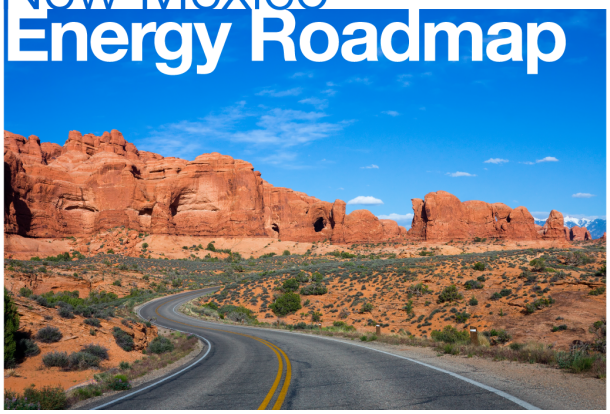
New Mexico Energy Roadmap



SCENARIOS & BASELINE REPORT

- Four hypothetical scenarios about New Mexico's energy and economic future
- Baseline data on energy production, state economics, environmental conditions and workforce development
- A foundation for discussions of the Energy Roadmap steering committee

CONVENER
New Mexico Energy Minerals and Natural Resources Department (EMNRD)

RESEARCH AND FACILITATION
New Mexico First

Energy Conservation & Management Division

Great Seal of the State of New Mexico 1912

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EXECUTIVE SUMMARY

This report was developed for the participants of the New Mexico Energy Roadmap project to inform the development of strategies that strengthen and diversify New Mexico's energy economy. Generally, the content of this report identifies potential assets, weaknesses and opportunities for New Mexico's energy future. The report contains two major sections:

1. The body of the report contains four scenarios describing hypothetical futures for New Mexico's energy economy.
2. The appendices provide baseline data on New Mexico's energy use and production, as well as energy-related economic, policy and higher education data.

Four Different Futures

The four hypothetical short stories – or scenarios – each describe the future of New Mexico's energy economy. The stories were developed through a process called "scenario planning" – drawing heavily from the viewpoints of steering committee members. The scenarios are based on two primary factors: the level of economic vitality (high or low) and the level of innovation (high or low).

At the onset of the project, surveys were provided to energy stakeholders asking about metrics for the energy economy. Based on the results, EMNRD and New Mexico First identified **two critical variables: economic vitality and innovation.** Economic vitality includes factors like state revenues, employment or Gross Domestic Product (GDP). Innovation includes factors like entrepreneurship, application of new research, or pursuit of new technologies. As a result, the following four stories were developed:

1. *Poor and Stuck* describes a world with a poor economy (↓$) and almost no innovation (↓💡).
2. *Rich and Risk Averse* envisions a future with a strong economy (↑$) but low innovation (↓💡).
3. *Frugal and Creative* offers a world with a poor economy (↓$) but very innovative people (↑💡).
4. *Wealthy and Wild* presents a future with a vibrant economy (↑$) and high innovation (↑💡).

Steering committee participants were asked to describe characteristics of these four different futures. Many of those ideas are included in these stories, particularly the items ranked highest by the group. Additional elements came from online surveys, news reports, as well as from both technical and policy research. Details of the stories are informed by present-day facts as much as possible. Projections and assumptions are followed up with research to demonstrate their potential.

Baseline Data

To assist steering committee members in understanding the full picture of New Mexico's current energy economy, the appendices provide baseline details on:

- Energy sources, uses, costs, production history, environmental considerations and infrastructure
- Economic and policy factors, including tax laws, barriers to growth and other market factors
- Energy research on new technology
- Higher education and workforce data on energy careers

FOREWORD

Purpose of the Project

The New Mexico Energy Roadmap project is a statewide initiative to strengthen and diversify the state's energy economy. In this project, stakeholders will craft strategies on future energy production, distribution, efficiency and usage. The roadmap will define the steps needed to move toward a more diverse energy portfolio while improving economic outcomes for New Mexico. It will build on the *2015 New Mexico Energy Policy and Implementation Plan* developed by the New Mexico Energy Minerals and Natural Resources Department (EMNRD).

The New Mexico Energy Roadmap project and related activities are overseen by EMNRD, with the cooperation and support of state and local government agencies, representatives from all the energy sector industries, and energy professionals poised to contribute constructively to the project's recommendations.

This report has two sections:

- The body of the report contains four scenarios describing hypothetical futures for New Mexico's energy economy. These will inspire potential policy changes and industry activities in the state.
- The appendices provide baseline data on: New Mexico's energy sources, uses and infrastructure; economic indicators and policies; energy studies; and higher education in energy fields.

Scenario Planning

The method, called scenario planning, has been well-tested by local, national and international groups as varied as Sandia National Labs, the nation of South Africa, the U.S. Department of Defense, the Shell oil company and multiple educational entities.

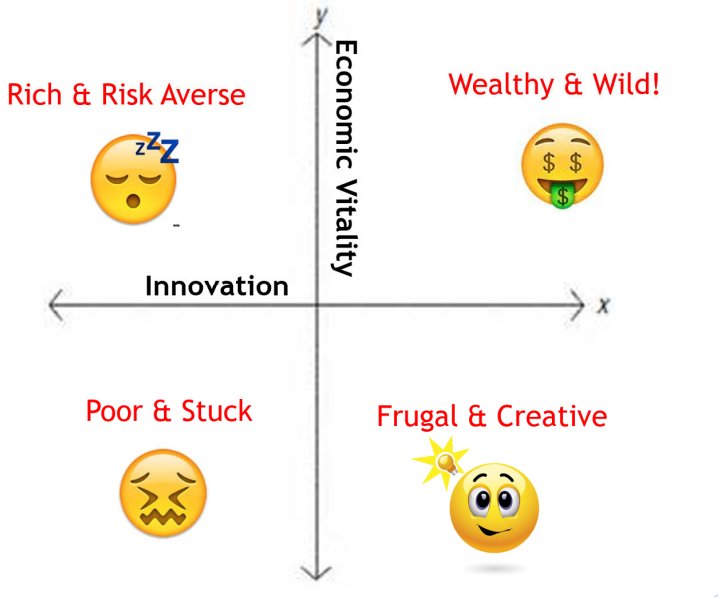
Simply put, scenario planning is an approach that allows creative problem-solving by looking at an issue through the lens of different short stories. These stories, each of which contains different policy conditions and potential outcomes, enable people to think about issues differently than if the information were presented as raw data like charts or tables. (This report has plenty of those, as well, in the research appendices pages 36-62.)

Good scenarios are provocative, plausible, broad, diverse in perspective and understandable by laypeople. **It is important to note that the scenarios are not intended to be accurate predictions of the future, nor are they an exact science.** Any number of different stories could have been developed that may have been equally relevant to stakeholder discussions. The stories are simply intended to jump-start conversations and inspire creative ideas for next steps. They are intended to help us envision futures we might want, as well as future problems we want to avoid.

New Mexico First used an approach that develops the stories around two critical variables (presented as X and Y axes), which are then put together in different combinations to produce four stories. In our case the chosen variables were economic vitality and innovation.

As a result, the following four stories were developed, all hypothetically set in 2027:

- *Poor and Stuck:* New Mexico's economy is struggling, and our people see no way out. There is almost no money and no innovation in this world.
- *Rich and Risk Averse:* The state's economy is strong, largely because oil prices are high. However, there is no spirit of innovation or interest in diversifying our financial base.
- *Frugal and Creative:* New Mexico's finances are still weak, but our culture of innovation creates an exciting time. We are working toward a more dynamic future.
- *Wealthy and Wild:* The state's economy is robust and growing stronger. We also benefit from a high degree of innovation and willingness to take risks.



FUNDAMENTAL ASSUMPTIONS

All four scenarios were based on the following fundamental assumptions:

- Growing New Mexico's energy economy is critical.
- Further diversifying the types and sources of energy production is an essential tool to achieving growth.
- Building resilience to withstand market booms and busts in the energy sector is essential to New Mexico's economic success.
- Preserving the natural environment is an essential element of the work, including protecting water and land from pollution and reducing emissions such as carbon dioxide (CO2).

WHAT'S IMAGINED AND WHAT'S REAL?

The footnotes, blue sidebars, introduction and appendices provide accurate, current data that inform the possible futures. The scenarios of the state's future are imagined, based on inputs from the first New Mexico Energy Roadmap meeting, the project survey, media coverage of the energy industry, and research reports. The best sources for what is *actually occurring* in New Mexico today are the introduction and 30-plus pages of appendices providing an energy data baseline.

Convener

The New Mexico Energy Minerals and Natural Resources Department's Energy Conservation and Management Division (ECMD) is the Principal Investigator for the project and has administrative responsibility for the cooperative agreement between the State of New Mexico and the U.S. Department of Energy. ECMD is responsible for all financial reporting, data collection, reporting of progress on the workplan and submittal of all deliverables.

ECMD develops and implements effective clean energy programs — renewable energy, energy efficiency, alternative fuels, and safe transportation of radioactive waste — to promote economic growth, environmental sustainability, and wise stewardship of our natural resources while protecting public health and safety for New Mexico and its citizens.

Policy Research and Facilitation

New Mexico First engages people in critical issues facing their state or community. The public policy organization offers unique events that bring people together to develop their best ideas for policymakers and the public. New Mexico First also produces nonpartisan public policy reports on critical issues facing the state. These reports – on topics including natural resources, education, the economy, healthcare and effective government– are available at www.nmfirst.org.

Our state's two U.S. Senators, Tom Udall and Martin Heinrich, serve as New Mexico First's honorary co-chairs. The organization was co-founded in 1986 by U.S. Senators Jeff Bingaman (retired) and the late Pete Domenici.

Authors and Reviewers

This New Mexico First report was prepared by Heather Balas, Kelsey Rader and Margie Tatro. Ms. Tatro, of Reineke Construction, is a valued research partner and subcontractor on this project. Report reviewers include the staff of the Energy Conservation and Management Division, as well as Abbas Akhil and Bobbie Williams.

INTRODUCTION

New Mexico is a key supplier of energy to our country, and the state's economy is highly reliant on the industry. **Before this report presents the hypothetical scenarios for our state's energy future, it first offers this brief overview of the *current* situation.** This introduction provides a foundation for readers on today's energy enterprise; it does not predict the future or suggest solutions to current challenges.[1]

Energy Sources, Uses and Costs

New Mexico is the seventh-largest net supplier of energy to the nation. Most of that energy comes from fossil-based energy sources. The most recent data show that New Mexico ranks fifth nationally in crude oil production, eighth in natural gas production, and tenth in coal production. The state also ranked sixth in the nation in utility-scale electricity generation from solar energy and seventeenth for installed wind capacity. New Mexico ranks second in uranium reserves.

Why present all those numbers? Because they illustrate New Mexico's uniqueness. Few other places on the planet – much less our country – hold such a wealth of varied natural resources. With those assets come important and challenging decisions about our environment, our people and our economy.

One major use for these resources is electricity. We burn mostly coal and natural gas to generate electrical power – some of which we use here at home and the rest we sell to neighboring states. We also harness renewable sources (a combination of geothermal, hydroelectric, biomass, solar[2] and wind) to create about one-tenth of the state's electricity supply.

In terms of our overall energy consumption, New Mexicans use more than the national average – primarily because we drive a lot. By contrast, if one looks at just our residential consumption (electricity and natural gas), we use less than the nation at large. We also spend less on energy compared to the national average – particularly on natural gas.

Infrastructure facilities such as pipelines, rail lines, transmission lines, refineries, power plants and highways enable us to transport energy here at home and to out-of-state buyers. With exception of the northeast corner of the state, New Mexico has high-voltage transmission lines as well as oil and natural gas pipelines in many areas. The state is involved in the expansion of transmission systems, pipelines, and rail facilities to support the movement of energy products.

[1] The "energy enterprise" in New Mexico is the business of extracting, harvesting, converting, transporting, and using energy resources and includes the management of by-products associated these activities. Business elements include physical, human, financial, and regulatory infrastructures – many of which have interdependencies with local, state, regional, federal and global systems.

[2] The term solar refers to all technologies that harness energy from the sun, including photovoltaics, solar thermal, and concentrating solar power.

Environmental Considerations

Environmental issues associated with energy production primarily include emissions and water issues. New Mexico's energy industry generates by-products including carbon dioxide, sulfur dioxide, nitrogen oxide and methane. Half of the state's overall carbon dioxide emissions originate in the conversion of coal and natural gas into electricity. The state achieved a 14 percent reduction in the state's energy-related carbon dioxide emissions between the years 2000 and 2014.

Water is required for some energy operations. Surface and groundwater used by the state's energy industry is very little when compared to agricultural and municipal uses. In 2010, the combination of mining and power generation withdrew less than 3 percent of New Mexico's overall water withdrawals from both surface and groundwater sources.[3] This included petroleum, natural gas, coal and any other mineral substances. Produced water in New Mexico is estimated at 891 million barrels in 2015.[4] Much state and national attention has been devoted to re-using produced water for other purposes, such as drilling, landscaping or agriculture. Nationally, this activity happens on a limited basis, including in California where treated produced water irrigates almonds and pistachios. However, most states – like New Mexico – have thus far found the desalination and treatment of this mineral and organic-laden water to be too expensive. Groundwater contamination is also a concern with energy or mineral extraction.

Economics

New Mexico's energy enterprise is a significant source of the state's finances and jobs. Annual revenues and historic contributions from the oil and gas industry alone represent roughly one-third of all dollars used to provide services to New Mexicans. Energy-related jobs are estimated to contribute about 7 percent of employment in the state and support approximately 13 percent of New Mexico's gross domestic product (GDP).

A plethora of laws, regulations and policies in New Mexico present a complicated landscape for lawmakers as well as energy sector participants.[5] The state's renewable energy portfolio standard, the pending national clean power plan rules and energy efficiency policies have direct bearing on the four scenarios.[6] Summaries of these policies are included in Appendix B.

Global Market Factors

The prices of oil and natural gas affect national trade decisions as well as individual and corporate investment and spending decisions. For New Mexico, the historic fluctuations and current low production of oil – a result of global oil prices – stress state resources. The United States is a net importer of crude oil and natural gas. Mexico and Canada are important players in the nation's oil and natural gas world.

[3] (N.M. Office of the State Engineer, 2013)
[4] (NM Water Resources Research Institute, October 2013)
[5] (N.M. Taxation and Revenue Department, 2016)
[6] In October of 2017, the U.S. Environmental Protection Agency (EPA) signed a measure to repeal the Clean Power Plan.

All these factors contribute to the complexity of New Mexico's energy economy today, and they absolutely influence our impending future. The following scenarios build on today's realities and help stakeholders consider the Land of Enchantment of tomorrow.

Scenario 1: Year 2027

POOR AND STUCK

Basic Assumptions

- **Low money:** New Mexico's economy is languishing. We do not have money to invest in energy-sector growth or other forms of economic expansion.
- **Low innovation:** We are not interested in being creative or trying new approaches. Our people and policymakers operate in a culture of anxiety toward change. They are comfortable with how we have always done things.

The Story

New Mexico is tired. Our people continue to struggle with finding good jobs. As of the year 2027, we are home to fewer employers than ever – especially in the energy sector. And, since energy production used to be the bedrock of our economy, a sense of near-desperation hovers over communities like a dark cloud. People have few expectations that things will get better, and their defeatist attitudes cause them to focus less on their overall community and more on the survival of "me and mine."

People outside of New Mexico lack confidence in us as well. Our state credit rating dropped from AA+ in 2017 to BBB in 2027, so our borrowing capacity is seriously hindered.[7] That drop means highway jobs and other types of infrastructure construction are frozen.

A decade ago, people were optimistic that New Mexico was on the mend. The exciting prospects people used to talk about – algae-based fuels, expansion of natural gas vehicles, petrochemical plants, geothermal energy, biomass – all fell away. For example, the woody biomass that could have become energy feedstock instead fuels massive wildfires. [8] Those fires undermine the tourism industry, contaminate surface water, and create more competing demands for the groundwater on which the energy industry relies.

Rural communities have taken some of the hardest hits. Economic and population declines in places that rely on energy industries resulted from the downturn in business. Some rural areas are also experiencing increased power outages and infrastructure failures.

On the matter of carbon dioxide, our emissions levels are largely flat for the last decade. We emit about 50 million metric tons of carbon dioxide each year, most of it in the electric power sector.[9]

[7] (Pew Charitable Trusts, 2017)
[8] Energy feedstocks are any renewable, biological material that can be used directly as a fuel, or converted to another form of fuel or energy product. Biomass feedstocks come from plants (including decaying matter in wildernesses) and algal materials. They can be used to produce transportation fuels, electrical power and heat and other bioproducts. Feedstock supply is the essential first link in the biomass-to-bioenergy supply chain. (U.S. Department of Energy, n.d.) Woody biomass has also been linked to both direct and indirect societal, economic and environmental benefits.
[9] Because this scenario predicts emissions remain flat, numbers match 2014 figures, the most current available. (U.S. Energy Information Administration, 2017)

LOOKING BACK

A decade ago, back in 2017, New Mexicans thought our state was in trouble. They worried about the size of the economy, the availability of workforce, and the state's reliance on the oil and gas industry. But those times seem like a heyday compared with modern conditions. The state's gross domestic product (GDP) retracted considerably in the last decade, from $93 billion to $78 billion.[10] We still hold the worst unemployment rate in the nation, but the actual percentage has worsened from 6.4 percent in 2017 to 8.3 percent in 2027.[11] The state dropped from being the seventh-largest net supplier of energy in the nation to 14th.[12]

Part of those reductions tie to a lack of infrastructural support to move our potential sources of renewable electricity. Renewable electricity producers – especially wind and solar – struggle with the absence of transmission infrastructure. We never overcame rights-of-way barriers on tribal and military lands, so the new high-voltage lines never materialized. Other states, including Texas, Colorado, Kansas, Wyoming and Arizona, upgraded their transmission facilities to provide solar and wind-based electricity to growing markets on both coasts and to Mexico. New Mexico – once considered a potential world leader in diversified energy production – remains a small player on this global field.

Oil and gas drilling is also declining. Oil production levels and natural gas processing volumes dropped from 825 billion cubic feet of natural gas in 2016 to under 400 billion cubic feet per year.[13] Communities reliant on this sector are experiencing dwindling populations

HOW ECONOMIES GROW

Most economists agree that "economic base" jobs are essential to any growth strategy. **An economic base (or primary) industry** produces a product or service that is sold beyond our borders and thus draws *outside* money.

Secondary industries produce goods or services that remain *in* the area.

Energy companies can be both primary *and* secondary industries because they may sell power in the state or may export it to others.

Examples of large and small economic base jobs related to energy might include oil and gas drilling, manufacturing of solar systems, or research projects funded by entities outside New Mexico.

Cultivation of large businesses is a common goal of economic developers. Inclusion of small businesses in the overall mix is also important. Small businesses have consistently driven New Mexico's employment growth; nationally they continue to create jobs even during economic slow-downs.

[10] The most current year available for New Mexico's GDP is 2016, or $93.3 billion, making us 38th in the nation. The state's GDP has steadily but modestly increased over the last decade. Since this scenario's 10-year projection predicts steady decreases, we inverted the actual growth and used New Mexico's GDP from a decade ago: 2006, $78 billion. (Bureau of Economic Analysis, 2017)
[11] This scenario matches today's reality of New Mexico holding the worst unemployment rate in the nation. It conservatively matches the actual highest unemployment rate of the last decade, 8.3 percent in summer 2010. Source: (U.S. Department of Labor, Bureau of Labor Statistics, 2017)
[12] The seventh largest supplier data is as of 2015, the most current year available. (U.S. Energy Information Administration, 2017)
[13] (U.S. Energy Information Administration, 2016 Natural Gas Annual Report, Table 6)

and a lack of financial resources for critical services such as schools, water, sewer, police, and medical support.

The reduction in fossil-fuel production resulted in fewer economic-base jobs. It also made a major dent in the state operating budget. Related service industries, such as hotels and restaurants in drilling communities, are struggling. Back in 2014, business travelers had a hard time finding lodging in places like Hobbs because the hotels were all booked. Or, they might pay $250 a night.[14] Now the hotels advertise deep discounts and many sit empty.

The New Mexico Legislature is – once again – in a special session to decide how to balance the budget. These sessions are pretty much the norm in recent years. For generations, New Mexico has relied on the oil and gas industry to buttress the state budget, contributing up to a third of our general fund.[15] This fund provides dollars for education, health and human services, transportation and a wide array of other government functions. In the absence of reliable state funding, safety-net services are underfunded. The portion of New Mexico's population living in poverty has grown from 20 percent a decade ago to a quarter today in 2027.[16]

How Did These Declines Happen?

It was a combination of factors. Many of our skilled professionals migrated from the state for better jobs and higher wages, leaving us with a brain drain we simply could not overcome.[17] We failed to invest in higher education to prepare a future workforce; high-performing college students often left the state to find their first jobs. We lost momentum on science, technology, engineering and math (STEM) education at the K-12 level, as well. Budget cuts, coupled with the fact that science remained a lower priority in academic accountability systems, prompted elementary schools to continue scaling back the number of science hours in the classroom.[18]

Multiple entrepreneurs and business people voiced concerns about regulatory and policy barriers. Those with investment dollars observed the chaos, lack of vision, and workforce shortages in the state and took their startup projects elsewhere. Perceived problems included:[19]

- The notion that some industries were singled out for tighter regulations than others, creating winners and losers
- A need for streamlined and clear permitting processes
- A lack of predictability on tax and other public policies
- A lack of alignment with federal regulations, particularly regarding nuclear energy

[14] (Cohn, 2016)
[15] The most recent estimate (2016) for oil and gas impact on the general fund is 28 percent; it was estimated at 35 percent in FY 2014. (NM Tax Research Institute)
[16] The most recent estimate for New Mexico's poverty rate is 20.1 percent. (U.S. Census Bureau, 2016)
[17] Between 2010 and 2016, roughly 37,380 more people left New Mexico than moved here, many of them skilled professionals. Hypothetically, if that rate loss continued through 2027, the state would lose over 103,000 people. (Coleman, 2017)
[18] The documented trend of reducing time for elementary science has been happening in New Mexico and across the nation for several years. New Mexico fourth graders spend an average of two hours per week on science. (Blank, 2013) Last year's national science testing results shows that only 21 percent of New Mexico eighth-graders were at or above "proficient" in science, and 45 percent were "below basic." (Burgess, 2016)
[19] These actual regulatory and policy concerns were collected by New Mexico First via an online survey from the New Mexico Energy Roadmap steering committee and from EMNRD's 2015 energy policy plan. (NM Energy, Minerals, Natural Resources Department, 2015)

- Unpredictable, lengthy right-of-way procedures

New Mexico is not the only state to experience the boom-and-bust cycle of the oil and gas industry. The industry is – by its very nature – cyclical. Forces completely beyond our control led to major shifts in fossil fuel profit margins. Nationally, the cost of a barrel of oil declined from a high of 2008 of $96, to $47 in 2017, to $35 in 2027 due to declining or flat demand growth.[20] Even with these reductions, the industry continued to finance a major portion of our safety-net services through contributions to the Severance Tax Permanent Fund, Land Grant Permanent Fund, gross receipts and other taxes.[21]

NATIVE LANDS – COAL, SOLAR AND URANIUM ISSUES

In 2027, poverty on native lands is higher than ever. The jobs of the past – such as those at the San Juan Generating Plant and the Navajo Generating Station in Arizona – dried up because surrounding states do not want coal-fired electricity anymore. A decade ago, roughly a third of New Mexico's coal production occurred on tribal lands.[22]

Regarding electricity on tribal lands, it is still true that some tribal members do not have power at their homes.[23] Previous efforts to innovate and establish solar-based electrification for light and cooking halted when the financing evaporated.

In western New Mexico, federal dollars largely cleaned up legacy uranium issues on the three official superfund sites (Phillips Uranium Mill in Ambrosia Lakes, the Shiprock Mill and Homestake Mill). Of the 259 closed uranium production mines, 137 still lack record of cleanup work. Active uranium mining stopped in New Mexico in 1998, so many of the former miners passed away in the last decade. An estimated 3,000-5,000 Navajo people worked in the uranium mines, starting in 1944. Exposure to toxins in the mines may cause bone, head and nasal passage tumors, as well as lung cancer. The history of health and environmental issues have led community members to oppose the renewal of uranium mining.[24]

However, advocates for uranium mining report that the industry has considerably changed safety practices. Over a dozen permits have been filed to re-open mines. Noting that the state holds the second-largest uranium reserve in the nation, some companies tout the potential job opportunities for tribal and non-tribal community members. Supply chain proponents suggest that western New Mexico could become a logical in-state supplier to the nation's only uranium enrichment facility, operated by URENCO, which is located near Hobbs.[25]

[20] Context for scenario prediction: while the projection figure seems low, since the turn of the century, the annual average price of a barrel of crude oil fell below $40 in the following years: 2000-2004 and 2016. (U.S. Energy Information Administration, 2015)
[21] See Appendix B for an overview of energy taxes.
[22] As of 2016, about a third of coal production in New Mexico occurred on tribal lands, a third on federal lands, and third on private lands. (NM Energy, Minerals, and Natural Resources Department, 2016)
[23] Electricity access not available to all tribal homes. (National Congress of American Indians, n.d.)
[24] Figures in this paragraph are not predictions. Drawn in 2017 from the following sources: (New Mexico Tech, n.d.), (Conservation Voters New Mexico, n.d.), (AZ Central, n.d.), (Health Physics, 2011), (Environmental Protection Agency, 2011)
[25] Again, arguments in this paragraph are not predictions but reflect 2017 perspectives, informed by the following sources: (New Mexico Tech), (Wise Uranium Project, 2016), (Hartranft, 2013).

HIGHER EDUCATION AND WORKFORCE

Our extensive higher education system – which includes 29 public community colleges, tribal colleges, branch campuses and universities – should be ample to produce the workforce we need for today and the future.[26] However, we struggle with colleges that are not aligned with one another and degree programs that are not coordinated with changing energy fields. State funding for higher education has declined, adding financial stress to students.

Furthermore, there is a perception by employers that we have a lack of skilled workers, and a similar view by potential workers that there are not enough good jobs. In some communities, these perceptions are true. In other cases, the negative attitudes lead people to give up – even when opportunities are available.

PLANNING

Another reason New Mexico finds itself in this position is our lack of active planning. We held plenty of community forums and strategic planning sessions – producing dozens of recommendations. But we fail to act on them. The reports sit on shelves in government offices.

Conclusion

Bottom line, in this scenario New Mexico is floundering. Our lack of innovation, coupled with limited financial resources, makes our state less than enchanting. What policy reforms might have prevented this scenario? What industry practices should we have pursued? Even if we *had* made major changes, what types of challenges are beyond our control – and what risk mitigation activities might have reduced their impact on our quality of life?

[26] (NM Higher Education Department, n.d.)

Scenario 2: Year 2027

RICH AND RISK AVERSE

Basic Assumptions

- **Good money:** New Mexico's state budget is booming, due primarily to high revenues from the extractive industries of oil, gas and coal.
- **Low innovation:** We are not interested in being creative or trying to diversify our economy. Our people and policymakers are happy with the way things are; they are uncomfortable with change.

The Story

Life is good, for some of us, for now! In most parts of the country, people hate it when gas prices are high. But, here in New Mexico, an average of 40 percent of our state budget comes from oil and gas revenues. So, we like it when fuel is expensive.[27] Oil runs at $67 barrel today, compared with a decade ago when it was $47 a barrel. [28] The Legislature is happy because it can balance the state budget. Our public schools, colleges and universities and social service agencies have predictable finances to advance their missions.

Our state's credit rating is the highest possible, with all three major agencies rating us at AAA. The higher a state's credit rating, the lower the cost to repay its bonds – so New Mexico is investing in important infrastructure, like roads, sewers and aged dams and bridges.[29]

That's the good news.

On the downside, personal wealth is more concentrated than in neighboring states. People in the oil and gas industry, and in their

ENERGY TAXES AT A GLANCE

The oil and gas industry pays a wide array of taxes. Some are paid by all corporations; others – such as severance tax –only apply to entities that permanently "sever" something from the land (e.g., oil, gas, coal, silver, timber).

General Fund sources that receive revenue from oil and gas include:

- Gross Receipts Tax
- Compensating Tax
- Personal Income Tax
- Corporate Income Tax
- Oil & Gas School Tax
- Oil Conservation
- Resources Excise
- Natural Gas Processors
- Land Grant Permanent Fund Earnings
- Severance Tax Permanent Fund Earnings
- Federal Mineral Leasing
- Land Office Income

[27] This scenario predicts increased fossil fuel revenues, so the predicted effect on the state general fund would increase. The most current data estimates the industry's impact at 28 percent for FY2016. (N.M. Tax Research Institute, 2017)
[28] (U.S. Energy Information Administration, 2015)
[29] The ratings are based on both quantitative and qualitative factors. The three major rating agencies include Standard & Poors, Moody's Investors Service, and Fitch Ratings. They assess state economic performance using a variety of core criteria, including trends in the state's economy, government financial performance, debt load, long-term costs, and political structure. (Pew Charitable Trusts, 2017)

surrounding communities, are doing well economically. However, the industry itself only provides a modest portion of the state's jobs.[30] Unemployment is common in other career fields and in urban areas.

New Mexico – unlike a decade ago – is not recognized for our entrepreneurial spirit beyond the extractive industries.[31] We have not raised a culture of risk-takers. Even though expert researchers work at the national laboratories, we are not deploying technology transfer to move that intellectual property into the private sector. Instead we remain heavily reliant on federally funded jobs.[32]

How Did We Get Here?

Multiple conditions contributed to the mix of beneficial and worrisome aspects of New Mexico's economy. Beyond our control – but to our financial benefit – the cost of a barrel of oil skyrocketed in 2022 and stayed high ever since. In addition, the nation embraced compressed natural gas (CNG) vehicles during the last decade, including buses and locomotives. Because New Mexico remains eighth in the nation for natural gas reserves, the national shift sparked an increased need in one of our state's key products.[33]

On the other hand, much of this gas was extracted from shale rock formations through hydraulic fracturing. What some people called the "shale revolution," others called a "fracking crisis." Fracking is highly controversial due to public concerns about groundwater contamination, earth tremors and public health. Industry advocates question the science behind these claims. The last decade saw multiple court battles by municipalities or

CASE STUDY: DENVER

People who visit Denver today find a bustling city with a varied economy that includes energy, aerospace, software and technology, bioscience and healthcare. The metro area has one of the healthiest GDPs in the nation. However, its economy was not always this diversified.

Back in the early 1980s, Colorado was heavily reliant on its energy revenues. Oil and gas was such a part of the culture that it sparked the popular oil tycoon soap opera, *Dynasty*. Some of us may recall the tribulations of the ever-feuding Carringtons, but few remember the intensity of the real-world economic crash that upended the region's financial base. Over the decade, oil prices dropped from $40 a barrel (the equivalent of $115 today) to $10 a barrel. Denver's office towers, previously filled with oil and gas companies, became 30 percent vacant. With job losses, falling incomes, and a faltering commercial real estate market, the housing boom also collapsed. Recovery took years.

Ultimately, local economic and political leaders rebuilt the oil and gas industry – a staple of their community and economy. They also aggressively pursued other forms of revenues, creating a highly varied economic base.

Today's community planners also are diversifying the types of energy they consume. For example, in July 2017, a new partnership was announced between the National Renewable Energy Lab, Panasonic and Xcel Energy to optimize the energy load profile of a new mixed-use development.

Sources: (MetroDenver, 2017), (Colorado Biz, 2016), (Randolph, 2017)

[30] Labor codes do not track "energy jobs" or "oil and gas jobs" as a category. Instead these are spread out among multiple codes. It is thus difficult to count the number of people employed by the energy industry. (U.S. Department of Energy, 2017)
[31] New Mexico ranks 12th in the nation on the Kauffman Index for entrepreneurial startups. (Kauffman Foundation, 2016)
[32] As of 2014, 35 percent of New Mexico's GDP came from the government sector (federal and state). (Ballotpedia, 2017)
[33] (NM Energy Forum, n.d.)

counties attempting to block fracking in their areas. A wide range of legislation has been introduced in each legislative session, some bills attempting to slow fracking and others supporting its expansion.[34]

RENEWABLE PORTFOLIO STANDARDS ROLLED BACK

Perhaps the biggest surprise of the last decade was the repeal of New Mexico's Renewable Portfolio Standards (RPS). Like Kansas and West Virginia, the New Mexico Legislature made the standards voluntary. Before the repeal, the law required all New Mexico investor-owned electric utilities in the state to acquire 20 percent of power from renewable sources by 2020. They were making progress toward their regulatory targets, yet New Mexico was producing only 9 percent of electricity from renewable sources in 2017. However, lawmakers stepped back from those goals and opted not to renew the Renewable Energy Tax Credits when they expired in January of 2018. On the federal level, the U.S. Supreme Court softened EPAs rules on carbon dioxide emissions and the Clean Power Plan requirements disappeared.[35]

The planned expansion of the transmission grid would have supported both New Mexico's renewable energy development as well as the industry's capacity to export to other states. All the possible transmission routes failed, due to a combination of challenges including access to capital, rights-of-way, lack of predictable public policies, and concerns about national security.[36] Solar, wind and geothermal energy investors moved their dollars to other states.

On the matter of carbon dioxide (CO2) emissions, we emit more than a decade ago. This year, 2027, we saw our highest emissions rate since 2006 – more than 60 million metric tons.[37]

TRIBAL LANDS

Like the rest of New Mexico, the picture on native communities is a mix of good and bad news. The predicted closure of the coal-fired generating plant in the Four Corners area did not happen. Hundreds of jobs for Navajo people and others in the surrounding area were retained. We pursued a 2020 feasibility study on the topic of exporting coal by rail from northwestern New Mexico.[38] As a result, the regional economy turned around and actually expanded in the last decade. However, CO2, methane and other emissions continue to be released into the air.

Some area residents blame particulates from the power plants for high rates of asthma, pneumonia and bronchitis and criticize the tribal members who work at the plants and related coal mines.[39] International researchers continue to use satellites to monitor the methane cloud that hovers over the region.[40]

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[34] Examples of concerns in news reports: (Bagay, Melorie, 2017), (Ray, 2016), (Cleveland News, 2014), (Paskus, Laura, 2015)
[35] The Clean Power Plan is a national policy aimed at combating anthropogenic climate change. Under executive order by President Trump, the EPA is currently reviewing the plan.
[36] New Mexico lands are controlled by many different entities. (Military Authority, 2017) (Ballotpedia, 2017)
[37] The most current year of actual data available is 2014, when New Mexico's CO2 emissions were 50 million tons. (U.S. Energy Information Administration, 2017)
[38] This research is called for in NM's Energy Policy and Implementation Plan. (NM Energy, Minerals, Natural Resources Department, 2015)
[39] (Los Angeles Times, 2014)
[40] (National Aeronautics and Space Administration, 2016) (PBS, 2015) The methane hotspot, discovered by European satellites, appears as a red spot hovering over the region. Researchers do not know if it is caused by natural emissions, industry activity, or a combination of both.

Similarly, tribal members across the state are conflicted about hydraulic fracturing. Some tribal members are selling their mineral leases, earning money for their families. Others oppose such sales, arguing the extraction leads to pollution and increased traffic on tribal lands.[41] The All Pueblo Council of Governors, representing New Mexico's 19 pueblos, recently updated its 2014 proclamation asking the federal government to protect archaeological sites and sacred properties associated with Chaco Canyon National Historical Park, which is located near prime fracking areas.[42]

RIGHTS-OF-WAY

Most of the proposed transmission expansion projects in New Mexico seek to route at least part of their lines over tribal or government land. We are home to 23 tribes and pueblos. And the federal government controls 35 percent of land in the state, such as U.S. forests, wildlife refuges, BLM lands, and four military bases.

Applying for and receiving rights-of-way over federal lands can be a long and often cumbersome process. Most federal agencies have their own regulations for granting rights-of-way. So, if a project runs through multiple federal or tribal lands, one must apply to each federal agency for a right-of-way separately. Further, granting a right-of-way on federal lands will likely trigger reporting and assessment requirements under the National Environment al Policy Act (NEPA). Other assessments may also be required under federal statutes such as the Endangered Species Act and the National Historic Preservation Act.

Among tribes and pueblos, some accept transmission lines on their land because they earn revenues and – in many cases – improve energy access for people. Both the Santa Clara and Pojoaque pueblos supported transmission projects, in part, because of economic benefits. Tribes are also increasingly securing higher prices. For example, San Ildefonso Pueblo earned only $114,000 on one deal in the 1980s; in 2014 they secured nearly $4.7 million for a utility right-of-way. In other cases, tribes do not grant a right-of-way, particularly if the route passes near sacred lands or the financial compensation is perceived inadequate. Changes in tribal leadership can be another challenge to right-of-way negotiations.

Military lands also present sensitivities. For example, the Pentagon previously opposed the Sun Zia line across White Sands Missile Range. Military leaders feared the line could threaten national security. The issue was resolved, and the project is now moving forward.

Sources: (Oswald, 2016), (Wall Street Journal , 2014), (Defense One, 2013) (National Telecommunications and

[41] (Indian Country Media Network, 2015)
[42] (Navajo-Hopi Observer and Western News and Info, 2017)

HIGHER EDUCATION

Our higher education institutions are producing a healthy number of science, technology, engineering and math (STEM) graduates. From a low of 2008 of 4,078 of college graduates with STEM degrees, we have been modestly increasing each year.[43] The associate degree and credentialing programs that license petroleum technicians, housed at New Mexico Junior College and San Juan College, have waiting lists for their classes. However, other types of energy degrees – like the wind turbine program at Mesalands Community College – closed when the RPS changed.

WORRYING ABOUT THE FUTURE

While many people are comfortable with New Mexico's economic situation, others worry. They worry that our economic foundation is neither sustainable nor predictable. People wonder if we could face the kind of busts that plagued the oil-producing states in in the 1980s, as seen in larger cities like Houston and Denver. Economic forecasters worry that we are hoarding the revenues we are earning now, rather than reinvesting them in a more diversified economic foundation.

In addition, some leaders in the oil and gas industry feel they are being asked to carry too much weight for the state. New Mexico's reliance on one industry places a heavy burden on them.

Conclusion

The New Mexico described here really is a combination of strength and weakness. We see a state that is paying its bills, with lawmakers grateful for the economic stability. We also see a state that is perhaps setting itself up for a future crash, since no single industry can be expected to grow in perpetuity. Booms and busts are to be expected. What should New Mexico leaders in this scenario be considering? What should they work hard to retain? What should change, and how can community conflicts be addressed constructively?

[43] The number of college STEM graduates in New Mexico has been climbing since 2008, to 5,546 in 2014 – the most recent year for which data was released. (NM Higher Education Department) Additional information is provided in Appendix D.

Scenario 3: Year 2027

FRUGAL AND CREATIVE

Basic Assumptions

- **Low money:** New Mexico's economy continues to struggle. We do not have state or private resources necessary to invest in high-cost projects or technologies.
- **High innovation:** We are committed to taking action toward the long-term health of the energy economy. This tenacity results in collaboration across the aisle and between industries, as well as careful planning and low-cost, innovative actions.

The Story

Thinking forward. The year 2027 marks a change in New Mexico's energy economy. Jobs and financial resources may not be as plentiful as New Mexicans want or need, but that has not stopped citizens and industry leaders from taking steps toward healthier, more sustainable energy industries. Politicians, organizations and citizens are willing to work on creating common ground.

Although innovation and the spirit of collaboration run high, New Mexico's funding sources are low. Our GDP is slightly better than a decade ago – hovering around $100 billion – but we have not maintained a strong period of growth.[44] This lack of financial resources leads to a lot more thinking than doing. Activities such as planning, changes to the tax structure, and innovations in public-private partnerships are among other efforts to change our economic future. Optimists believe this planning work will set New Mexico up to seize opportunities when money becomes available.

New Mexico relies on oil and gas as its primary source of funds and energy. Accordingly, citizens recognize that they are in the "bust" phase since oil prices are down, but they are hoping for a "boom" phase to make some of their planning investments a reality.

One difference between now and 2017 is that collaboration is a shared trait among all energy stakeholders, and this goal shapes the policy changes and investments being made. Increased bipartisanship has allowed for energy policies that do not shift greatly with the political winds. Dynamic and unique working partnerships are also a major cost-sharing approach utilized in a number of ways.

Another shift is the increased focus on top-notch academic preparation, especially in math and science. We closed achievement gaps and grew the graduation rate to surpass all our neighboring states, including Texas.[45] We provide computer training at the elementary, middle and high school levels. Today's high school graduates were just second graders a decade ago, when we expanded a statewide drive for educational excellence. Our efforts have paid off, because the 2027 graduating class demonstrates the highest reading, math and science proficiency rates the state has ever seen.

[44] The most current year available for New Mexico's GDP is 2016, or $93.3 billion. (Bureau of Economic Analysis, 2017)
[45] About 69 percent of New Mexico students graduated from high school in 2016, compared with 88 percent of students in neighboring Texas. (Education Week, 2016)

New Mexico is preparing to go further. We are taking affordable steps to diversify our energy portfolio, support existing industry, and improve our understanding of previously untapped energy resources.

How Did We Get Here?

For years, New Mexico was a national leader in coal, natural gas and oil production. Declines in the coal industry and the variable nature of oil and gas prices prompted efforts to expand the entire economy, including, but not limited to, energy. Adopting a forward-thinking, proactive approach, laced with optimism and a can-do attitude, state leaders looked for ways to further diversify the state's conventional and renewable energy portfolio. Additionally, our state pursued opportunities to improve energy efficiency across all energy industries and end uses.

SANDIA SCIENCE AND TECHNOLOGY PARK

One real-world example of successful public-private partnerships is the Sandia Science and Tech Park. This national laboratory research park model provides a campus-style, pedestrian oriented space of over 200 acres for technology oriented businesses and government research. The park houses 42 different companies and organizations that combined employ over 2,000 employees.

Source: (Sandia S&T Park)

MORE AND SMARTER PARTNERSHIPS

By 2027, the pursuit of energy innovation paired with low levels of funding has led to several key changes in the state's energy economy. All parties involved in energy have committed to treating energy as a nonpolitical issue. Additionally, collaboration among political parties, industries, governments and the public has increased across the board.

Support for more public-private partnerships (P3s) grew in recent years. These efforts bring government and private organizations together to combine financial resources and expertise to complete projects the public needs. Legislation crafted by a partnership of industry, public and environmental advocates enabled the development of a framework for how these partnerships should work.[46] While the state's economy does not support many new projects, we at least have a legal foundation for developing them in the future. That said, uncertainty around application of the state constitution's Anti-Donation Clause continues to surface in many policy discussions.[47]

Other types of partnerships also thrived. National labs expanded access to unique facilities for both large- and small-scale companies to research, test and develop new technologies.[48] Efforts to expand tech transfer from the labs to commercial markets continue. The federal government invested in an energy innovation hub to bring together top researchers from academia, industry and government to make significant advances in energy technology.[49]

[46] The D.C.-based Bipartisan Policy Center researched P3 legislation and approaches across the nation. (Bipartisan Policy Center, 2015)
[47] The Anti-Donation Clause of the New Mexico State Constitution forbids all state and local government from lending credit or making donations to any person, association, public or private corporation. Determining what is considered a "donation" and, accordingly, what programs cannot receive government funding under the law has been a complicated subject of legal debate (i.e. legality of lottery scholarship program, providing below-market rentals or subsidized meals to charitable and civic organizations etc.) (Hall, 2014)
[48] An example of this includes the Combustion Research Facility at Sandia National Labs' California site. Engine manufacturers use the CRF to model and test advanced engines for transportation.
[49] Programs such as this are detailed on the U.S. DOE website (U.S. Department of Energy, 2017), (U.S. Department of Energy, 2010)

WATER AND ELECTRICITY

Collaborations between unexpected partners also proved successful. The acequia associations, ranchers and rural electric cooperatives worked together to generate small amounts of electricity from irrigation water. Small, existing reservoirs that supply acequias often release enough water during portions of the year to power small turbines. These small turbines, placed in irrigation channels or streams, make enough electricity to power small loads such as electric fences, lights and other home, farm, ranch or village electricity needs.[50] These "micro hydropower plants," with capacities of a few hundred kilowatts, are low-cost and installed by local businesses in partnership with the local coop. This activity was recognized nationally as one of the state's most effective low-cost innovations of the last decade.

URBAN PLANNING AND ENERGY

New Mexicans realized they could reduce emissions and promote energy savings by changing the way cities and neighborhoods are laid out. Municipalities across the state implemented an array of urban zoning reforms to make communities more walkable and bikeable. Mixed-use zoning enabled more residential and commercial activities to inhabit the same areas, reducing traffic and fuel consumption. Compact development (building in higher density areas as opposed to expanding development and creating sprawl) was another strategy to reduce the carbon footprint of urban areas and create energy savings.[51]

Planning and Research

A variety of in-depth planning efforts are underway. We may not have the financial resources to act on these plans yet, but we are working hard – and spending what money we have on the research needed to act on these activities in the future. Our research also considers potential future climate-change impacts to New Mexico. When the money for high-cost investments becomes available, the state will be prepared to seize opportunities! All the following examples are part of this large-scale planning effort.[52]

EDUCATION AND WORKFORCE

One of the most important planning efforts of the last 10 years was expanded workforce development. This initiative required identifying gaps and needs in New Mexico's energy industry, and finding ways to build a better energy workforce pipeline. Energy workforce planning involved revamping and readjusting curricula to keep up with the relevant topics and needs of New Mexico's different energy sectors.

Particularly in community colleges, universities and technical schools, faculty and energy employers began an open and steady dialogue about the skills employers needed and the classroom support to provide those skills.[53] One important component was building on the success of community colleges

[50] (Home Power, 2017)
[51] (Environmental and Energy Study Institute)
[52] EMNRD's 2015 Energy Policy and Implementation Plan details the need for accurate science and technology-based data to better understand the pros and cons of future advances in technology. Details and recommendations can be found in this report. (NM Energy, Minerals, Natural Resources Department, 2015)
[53] Details on this recommendation are found in the EMNRD 2015 Energy Policy and Implmentation Plan (NM Energy, Minerals, Natural Resources Department, 2015)

in retraining workers from declining industries to others on the rise, as well as teaching transferable skills to new students in STEM fields.[54]

Finally, a statewide effort refining connections between degrees for intercampus transfers and articulation between high school and college was put into place. This effort resulted in fewer students needing remedial courses and a more accessible education system for students.

ELECTRIFICATION RESEARCH

While we could not make big investments in cutting-edge technology or large-scale changes in energy use, we wanted to better understand the pros and cons of future possibilities. Research in total electrification was one such project. Total electrification refers to the use of electricity – rather than oil and natural gas – for heating, cooking and transportation. Research found that potential benefits of total electrification could lead to significantly lower greenhouse gas emissions and higher electricity sales, which would benefit utilities.[55] Potential drawbacks included expensive changes to the infrastructure and the challenge of converting household and industrial appliances.

WATER USE BY OIL AND GAS INDUSTRY

Based on the trends and successes already established from years past, oil and gas companies operating in New Mexico continued to expand innovative industry practices to reduce freshwater consumption and surface impact (also known as "footprint reduction").[56] The industry actively pursued research into water injection alternatives. These alternatives both maximize water use efficiency and minimize water contamination risks.[57] By working with lawmakers on these issues and staying on top of industry trends, the industry remained a responsible contributor to New Mexico's energy economy.

CARBON CAPTURE AND SEQUESTRATION

Another area of research included carbon capture and sequestration. Carbon capture and sequestration takes carbon dioxide from power plants, oil refineries, and other industrial facilities that would normally be emitted into the atmosphere and stores it underground in deep saline formations, depleted oil and natural gas reservoirs, or unmineable coal seams.[58]

TRANSMISSION GRID RESEARCH

An untapped energy potential in New Mexico centers largely around solar, wind and geothermally generated electricity. To profit from these resources, our state needs a plan to export and sell this electricity to other states. A key component of this plan is transmission – power lines that can carry renewable electricity from its generation source to communities out of state.

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[54] Community colleges such as San Juan Community College School of Energy in Farmington and Mesalands Community College have the potential to offer programs that retrain workers from one energy sector for another (San Juan Community College school of Energy, n.d.) (Mesalands Community College, 2017)

[55] (Center for New Energy Economy, 2017)

[56] (U.S. Department of Energy) The Department of Energy and many in the oil and gas industry continue to strive toward reducing surface impact and consolidating oil and gas operations to become more economically efficient, as well as to reduce potential environmental impacts.

[57] (State of Oklahoma Water Resources Board, 2017)

[58] According to the Southwest Regional Partnership on Carbon Sequestration, headed by New Mexico Tech, the region's natural geology makes it ideal for carbon sequestration. This factor could drive economic development opportunities in the region. The San Juan Basin is one of the top ranked basins in the world for carbon dioxide storage in coalbeds. Interestingly, injecting carbon dioxide into coalbeds enhances the recovery of coalbed methane, an important source for natural gas.

Our research warns that building transmission facilities cannot be accomplished without enormous coordination.[59] Because these transmission lines encompass hundreds of miles they must often cross land owned by many different entities. To build on another's land requires a right-of-way – a contracted legal authority to pass through a specific route on the land of another.[60]

However, we learned a great deal from existing transmission projects about potential challenges and benefits of transmission expansion. Monitoring the SunZia project helped many understand the potential for opening up central New Mexico to thousands of megawatts of wind energy.[61] Similarly, organizations, such as the Southwest Area Transmission group, facilitated regional transmission conversations – opening more transmission expansion opportunities.[62]

TAX STRUCTURE AND BASE

Fundamental to improving the energy economy was ongoing research and action on adjusting the tax structure, with the goal of securing a more fruitful and stable economic base. Over the past years, regulators, industry leaders and tax experts looked at adjustments to our gross receipts tax (GRT), our enormous array of tax credits, incentives and other carve-outs, and they conducted important research on how to diversify sources for capital projects. Capital outlay funds pay for building projects, such as a new high school gym, updated water treatment plant, or a new roof for a community center. In New Mexico, most of these construction projects are financed from permanent-fund investments by the oil and gas industry.[63] A large-scale public financing study was launched in 2025 on how to diversify this investment base.

However, the majority of planning went toward expanding the tax base. Diversifying the types of business that operate in New Mexico, and thereby garnering multiple sources of taxation is considered vital to the state's future. Over the last decade, extensive outreach and research have focused on bringing in more outside investment to New Mexico.

Conclusion

In this hypothetical future, New Mexicans keep thinking forward despite living with undesirable economic conditions. Limited resources are not dampening our pursuit of innovation. This relentless optimism can lead to opportunities, but the question is how can we get there? What are the necessary mindset changes and commitments that industry, regulators and other stakeholders would need to adopt to achieve this future? Are we on this path already? Deciding what changes are within our power to make and acting on them are fundamental to moving forward.

[59] EMNRD's 2015 Energy Policy and Implementation Plan addresses these concerns and recommends a new framework for inter-governmental harmonization and asset deployment (NM Energy, Minerals, Natural Resources Department, 2015)
[60] A working group in 2004 identified issues surrounding federal rights-of-way. (National Telecommunications and Information Administration, 2004). Permission for rights-of-way on federal and tribal lands are regulated by federal law and often require different applications or may trigger assessments, reporting and requirements under statutes such as the Endangered Species Act, the National Historic Preservation Act and the National Environmental Policy Act. Additional information on rights-of-way appears in Scenario 2.
[61] (Nicole, 2017)
[62] Southwest Area Transmission (SWAT) is a group of transmission regulators, governmental entities, transmission users, owners and operators, and environmental entities that promote regional planning in the southwest. (Southwest Area Transmission, 2015)
[63] The percentage of the Land Grant Permanent Fund attributed to oil and gas production is 96.6 percent; the percentage for the Severance Tax Permanent Fund is 86 percent. (NM Tax Research Institute, 2014)

Scenario 4: Year 2027

WEALTHY AND WILD

Basic Assumptions

- **Great money:** New Mexico's economy is on a strong upswing. We have good jobs, lots of private-sector investments and ample state funds.
- **High innovation:** People and policymakers embrace imaginative solutions, actively pursue expansions to our energy sector, and work every day to continue broadening our overall state economy. Previously developed research and planning efforts lay a foundation for the changes in this exciting time.

The Story

New Mexico is thriving. The overall economy is diversified and experiencing growth in all sectors. During the last decade, we exceeded the New Mexico Jobs Council targets for economic-base jobs – creating and filling over 152,000 positions. Of those jobs, we met the council's target for extractive and energy careers, filling 22,000 new or previously vacant jobs across the state.[64] Accordingly, this employment growth translated into increased state revenues.

Not only is the economy experiencing high growth, but New Mexicans continue to push innovative limits. They want new technology – both within the energy sector and beyond. People are committed to collaboration to achieve the long-term success of the state's economy. The partisan and regional bickering of the past was set aside.

To that end, we put our money behind big ideas. Our 2027 energy infrastructure is state-of-the art, and enables both conventional and renewable energy companies to take advantage of opportunities in export markets.[65] Transmission grids and energy storage facilities are reliable and growing as necessary. Electricity from wind generation has almost tripled from just over 1,000 megawatts a decade ago.[66] Solar generating capacity nearly quadrupled, in part due to utility company investments in large fields of photovoltaic arrays. Public buildings have taken large strides in becoming more energy-efficient.[67]

Apart from improvements in energy infrastructure, New Mexico made investments in other areas to support energy. Strong connections between education institutions and the energy industries has led to a prepared and locally available energy workforce. Furthermore, major expansions in health, technology and manufacturing careers diversified the overall base. Unlike a decade ago, we no

[64] The scenario figures match the job council's targets. Its research estimates that New Mexico needs to create 15,000 economic base jobs a year for 10 years to offset natural attrition and close unemployment gap. (N.M. Jobs Council , 2016)
[65] Research exists on economic opportunities for exporting wind based electricity, one study assessing potential for 2000 MW of capacity from New Mexico and Wyoming. (California Independent System Operator, 2017)
[66] Most recent available data is 2015, when statewide wind installed capacity was 1,100 MWe (megawatts-electric) and solar installed capacity 406 MWe. Another metric is electrical power generation by megawatt hour. 2015 wind generation under this measure is over 2 million megawatt hours; solar generation is almost 615,000 megawatt hours. (U.S. Energy Information Administration, 2017)
[67] Maximizing cost-effective deployment of energy efficiency in public buildings is a recommendation from EMNRD's 2015 Energy Policy and Implementation Plan (NM Energy, Minerals, Natural Resources Department, 2015)

longer place the burden of our state's economic well-being on one particular industry. Oil and gas remains a key part of the financial picture, but other industries carry weight as well.

In both urban and rural spaces, communities and government have come together to improve the overall quality of life in New Mexico. Both visitors and citizens find New Mexico a naturally beautiful, safe and friendly place where children get strong educations and good jobs are readily available. Unlike a decade ago, more people are moving into our state than leaving it.[68]

How Did We Get Here?

When times were lean, New Mexicans never took their eyes off the prize. Innovation and the desire to achieve a better future pushed our state to plan with strong research. Once the overall economy began to diversify and grow, money started filling state coffers, and leaders were ready to move past research into reality.

REGULATORY CHANGES

People knew that making New Mexico a more business-friendly state was key to encouraging growth and resiliency in the energy economy. To accomplish this goal, we took a hard look at the regulatory environment in New Mexico. The regulatory changes made over the past 10 years are lauded by both industry and environmental experts. They struck a balance between the industry's need for predictable and stable expectations while also ensuring that environment, human health and cultural sites are adequately protected.

Changes could be sorted in the following general categories:

- Clarity in regulatory expectations
- Accountability for agency regulatory timelines and approval of projects
- A more even playing field between the different energy resources
- Consistent energy tax policies providing certainty for conventional and renewable industries
- Regulations based on the best available science that are responsive and adaptive to new technologies

TRIBAL ENERGY DEVELOPMENT

While the decision to engage in energy development is entirely dependent on a tribe's values, in 2027 many tribes are exploring ways to expand energy development on their lands. Historically, coal, oil and gas were developed by tribes including the Navajo Nation and the Jicarilla Apache for many years.[69] However, research indicates there is significant potential for tribes in New Mexico to develop wind and solar generation, as well.[70]

One of the greatest barriers in the past to tribal energy development has been an uncertain and cumbersome regulatory climate. Tribes must consider jurisdiction, capacity-building, appropriate state and federal regulations to the energy resource, market demands, as well as environmental,

[68] Between 2010 and 2016, roughly 37,380 more people left New Mexico than moved here. Under a positive population growth scenario this trend would reverse (Coleman, 2017)
[69] (U.S. Bureau of Indian Affairs, 2012)
[70] (U.S. Department of Energy)

cultural and sacred site protection. Recognizing these burdens, new and amended legislation continued to allow for tribes to simplify the regulatory processes for tribal energy projects.[71]

RENEWABLE PORTFOLIO STANDARDS

Unlike other states that rolled back RPS laws, New Mexico's expanded. We met those targets, reaching 25 percent of our energy from renewable sources by 2025. We also broadened the types of clean energy that count toward reaching RPS goals. The target will continue to increase by 3 percent a year until 2040.[72] Given the increase in renewable energy use, our carbon dioxide emissions decreased.

However, since we also experienced increased economic growth in other sectors, our overall energy consumption grew. So, the per-user emissions decreased considerably, but our overall statewide decrease was more modest. As of 2027, we emit about 45 million metric tons of carbon dioxide each year.[73]

METHANE-TO-CHEMICAL MANUFACTURING PLANTS

New Mexico further diversified its economy by expanding the way we use petroleum resources. A new manufacturing plant opened in 2025 in the Four Corners area that produces the petrochemical polypropylene. Polypropylene is a plastic derived from methane, which is the primary ingredient in natural gas. Polypropylene can be used to make water bottles, food containers, medical supplies and other plastic products. Most of the sales occur in California and Arizona. Remaining sales are in other areas of the United States, as well as international markets.

The plant required years of planning, large-scale out-of-state capital investors, and rigorous partnerships between government and private sectors. Important collaboration among environmental, tribal, economic development and research entities helped address water supply, air quality and other considerations.

Research is underway for a similar plant in the Gallup area to manufacture chemically produced urea, which would be used to make fertilizer. Urea is made from ammonia, to be manufactured in this plant from methane by steam reforming. Researchers predict that most of the buyers will come from U.S. markets, as well as Australia, Japan, British Columbia and Canada. Groundwater and other types of environmental protection are major elements of the research.

INNOVATIONS IN OIL AND GAS PRODUCTION

"Produced water" is an industry term for the water that is separated from petroleum during exploration and extraction. When that water is cleaned up for other uses, it becomes a valuable

[71] The Energy Policy Act of 2005 and the HEARTH Act passed in 2012 authorizes tribes to enter into tribal energy resources agreements (TERAs), which allow tribes to forgo DOI approval for leases and rights-of-way for energy development on tribal lands. In some cases, this could result in reduced development costs and shorter timelines. It is possible legislators going forward will recognize the need for streamlined energy regulations as applied to tribes, and will make amendments or new legislation to this end. (Thomas, 2014)

[72] Legislation was introduced in 2017 to make this change in RPS (NM State Legislature, 2017)

[73] This projection of energy related CO2 emissions reduction history is based on New Mexico's CO2 emissions rate between 2000 and 2014 extended out to 2027 (U.S. Energy Information Administration, 2017)

commodity in the arid southwest.[74] Recycling of produced water has come a long way since New Mexico's Oil Conservation Commission approved the 2015 rule clarifying its use.[75] Due in part to research from the Tularosa Basin National Desalination Research Facility in Alamogordo, it has become more cost effective to deploy produced water for agricultural and industrial uses. Additionally, some filtration practices allowed for the extraction and reuse of solids and materials such as methanol, salt and metals. These items can be sold for commercial purposes, thus diversifying oil and gas revenue sources.

Just as water can be reclaimed, so too can carbon dioxide or methane be converted into useful products. Examples include: high-temperature solar reactors that use water and carbon dioxide to make liquid methanol or other fuels; systems to enhance algae production for biofuels; bacteria to convert carbon dioxide into feedstocks for plastics; or new membranes to capture carbon dioxide and to make building materials.[76] Some of these conversion activities have already proven to be commercially viable here in New Mexico; others are being researched.

Finally, New Mexico oil and gas companies also looked to new markets to better expand their export opportunities. Given our state's proximity to Mexico, it was a logical choice to begin exporting natural gas to Mexico and increase revenue streams.

TRANSMISSION, STORAGE AND RENEWABLE INNOVATIONS

The ability to harness and profit from our diverse energy resources required updates to the existing transmission grid infrastructure. The grid from 2017 was primarily equipped to handle electricity produced from conventional sources such as coal, oil and natural gas. To tap the full potential of our solar, wind, geothermal and other sources, changes in transmission and storage infrastructure were needed.

After making the regulatory changes necessary to streamline the upfront bureaucratic process, funding was put into expanding existing transmission projects. In addition, we are in the process of exploring new routes to further expand these high-voltage lines, enabling us to meet market demands in other states. The results of the transmission expansion have brought increased revenue and jobs to the state. For example, during construction alone, the SunZia transmission project brought over 40,000 jobs (measured in man years), over $2 billion in salaries, and $240 million in state and local taxes to New Mexico and Arizona.[77]

Because renewable energy is intermittent (it relies on the sun shining and wind blowing), building up storage capacity was a vital step to supplying New Mexico's baseload with energy generated from renewables. It is noteworthy that significant barriers had to be overcome to expand energy storage.

[74] Some filtration systems allow for produced water to be treated and meet environmental quality standards. This water can then be returned to the hydrologic cycle, rather than remain contained and unusable. (Eureka Resources LLC, 2015)
[75] Title 19, Chapter 15, Part 34 of the New Mexico Administrative Code, became effective on March 31, 2015.
[76] (Vocus PRW Holdings, LLC, 2017) (Forbes, 2013)
[77] This is based off economic impact estimates determined by the University of Arizona and New Mexico State University (The University of Arizona and New Mexico State University, 2015)

These included high capital costs, regulatory challenges, market availability, utility and developer business model challenges, and technology maturation. [78]

One innovation involved the pairing of conventional and renewable energy. Energy experts identified localized pockets of stranded natural gas in the frontier basin where Tucumcari is located.[79] After an initial investment to develop infrastructure to transport the gas, it became the power source to keep wind turbines turning when wind speeds were down. This action became a solution to potential intermittency issues from wind energy production. In addition, our state invested in a wind turbine manufacturing facility, due in part to our success in wind energy production.

When funds became available, New Mexico institutions decided that energy storage was an important investment to diversifying New Mexico's energy usage and growing other energy industries. The result of these upgrades not only supported renewable energy development, but also provided improvements to the grid. Innovations such as pumped hydro plants powered by solar or wind were realized. Benefits such as frequency regulation, support to grid connected generators, assistance to the grid post-blackout, and overall improved grid resiliency were top results of energy storage investments.

DECENTRALIZED ENERGY

To further push innovation in the electrical field, some in New Mexico began to invest in technologies that promoted decentralized energy, including microgrids and other localized energy distribution. Distributed energy resource technologies focus on providing energy generators that are not connected to the grid and are much closer to where the energy is used.[80] This is different from the traditional structure where large, central power plants generate energy that is then distributed across an interconnected grid.

These small-scale power generation units typically do not use high-voltage transmission lines, and may be more reliable, efficient, environmentally friendly and less expensive than the traditional electric power grid. They are desirable to some communities and industrial users living in rural areas or are concerned about grid reliability during storms or cyber-attacks.

SMALL MODULAR NUCLEAR REACTORS

Small Modular Reactors (SMRs) are nuclear-fueled electricity generation technologies with a gross electrical generating capacity of 300 megawatts of electricity or less. Starting in 2026, New Mexico began deploying them on a pilot basis. While there are several different types of reactors, the most mature is the advanced pressurized water reactor. Licensing and approval of a design came through in 2023.

Some New Mexicans favor this type of energy production because SMRs do not emit greenhouse gases, can be constructed in incremental units to match demand and can be largely fabricated in a

[78] (U.S. Office Of Energy Efficiency and Renewable Energy, 2013)
[79] (New Mexico Energy, Minerals and Natural Resources Department) "Stranded gas" refers to gas resources that due to location, or physical and economic reasons remain undeveloped. A frontier basin is a basin where exploration activities have not been carried out and a significant volume of resources are categorized as undiscovered.
[80] Distributed energy resources technologies include fuel cells, photovoltaics, microturbines, reciprocating engines, load reduction, and others. (National Institute of Building Sciences, 2016)

factory, thus reducing field construction costs. The central portion of New Mexico was determined to be potentially suitable for this technology and is the location for our pilot project.[81]

HAWAII'S ENERGY TRANSFORMATION

New Mexicans might find inspiration in real-world examples from Hawaii's transformation of its energy enterprise. Though the natural resources, economics, and policy dynamics are different from New Mexico, similarities exist in terms of diverse cultures, interests and opportunities.

The nation turned toward recession in 2008. Hawaii's economy, highly dependent on the military and tourism, followed suit. Energy prices were high (over 35 cents a kilowatt hour for electricity), and state dollars were reserved for critical health and emergency services. Hawaii was solely dependent on imported oil for transportation and electricity.

Hawaiian business, government and native leaders chose to collaborate to create a different future. Renewable energy, energy efficiency, sustainability, and conservation were primary topics in discussions statewide. Inventories of the islands' indigenous energy sources were updated, and energy policies were revised at county and state levels. Controversy ensued regarding the harnessing of renewable sources, especially ground sources such as geothermal, given their role in native traditions. A joint initiative with the U.S. Department of Energy brought in talent and resources at the national level. Students engaged in energy innovation fairs while learning about energy sources, conversion processes and end uses. Youngsters educated their parents on conservation and related matters.

As the economy slowly rebounded, key leaders emerged and took posts in the regulatory agency, state energy office, and Legislature to advance innovation and shift to more of the islands' indigenous energy sources. Energy and technology accelerators were created to stimulate local entrepreneurship. Utility and military leaders experimented with microgrids and energy storage projects. International partners were secured to invest in Hawaii's energy transformation. One partner developed a statewide report card to track results in energy goals for transportation, efficiency, renewables, smart grid and economics. Eight years later, overall progress reflected major statewide changes in social and environment al norms, as well as the state's overall economic health.

Sources: (Hawaii Department of Business) (Pacific International Center for High Technology Research) (Gallagher, 2016) (Blue Planet Foundation, 2016)

81 Research by EMNRD identified site suitability for SMR projects, including locations in central New Mexico. (NM Energy, Minerals and Natural Resources Department , 2015)

ALTERNATIVE FUELED VEHICLES

Following the trend of innovation and investing in diversified energy sources, alternative-fuel vehicles such as compressed natural gas, biofuel, electric, and hybrid vehicles are increasing in popularity. Back in 2016, 254 new light-duty fuel-cell, all-battery, and plug-in hybrid electric vehicles were sold in New Mexico; that number has increased by 20 percent since then.[82]

Natural gas fueling stations and electric vehicle charging stations appear in most New Mexico cities. Additionally, electric and natural gas grids are strategically located on the interstate to support these vehicles. Santa Fe Community College continues to pioneer work in biodiesel vehicles, helping to make this technology more commercially available.[83]

Conclusion

This New Mexico of 2027 is thriving – both economically and innovatively. It looked to the economies of neighboring states and matched pace. The people of this imagined future were restless and sought out new opportunities; they were determined to be a leader nationally and globally. Looking at this future, how might we achieve this reality? What part of this world would we definitely favor? What about this future worries us? Could this much enthusiasm lead us to be reckless?

[82] This is an estimate based on present-day numbers provided by the Alliance of Automobile Manufacturers and by Bloomberg L.P. estimates that electric vehicles will make up 54% of new vehicle sales in 2040 (Alliance of Automobile Manufacturers, 2017) (Bloomberg New Energy Finance, 2017)

[83] Santa Fe Community College currently offers coursework in developing biodiesel vehicles. (Santa Fe Community College, 2017)

APPENDICES

Appendices A and B summarize the status of the energy enterprise in New Mexico in the 2015-2016 timeframe.[84] Appendix C includes summaries of reports and studies that may be useful during the development or implementation of New Mexico's Energy Roadmap. Appendix D outlines higher education development topics.

Please note, for data available over multiple years, the authors attempted to provide as many years as are available or practical to display. That means that some charts might start with 1982 and others 2000. Maximum data availability was prioritized over consistency. The primary author of this baseline data section is energy engineer Margie Tatro.

Appendix A

NEW MEXICO ENERGY BASELINE

Energy Sources, Uses, and Costs

New Mexico is the seventh-largest net supplier of energy to the nation; energy consumption per capita in the state is above the national average; and energy expenditures per capita are below the national average.[85] The state produces energy from predominantly fossil-based sources as shown in Figure 1.[86]

In 2015, New Mexico ranked fifth nationally in crude oil production, eighth in natural gas production, and tenth in coal production. The state also ranked sixth in the nation in utility-scale electricity generation from solar energy[87] and 17th for installed wind capacity.[88] New Mexico ranks second in uranium reserves in the United States.[89] Energy sources are distributed across the state (See Figure 2.)

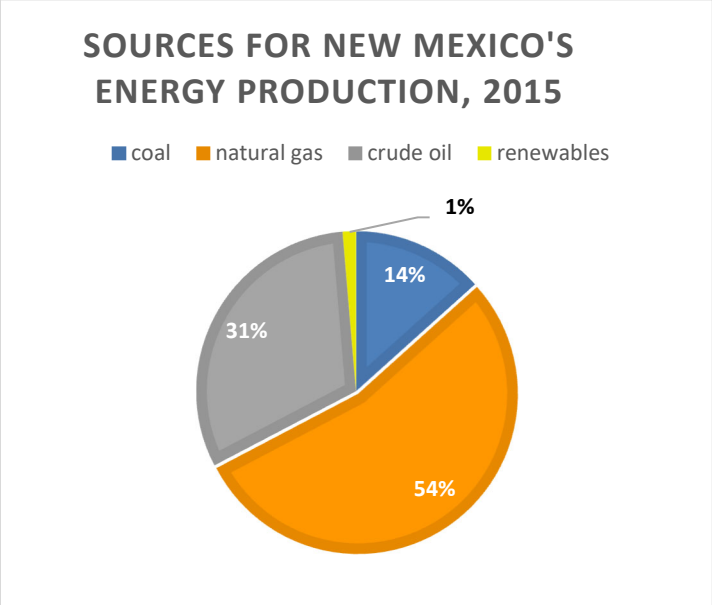


Figure 1: Energy Production Sources, N.M. (EIA)

[84] The "energy enterprise" in New Mexico is the business of extracting, harvesting, converting, transporting, and using energy resources and includes the management of by-products associated these activities. Business elements include physical, human, financial, and regulatory infrastructures – many of which have interdependencies with local, state, regional, tribal, federal and global systems.
[85] New Mexico energy consumption per capita in 2015 was 325 million BTU and expenditures per capita were $3432. The national averages are 303 million BTU and $3512, respectively. New Mexico ranks number 34th in energy expenditures per capita and 20th in energy consumption per capita. (U.S. Energy Information Administration, 2017)
[86] Data are based on a common unit of energy, the British Thermal Unit. Crude oil production in 2016 in New Mexico was 150 million barrels, natural gas production was 1,245,000 million cubic feet, coal production was 20 million short tons, and renewable production was 3 million mega-watt-hours.
[87] Energy production in New Mexico from all sources in 2015 was 2676 trillion BTU and consumption was 758 trillion BTU. (U.S. Energy Information Administration, 2017)
[88] (American Wind Energy Association, 2017)
[89] (N.M. Institute of Mining and Technology-Bureau of Geology and Mineral Resources, 2016)

NEW MEXICO'S ENERGY ASSETS

The state's above ground energy assets are widely distributed, as shown in the illustration below. Not shown are important resources including the national labs and the educational entities that prepare people for energy-related careers. (See Appendix D.)

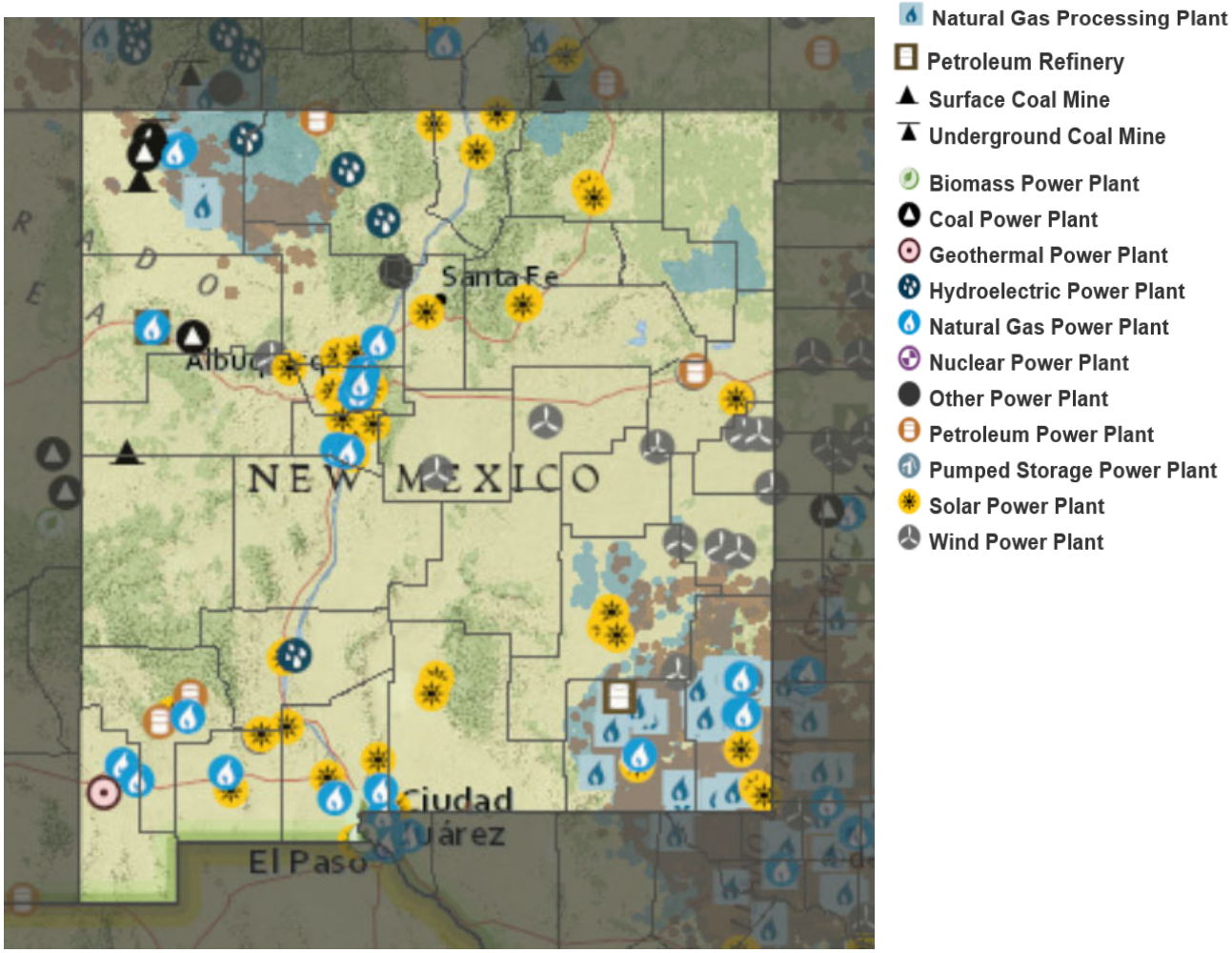


Figure 2: N.M. Energy Assets

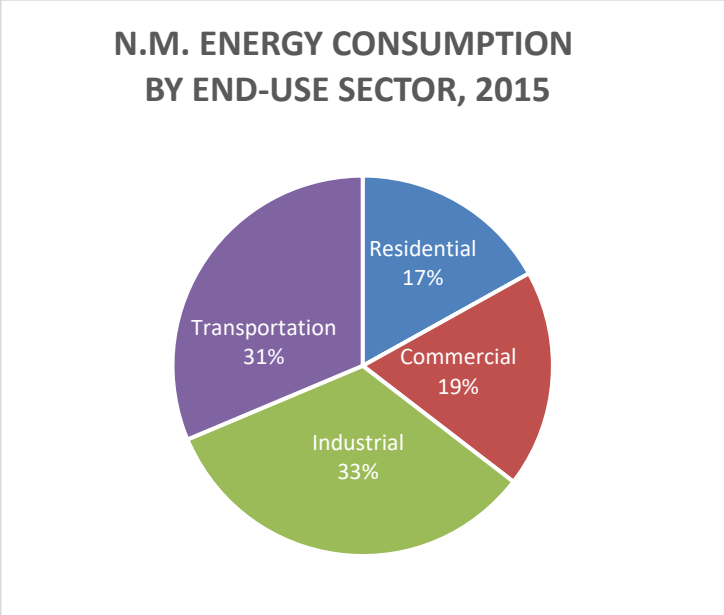


Figure 4: Energy Use by Sector, N.M., 2015 (EIA)

Industrial and transportation sectors account for over 64 percent of energy consumed in New Mexico, as shown in Figure 3.[90] In a national ranking system that places the most energy consuming state as number one, New Mexico ranks 20th in energy consumption per capita. In 2015, coal was the dominant electricity fuel source, with natural gas, wind, and solar also contributing to the production of electricity. (See Figure 10.) Total net electricity generation in the state was approximately 33 million megawatt-hours and the electric power net summer capacity was close to 9000 megawatts.[91] Renewable energy (geothermal, hydroelectric, biomass, solar and wind) sources were harnessed to create 8.7 percent of New Mexico's electricity in 2015.[92] New Mexico exported 8 million megawatt-hours of electricity in 2015, resulting in a net electricity trade index of 1.3.[93] Federal facilities in the state had an electricity demand of approximately 145 megawatts in 2016.[94]

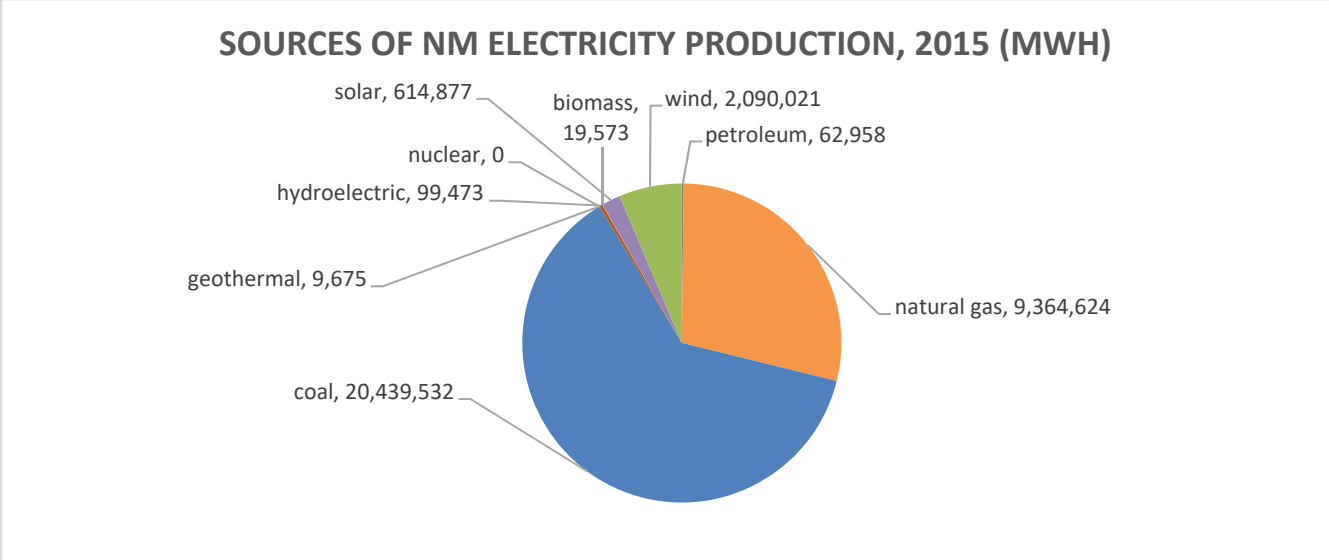


Figure 5: Electricity Production, N.M., 2015 (EIA)

[90] Energy consumed by all four sectors (industrial, transportation, residential, commercial) in 2015 in New Mexico was estimated at 676 trillion BTU. (U.S. Energy Information Administration, 2017)
[91] This is total electric capacity in New Mexico. A portion of this capacity is privately generated and not necessarily available for dispatch to the grid.
[92] (U.S. Energy Information Administration, 2015)
[93] Net trade index is the ratio of electricity supplied divided by the total disposition minus the net interstate trade amount.
[94] (N.M. Energy, Minerals and Natural Resources Department, 2016)

TABLE 1: NOMINAL ELECTRICAL LOAD OF NEW MEXICO'S MAJOR FEDERAL FACILITIES

Facility	Nominal Electrical Load (kilowatts)
Los Alamos National Laboratory	44,084
Sandia National Laboratories	27,760
Kirtland Air Force Base	26,600
Holloman Air Force Base	17,300
White Sands Missile Range	15,200
Cannon Air Force Base	11,100

Energy consumption per capita in the state is above the national average. Table 2 lists the state's ranking across sectors. New Mexico is lower than average in residential consumption and higher than average in transportation.

TABLE 2: NEW MEXICO ENERGY CONSUMPTION PER CAPITA BY SECTOR

Energy consumption per capita in 2015	New Mexico (million BTU)	National average (million BTU)	Difference from national average	National Rank*
Residential	55.1	63.8	-14%	47
Commercial	60.0	56.4	+6%	25
Industrial	108.0	97.8	+10%	21
Transportation	101.7	84.9	+20%	13
Total consumption	**324.7**	**303.1**	**+7%**	**20**

**Rank of one indicates the state with the most energy use per capita. (EIA)*

New Mexicans spend less on annual energy products and services compared to the national average. New Mexico energy expenditures per capita in 2015 were $3,432, while the national average was $3,512.[95] As of April 2017, New Mexico energy prices are below the national average. The average retail price for electricity is 9.25 cents per kilowatt-hour, though prices range between 6.07 and 12.63 cents per kilowatt-hour for industrial and residential uses, respectively. This residential electricity cost places New Mexico at number 23 nationally. Electricity rates for industrial, commercial, and residential users are lower than national average rates by eight, four, and one percent, respectively.[96] Natural gas for residential users in New Mexico costs $8.85 per thousand cubic feet, a rate that is 22 percent lower than the national average; this ranks the state 40th nationally.

New Mexicans consumed 46 million barrels of petroleum (mostly motor gasoline and diesel fuel) and spent about $4 billion on transportation fuel in 2015. Expenditures for motor gasoline totaled $2.2 billion, or roughly $1,100 per person for 2015. New Mexico ranks 35th nationally in motor gasoline expenditures per person.[97] Vehicle miles travelled in N.M. in 2015 was 13,064 miles per capita.[98] Zero emissions vehicles in the state represented less than 0.2 percent of new cars sold in 2015.[99] Compressed natural gas vehicles estimated in use in N.M. in 2015 is 800.[100] The

[95] (U.S. Energy Information Administration, 2017)
[96] (U.S. Energy Information Administration, 2017)
[97] The national average expenditure per person for motor gasoline in 2015 was $1,068 and the N.M. average was $1,074. (EIA, 2017)
[98] NM DOT data for vehicle miles travelled extracted from Federal Highways Administration VM2 reports. 2015 number was 27,435 million miles.
[99] Zero emissions vehicles include light-duty fuel-cell, all-battery, and plug-in hybrid electric vehicles. In 2015, 171 new ZEVs were sold in the state; 254 were sold in 2016. (Alliance of Automobile Manufacturers, 2017)
[100] Information provided by Natural Gas Vehicle America and cited in NM EMNRD report entitled "New Mexico Natural Gas Vehicle Report

state's alternative fueling infrastructure in 2016 included 14 compressed natural gas fueling stations, one liquefied natural gas fuel station, and 52 electric vehicle charging stations.[101] Public transit ridership in New Mexico was 16 million during the state's 2016 fiscal year (July 1 – June 30, 2016).[102]

ENERGY USE SUMMARY

A single picture of New Mexico energy use for 2015 is shown in the Sankey diagram below. Energy sources shown on the left (in units of trillion BTU) are used for electricity production as well as for residential, commercial, industrial and transportation needs. The thickness of the colored lines represents energy that is consumed or rejected in each sector. Rejected energy (represented by the light grey lines) is energy that is lost during conversion from one form to another and is calculated based on sector average efficiencies.[103]

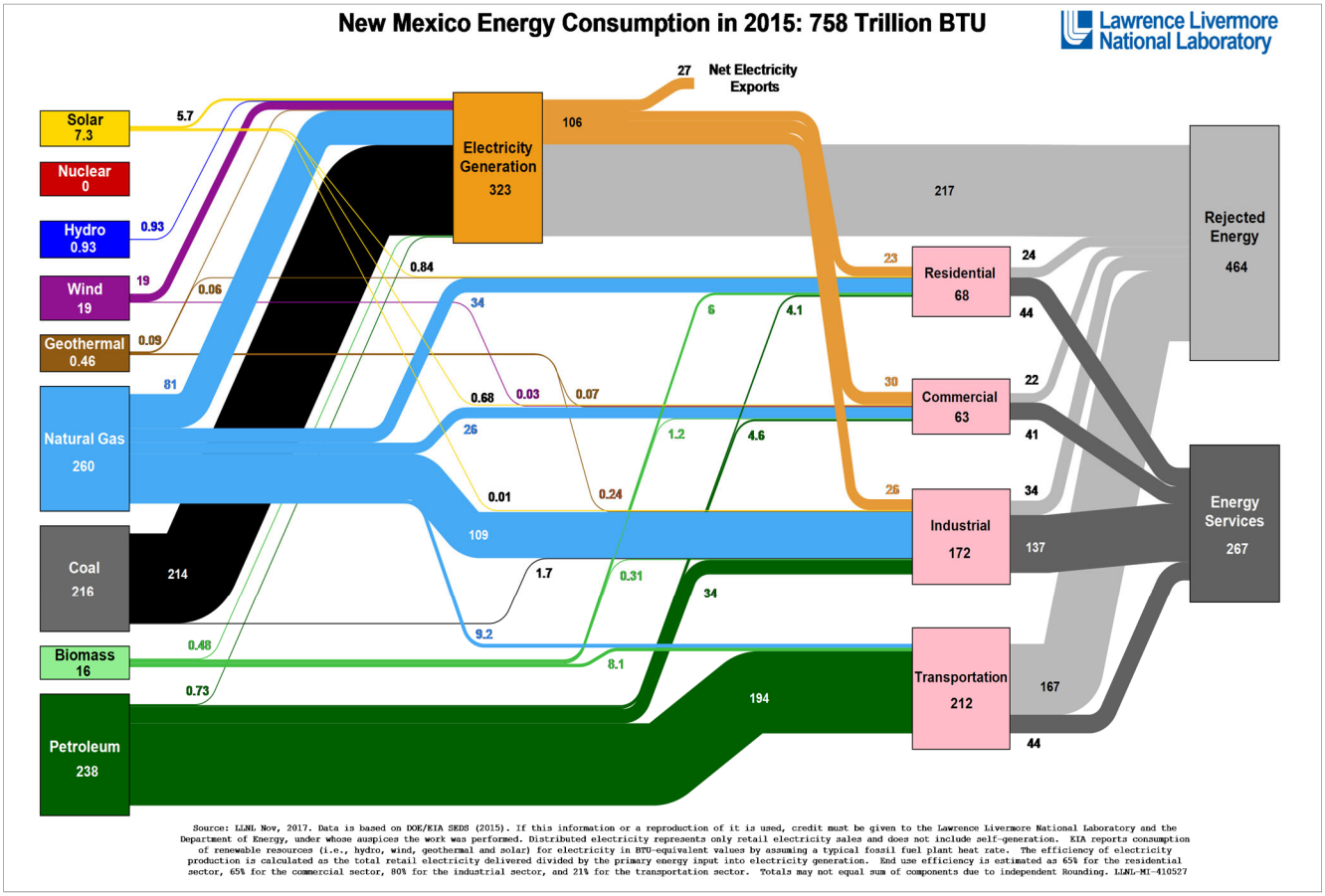


Figure 6: Sankey Diagram, N.M. Energy Consumption

2016 House Joint Memorial 5: Increase Natural Gas Vehicle Use," November 2016

[101] (N.M. Energy, Minerals and Natural Resources Department, 2016). Eight of the 14 CNG fueling stations are open to the public. As of July 2017, NM had 57 electric vehicle charging stations.

[102] (N.M. DOT Transit Fact Sheet, 2017) Note that ridership during FY2015 was 17.5 million.

[103] For example, during the combustion of natural gas and petroleum, some energy is lost in the forms of heat and light.

Energy Production History

NATURAL GAS

Natural gas production in New Mexico reached a high point in the year 2000 as shown in Figure 7.[104] In 2016, 63 percent of natural gas production occurred on federal land, 20 percent on state land, 14 percent on private land, and three percent on tribal land.[105]

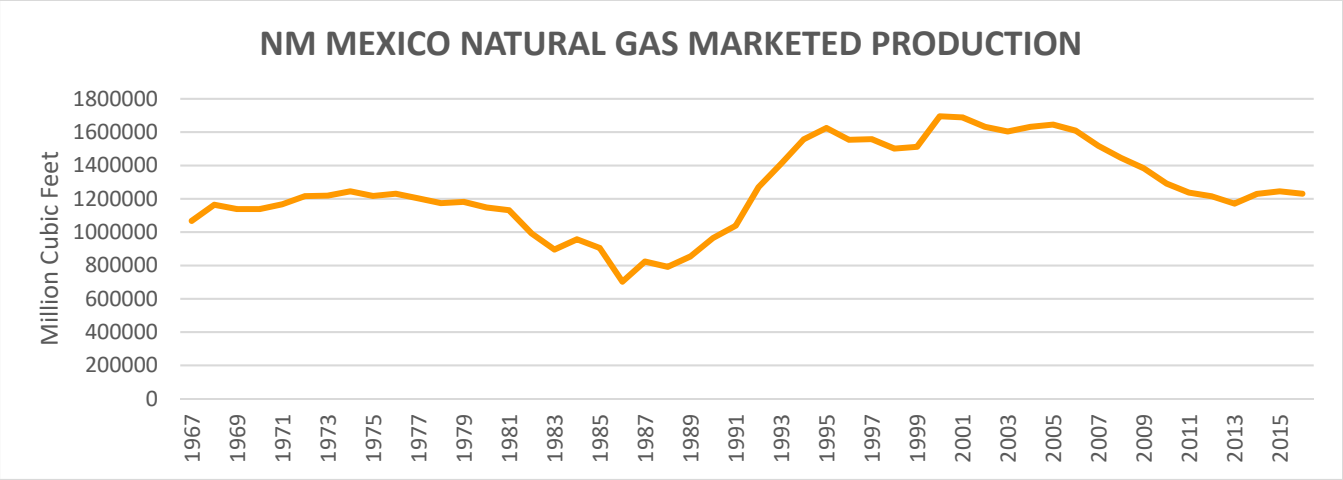


Figure 7: Natural Gas Production, N.M., 1967-2015 (EIA)

PETROLEUM

Production of crude oil increased dramatically in New Mexico between 2011 and 2015 as shown in Figure 8.[106] A variety of land owners participate in petroleum extraction. In 2016, 55 percent of oil production occurred on federal land, 34 percent on state land, ten percent on private land, and one percent on tribal land.[107]

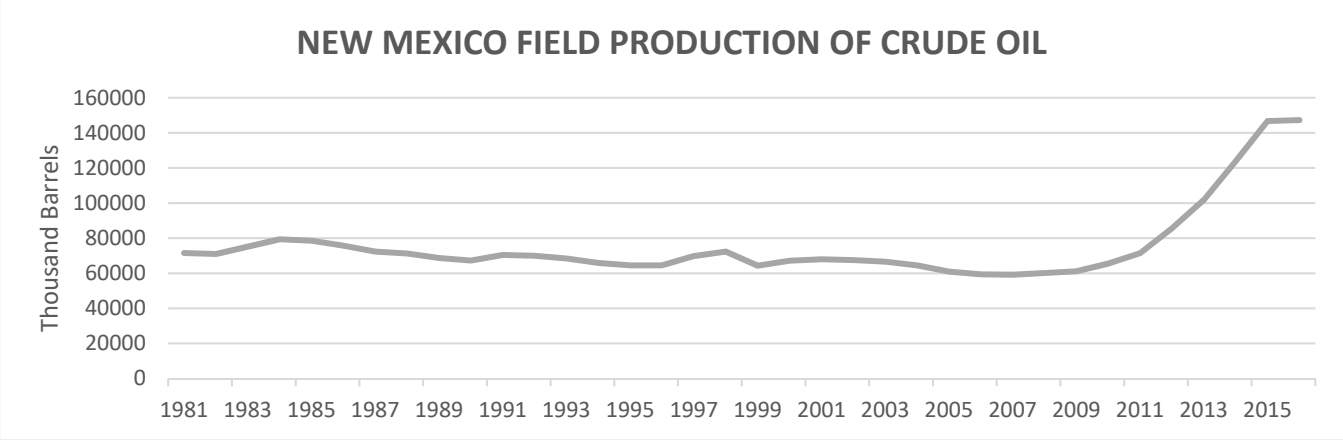


Figure 8: Crude Oil Production, N.M., 1981-2015 (EIA)

[104] (U.S. Energy Information Administration, 2017)
[105] (N.M. Energy, Minerals and Natural Resources Department, 2016)
[106] (U.S. Energy Information Administration, 2017)
[107] (N.M. Energy, Minerals and Natural Resources Department, 2016)

COAL

Coal production was relatively consistent until 2014, see Figure 9.[108] New Mexico's coal is produced on federal, private, and tribal lands in relatively equal percentages.[109]

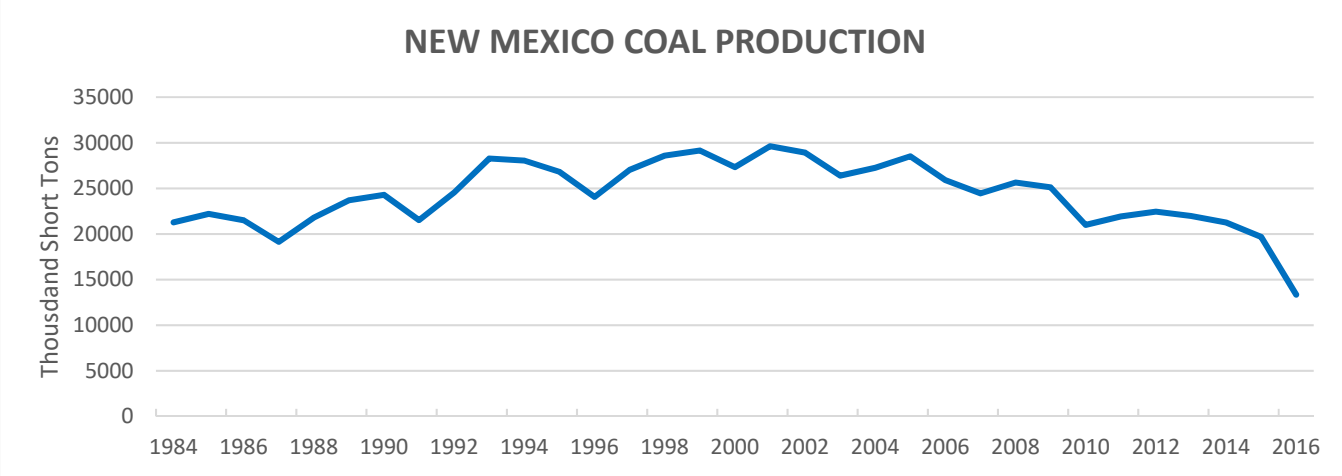


Figure 9: Coal Production, N.M., 1984-2016 (EIA)

RENEWABLES AND ELECTRICITY PRODUCTION

Renewable energy sources are primarily used for electricity production in New Mexico. Therefore, long-term tracking of these sources is most usefully presented as a share of total electricity production.

Sources for New Mexico's electricity production have changed in the past 25 years. Production from coal has declined while natural gas, wind, and solar based production has increased. Percentages shown in Figure 10 are based on megawatt-hours of electricity produced. Renewable energy (geothermal, hydroelectric, biomass, solar and wind) sources were harnessed to create 8.7 percent of New Mexico's electricity in 2015.[110]

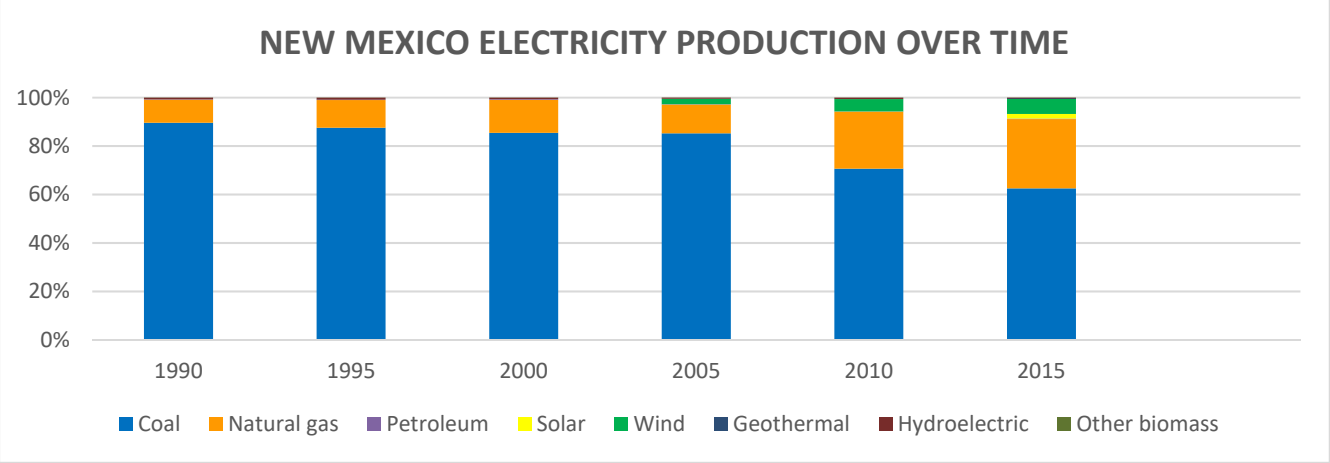


Figure 10: Electricity Production, N.M., 1990-2015 (EIA)

[108] (U.S. Energy Information Administration, 2017)
[109] (N.M. Energy, Minerals, and Natural Resources Department, 2017)
[110] (U.S. Energy Information Administration, 2017)

Environmental Considerations

New Mexico's energy enterprise generates by-products including carbon dioxide, sulfur dioxide, and nitrogen oxide. Water is required for some energy operations and as such, is a critical issue in an arid climate.

CARBON DIOXIDE EMISSIONS

Fifty million metric tons of carbon dioxide (CO_2) -- half coming from the conversion of coal and natural gas to produce electricity – were generated in 2014.[111]

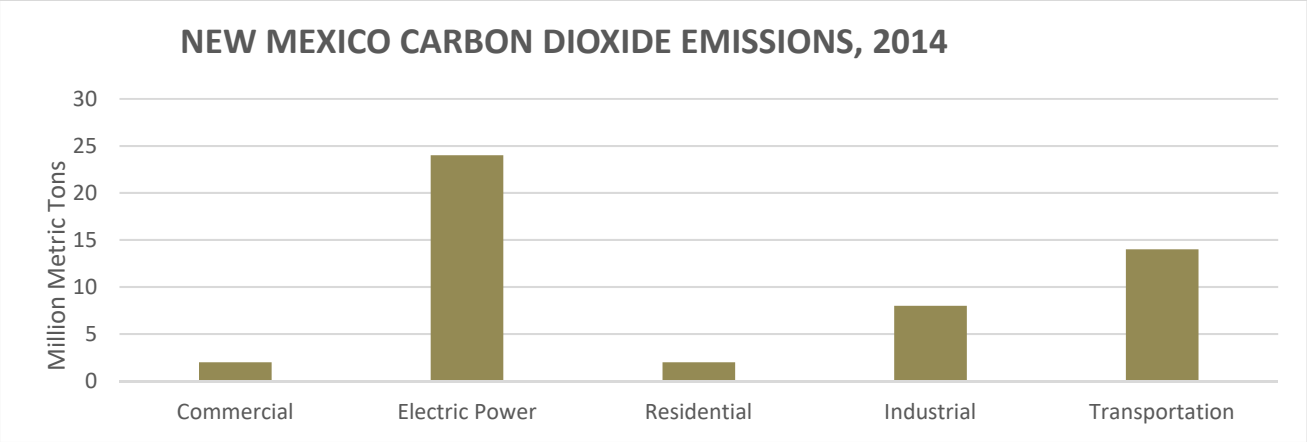


Figure 11: Energy-Related Carbon Dioxide Emissions, N.M., 2014 (EIA)

New Mexico is ranked 37th nationally in terms of CO_2 emissions. The coal and natural gas conversion process generated 11 thousand metric tons of sulfur dioxide and 42 thousand metric tons of nitrogen oxide in 2014.[112] The state achieved a 14 percent reduction in the state's energy related carbon dioxide emissions between the years 2000 and 2014, as shown in Figure 12.[113]

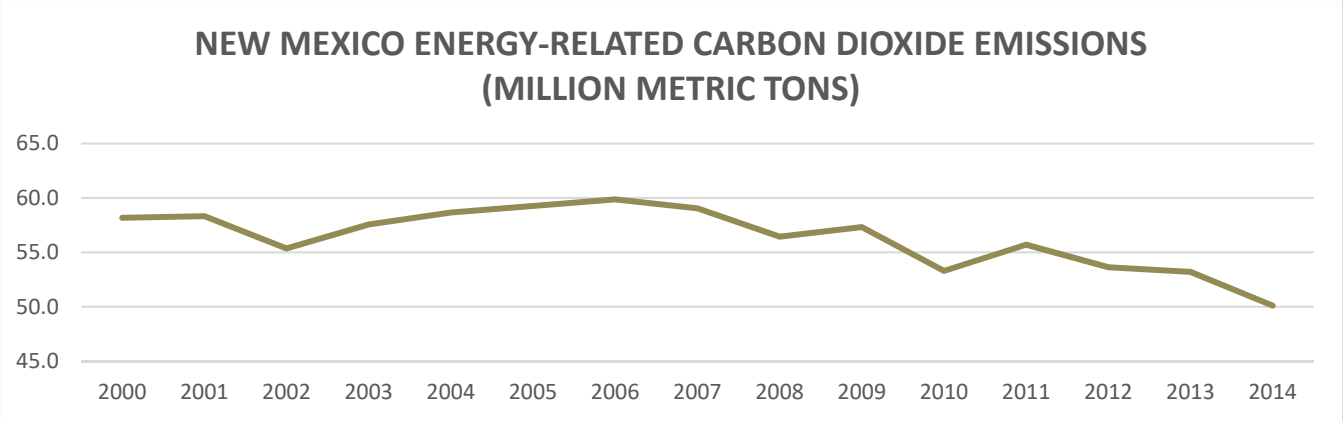


Figure 12: Energy-Related Carbon Dioxide Emissions, N.M., 2005-2014 (EIA)

[111] Transportation contributes most of the rest of the carbon dioxide emissions. Transportation contributes 14 million metric tons, residential and commercial each contribute 2 million metric tons, and industrial contributes 8 million metric tons.
[112] (U.S. Energy Information Administration, 2017)
[113] Carbon dioxide emissions metrics tracked by the U.S. EIA (total emissions, emissions per capita, emissions per unit of energy consumer, and emissions per unit GDP) assign the emissions to the state that converts the source into electricity or consumes the source directly. A different metric may be desirable when discussing New Mexico's energy import and export decisions.

NITOGEN OXIDE EMISSIONS

Opportunities for reductions in nitrogen oxide (NOx) emissions in New Mexico exist in the transportation sector, given that 44% of NOx emissions (98,970 tons) originated from the state's mobile sources in 2014.[114] Primary contributors to mobile source NOx emissions in N.M. are shown in Figure 13 and include on-road diesel heavy duty vehicles, locomotives, and on-road gasoline light duty vehicles.

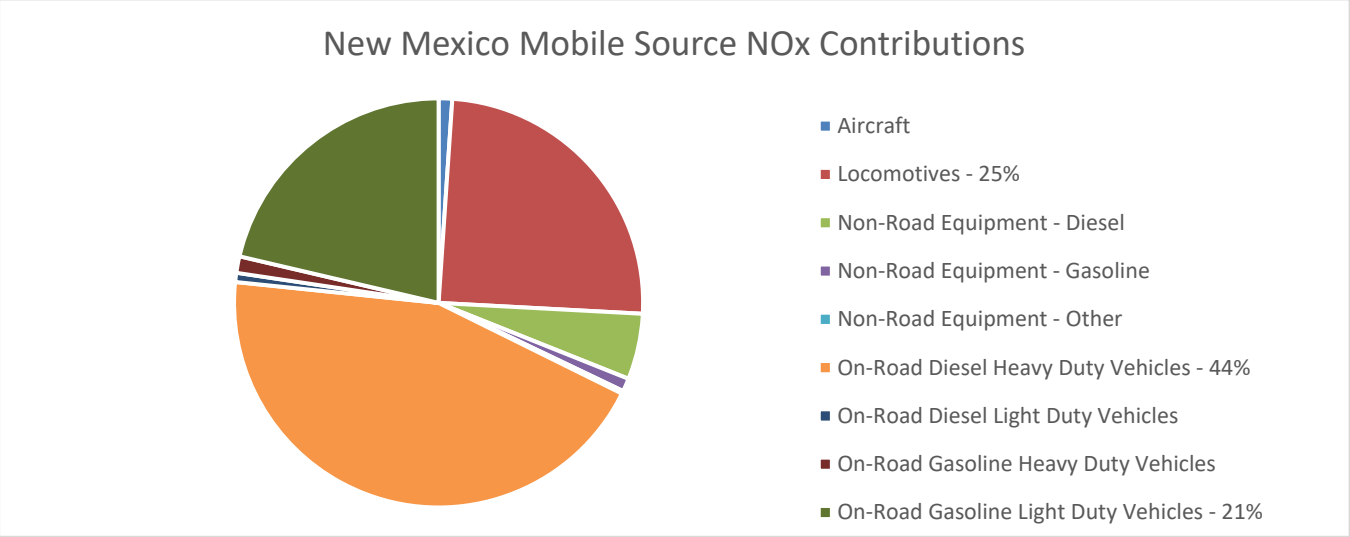


Figure 13: N.M. Mobile Source NOx Contributions (U.S. EPA 2014 National Emissions Inventory)

VENTED AND FLARED GAS CONSIDERATIONS

Management of vented and flared gas presents energy efficiency and emissions reductions opportunities in New Mexico. Flared gas is excess natural gas or a mixture of gases that is vented from natural gas wellheads and burned at the vent stack. Venting or flaring may occur during drilling, when waste gas and or nitrogen laden gas is a waste product either because no collection or processing infrastructure exists, or because the gas is not suitable for delivery to a pipeline. Venting or flaring may also occur after well completion, when gas production exceeds the collection pipeline capacity. In 2016, vented and flared gas represented 1.96% of all natural gas transported from New Mexico sources.[115]

WATER FOR ENERGY OPERATIONS

In the year 2010, the combination of mining (of all types, including petroleum, natural gas, coal, and any other mineral substances naturally occurring in the earth's crust) and power generation withdrew less than three percent of New Mexico's overall water withdrawals from both surface and groundwater sources. Mining accounted for 41,559 acre-feet (AF), mostly from groundwater sources, and power generation accounted for 58,339 AF (mostly from surface water sources) of withdrawals in 2010 as shown in Figure 14.[116]

[114] (U.S. EPA , 2014)
[115] N.M. Energy, Minerals and Natural Resources Department's Oil Conservation Division tabulates monthly vented and flare gas data from producers' C-115 reports. For 2016, vented and flared gas amounted to 25.11 billion cubic feet and total transported natural gas was 1,279 billion cubic feet. It is noted that reporting from small producers may be incomplete.
[116] Please note that Industrial water use is actually 0.33 percent. The chart shows it as zero because it rounds to the nearest whole number. In addition, produced water quantities are not included in the state's Water User Reports, which are prepared every five years.

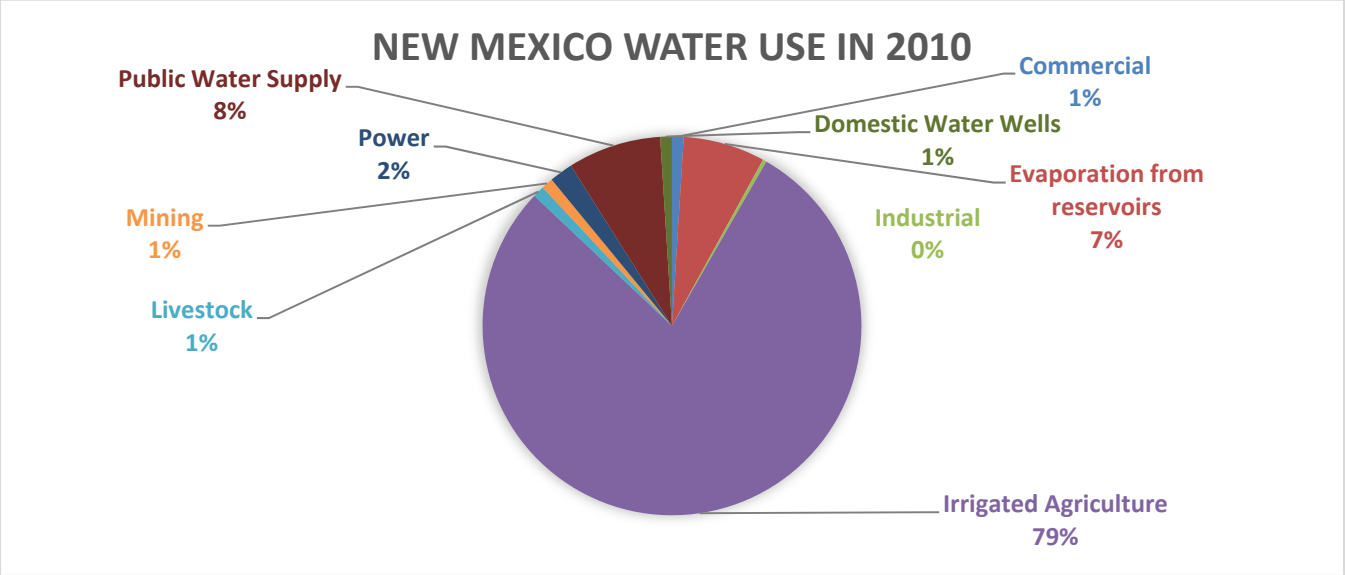


Figure 14: Water Use by Category, N.M. (OSE)

Withdrawals in the power category decreased approximately eight percent between 2005 and 2010.[117] Of these withdrawals, 47,434 AF (81.3 percent) were from surface water and 10,905 AF (18.7 percent) were from groundwater sources.

Note that all references to water use refer to it being withdrawn from a surface or groundwater source. Much of the water withdrawn returns to the environment and is thus not truly consumed. Brine water pumped from a depth of 4,000 to 5,000 feet during any mining operation, which is returned by injection into deep brine aquifers, is not included in the state inventory since its impact on the net supply of fresh water is zero. However, water pumped from freshwater aquifers for the secondary recovery of oil, which is later disposed of by injection into deep brine aquifers or spread on the land surface where it evaporates, is treated as a withdrawal.

Historically, the biggest water concerns about the extractive industries are not the amount of water used but rather the potential for groundwater contamination. Consequently, these industries are highly regulated and monitored by state agencies. Water separated from petroleum during processing (produced water) is usually either discharged into lagoons where it is evaporated or injected into deep aquifers. Produced water in New Mexico increased from 708 million barrels in 2010 to 891 million barrels in 2015.[118]

Energy Infrastructure Facilities

Infrastructure facilities such as transmission lines, pipelines, rail lines, refineries, power plants, and highways transform and deliver energy products throughout and across New Mexico, and are essential to the state's energy enterprise. The map in Figure 15 illustrates the concentration of energy delivery infrastructure in northwest and southeast New Mexico.[119]

[117] (N.M. Office of the State Engineer, 2013)
[118] Note that New Mexico's Water Resources Research Institute maintains a database of produced water statistics. (WRRI, 2017)
[119] (U.S. Energy Information Administration, 2017)

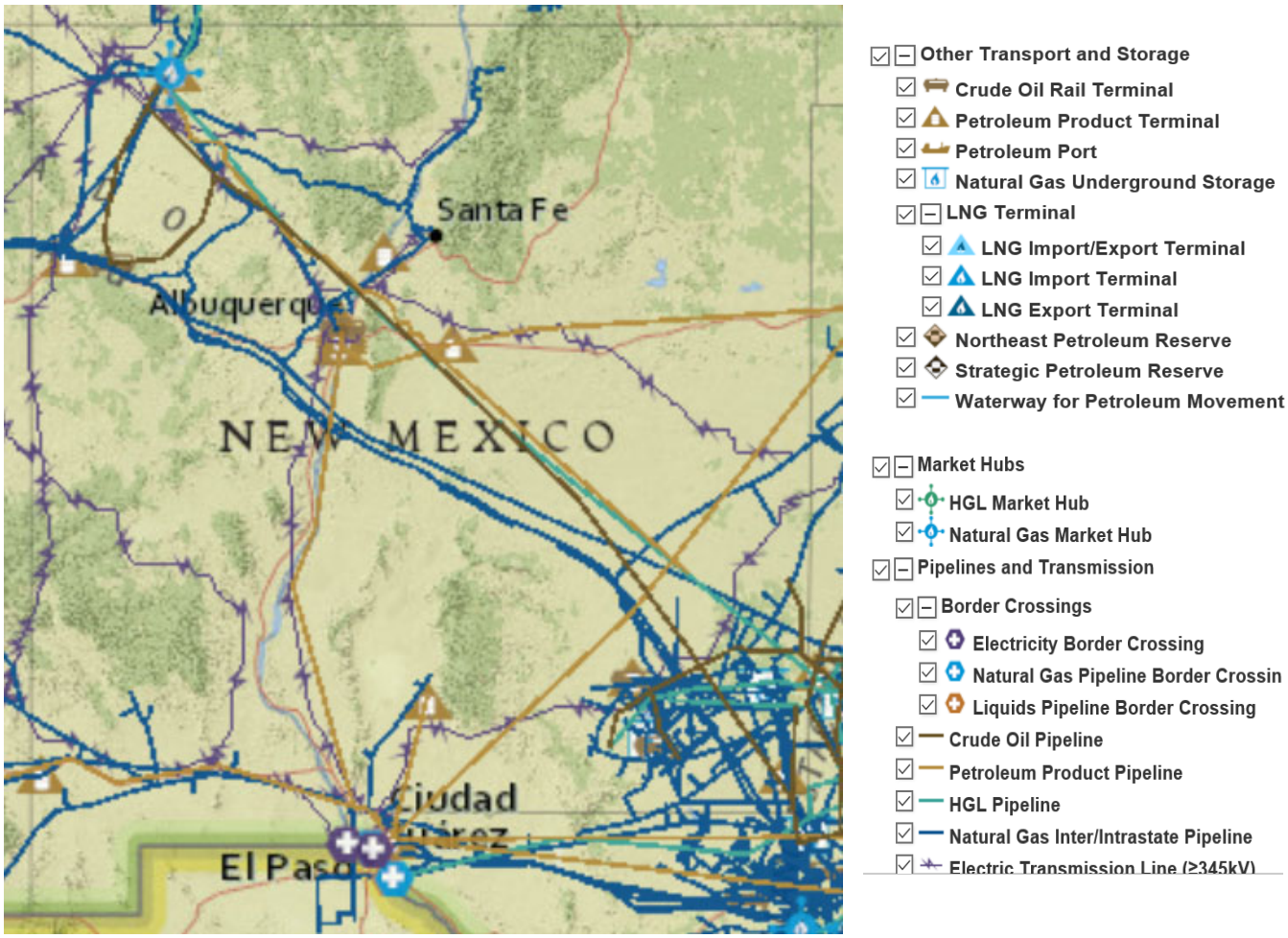


Figure 15: New Mexico Energy Delivery Facilities (EIA)

The U.S. maps in Figure 16 show that the state is located at the intersection of three of the National Electric Reliability Council (NERC) regional entities and three electricity market organizations.[120] NERC oversees the reliability functions for the nation's electric grid. Regional transmission organizations and independent system operators coordinate electricity delivery and generation functions. New Mexico's location complicates the number of interfaces required by electricity providers who operate in the region. The absence of federally regulated power lines (transmission) in the eastern and west central areas of the state is both a challenge and an opportunity.

[120] (Quadrennial Energy Review Task Force, 2015)

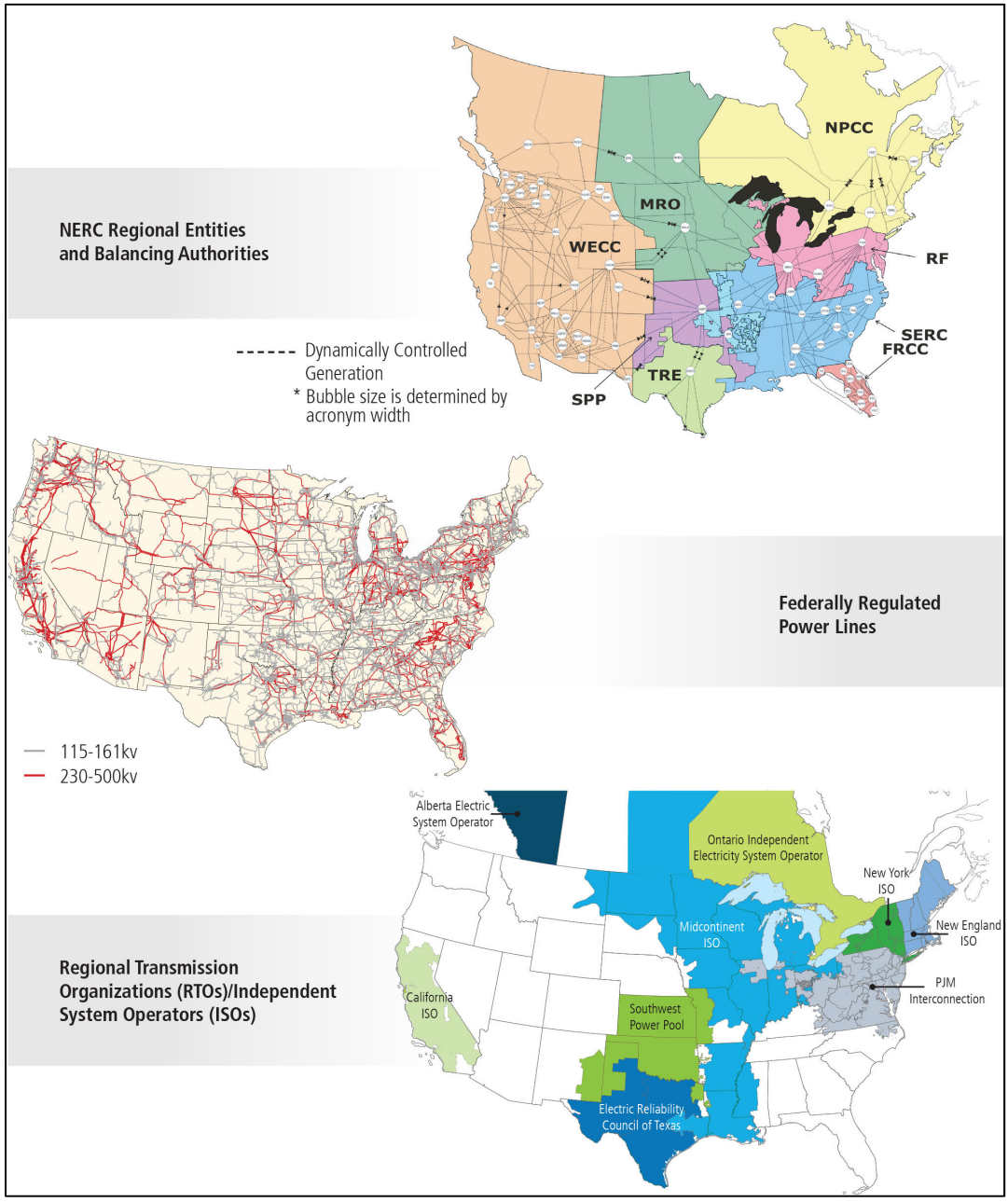


Figure 16: National Electric Infrastructure Jurisdictions (QER)

Transmission lines and substations are necessary for moving electricity from where it is generated to where it is used. Pairs of high voltage (345 kilovolt) transmission lines originate at the San Juan and Four Corners generating stations in the northwest corner of the state.[121] These lines serve the central part of New Mexico and Arizona. Additional lines

[121] The two 345 kilovolt lines between northwestern New Mexico and the Albuquerque metro area have a capacity of 1000 megawatts each. A 345 kilovolt line between the Albuquerque area to the Clovis area has a capacity of 500 megawatts.

run east and south, as shown in Figure 15. Projects are being developed to increase the capacity for moving electric power around and across the state.[122]

Electricity is a highly reliable and versatile form of energy. Two events of disturbance that impacted New Mexico were reported in the electricity system in 2016.[123] Local disruptions are not included in the U.S. DOE reporting system.

Pipelines in New Mexico carry natural gas and crude oil, as well as liquids derived from these resources such as refined petroleum products (i.e., gasoline, diesel fuel, jet fuel, and fuel oil). Liquid carbon dioxide and other liquids such as propane, ethane, butylene, and anhydrous ammonia are also transported in pipelines. In 2016, the state's inventory included 27,000 miles of natural gas pipelines and 7,000 miles of liquid pipelines.[124] Planned expansions in U.S. liquid fuels pipelines (as of the end of 2014) included additional capacity for transporting New Mexico's products to Texas transportation hubs (see Figure 17).[125]

One measure of the size of the state's natural gas delivery infrastructure is the volume of natural gas processed within the state. In 2016, New Mexico facilities processed 825 billion cubic feet of natural gas.[126]

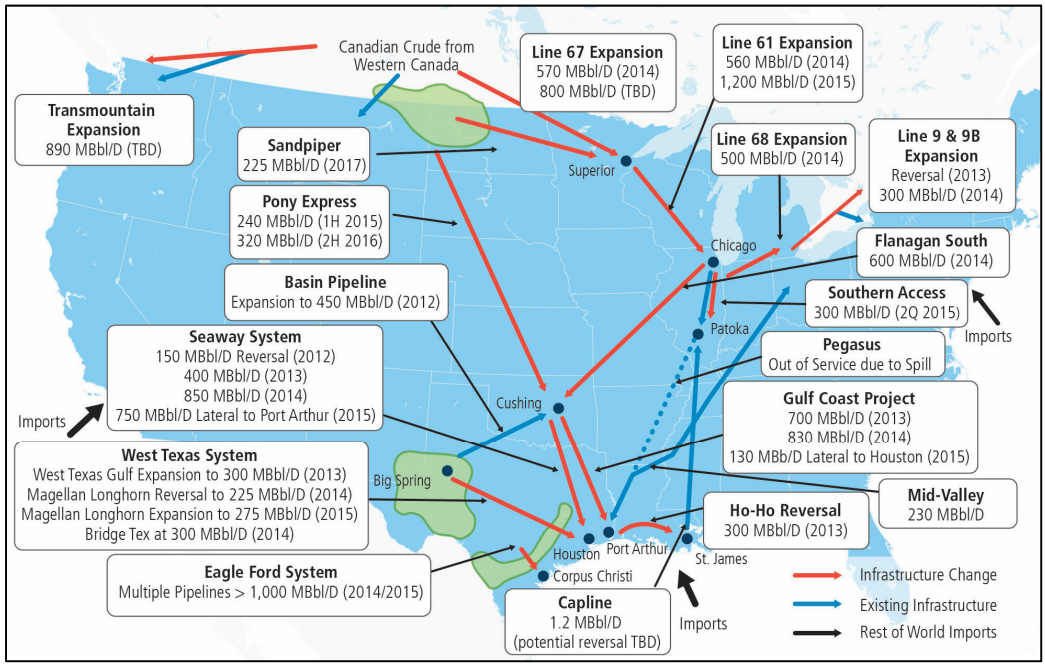


Figure 17: Examples of Liquid Fuels Pipeline Reversals and Expansions Accommodating Domestic and Canadian Supply (QER)

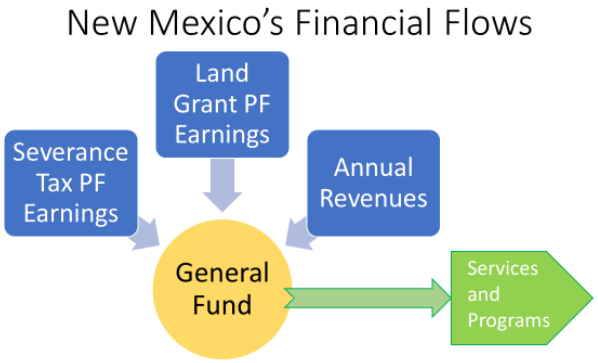
[122] For example, the SunZia project aims to build new transmission lines to deliver power from the east-central part of New Mexico to Arizona using 500 kilovolt lines. This would add 3000-4500 megawatts of capacity to the state's transmission system.
[123] (U.S. Department of Energy, 2016)
[124] (U.S. Department of Transportation, 2017)
[125] (U.S. Department of Energy, 2015)
[126] (U.S. Energy Information Administration, 2016 Natural Gas Annual Report, Table 6)

Appendix B

ECONOMIC AND POLICY BASELINE

New Mexico Financial Resources

New Mexico's general fund provides resources to deliver services and programs to its citizens. This fund receives dollars from annual revenues, as well as earnings from the two permanent funds – the Land Grant Permanent Fund (LGPF) and the Severance Tax Permanent Fund (STPF). For FY2016, the size of the general fund was $6 billion, the LGPF was $14 billion, and the STPF was $5 billion.[127] The state also borrows money to make up for deficits when annual revenues are insufficient to cover annual spending allotments. The state's debt in 2015 was $6.74 billion and as of 2017, the state has a credit rating of AA+.



Below is a summary of revenues held in the general fund as well as allotments made from the general fund. Federal aid, which represented 35 percent of state revenues in 2014,[128] is not included in this summary (revenues nor allotments).

TABLES 3 AND 4: GENERAL FUND REVENUES AND ALLOTMENTS

GENERAL FUND REVENUES	FY2016 ($ IN MILLIONS)
Gross Receipts	1,975.4
Compensating	46.9
Selective Sales Taxes	531.5
Personal Income Taxes	1,715.8
Corporate Income Taxes	118.5
Severance Tax	279.8
License Fees	54.8
Interest Earnings (From Permanent Funds)	773.8
Rents and Royalties	437.8
Tribal Gaming Revenue Sharing	64.4
Misc. Fees	48.1
Non-Recurring Revenues	96
Total	**$6,564.9**

GENERAL FUND ALLOTMENTS	FY2016 ($ IN MILLIONS)
Legislature	26.0
Judicial	276.5
General Control	193.1
Regulatory	59.5
Natural Resources	84.3
Health/Welfare	1,680.8
Public Safety	435.3
Transportation	27.2
Other Education	116.1
Public School System	2623.3
Higher Education	843.3
Total	**$6,365.6**

[127] (NM Department of Finance, 2016)
[128] (Ballotpedia, 2016)

Several annual revenue sources stem from New Mexico's energy sectors. The gross receipts, compensating tax,[129] corporate income tax, severance tax, and some royalties originate from energy activities. Interest and earnings from the permanent funds also generate revenue. Estimates regarding the contribution of specific energy sectors to annual revenues vary. One study attributes 28 percent of the FY2016 general fund to current and historical oil and gas activities.[130]

Energy, Jobs, and New Mexico's Gross Domestic Product

New Mexico's gross domestic product was $93.3 billion in 2016, a decrease of 0.5 percent from 2015.[131] Energy sector business activities are not tracked explicitly by the U.S. Bureau of Economic Analysis.[132] The following energy-related industries contributed 13 percent to the state's GDP in 2016: natural resources and mining, transportation and warehousing, and utilities. (See Figure 18.) Other private sector industries which contribute to the energy enterprise include manufacturing, construction, information, and professional services. [133]

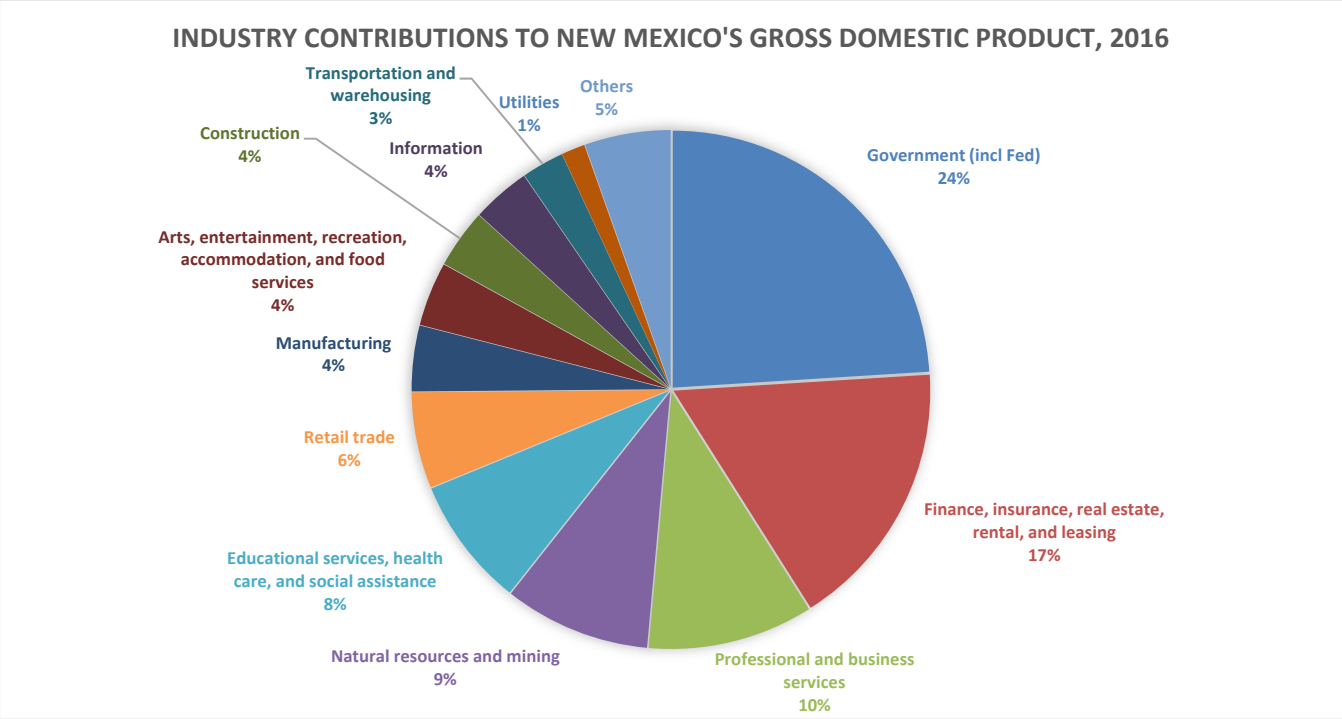


Figure 18: N.M. GDP by Industry (N.M. Tax and Revenue)

[129] Compensating tax is a tax borne directly by the oil and gas producers and support companies. For example, a horizontal drilling rig purchased outside the state, but imported and used in operations in New Mexico, is subject to a compensating tax.
[130] (New Mexico Tax Research Institute, 2015)
[131] (U.S. Bureau of Economic Analysis, 2017) Gross domestic product (GDP) by state is the market value of goods and services produced by the labor and property located in a state. GDP by state is the state counterpart to the nation's GDP.
[132] Industry classifications are per the North American Industry Classification System.
[133] (U.S. Bureau of Economic Analysis, 2017)

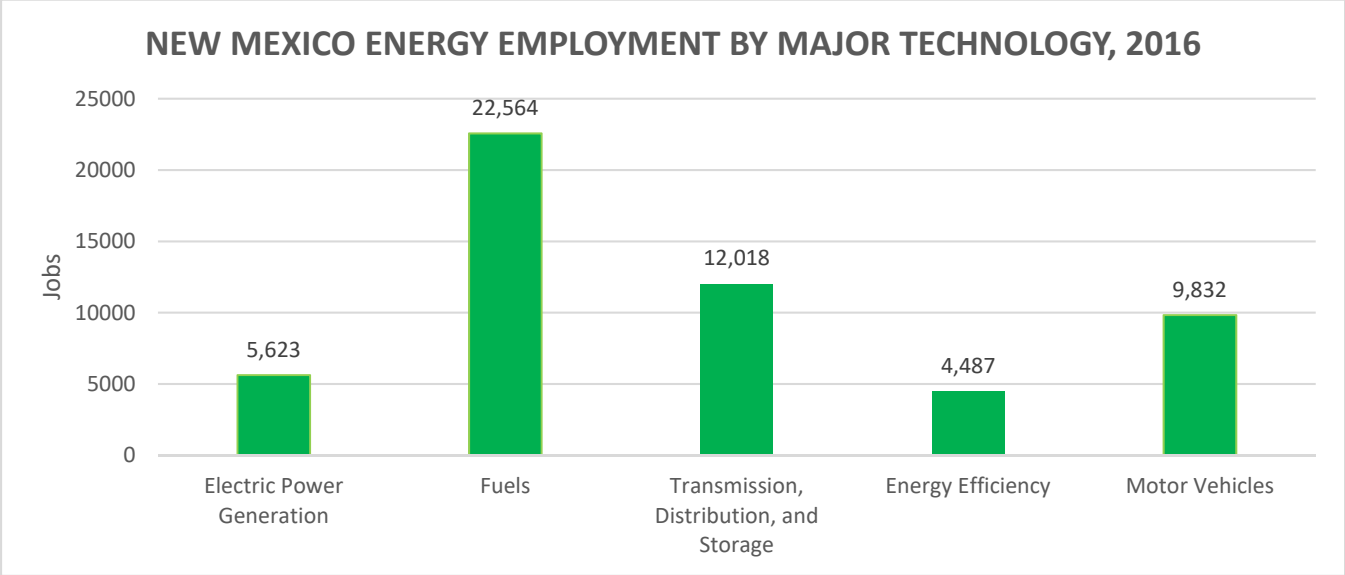


Figure 19: N.M. Energy Employment by Technology (DOE)

The U.S. Department of Energy reported that the energy sector in New Mexico provided employment for 54,525 workers in 2016, as shown by combining the jobs in Figure 19.[134] This represents 6.8 percent of employment in the state. Employment in all occupations within the state during this same year was 805,440 and the annual mean wage was $44,160.[135] Unemployment in the state in 2016 was 6.7 percent and the national unemployment rate was 4.9 percent.[136] In 2015, 20 percent of New Mexicans were below the poverty level.[137]

Indicators of Economic Activity

Rig counts and producing natural gas wells are two measures of economic activity in the oil and gas industry. Though these measures fail to account for updated drilling and production technologies, which have improved the production per well in many cases, trends may be useful to monitor. New Mexico's average rig count in 2015 was 53 and 40,600 wells were producing natural gas that year.[138] Annual average number of rigs in the state was 68 for the year 2000.[139] Figure 20 shows the generally increasing number of natural gas wells in the state since 1990. Note the historic peak in 2010 at 44,750 wells.

Selection of an indicator to monitor economic activity in the electricity sector is challenging. Growth of jobs in electric power generation and transmission, distribution, and storage is one such indicator.

[134] (U.S. Department of Energy, 2017)
[135] (U.S. Department of Labor, 2017)
[136] (N.M. Department of Workforce Solutions, 2017)
[137] (U.S. Census Bureau, 2017)
[138] (U.S. Energy Information Administration, 2017), (NASDAQ, 2017)
[139] (U.S. Energy Information Administration, 2017)

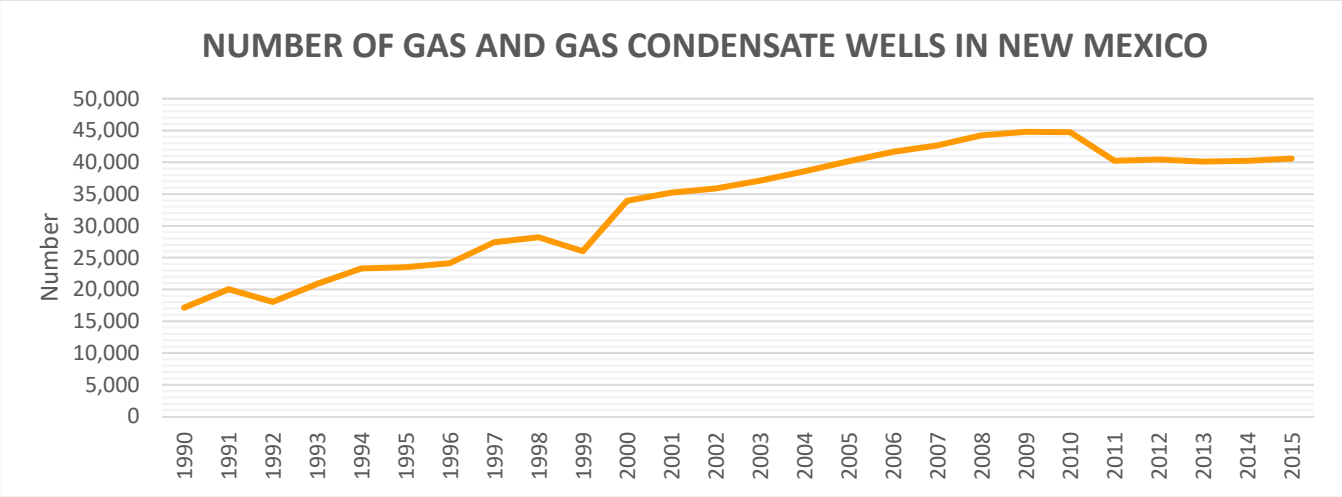


Figure 20: Natural Gas Wells in N.M., 1990-2015 (EIA)

Energy Tax Laws and Policies

TAX LAWS SYNOPSIS

Five broad categories of tax expenditures existed in 2016 in New Mexico: citizen benefits, economic development, environment, conservation, renewable energy, healthcare and highly specialized industries.[140] Energy sector tax programs can be grouped according to four intended outcomes: workforce development, economic investment, market stimulation, and industry stimulation. Table 5 lists the current energy tax programs per these outcomes.

TABLE 5: NEW MEXICO'S ENERGY SECTOR TAX PROGRAMS[141]

Workforce Development	Economic Investment	Market-focused Stimulus	Industry-focused Stimulus
No Relevant tax programs	Credit, Qualified Business Facility Rehabilitation	Credit, Solar Market Development	Credit, Sustainable Building (Construction Industry)
	Credit, Geothermal Ground-Coupled Heat Pump	Credit, Renewable Energy Production	Credit, Blended Biodiesel Fuel (Special Fuels Supplier)
			Credit, Advanced Energy (Utilities)
			Credit, Agricultural Biomass (Ag)
			Credit, New Sustainable Building (Construction Industry)
Gross Receipts & Compensating Tax Regime Programs			
No Relevant Tax programs	Credit, Biodiesel Blending Facility	Deduction, Wind & Solar Equipment Sales to Government	Deduction, Converting Electricity (Utilities)
	Deduction, Biomass-Related Equipment; Biomass Materials	Deduction, Solar Energy Systems	Deduction, Electricity Exchange (Utilities)
	Deduction, Equipment for Certain Electric	Credit, Alternative Energy Product Manufacturers	Deduction, Advanced Energy (Utilities)

[140] Over 240 different taxation mechanisms are described in the 2016 Tax Expenditure Report. (N.M. Taxation and Revenue Department, 2016)
[141] (N.M. Taxation and Revenue Department, 2017)

Workforce Development	Economic Investment	Market-focused Stimulus	Industry-focused Stimulus
	Transmission or Storage Facilities		(Construction Industry)
			Credit, Advanced Energy (Utilities)

Not included in the previous table are: excise taxes, severance taxes, oil and gas production incentives, conservation tax, emergency school tax and ad valorem production taxes. In addition, there are eleven programs (e.g., natural gas processors exemption, use of electricity to process electricity exemption and credit paid to Navajo Nation) that provide for exemptions and credits enacted to prevent taxation by multiple programs or jurisdictions, and are also present in New Mexico law.

CARBON DIOXIDE EMISSIONS

Assuming the August 2015 U.S. Environmental Protection Agency rule for regulating carbon dioxide emissions from existing electricity generation facilities is upheld after Supreme Court review, nine New Mexico plants would be included in the state's clean power plan.[142] The Clean Power Plan rule requires these facilities to reduce their 2012 carbon emissions by 36 percent by 2030, or from an average emissions rate of 1,798 pounds of CO_2 per megawatt-hour to 1,146 pounds per megawatt-hour.[143]

ENERGY EFFICIENCY

New Mexico's performance in energy efficiency dropped in the past two years. The American Council for an Energy Efficient Economy's state energy efficiency scorecard listed the state's ranking as 31 in 2014 and 35 in 2016.[144] On the positive side, New Mexico has sustainable building and high-performance building efficiency programs in place. New Mexico's Energy Savings Performance Contracting program also enables financing for energy efficiency projects.

SUSTAINABLE BUILDING TAX CREDIT

New Mexico's Sustainable Building Tax Credit is an income tax credit to encourage private sector design and construction of energy efficient, sustainable buildings for commercial and residential use. The tax credit is based on third-party validation of the building's level of sustainability. New Mexico is the only state in the country to have such a financial incentive. As of summer 2017, the program has certified 595 homes this year -- applying a total of $3.75 million in tax credits.

Renewable Energy Policies

The Renewable Energy Act (REA) and Rule 572 established a Renewable Portfolio Standard (RPS) applicable to all investor owned electric utilities in New Mexico.[145] This standard requires investor owned utilities (IOUs) to sell a portion of electricity originating from renewable sources. In 2006, the RPS was set at five percent of retail sales in kilowatt-hours, reaching ten percent by the year 2011. Legislative changes to the REA (SB418, signed March 5, 2007) increased the RPS percentages and extended the time lines. IOU's must now have in their portfolio as a percentage of total retail sales to New Mexico customers, renewable energy of no less than 15 percent (by 2015) and

[142] These plants include two coal plants (Escalante, San Juan), four oil or gas steam electric generators (Cunningham, Maddox, Reeves, Rio Grande), and four natural gas combustion turbines (Afton, Luna, Bluffview, Hobbs).
[143] (N.M. Energy, Minerals and Natural Resources Department, 2016)
[144] (N.M. Energy, Minerals and Natural Resources Department, 2016)
[145] (NM Public Regulation Commission, 2017)

20 percent (by 2020).[146] Solar, wind, geothermal, fuel cells that are not fossil fueled, and biomass, are included in the RPS. Hydropower is not included. Renewable assets installed on the electric customer's side of the meter are not included in this standard unless the customer is a qualifying facility or the customer transfers eligible renewable energy credits to the utility.[147]

Changes to the REA in 2007 also included expanding the RPS requirements to rural electric cooperatives (Co-ops). Renewable energy must comprise of no less than 5 percent of retail sales to New Mexico rural electric cooperative customers by 2015 and the RPS will increase at a rate of 1 percent annually until 2020, at which time the RPS will be 10 percent. In addition to the RPS, Rule 572 also requires that Co-ops offer a voluntary renewable energy program to their customers provided their supplier makes renewable resources available.

One tax policy that supports the Renewable Portfolio Standard is the Renewable Energy Production Tax Credit (REPTC).[148] An analysis of the REPTC program for the period 2003-2012 showed tax expenditures of $61.6 million, with another $60 million in potential tax liability over that period from unclaimed tax credits.[149] The REPTC expires in 2017 and is currently capped at $20 million per year for solar and $20 million per year for wind.[150] The tax expenditure was $15 million in FY2015.[151] The macroeconomic impact of the construction and operation of REPTC-certified facilities over the 2003 through 2012 evaluation period is significant. The total labor income impact on New Mexico economy is over $400 million. The employment impact is over 9,000 jobs over the same period.[152]

BACKGROUND INFORMATION: RENEWABLE ENERGY ACT

New Mexico's Renewable Energy Act was passed in 2004. Legislative findings and intent of the law are summarized here.

Renewable Energy Act, Article 16: Section 2, 62-16-2.

A. The legislature finds that:
(1) the generation of electricity through the use of renewable energy presents opportunities to promote energy self-sufficiency, preserve the state's natural resources and pursue an improved environment in New Mexico;
(2) the use of renewable energy by public utilities subject to commission oversight in accordance with the Renewable Energy Act can bring significant economic benefits to New Mexico;
(3) public utilities should be required to include prescribed amounts of renewable energy in their electric energy supply portfolios for sales to retail customers in New Mexico by prescribed dates;
(4) public utilities should be able to recover their reasonable costs incurred to procure or generate energy from renewable energy resources used to meet the requirements of the Renewable Energy Act;
(5) a public utility should have incentives to go beyond the minimum requirements of the renewable portfolio standard;

[146] Per NM PRC dockets filed by NM's investor owned utilities, the three utilities met the standard in 2015 after having approximately 20% of electricity sales exempted from the renewable requirement.
[147] More information about renewable energy credits is included in Article 16: Section 5, 62-16-5 (Renewable energy certificates; commission duties) of the Renewable Energy Act, http://nmprc.state.nm.us/utilities/renewable-energy-act/05.html
[148] This policy allows taxpayers to receive a credit against their personal or corporate income tax for producing electricity using solar heat or light, wind, or biomass. The credit only applies to taxpayers who generate the electricity for sale to third parties.
[149] (N.M. Energy, Minerals and Natural Resources Department, 2015)
[150] (N.M. Taxation and Revenue Department, 2017)
[151] (N.M. Taxation and Revenue Department, 2016)
[152] NM Energy, Minerals and Natural Resources Department, 2015, Economic Analysis of the New Mexico Renewable Energy Production Tax Credit Final Report

(6) public utilities should not be required to acquire energy generated from renewable energy resources that could result in costs above a reasonable cost threshold; and
(7) it may serve the public interest for public utilities to participate in national or regional renewable energy trading.

B. The purposes of the Renewable Energy Act are to:
(1) prescribe the amounts of renewable energy resources that public utilities shall include in their electric energy supply portfolios for sales to retail customers in New Mexico by prescribed dates;
(2) allow public utilities to recover costs through the rate-making process incurred for procuring or generating renewable energy used to comply with the prescribed amount; and
(3) protect public utilities and their ratepayers from renewable energy costs that are above a reasonable cost threshold.

DISCUSSION DURING LAW'S IMPLEMENTATION

One person who was serving as a Public Regulatory Commissioner during the period the law (REA) was amended and implemented, noted that in addition to the objective of creating environmental benefits in the electricity portfolio, an equally important objective of the RPS was technology development. This latter objective served to push deployment of new renewable technologies with the hope of reducing costs. The creation of revenue to the state from renewable energy generation was not a driver for the law or standard.

A possible explanation for the sun setting of New Mexico's RPS in 2020 relates to national trends. When implementing the REA and RPS, the commission discussion included an assumption that a national carbon emissions standard or renewable portfolio standard was likely to be in place by 2020; renewable energy costs would decline; and the need for a statewide RPS would be obsolete.

Retail sales were the basis for the RPS because this metric straightforward to track given the dynamic nature of New Mexican electricity imports and exports. Nameplate capacity metrics had the disadvantage of incentivizing renewable power plants to be built, regardless of their efficiencies or operating times.

RPS FUTURE OPTIONS DISCUSSION

A variety of paths forward regarding New Mexico's RPS have been proffered by advocates and critics alike. The argument for each path along with pros and cons are suggested work to be done by one or more roadmap working groups. Some options include the following:

- Allow the RPS to end in 2020 without extension
- Extend the RPS (as is) beyond 2020 (perhaps to 2040)
- Modify the RPS and extend beyond 2020 (perhaps to 2040)
- Alternative options:
    - Should the RPS be a zero emissions standard that allows for nuclear and hydro?
    - Should it include an energy storage requirement for non-dispatchable power additions?
    - Should it include an electrification incentive to increase utility revenues, while also incentivizing more distributed generation by allowing behind-the-meter generation that is dispatchable?

Energy Production on Tribal Land

Generally, tribes have the right to regulate non-Indian commercial transactions. However, many aspects of energy development on tribal lands require the approval of the Department of the Interior (DOI). Additionally, there are federal environmental and archaeological regulations that apply to tribal lands, which may be triggered in the event

of energy development. Under federal regulation alone, navigating the complexity of these laws can generate substantial costs and uncertainties for an energy development project. State regulations also have the potential to impact tribal energy developments.

In the case of renewable energy projects, tribes do have options to bypass some federal approvals. The Energy Policy Act of 2005 and the HEARTH Act passed in 2012 authorizes tribes to enter into tribal energy resources agreements (TERAs), which allow tribes to forgo approval for leases and rights-of-way for energy development on tribal lands. In some cases, this could result in reduced development costs and shorter timelines. Other options for tribes include proactively enacting energy development regulations to pre-empt any conflicting state laws. Finally, tribes can avoid federal oversight, control and state taxation by structuring any energy project as a tribally-owned project where the tribe is at least a 51 percent owner.[153]

Global Energy Market Factors

COST OF OIL

The New Mexico crude oil purchase price in 2016 was $39.18 per barrel. Figure 21 shows the historic purchase price and the precipitous drop between 2014 and 2015, from $83.44 per barrel to $44.40 per barrel.[154]

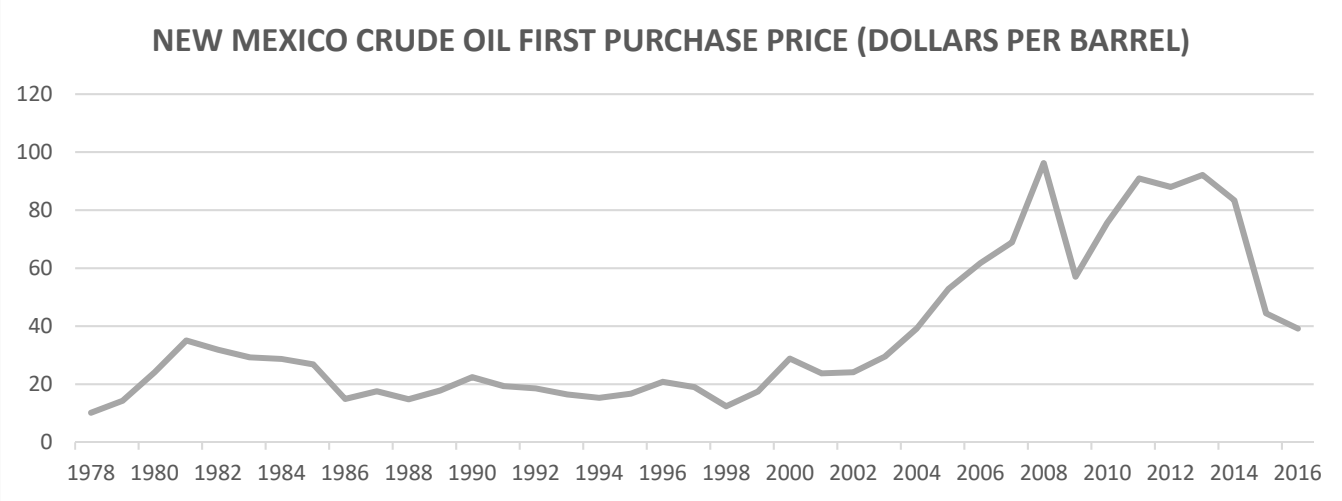


Figure 21: N.M. Crude Oil Purchase Price, 1978-2016 (EIA)

COST OF NATURAL GAS

The world market for natural gas strongly influences prices. The volatility of import and export prices for natural gas in the United States between 1985 and 2015 is shown in Figure 22.[155]

[153] (Thomas, 2014)
[154] (U.S. Energy Information Administration, 2017)
[155] (U.S. Energy Information Administration, 2017)

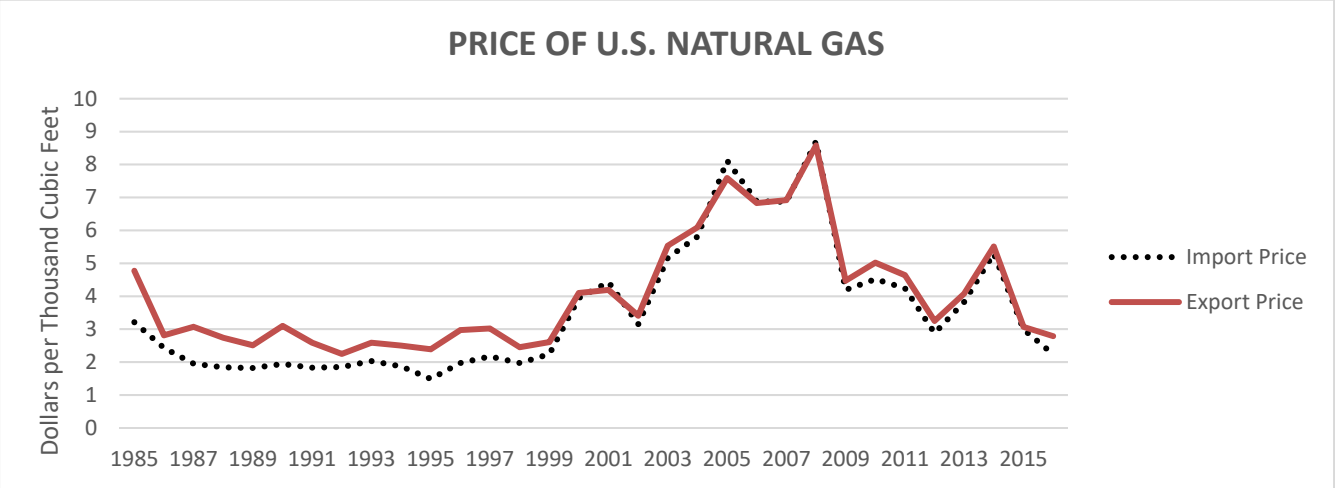


Figure 22: History of U.S. Natural Gas Prices, 1985-2015 (EIA)

ENERGY TRADE

The United States is a net importer of crude oil and natural gas. Mexico and Canada are important players in the nation's oil and natural gas world.

In 2016, the United States imported approximately 10.1 million barrels per day of petroleum from about 70 countries. Petroleum includes crude oil, natural gas plant liquids, liquefied refinery gases, refined petroleum products such as gasoline and diesel fuel, and biofuels including ethanol and biodiesel. About 78 percent of gross petroleum imports were crude oil.

In 2016, the United States exported about 5.2 million barrels per day of petroleum to 101 countries. Most of the exports were petroleum products. The resulting net imports (imports minus exports) of petroleum were about 4.9 million barrels per day. The top five source countries of U.S. petroleum imports in 2016 were Canada, Saudi Arabia, Venezuela, Mexico and Colombia.[156]

The United States exported over 2 trillion cubic feet of natural gas via pipelines from Mexico and Canada, and imported approximately 4 trillion cubic feet of natural gas from these two North American trading partners.[157] In contrast to the large number of U.S. oil trading countries, Mexico and Canada are by far the largest natural gas trading partners for American natural gas.

New Mexico exports natural gas, petroleum and coal to other states. Reflecting the dynamic natural gas market, in 2015, New Mexico produced 1.2 trillion cubic feet of gas, imported 0.8 trillion cubic feet from other states, consumed 0.3 trillion cubic feet, and exported 1.6 trillion cubic feet to other states. In the same year, New Mexico produced 147 million barrels of oil and consumed 46 million barrels of oil. Coal production in the state amounted to 20 million short tons and consumption was 12 million short tons in 2015.[158]

[156] (U.S. Energy Information Administration, 2016)
[157] (U.S. Energy Information Administration, 2017)
[158] (U.S. Energy Information Administration, 2017)

Appendix C
ENERGY STUDIES

Selected studies regarding New Mexico's energy enterprise are summarized below. They include a 2016 report on small modular nuclear power plants, a 2013 report on renewable energy storage, two reports on the topic of hydroelectricity and pumped storage hydroelectric plants nationwide, two reports (2015 and 2017) from the national Quadrennial Energy Review, and one key report on natural gas vehicles in the state.

SMALL MODULAR REACTOR NUCLEAR POWER PLANT

A preliminary study to investigate the feasibility of deploying a Small Modular Reactor (SMR) nuclear power plant in New Mexico was conducted in 2016.[159] This effort produced a state map showing areas where a small modular reactor facility (of less than 300 megawatt-electric capacity) appears feasible based on seven exclusion or avoidance criteria. (Note: one omission was the overlay of existing electric transmission infrastructure.)

The authors report that there are clearly areas in the state that that could meet the conditions for developing an SMR nuclear power plant. After excluding areas of the state based on more than 40 different criteria such as existing federal and state lands, seismic zones, water availability, population centers, and habitat of threatened and endangered species, there are still significant areas of the state that could support an SMR.

Based on considerations such as water availability, areas such as the central portion of the state are potentially suitable for deployment of SMR nuclear power plants. Given the four different developers currently in the business, the initial capacity investment range for the SMRs is suggested to be between 160 and 570 megawatts representing both single reactor and multiple reactor configurations.

N.M. RENEWABLE ENERGY STORAGE TASK FORCE REPORT

This document outlines eight ideas for consideration regarding the use of energy storage to support renewable power generation in New Mexico.[160] The authors (a diverse group of New Mexicans from electric utilities and cooperatives, national laboratories, universities, private sector, renewable energy, environmental non-profits and state government) examined the federal and state policies and initiatives regarding renewable energy storage in Colorado, Texas, Arizona and California.

HYDROELECTRIC PLANTS

An assessment of opportunities for new pumped storage hydroelectric plants researched whether using existing water features as auxiliary reservoirs would be feasible.[161] This report screened opportunities for pumped hydroelectric facilities across the United States. One feasible project was identified in New Mexico. The location includes a pair of proximate water bodies with a potential elevation difference (hydraulic head) of 242 feet.

[159] (N.M. Energy, Minerals and Natural Resources Department, 2016)
[160] (N.M. Energy, Minerals and Natural Resources Department, 2013)
[161] (Idaho National Laboratory, 2014)

PUMPED STORAGE DEVELOPMENT

The National Hydropower Association developed a white paper on the challenges and opportunities for new pumped storage development.[162] This document lists three hydroelectric pumped storage facilities permitted in New Mexico as of 2011 – Sweetwater, Yegua Mesa, and Mesa de Los Carros.

QUADRENNIAL ENERGY REVIEW

The first installment of the Quadrennial Energy Review (QER) was published in 2015. [163] It describes how to modernize our nation's energy infrastructure to promote economic competitiveness, energy security and environmental responsibility. The QER is also focused on energy transmission, storage and distribution, as well as the networks of pipelines, wires, storage, waterways, railroads, and other facilities that form the backbone of our energy system. The QER seeks to identify vulnerabilities in the system and proposes major policy recommendations and investments to replace, expand and modernize infrastructure where appropriate. The second installment report was released in early 2017 and focuses on transforming the nation's electricity system.

NEW MEXICO NATURAL GAS VEHICLE REPORT

The New Mexico Natural Gas Vehicle Report (NGV Report) was initiated through New Mexico House Joint Memorial 5 and was completed in November of 2016. The report summarizes natural gas for transportation and NGV use on a national and state level, current NGV programs in surrounding states and potential federal funding opportunities. The NGV Report concludes with recommendations as to how New Mexico can benefit from transportation fuel diversity. A few highlights of the report are summarized here.

At present, New Mexico's use of natural gas as an alternative transportation fuel is much less than in surrounding states. Texas, Colorado, Oklahoma, and Utah all have more robust state programs in place that benefit from incentives and other statutory requirements to promote NGV infrastructure and NGV use in both the private and public sectors. In addition to the development of the NGV Plan, the workgroup of EMNRD, the New Mexico NGV Coalition, the Land of Enchantment Clean Cities Coalition, and the New Mexico Gas Company are continuing to promote the use of NGVs through the development of a pilot project that incorporates NGV fleets and infrastructure in the Santa Teresa, New Mexico border region of the state. Actions are also in place to increase the number of fueling stations accessible to the public, especially along major transportation corridors. EMNRD and the New Mexico State Land Office are currently exploring how best to utilize the state's natural gas resources, reduce flaring and increase natural gas royalties for the state. The report concludes with over a dozen actions and policies that can aid the growth of the NGV market in New Mexico.

[162] (National Hydropower Association, 2012)
[163] (U.S. Department of Energy, 2015)

Appendix D

HIGHER EDUCATION

New Mexico's future energy economy will rely on a capable workforce equipped for employment in various energy careers. The following charts and tables present current activity and opportunities among our many colleges and universities -- focusing education the science, technology, engineering and math (STEM) fields.

Levels of STEM Degrees from New Mexico Colleges

Regardless what major students pursue, it benefits the overall New Mexico economy to have an educated workforce. In 2016, a combined total of 4,869 STEM and energy degrees were awarded, including certificates.[164] See page 60-61 for the list of specialties included in these totals. Figure 23 below shows the breakdown of total STEM degrees awarded, all majors combined.

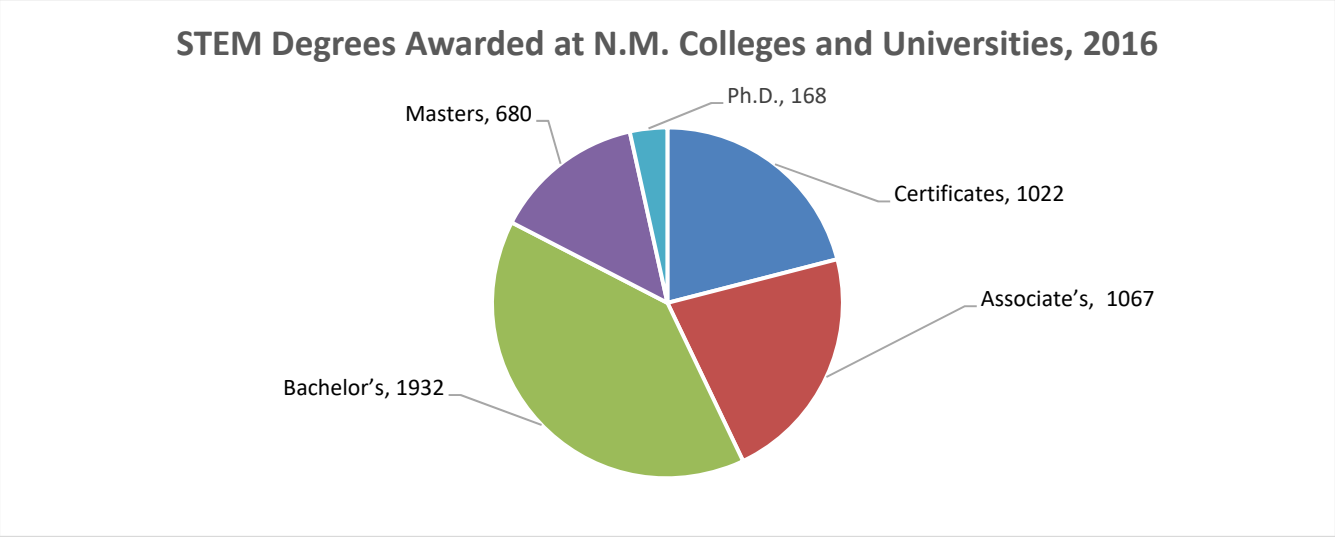


Figure 23: Degree Type and Quantity, N.M., 2016 (NCES)

Multiple Institutions of Higher Education

The following treemap chart illustrates the volume of STEM, energy and information tech degree completions at institutions of higher education in New Mexico. Degrees include certificates, associate's (AAs), bachelor's (BAs), masters and Ph.Ds. A detailed list of the degree specialties that are included in this chart is provided on page 62. For additional detailed information on the number and type of awards given per institution, please contact New Mexico First at www.nmfirst.org.[165]

[164] (National Center for Educational Statistics, 2017)
[165] (National Center for Educational Statistics, 2017)

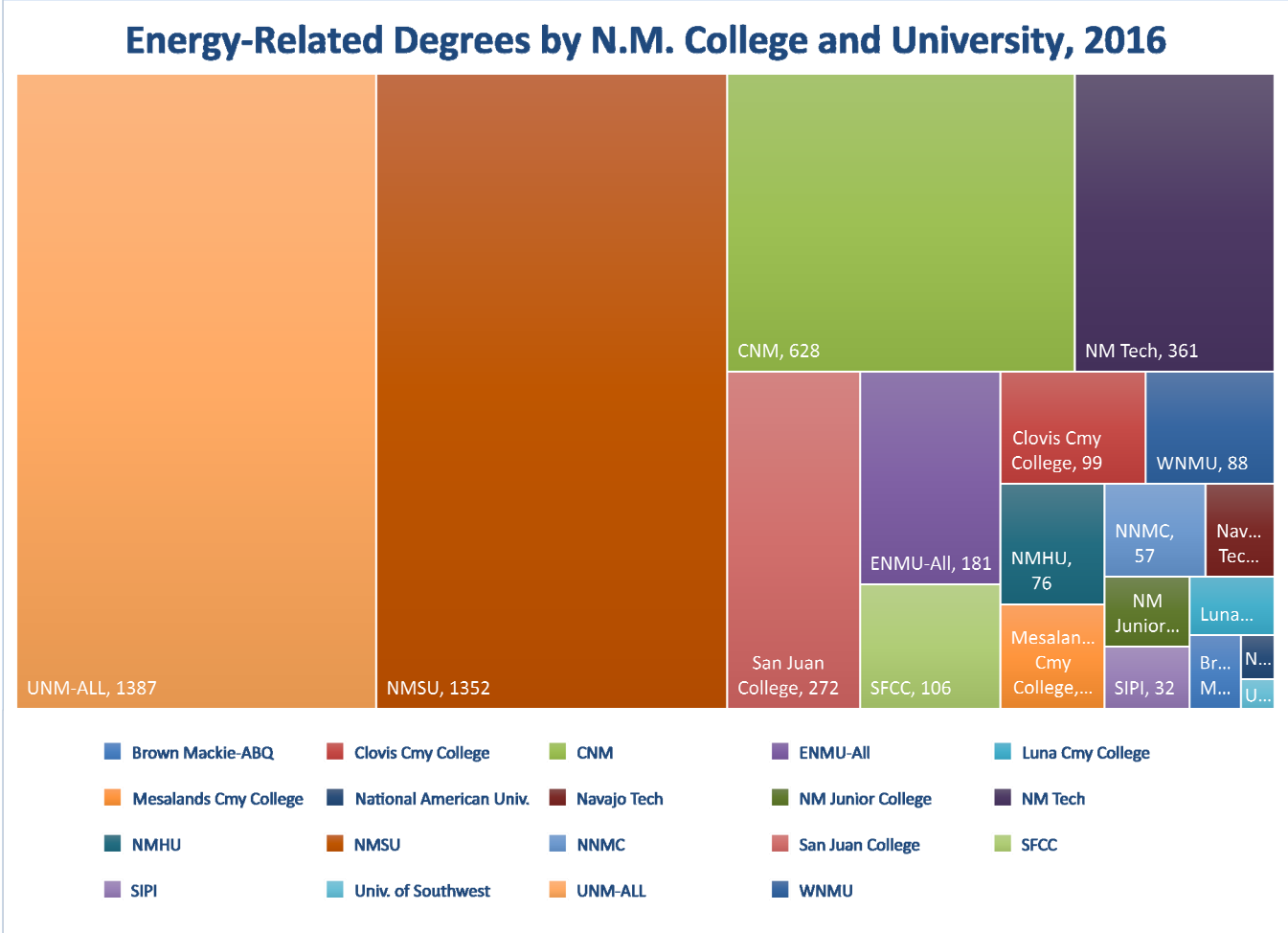


Figure 24: Energy-Related Degrees, N.M. (National Center for Educational Statistics, 2017)

The following graph demonstrates the general increase of New Mexico graduates with STEM degrees between the years 2007 and 2014. This data was prepared by the state and may not reflect the exact same degree specialties selected for the charts above.

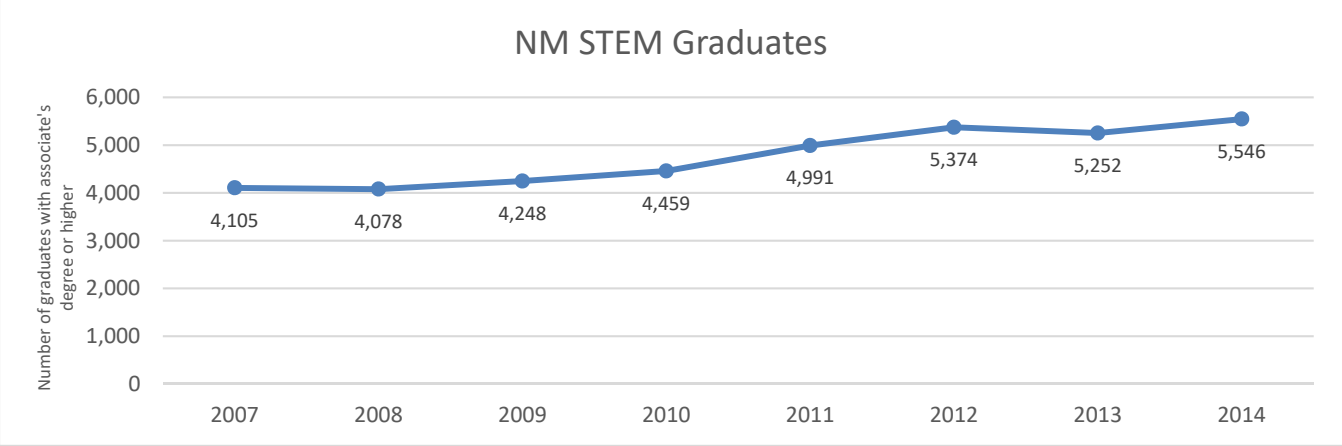


Figure 25: Total College STEM Graduates, N.M. (HED)

Degrees by Major Degree Categories

The following chart lists energy-related degrees (including credentials) by major field of study at higher education institutions in New Mexico. The chart also includes the number of completions for every field. These broad categories are comprised of dozens of detailed degree specialties. Those specialties are listed in the following section.

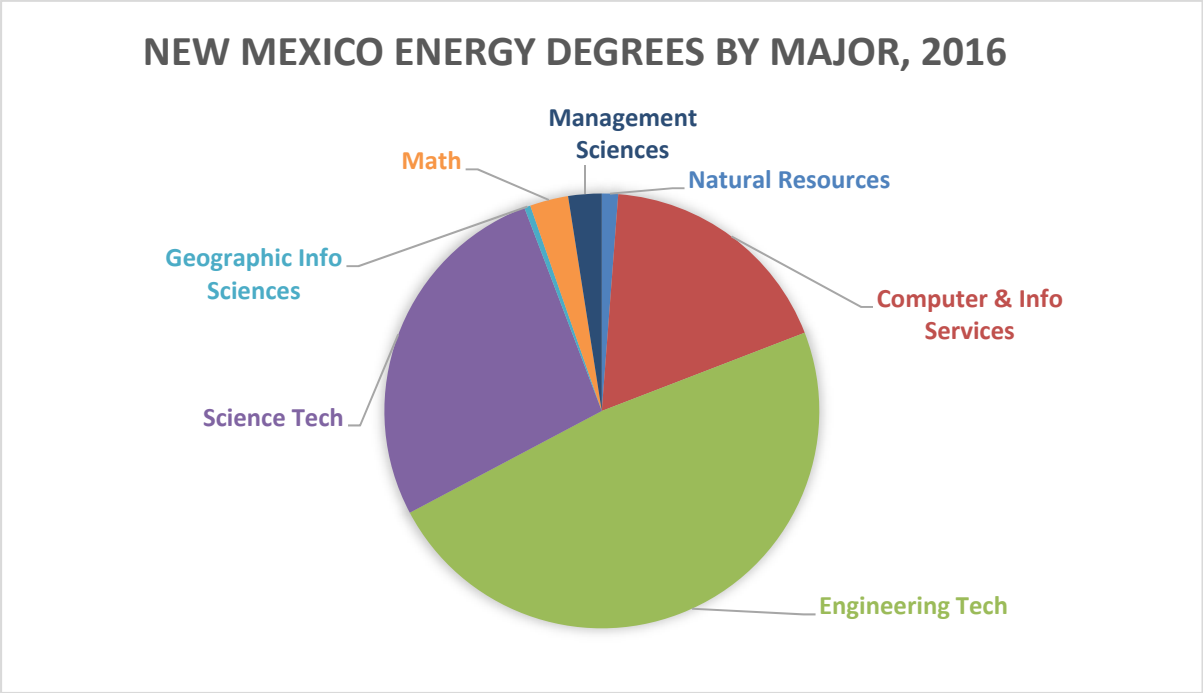


Figure 26: Energy Degrees, N.M. (National Center for Educational Statistics, 2017)

Degree Specialties

The following list of degree specialties support careers in energy and STEM-related fields. The selected specialties come from the STEM Designated Degree Program -- a complete list of fields that the federal Department of Homeland Security compiles based on the National Center for Education Statistics (NCES) definition of a STEM field. Each degree is coded with a Classification of Instructional Programs (CIP) number, so that graduates can be tabulated across campuses across the nation.[166]

NATURAL RESOURCES/CONSERVATION, GENERAL
Environmental Studies
Environmental Science
Natural Resources Conservation and Research, Other
Water, Wetlands, and Marine Resources Management
Forest Sciences and Biology
Urban Forestry

COMPUTER AND INFORMATION SCIENCES, GENERAL
Artificial Intelligence
Information Technology
Informatics
Computer and Information Sciences
Computer Programming
Data Processing and Data Processing Technology/Technician
Information Science/Studies
Computer Systems Analysis
Computer Science
Web Page, Digital/Multimedia and Information Resources Design
Data Modeling/Warehousing and Database Administration
Computer Graphics
Modeling, Virtual Environments and Simulation
Computer Software and Media Applications, Other

[166] (U.S. Department of Homeland Security, 2017)

Computer Systems Networking and Telecommunications
Network and System Administration/Administrator
System, Networking, and LAN/WAN Management/Manager
Computer Security
Web/Multimedia Management and Webmaster
Information Technology Project Management

ENGINEERING TECHNOLOGY, GENERAL
Architectural Engineering Technology/Technician
Civil Engineering Technology/Technician
Electrical, Electronic and Communications Engineering Technology/Technician
Laser and Optical Technology/Technician
Telecommunications Technology/Technician
Integrated Circuit Design
Electrical and Electronic Engineering Technologies/Technicians, Other
Biomedical Technology/Technician
Electromechanical Technology/Electromechanical Engineering Technology
Instrumentation Technology/Technician
Robotics Technology/Technician
Automation Engineer Technology/Technician
Electromechanical and Instrumentation and Maintenance Technologies/Technicians, Other
Heating, Ventilation, Air Conditioning and Refrigeration Engineering Technology/Technician
Energy Management and Systems Technology/Technician
Solar Energy Technology/Technician
Water Quality and Wastewater Treatment Management and Recycling Technology/Technician
Environmental Engineering Technology/Environmental Technology
Hazardous Materials Management and Waste Technology/Technician
Environmental Control Technologies/Technicians, Other
Plastics and Polymer Engineering Technology/Technician
Metallurgical Technology/Technician
Industrial Technology/Technician
Manufacturing Engineering Technology/Technician
Welding Engineering Technology/Technician
Chemical Engineering Technology/Technician
Semiconductor Manufacturing Technology
Industrial Production Technologies/Technicians, Other
Occupational Safety and Health Technology/Technician
Quality Control Technology/Technician
Industrial Safety Technology/Technician
Hazardous Materials Information Systems Technology/Technician
Quality Control and Safety Technologies/Technicians, Other
Aeronautical/Aerospace Engineering Technology/Technician
Automotive Engineering Technology/Technician
Mechanical Engineering
Mining Technology
Petroleum Technology
Mining and Petroleum Technologies
Construction Engineering Technology/Technician
Surveying Technology/Surveying
Hydraulics and Fluid Power Technology/Technician
Engineering-Related Technologies, Other
Computer Engineering Technology
Computer Hardware Technology
Computer Software Technology
Drafting and Design Technology
CAD/CADD Drafting and/or Design Technology
Architectural Drafting and Architectural CAD/CADD
Civil Drafting and Civil Engineering CAD/CADD
Electrical Drafting and Electrical CAD/CADD
Mechanical Drafting and Mechanical Drafting CAD/CADD
Drafting/Design Engineering Technologies/Technicians, Other
Nuclear Engineering Technology/Technician
Engineering/Industrial Management
Engineering Design
Packaging Science
Engineering-Related Fields, Other
Nanotechnology
Engineering Technologies and Engineering-Related Fields, Other

SCIENCE TECHNOLOGIES/TECHNICIANS, GENERAL
Biology Technician/Biotechnology Laboratory Technician
Industrial Radiologic Technology/Technician
Nuclear/Nuclear Power Technology/Technician
Nuclear and Industrial Radiologic Technologies/Technicians, Other
Chemical Technology/Technician
Chemical Process Technology
Physical Science Technologies/Technicians, Other
Science Technologies/Technicians, Other

MANAGEMENT SCIENCE
Business Statistics
Actuarial Science
Management Science and Quantitative Methods, Other

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