technologies, and considering data-based trends and forecastable system-wide changes to meet legally mandated decarbonization goals.

https://www.santafe.edu/news-center/news/report-path-decarbonization

APPENDIX 8

Cybersecurity Jobs

Millions of unfilled jobs

Experts have been tracking the cybersecurity labor shortage for at least a decade — and now, a new surge in companies looking to hire following recent attacks could exacerbate the problem. The stakes are only growing, as technology evolves and bad actors become more advanced.

In the United States, there are around 879,000 cybersecurity professionals in the workforce and an unfilled need for another 359,000 workers. According to a 2020 US Bureau of Labor Statistics projects "information security analyst" will be the 10th fastest growing occupation over the next decade, with an employment growth rate of 31% compared to the 4% average growth rate for all occupations.

Not a short-term solution

A variety of education, training and up-skilling programs are already working to address the shortage. Networks, providing a crucial service for small cities and counties that might not otherwise be able to afford it.

Experts say there's also an opportunity to bring new talent into the industry by focusing on diversity. Just 25% of cybersecurity professionals are women, so (ISC) launched a diversity, equity and inclusion program this year aimed at recruiting and keeping more women in the profession, Rosso said.

“Because even with existing training programs, the global cybersecurity labor gap is expected to grow by 20% to 30% annually over the next several years,” (ISC)'s Rosso said. Experts say both the public and private sectors must invest more in growing the industry's workforce.

Portions of President Joe Biden's $2 trillion American Jobs Plan could help. The infrastructure proposal includes $20 billion for state, local and tribal governments to update and improve cybersecurity controls for their energy systems.

Still, experts say more needs to be done, suggesting a broad rethinking of education systems from elementary school through higher education to include more cybersecurity training.

"Sadly, there's not a short-term solution," GuidePoint's Orme said. "I think we need to take a long-term view of it – as a lot of our adversaries do – to say, how can we systematically build the next generation and the generation after that and create a flywheel of qualified security talent that will be entering the workforce over the next 50 to 100 years?"

Excerpted from CNN News – Clare Duffy, CNN Business, Updated 3:48 PM ET, Fri 5/28/ 2021

APPENDIX 9

Sustainable Clean Energy & the Environment

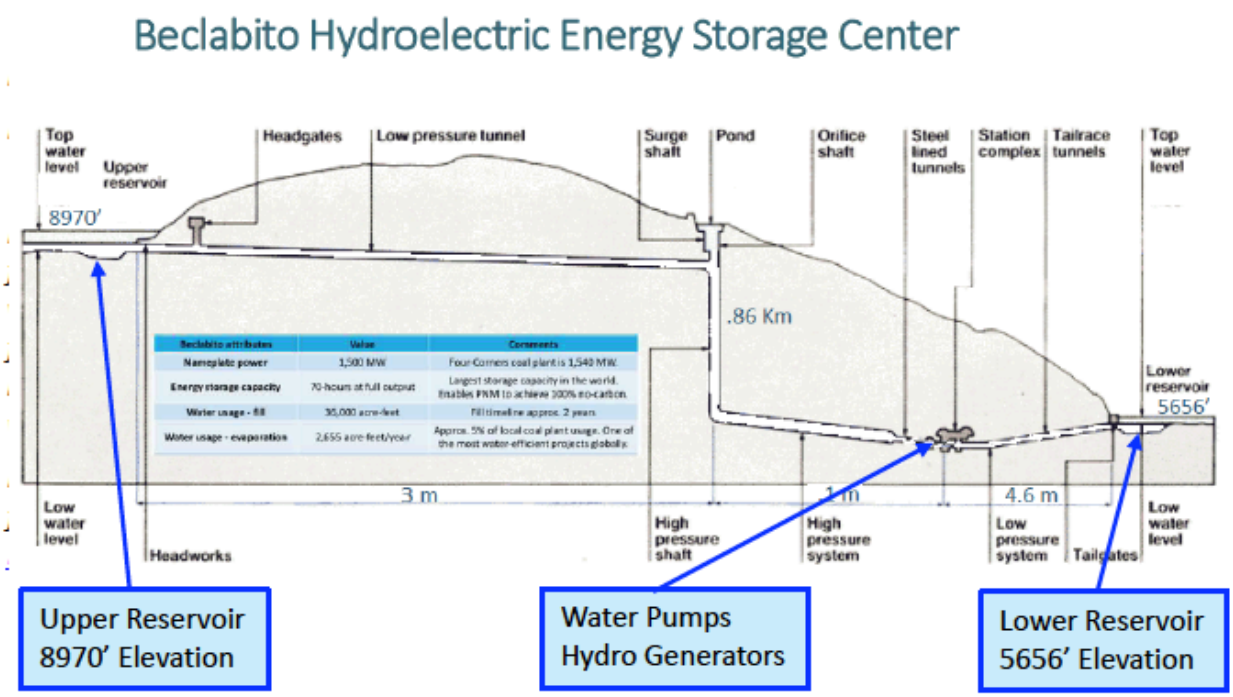
Pumped Storage Hydroelectric Power

This is both a foundational issue and an opportunity to create jobs in a clean energy economy.

Beclabito Pumped Storage Hydroelectric Power Facility

New Mexico and the Navajo Nation have historically supported large electricity production assets located on state, private, and tribal lands. Those generation assets exported electricity to large western population centers and supported substantial numbers of skilled, high paying local jobs and revenues. With the unique Beclabito seasonal duration pumped storage hydro (PSH) project, N.M. and the Navajo Nation have the opportunity to lead the transition to a low/no carbon grid, which likely *will operate at lower* than today's grid. The opportunities for power sector economic development are large; the opportunities to attract energy consuming industries seeking low-cost no-carbon power are larger.

The Beclabito project would replace San Juan Coal Fired Plant with 1500 MW solar and wind and would firm the power with pumped hydroelectric storage. It operates by filling the upper reservoir when excess wind/solar exist and then draining the upper reservoir through hydroelectric generators when demand exceeds supply.



Researchers studying highly and fully decarbonized grids have reached the conclusion that seasonal duration storage (70 to 150+ hours duration) is required to achieve low-cost and reliable systems. The proposed Beclabito project at 1,500 MW and 70 hours of duration was conceived to meet these requirements.

The Beclabito project is a $3.6 billion capital project, with half of that capital spent locally on construction activities building dams, tunnels, and an underground powerhouse. The project lifetime is expected to be 100+ years.

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	Direct Jobs Created	Indirect Jobs Created (1)	Induced Jobs Created (1)	Total Jobs Created	Comments
Construction Activities - lasting 16 years					
PSH Plant - Build (2)	607	534	838	1,979	4 PSH plants @ 4-years construction time - built successively over 16 years
Solar Plants - Build (3)	139	123	192	454	16,000 MW ($16 billion capital) solar power plants - built over 16 years
Total Construction Jobs	**746**			**2,434**	
Plant Operations Activities - lasting 100 years					
PSH Plants (2)	200	806	334	1,340	4 Plants
Solar Power Plants (3)	507	2,042	845	3,394	Approx. 10 Sq Mi
Total Operations Jobs	**707**			**4,734**	
Refurbishment Activities - @ 20-25 years					
Solar Plants - Refurb (2)	139	123	192	454	Solar power plant rebuilds @20 yrs due to module efficiency etc. Continuous activity for 100 years.
PSH Plant - Refurb (2)	152	134	210	496	Every 25 years - 25% of initial build
Total Refurb/Construction Jobs	**291**			**949**	
References:					
1. "Updated employment multipliers for the U.S. economy"; Economic Policy Institute, Josh Bivens, 1/23/19					
2. Source: Kinetic Power industry-based (Black & Veatch, MWH, NREL, Argonne) meta analyses					
3. PNM filing to PRC for San Juan Replacement Plan, Table TGF-2					

The economic development opportunities and benefits for New Mexico would apply in three principal categories:

- **Construction and operation of renewable grid assets:**
  The capital cost to buildout PNM's decarbonized grid, to include wind, solar, and storage is estimated at approx. $6.8 billion. Note that pumped storage hydro

represents an enormous local construction project. Many other storage technologies (such as batteries) are fabricated in factories located elsewhere.

- **Substantially increased value of New Mexico clean power exports:**
  New Mexico is currently exporting substantial amounts of variable wind power to power markets to our west. These exports utilize the transmission system to < 50%. New Mexico could export a far more valuable firm, dispatchable (or baseload) no-carbon product by adding solar + seasonal storage. Transmission utilization could rise to 100%, deferring the need for incremental interstate transmission builds.
- **Attract companies seeking reliable, low cost no-carbon electricity to New Mexico. Potentially achieve the lowest cost electricity rates in the U.S. through decarbonization.**
  The list of companies seeking reliable, low cost no-carbon electric supply is large. New Mexico has the opportunity to rank #1 country-wide on electric rates metric, even against competing carbon-based states.

Small Modular Pumped Storage

New Mexico State University and the State of New Mexico are exploring the use of produced water from the oil and gas industry for pumped storage projects in Southeast New Mexico. The costs of treating produced water from the oil and gas industry are substantial. Use of the water in energy storage systems could mitigate those costs and provide economic value to the oil and gas industry. The challenge for small, pumped storage projects is overcoming the economies of scale. The civil work for even small hydro-electric projects is substantial. As an example, Los Alamos County added a 3-MW low flow turbine generator to its existing Abiquiu hydroelectric plant in 2008 and it cost ~ $9M, or $3000 per KW of capacity.

Hydroelectric Power

The County of Los Alamos, Farmington, and others own and operate hydroelectric generating plants. The flow of water is determined by irrigators and by flood control considerations rather than by electrical grid needs. Increased flexibility of flow could facilitate greater penetration of RE by reacting to the variability of RE. Cooperation by the interested parties could provide flexibility to the New Mexico grid operators.

ACRONYMS

NAIMI North American Intelligent Manufacturing Initiative

NMSU New Mexico State University

CIDESI El Centro de Ingeniería y Desarrollo Industrial (Center for Engineering and Industrial Development)

CNM Central New Mexico Community College

CO2 Carbon Dioxide

DoIT Department of Information Technology

DSM Demand Side Management

DSM Distributed System Management

DSP Distribution System Plan

EDA Economic Development Administration

ENMU Eastern New Mexico State University

EPSCoR Established Program to Stimulate Competitive Research

ETA Energy Transition Act

EV Electric Vehicles

HED Higher Education Department

i-CREW Innovation and Commercialization for a Regional Energy Workforce

IM Intelligent Manufacturing

IoT Internet of Things

IPCC International Panel on Climate

IRP Integrated Resource Plan

IT Information Technology

I-WEST Intermountain West Energy Sustainability & Transitions

LANL Los Alamos National Laboratories

MW Megawatts

NAM National Association of Manufacturers

NM New Mexico

NM DWS New Mexico Department of Workforce Solutions

NMEDD New Mexico Economic Development Department

NAIMI North American Intelligent Manufacturing Initiative

NMEMNRD New Mexico Energy, Minerals and Natural Resources Department

NMED New Mexico Environment Department

NMPRC New Mexico Public Regulation Commission

NMSLO New Mexico State Land Office

NMPRC New Mexico Public Regulation Commission

NMRETA New Mexico Renewable Energy Transmission Authority

NMT New Mexico Tech

PED Public Education Department

PNM Public Service Company of New Mexico

PSH Pumped Storage Hydroelectric

R&D Research and Development

RE Renewable Energy

RETA Regional Energy Transmission Authority

RT Regional Transmission Organization

RTO Regional Transmission Operator

SNL Sandia National Laboratories

STEM Science, technology, engineering, and mathematics

TBED Technology Based Economic Development

UNM University of New Mexico

WNMU Western New Mexico University