The Concept of a High Voltage Direct Current Network within New Mexico ("The New Mexico Express")

Executive Summary

This paper describes a Transmission proposal to construct a 2,000 MW link between the existing and new generation in New Mexico with market hubs at Four Corners and Tres Amigas, using buried, High Voltage Direct Current ("HVDC") transmission lines.

New Mexico is blessed with the potential to generate vast amounts of power fueled by natural gas, solar, wind, biomass and possibilities for major storage opportunities. With a State combined peak load of approximately 4.5 GW[1] and potential generation capabilities well above 50 GW, it is intuitively obvious that export of electric energy is the only option if New Mexico is going to reap the economic benefits of its resources and contribute significantly to a national energy solution. This means a commitment by the policy leaders of the state to support a definitive transmission program that is economically viable for the state. The objective of creating a State transmission policy has not been easy for New Mexico. The State has vast land areas and therefore many miles of transmission are needed. The State also has a relatively small population base (see Attachment F). So, unlike the transmission build out in Texas where the cost was uplifted to all electric customers, New Mexico must find other creative solutions to funding transmission investment in order to achieve the economic benefits without harming the State's ratepayers.

The project suggested in this paper offers the potential for a public, private (and state, federal) partnership in order to achieve a state transmission super highway. Typically, the construction of new transmission has been blocked by local land use and environmental concerns associated with overhead lines, despite the broad recognition of the need for new high capacity interstate transmission. To overcome these issues, the New Mexico Express ("TNME") proposes to use buried High Voltage Direct Current ("HVDC") cable, most of it along existing railroad or highway right of way. It is a technological solution to a longstanding regulatory problem.

Buried HVDC cable is technologically feasible and new manufacturing facilities are available in the United States to produce it. The combination of HVDC transmission to connect clean energy resources with load, and use of buried cable, will overcome many objections to new electric transmission and will facilitate the integration of New Mexico generation potential to electric load within and outside the State. From a national standpoint, this proposal advances technology and helps eliminate an important impediment to national energy policy by being the first long-distance, high voltage transmission project that will use buried HVDC cable in the U.S. For this reason, we believe the Federal government will have a strong interest in this project, which could be a model for projects in other locations.

Worldwide there are a number of countries addressing the need to generate electricity by natural gas and renewable energy from remote locations and transmit it to major load centers. Many of these countries have determined to construct HVDC lines as an overlay to the existing High Voltage AC networks. The advantages of this are understood by experts, and HVDC is increasingly seen as a reliable and economic means of transmitting energy long distances to load centers to support clean energy integration and economic growth. Attachment A shows some of these developments.

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[1] *Based on reported historical relationship between peak demand and electricity consumption for retail customers at New Mexico's utilities, and the total annual electricity consumption reported for New Mexico by the EIA for 2012.*

An organization termed the “Friends of the SuperGrid” in Europe has summarized the benefits of an HVDC overlay on an existing AC grid to connect generation and load over long distances:

> ”Supergrid" is the future electricity system that will enable Europe to undertake a once-off transition to sustainability. The full significance of a switchable HVDC innovation has not yet been appreciated by policy makers or by the business community. It is clear that a network incorporating a HVDC grid with the redundancy and reliability of current AC grids is now a reality and that the limits of what is technologically possible have been greatly expanded. HVDC technology will open markets, strengthen security of supply and create another global opportunity for European companies to export sustainable energy technology. The technology underpinning the Supergrid will give competitive advantage to the companies involved with its specification and design. This type of integrated AC/DC grid will be a template for what will be needed in other global markets including the US and China.

These statements confirm the opportunity that HVDC technology offers for New Mexico.

Any time a major innovative proposal is made, the naysayers and scoffers emerge. Connecting regions by the “transportation” needed to support commerce is not without precedent. Certainly everyone is familiar with the establishment of the Interstate Highway system and its’ economic value to the US economy. Another great parallel is the story of the Erie Canal (See Attachment E).

The Erie Canal construction began in 1817 and was completed by 1825. Within nine years, the fees collected recouped the entire $7 million dollar cost of the construction. Its purpose was driven by the economic need to deliver the resources from the west to the trading centers on the coastal regions; very similar to the electrical transmission needs today.

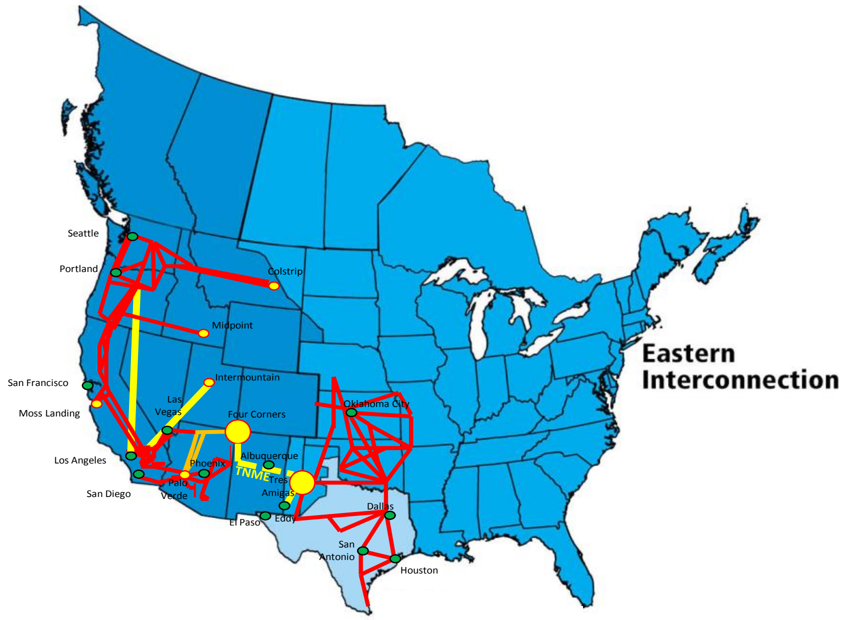
The Canal, when completed, moved more tonnage than all the colonies combined. It also provided critical infrastructure that logistically was a strategic factor in the Civil War and created such a “spin-off” of business opportunity that New York reaped its economic advantage.

But it almost did not happen. The federal government concluded that the project was “too” ambitious to undertake. Scoffers termed it a “folly” and that the lock and dam lifting system only a theory. Those that had a commercial advantage in the status quo lobbied the federal government extensively to prevent it. Thomas Jefferson described the proposal as “a little short of madness.” Yet the critical test is the test of use and the Erie Canal was not only successful but enjoyed resounding public support throughout its history.

The advantages of a buried HVDC Network in New Mexico connecting the population centers west of New Mexico with the centers in the East and Texas are similar in purpose to the Erie Canal. The West, East and Texas coast have the population and trading centers while the Southwest has the resources. A way to connect these regions is as important today as the Erie Canal was in 1817 (see Figure 1).

Obviously a solution needs to be found. In the Erie Canal era, the problem was an existing road network that could not transport large volumes of materials, was heavily rutted and became a sea of mud in inclement weather or dangerously icy in winter.

Figure 1. Connecting markets and resources



In the electrical world today, a growing problem is an interconnected and restricted AC network that is very difficult to change or adapt to new circumstances for the following reasons:

- AC power flows over the path of least resistance, so any change affects everyone connected to this grid. Since a single mistake on this “speed of light” product can have catastrophic consequences, all possible impacts must be studied. As seen in the discussion of Attachment D, this can take years.

- There is no single regulatory authority with responsibility for the entire network, so coordinating among all impacted entities with jurisdiction can create a tangled web of “approvals” with long delays before decisions can be made, if ever.

- It is extremely difficult to break out of the “chicken and egg” problem. Entities wanting to purchase power need certainty that the power will be available, but power can’t be available without the necessary transportation, which can’t be built without the PPA.

- It is extremely difficult to finance new technologies. Investors and lenders are often intolerant of technology risk, thus stifling innovation.

The solution in this proposal for the development of TNME addresses many of these concerns.

HVDC is becoming the transmission of choice elsewhere in the world (see Attachment A). This is largely because a new HVDC transmission connection is much simpler to study than studying the connection of a new AC transmission line to the integrated AC network. At the source, HVDC appears electrically as a generator. Further, its power is controlled and can be re-directed in milliseconds, thus allowing the impact studies to be much simpler.

The ability to manufacture HVDC cable has advanced rapidly. There are now at least two, and soon there will be three, facilities in the US that can produce HVDC cable and buried cable.

The cost issue of buried HVDC is mostly logistical. The industry needs to achieve a level of production to achieve economies of scale in the manufacturing of buried cable. The construction techniques are very similar to the construction of buried fiber optic cable. Nevertheless, there will be a high initial start up cost for this first buried HVDC project. Therefore, federal financial assistance will be sought for this initiative, to "prime the pump" so the nascent industry can grow to scale.

So, just as New York stepped up to build the Erie Canal, there is a marvelous opportunity for New Mexico to support a major HVDC buried transmission "express" network for the State, hopefully with support from the federal government to promote new technology.

TNME Phased Approach

TNME is proposed to occur in two phases. Phase I consists of a buried HVDC transmission line that traverses New Mexico, potentially utilizing rail or highway right of way ("ROW") to the degree technically and commercially feasible. The western terminal interconnects at Four Corners Substation, which is an electricity market hub that acts as a gateway to the Southwest. The eastern terminal interconnects at Tres Amigas, which acts as a gateway to Texas and Eastern markets. The New Mexico Express will allow electricity to flow east-to-west or west-to-east based upon prevailing market prices and demand for New Mexico generation resources.

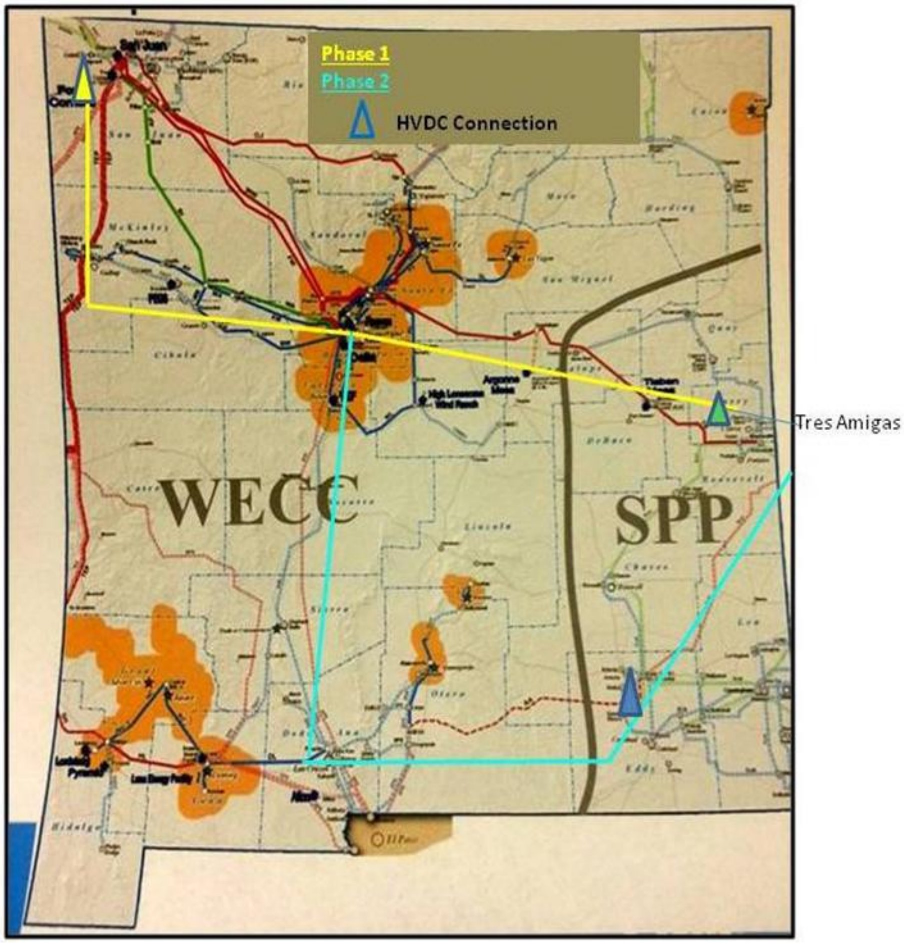
Phase 2 is a buried HVDC Cable between Tres Amigas and an upgrade to the existing Eddy County Tie (which connects the Eastern and Western interconnections in southern New Mexico). This additional connection will enhance the value of Phase I of TNME and provide for the interconnection of existing and new generation resources in southern New Mexico. Southern New Mexico has vast untapped energy sources that could be developed. The limiting factor on such development is the lack of adequate transmission to deliver energy from potential energy sources to markets.

Figure 2 below provides a map of both Phase I and Phase II of TNME.

In both Phases, the developers of TNME will work closely with local communities and resource developers across New Mexico to construct the facilities that will enable the vast economic potential of this State to be realized. Because the project will consist of buried HVDC cable, adverse local impacts should be marginal.

TNME provides the means to spur energy development leading to economic growth in a State threatened by the loss of market share as result of the country's move toward cleaner energy alternatives and away from coal-fired resources. In addition, TNME, much like the railroad or highways, provides a mechanism to move goods from areas of production to areas of consumption. This electricity super-highway will improve market efficiencies, promote innovation, open the door to new opportunities and encourage an inter-regional approach to energy development in support of national policy.

Figure 2. The New Mexico Express



<u>**The History of New Mexico Transmission Issues**</u>

New Mexico's transmission issues have been well documented. Several proposals have been put forward to help solve these issues and their proponents have spent years attempting to bring those proposals to fruition. Several proposals are languishing because of opposition, thus depriving New Mexico of the benefits of economic development and job creation they could bring to the State (see Attachment B for an example of the estimated economic benefits associated with renewable energy infrastructure investment).

Based on this prior experience, the proponents of TNME propose to use a "Consortium" approach to project development that is based on the following guidelines:

A. As noted above, obtaining use of right of way has been a consistent barrier to entry for transmission developers, especially merchant projects that do not have eminent domain authority. A buried HVDC solution will minimize these problems. In addition to the "out of sight" nature of the transmission line, it is anticipated that the safety, security and hazard reduction will generate more public support relative to overhead construction. TNME's sponsors and development team will work with the railroads and highway departments to secure the approvals necessary to bury the HVDC cable, similar to the fiber optic networks that one sees being buried along the highways.

B. It is proposed that a portion of the charges for transmission service will consist of a fee paid by shippers that will be remitted to the State government. (See Attachment C for a description of the potential fee income that could be generated for the benefit of the New Mexico economy). The project's proponents are hopeful that this will facilitate support in New Mexico for the project and reduce development risk by making the State a partner in the economic benefits of the project. This fee will be in addition to any other state or local taxes that would normally be paid by a New Mexico business.

C. To the extent practical, the project will use New Mexico's labor force and efforts will be made to assist in training the local workforce, coordinating with community colleges and others in the state, giving skills to be employed on this and similar future projects. It is also proposed that the use of HVDC technology and its engineering will provide opportunities for the colleges and universities and national labs in New Mexico to gain leading edge skills on the integration and construction of buried HVDC technologies.

D. New Mexico is a large state geographically, but with a small population base, thus making it extremely difficult to fund a major transmission project from electric consumers within the state. Therefore, it is proposed to seek investment support for this cutting edge project from government sources, with technology that can be applied elsewhere, and to obtain private investment for the remainder of the project cost.

E. The proponents envision a public, private partnership for development of TNME, with broad inclusion of interested parties. It is anticipated that investment opportunities will be widely available in the project for those prepared to take development risk in order to facilitate a successful completion.

F. The project will follow all the FERC and NERC rules and procedures applicable to the interconnection of the project to the transmission system, and will obtain FERC approval of all rates for transmission service.

The Electric Grid Today

The three U.S. electric interconnections (Eastern Interconnection, Western Interconnection and Electric Reliability Council of Texas ("ERCOT")) face similar challenges in meeting their electricity usage in light of load growth and inability to count on some generating resources in the short and long term because of unavailability, weather, age, and environmental considerations. Many generators that have been a mainstay of the electric system for decades are under pressure due to unfavorable economics and environmental concerns relating to climate change and other air pollution issues.

ERCOT, for example, issued seven energy emergency alerts ("EEAs") during the summer of 2011 and one control room watch in 2012.[2] Although California has not issued EEAs the last two summers, the California Independent System Operator ("CAISO") remains wary. The CAISO's 2013 summer assessment indicates that operating reserve margins under normal summer conditions are expected to

[2] *ERCOT News Release, September 25, 2012. See: http://www.ercot.com/news/press_releases/show/26312*

be 20.4% and drop to 10.4% under a one-in-ten scenario.[3] However, as a result of the shuttering of Southern California Edison's San Onofre Nuclear Generating Station ("SONGS"), California has seen electricity imports increase in 2012[4] and energy prices rise.[5]

Table 1 below summarizes the current request for proposals ("RFPs") in WestConnect, and highlights the need for additional generation and especially renewable generation, in the region, which TNME can help bring to market.

Table 1. TNME can help bring generation to market in WestConnect

WestConnect Member	Area	Capacity (MW)	Type	RFP Issue Date
Arizona Public Service	Gila Bend, AZ	32	solar	8-Aug-12
	AZ	7	solar	12-Oct-12
Basin Electric Power Co-operative	Eastern and Western interconnection	>25MW	baseload and cycling/peaking capacity	21-Jun-13
Black Hills Corporation	Southern Colorado	30	wind	8-May-13
El Paso Electric	El Paso, TX	Unspecified	dispatchable renewable (biomass, geothermal, etc.)	23-Jan-13
	El Paso, TX	Unspecified	wind	17-Aug-12
Xcel Energy	Southwestern Public Service area ("SPS")	>10MW	wind	15-Mar-13
Public Service Company of New Mexico	New Mexico	<50MW	all types of renewables	27-Nov-12
Sacramento Municipal Utility District	Sacramento, CA	Unspecified	solar	28-May-13
Tri-State Generation and Transmission Association	Colorado, Nebraska, New Mexico and Wyoming	<50MW	all types of renewables	13-Feb-13
Tucson Electric Power Company	Tucson, AZ	510 MW	All	10-May-13
Western Area Power Administration	Sierra Nevada Region (SNR)	Unspecified	RECs	Jul-13

Source Industry press, utility websites

In addition, many of the utilities in the Southwest have generation portfolios that consist of a fairly old fleet, with approximately 40% of total generating assets, and most coal-fired plants, older than 30 years of age. According to the National Energy Technology Laboratory and the Department of Energy, the average age of announced coal-fired retirements for the 2012-2020 period is 54 years[6], putting the bulk

3 *CAISO Summer Loads and Resources Assessment 2013. See: http://www.caiso.com/Documents/2013SummerLoads_ResourcesAssessment.pdf*

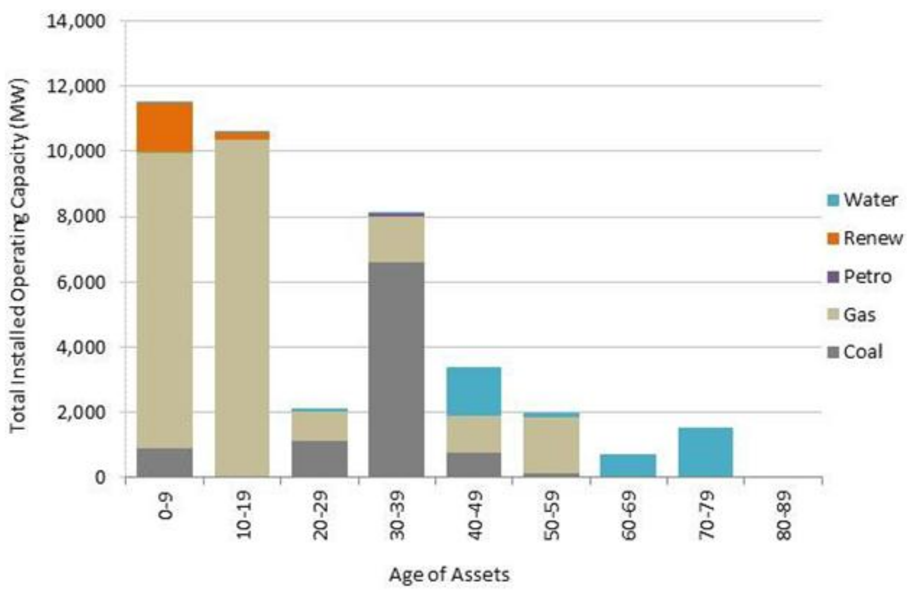
4 *United States Energy Information Administration (EIA), "San Onofre nuclear outage contributes to Southern California's changing generation profile", November 14, 2012. See: http://www.eia.gov/todayinenergy/detail.cfm?id=87*

5 *EIA "Extended nuclear plant outages raise Southern California wholesale power prices", March 26, 2013. See: http://www.eia.gov/todayinenergy/detail.cfm?id=10531*

6 *National Energy Technology Laboratory, "Tracking new coal-fired power plants," January 13, 2012. See:* http://www.netl.doe.gov/coal/refshelf/ncp.pdf

of coal generation resources in the Desert Southwest region of WECC well into the second half of the typical useful life for such resources. Figure 3 on the next page demonstrates the aging generation mix of the total installed operating capacity in the Desert Southwest sub-region by fuel-type.

Figure 3. Age of assets by fuel type in the Desert Southwest sub-region of WECC



Further compounding the challenges associated with an aging fossil fuel-fired generation fleet, renewed focus on climate change at the federal level highlights the pressing need for investment in clean energy and supporting infrastructure. On June 25, 2013, President Obama reaffirmed his commitment to his 2009 pledge to lower greenhouse gas emissions to 17 percent below 2005 levels by 2020. Specifically, the President's Climate Action Plan (the "Plan") puts the deployment of clean energy at the forefront of its strategy to combat climate change, identifying power plants as the largest concentrated source of emissions in the United States. The Plan focuses on cutting carbon pollution from power plants through continued regulation and emissions standards on new and existing plants. In addition to this, the President highlights the need to "expand and modernize the electric grid" to support reliability and the integration of clean energy sources.[7]

New Mexico is well-positioned to take advantage of its natural resources, if new infrastructure, like TNME, is built. The Four Corners region which consists of the San Juan Basin gas area is the largest field of proven natural gas reserves in the United States.[8] Much of New Mexico is suited for renewable generation resources including solar, wind and geothermal. Although rich in energy resources, New Mexico has low energy demand due in large part to its small population. Figure 4 provides an indication as to the size of the San Juan Basin (TNME will connect at the Four Corners Hub, which is located geographically at the corners of the four states per the map below).

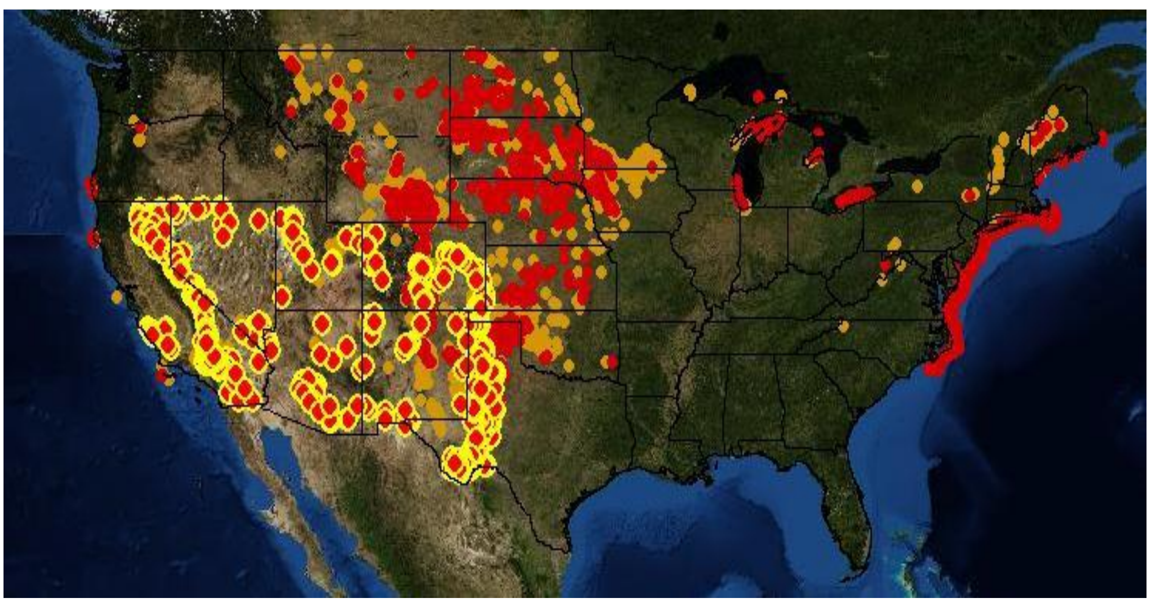
[7] *Executive Office of the President, "The President's Climate Action Plan," June 25, 2013. See: http://www.whitehouse.gov/sites/default/files/image/president27sclimateactionplan.pdf*

[8] *EIA. New Mexico State Energy Profile". See: http://www.eia.gov/state/print.cfm?sid=NM*

Figure 4. San Juan Basin Natural Gas Reserves

Figure 5 below provides an indication of the renewable energy potential in the Four Corners area. The yellow diamonds indicate high solar potential, the red diamonds high wind potential.

Figure 5. San Juan Basin Solar and Wind Energy Potential



Source NREL

Railroads provide a potential corridor for a transmission line spanning the Arizona-New Mexico border near Grants, New Mexico to the New Mexico-Texas border near Clovis, New Mexico (as shown in Figure 6 and Figure 7 below).[9] Interstate 40 also offers similar cross-state right of way for a proposed route for TNME (as shown in Figure 8 below). While these rail and highway rights of way have not been leveraged in the past for electric infrastructure, the buried HVDC design of TNME accommodates such a prospect in the future.

Figure 6. BNSF Railway East-to-West through New Mexico

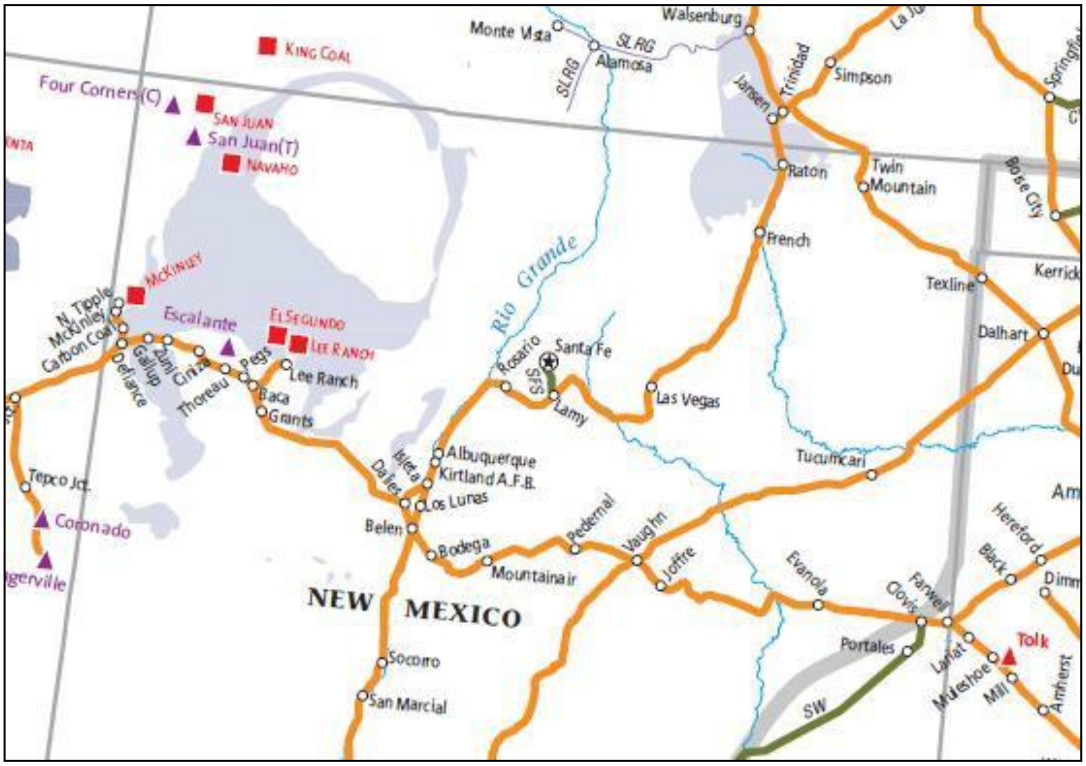


Figure 7. Union Pacific Railway East-to-West through New Mexico

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9 *BNSF Railway Coal Map. See: http://www.bnsf.com/customers/pdf/maps/coal_energy.pdf*

Figure 8. New Mexico Highway Map

The TNME will also benefit from the Tres Amigas project that will soon begin construction in eastern New Mexico and will be controlled by facilities located in Albuquerque.

Tres Amigas is a gateway that interconnects the Eastern Interconnection though Southwestern Public Service Company (Xcel Energy), with the Western Interconnection through Public Service Company of New Mexico and the Texas electrical grid through ERCOT.

Tres Amigas uses proven technology to convert alternating current (“AC”) electricity in one electrical grid to direct current (“DC”) electricity and back to AC electricity in a different electrical grid. By converting the electricity from AC to DC to AC, Tres Amigas is able to synchronize the electricity and allow for the physical flow of energy between the three interconnections.

Figure 9 below illustrates Tres Amigas location relative to the three electrical interconnections.[10] Figure 10 below is an artist’s rendering of Tres Amigas’ equipment configuration.[11]

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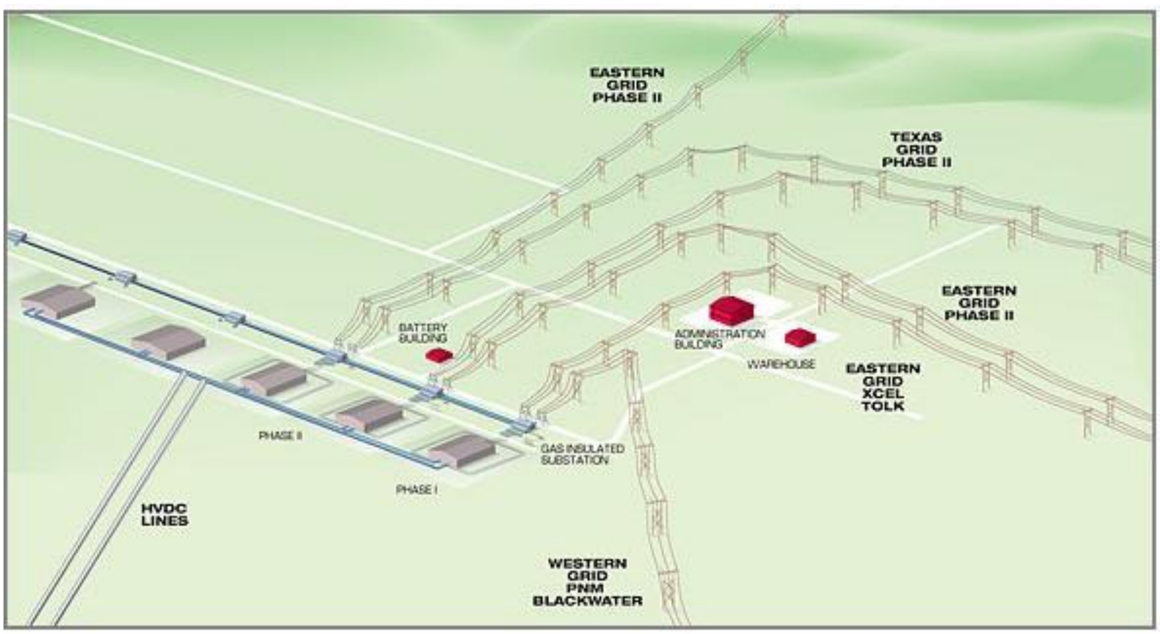
[10] *Pacific System Map. See: http://www.up.com/aboutup/reference/maps/system_map/index.htm*

[11] *Tres Amigas Location. See: http://www.tresamigasllc.com/location.php*

Figure 9. Tres Amigas Location Relative to the Three Electrical Grids

Source: Tres Amigas LLC, www.tresamigasllc.com/location

Figure 10. Tres Amigas Configuration



Source: Tres Amigas LLC, www.tresamigasllc.com/location

State Economic, Environmental and Policy Benefits of TNME

The benefits of building a buried HVDC superhighway in New Mexico include:

1. Economic Benefits
2. Enhanced Reliability
3. Increased Market Efficiency
4. Exploitation of New Mexico Natural Resources
5. Consistency with National Energy Policy

Economic Benefits to State Economy

As part of the guidelines for developing TNME, the project sponsors commit to use New Mexico labor to the extent practicable and provide training. During construction of TNME, significant dollars will flow directly into the local economy and expended locally. The direct spending will also create additional benefits in terms of new jobs and expansion of other supporting sectors of the New Mexico economy. Based on the RIMS II multiplier data, for every $100 million in construction sector spending, the Bureau of Economic Analysis has shown that the New Mexico economy will see an approximate increase in state economic output of $190 million, as well as create an additional 1,800 jobs.[12]

TNME will continue to positively contribute to the economy of New Mexico after construction is complete, when operations begin, by paying all relevant taxes to its local communities and the states as New Mexico business, by employing local labor to operate and maintain the transmission infrastructure, and through the proposed service fee paid by shippers and remitted to the state government. Attachment C contains an example of the potential range of revenues that could be collected by such a service fee, depending on the service fee rate and the total volume of energy flows on TNME.

In addition, TNME will motivate and provide an opportunity for new generation investment in New Mexico. Such new generation - wind, solar, biomass and natural gas - will further benefit the New Mexico economy. Studies show the multiplier effects of every dollar spent of such an investment on economic activity and new jobs for a state such as New Mexico. The attached illustration in Attachment B shows the economic benefits to New Mexico (with all the “multiplier” effects) arising from the development of 1,000 MW of wind and 1,000 MW of solar generation in New Mexico. These estimated economic benefits are based on the National Renewable Energy Laboratory’s Job and Economic Development Impact (“JEDI”) Models. For example, construction of 1,000 MW of utility-scale solar project would create 8,912 construction jobs in New Mexico, and expand the state economy (i.e., increase the state gross domestic product or “GDP”) in New Mexico by $638.4 million. Once the solar projects are operational, there will be an additional 185 jobs and an increase in state economic output by $11.2 million.[13] Similarly, construction of 1,000 MW of new wind generation projects would create 542 new jobs and increase state economic output by $34.5 million during the construction phase. The wind generators, like the solar projects, would also lead to 45 new jobs after construction is complete and operations begin, along with an estimated $2.2 million increase in state economic output.[14] As Attachment B shows, the

[12] *Based on Bureau of Economic Analysis’s RIMS II (2010/2010), Type II, Final Demand multipliers for output and employment.*
[13] *NREL Solar Project PV Model rel. PV10.17.11., assuming capital costs of $2,361/kW and O&M costs of $20/kW-year.*
[14] *NREL Land-based Wind JEDI Model, rel. W1.10.03, assuming capital costs of $2,592/kW and O&M costs of $20/kW-year.*

impact on job creation and economic output is even more substantial after taking into consideration the expected indirect and induced affects as the dollars of direct spending from the investment "ripple" throughout the local economy.

Enhanced Reliability

TNME enhances reliability in two primary ways. The first is that by developing a high-volume transfer capacity link between major electricity market centers and a resource-rich Four Corners trading hub, those market centers can capitalize on resources from Four Corners to meet customer demand obligations when legacy generation resources are unavailable or retiring due to environmental or other regulatory requirements.

The second major reliability benefit lies in the controllable HVDC technology that will be employed by TNME. The Western Interconnection consists primarily of long distance, high voltage AC lines that circle the West. Power flows on an AC network flow along the path of electrical least resistance. This can create large differences between scheduled and actual energy flows. With an HVDC connection between major electricity hubs, such as provided by TNME, energy flows on the AC systems in the southwestern sub-region of the Western Interconnection will be more controllable, making the power system more resilient.

Increased Market Efficiency

TNME will be interconnected with Tres Amigas, which in its role as a Balancing Authority, will make electricity available to the Western Interconnection, Eastern Interconnection and Texas power market.

Significant inefficiencies exist today in the southwestern region of the Western Interconnection in relation to transmission reservation and the trading of energy across utility systems. {Please refer to Attachment D for an overview of New Mexico's current transmission system and practices.} In addition to different driving fundamentals of supply and demand, market prices for energy frequently differ between neighboring utilities as a result of such inefficiencies, commonly referred to as "seam costs." But for the existence of seams, economic trading should improve wholesale market efficiency by allowing energy to flow from regions with surplus available generation to regions with unmet demand, providing an opportunity for the exporting region to make sales and for the importing regions to reduce customer costs.

TNME will improve the efficiency of wholesale energy trading in the Southwest by building additional transmission capacity for interested shippers to buy so that they can engage in economic trading.
A snapshot of historical market prices is useful to illustrate the potential magnitude of market efficiency improvements.

The Intercontinental Exchange ("ICE") provides an electronic trading platform for the purchase and sale of electricity primarily on a day-ahead basis. Reviewing prices for flow day June 28, 2013 produces the potential opportunity whereby The New Mexico Express in conjunction with Tres Amigas could have moved power west to east in response to market price signals. Below is a table of prices from ICE for flow day June 28, 2013.[15]

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[15] *ICE Report Center. See: https://www.theice.com/marketdata/reports/ReportCenter.shtml#report/54*

Table 2. ICE On-Peak Electricity Prices for June 28, 2013 Flow Day

Hub	Trade Date	Begin Date	End Date	Avg Price ($/MWh)
ERCOT North 345kV Peak	27-Jun-13	28-Jun-13	28-Jun-13	$ 133.54
Four Corners Peak	27-Jun-13	28-Jun-13	28-Jun-13	$ 51.25

Examples of Interconnection Opportunities

Table 2 above indicates that the average price of electricity for the hours between 6 AM and 10 PM was higher in the North Texas load zone than in the Desert Southwest (Four Corners Hub) by an average of $82.29/MWh. Assuming that transmission was available between Four Corners and ERCOT and within ERCOT, a trader could have sold 100 MW for 16 hours from Four Corners to ERCOT North and received gross revenue of $131,664 (100 MW x 16 hours x $82.29/MWh). ERCOT North could have benefitted by displacing more expensive generation priced at $133.54/MWh with generation from resources priced at $51.25/MWh. The extent of the market price differential is an indicator of potential inefficiencies in allocation of resources that trading could reduce, if physical capacity is available to facilitate such trading. TNME with Tres Amigas provides the physical infrastructure to make possible such efficiency improvements. Similarly, in ERCOT's real-time market for flow day June 27, 2013, prices in certain intervals spiked to triple digits as shown in Table 3 below.

Table 3. ERCOT Real-Time Price Spikes on June 27, 2013

Oper Day	Interval Ending	HB_BUSAVG	HB_HOUSTON	HB_HUBAVG	HB_NORTH	HB_SOUTH	HB_WEST	LZ_AEN	LZ_CPS	LZ_HOUSTON	LZ_LCRA	LZ_NORTH	LZ_RAYBN	LZ_SOUTH	LZ_WEST
6/27/2013	1615	126.32	126.33	126.31	126.32	126.35	126.23	126.34	126.35	126.34	126.34	126.32	126.32	126.37	132.55
6/27/2013	1630	115.03	115.05	115.02	115.04	115.07	114.92	115.06	115.08	115.05	115.07	115.04	115.04	115.09	122.88
6/27/2013	1645	68.82	68.53	68.73	68.96	68.69	68.75	68.71	68.73	68.54	68.72	69.33	69.92	68.74	85.84
6/27/2013	1700	68.29	68.01	68.2	68.42	68.17	68.21	68.18	68.2	68.02	68.19	68.77	69.32	68.22	85
6/27/2013	2000	49.68	38.13	46.79	59.31	26.27	63.45	290.27	40.57	37.23	99.82	60.29	59.22	50.86	70.88
6/27/2013	2015	41.67	38.98	40.97	43.96	36.2	44.73	98.67	39.6	38.77	53.58	44.19	43.94	42.08	61.55
6/27/2013	2215	46.11	36.75	43.78	53.89	27.14	57.34	240.45	38.68	36.04	84.34	54.67	53.8	46.43	57.89

The CAISO hour-ahead prices at Four Corners node[16] for those same intervals (offset by two hours to account for the difference between Pacific and Central time zones) are shown in Table 4 below.[17]

Table 4. CAISO HASP Prices at Four Corners during ERCOT Real-Time Price Spikes on June 27, 2013

OPR_DT	OPR_HR	NODE_ID_XML	MARKET_RUN_ID	LMP_TYPE	INTERVAL01	INTERVAL02	INTERVAL03	INTERVAL04
6/27/2013	14	FOURCORN_5_N501	HASP	LMP	$ 40.80	$ 44.56	$ 48.17	$ 51.93
6/27/2013	18	FOURCORN_5_N501	HASP	LMP	$ 51.12	$ 48.52	$ 49.29	$ 48.81
6/27/2013	20	FOURCORN_5_N501	HASP	LMP	$ 46.77	$ 44.97	$ 43.52	$ 41.64

During the peak hours in Texas, real-time prices throughout the state spiked to $115/MWh and $126/MWh between 4:00 PM and 4:30 PM. During that time, prices at Four Corners node in the CAISO market hovered in the mid-$40/MWh range. Such a price differential between market hubs ($80/MWh) encourages energy transfers that would improve market efficiency, if a means to physically transfer energy between ERCOT and CAISO was possible. TNME with Tres Amigas makes this hypothetical possibility a reality.

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[16] *CAISO uses a nodal or locational market design, as does ERCOT (SPP is moving to nodal market design as well). Prices are therefore reported at a specific location, for example at actual busbar at the Four Corner Unit 5.*

[17] *ERCOT Real Time Market. See: http://www.ercot.com/mktinfo/rtm/*

Consistency with National Energy Policy

The United States energy policy is summarized by the President's March 15, 2012 statement, "We can't have an energy strategy for the last century that traps us in the past. We need an energy strategy for the future – an all-of-the-above strategy for the 21st century that develops every source of American- made energy."[18]

By developing generating resources in New Mexico (natural gas, solar, wind and geothermal, and storage capabilities), building the infrastructure to transport that energy and linking market centers with HVDC transmission lines through a high tech AC-DC-AC gateway, TNME becomes a mechanism by which to turn policy into reality.

Phase II will establish a market hub at the Eddy County Tie by the establishment of a new HVDC technology in lieu of the old Line Computed Converter ("LCC"). Phase II of TNME will also establish a double circuit AC line to Tolk station connected to the Tres Amigas facilities and upgrade the AC connection to Albuquerque. This will create a "market node" that would allow the renewable resources in the Southern region of New Mexico to be developed and increase their capacity and energy into a network capable of serving the Western Interconnection, Eastern Interconnection and ERCOT.

Implementation

Implementation of TNME will require vetting with the appropriate organizations, for example:

1. Interconnection request with Arizona Public Service Company and joint owners as necessary

2. Neighboring utilities such as PNM, XCEL, SPS, EPE, NTUA that are affected systems

3. Western Electricity Coordinating Council (WECC) studies, CAISO, SPP, ERCOT

4. Permitting/Coordination (Federal)
    a. Tribes and U.S. Bureau of Indian Affairs
    b. U.S. Fish and Wildlife
    c. U.S. Army Corps of Engineers
    d. U.S. Department of Agriculture
    e. Federal Aviation Administration
    f. Federal Highway Administration
    g. U.S. Environmental Protection Agency
    h. U.S. Forest Service

5. Permitting/Coordination (New Mexico)
    a. New Mexico Public Regulatory Commission (PRC)
    b. New Mexico Department of Fish and Game
    c. New Mexico Historic Preservation
    d. New Mexico Department of Transportation

6. Federal Energy Regulatory Energy Commission

[18] *White House Website. See: http://www.whitehouse.gov/energy*

The list above does not pre-judge the merits or requirements of the functions but is rather a list of coordination agencies that need to be reviewed or involved.

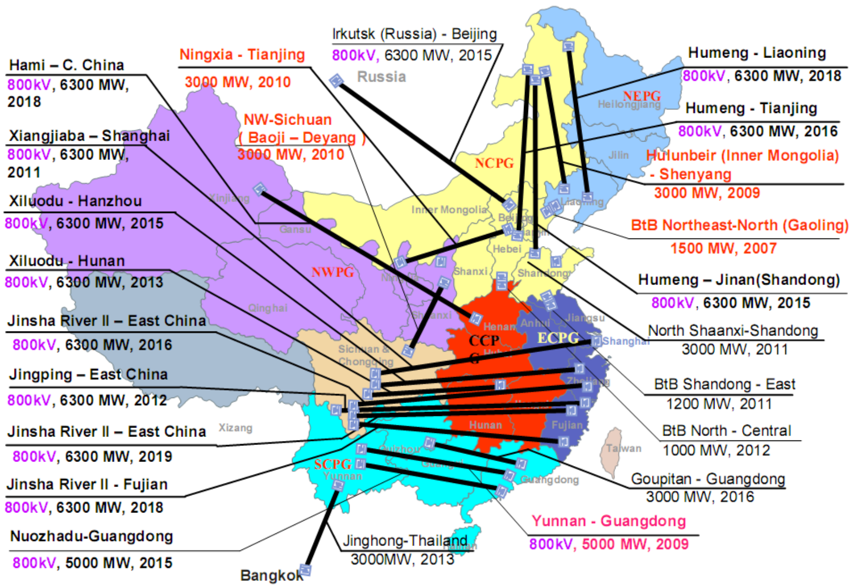
Development Cycle

The purpose of this paper is to introduce the visionary concepts of the TNME. The founders and developers will begin to study the next level of economic feasibility for the project, design a technology road map and establish the initial organizational structure of the project.

It is also envisioned that the TNME would be a public/private partnership of development. As such, TNME will work closely with all authorities involved and actively seek a consortium of industry leaders in electric transmission, infrastructure financing and project services.

These new electric highways for the state will be built to enhance the integration of the State's energy production potential with the opportunities of a national grid network.

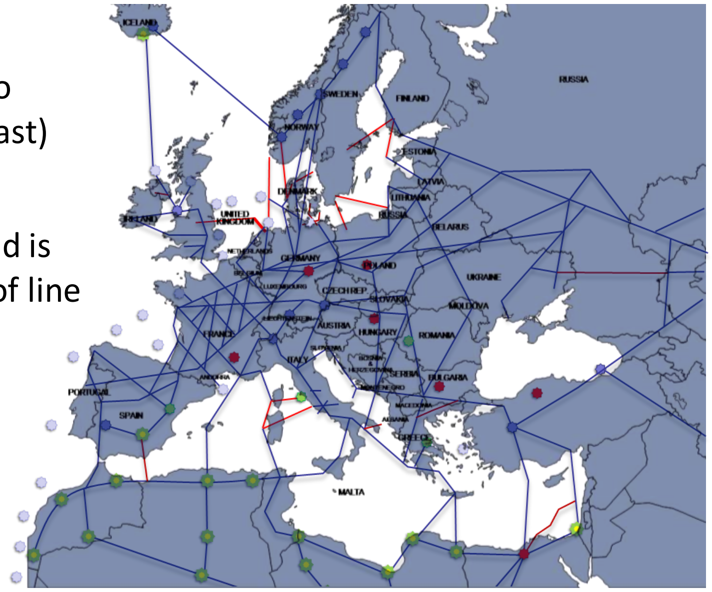
China: Current HVDC National Grid Plan



Europe: Extended Grid Plan

TRESAMIGAS LLC

- From Iceland (Northwest) to Israel (Southeast) = 3,200 mi
- Concept of grid is 25,000 miles of line



Solar Power
Wind Power
Geothermal
Hydro
Biomass

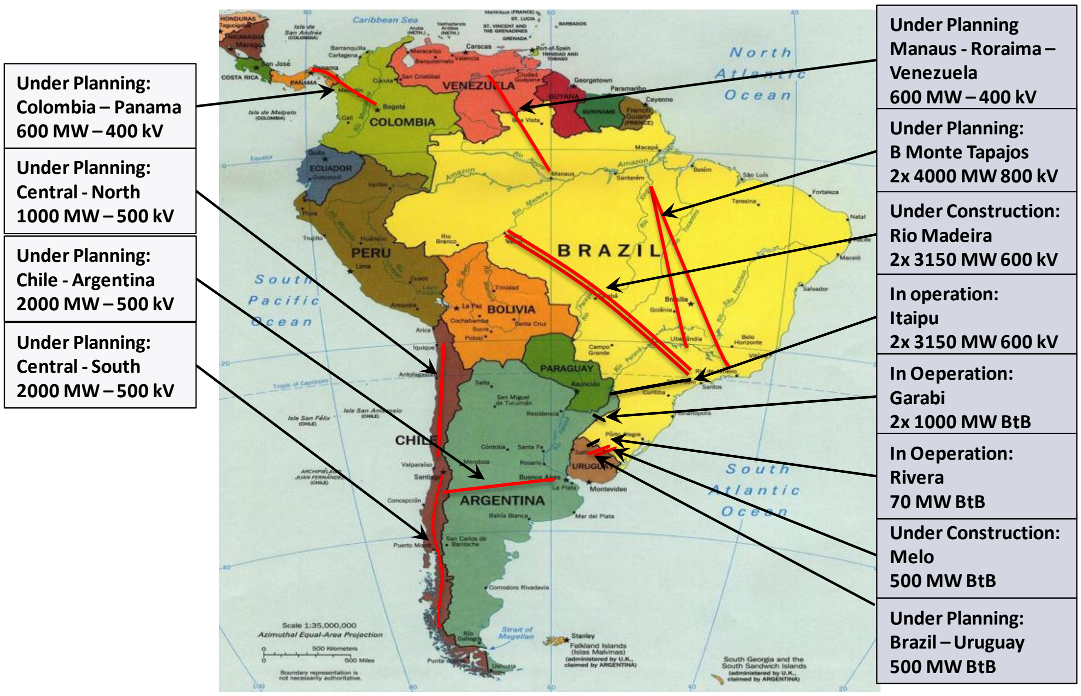
Connections already in place or planned
Vision of ABB and DLR

The new high-voltage network would range from the Sahara to the polar cap. The concept calls for main lines that are 40,000 kilometers long. And parts of it already exist.

9

South American HVDC projects in operation, construction or planned

TRESAMIGAS LLC



6

Figure 11. Demonstrating the economic development impacts of a 1,000 MW Solar and 1,000 MW Wind Investment (2020)

Source: NREL, Land-based Wind JEDI Model, rel. W1.10.03, assuming capital costs of $2,592/kW and O&M costs of $20/kW-year; NREL, Solar Project PV Model rel. PV10.17.11., assuming capital costs of $2,361/kW and O&M costs of $20/kW-year

Table 5. Example of revenues from service fee collected from shippers on TNME

	Revenues Collected, per annum					
	Implied Energy Flows (TWh)					
	8.8	10.5	12.3	14.0	15.8	17.5
	Assumed Utilization Rate					
Service Fee Rate ($/MWh)	50%	60%	70%	80%	90%	100%
$ 0.25	$2,190,000	$2,628,000	$3,066,000	$3,504,000	$3,942,000	$4,380,000
$ 0.50	$4,380,000	$5,256,000	$6,132,000	$7,008,000	$7,884,000	$8,760,000
$ 0.75	$6,570,000	$7,884,000	$9,198,000	$10,512,000	$11,826,000	$13,140,000
$ 1.00	$8,760,000	$10,512,000	$12,264,000	$14,016,000	$15,768,000	$17,520,000

Overview of Transmission in New Mexico

Transmission systems are designed to transmit electricity from generators to serve customer load. New Mexico's transmission system is no different. As large amounts of renewable generation, which is produced in areas rich in generation capability but far from major load centers, becomes prevalent the State's transmission system will have to adapt.

New Mexico's natural resources provide opportunities for large scale electricity production from both renewable and natural gas-fired generation projects. For New Mexico to realize the potential, it needs to develop the infrastructure to transmit energy from its generation sites to large load centers across the nation. The existing transmission system is not designed to provide this service.

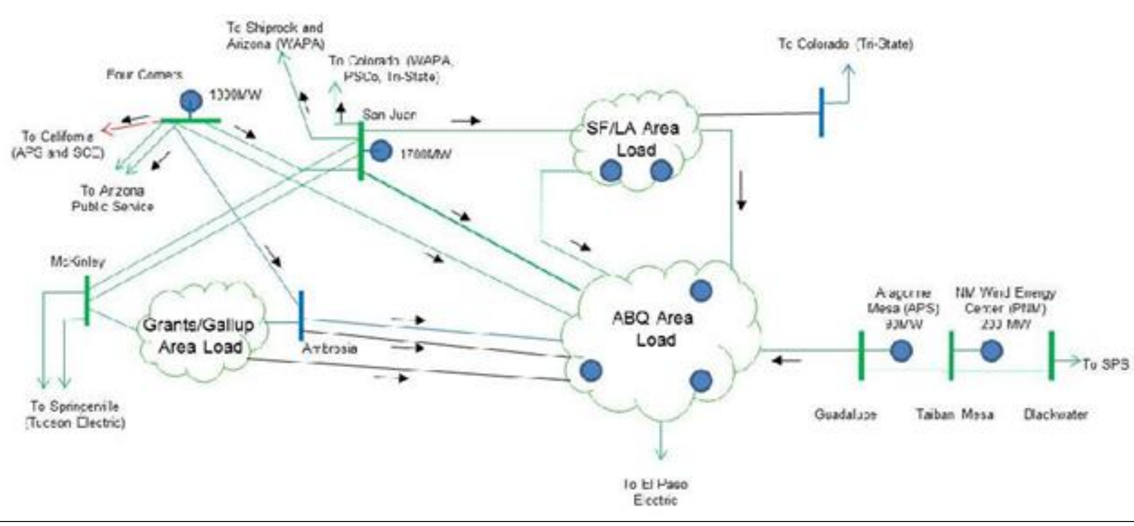
Although PNM's transmission system does not serve the entire state (Tri-State, Xcel/SPS, El Paso Electric also have transmission in New Mexico), it is a significant component of New Mexico's transmission system. The key for any generation developer using New Mexico transmission to market its supply to major load centers in the West is access to Four Corners. Four Corners is a major electricity hub in the Southwest connecting New Mexico with Arizona, California, Colorado and Nevada.

For a generation developer in New Mexico to market its supply to major load centers in Texas and the Midwest, it has to either connect with SPS's transmission system or if connecting to PNM's system, try to get through the 200 MW gateway at Blackwater Substation near Clovis. If connecting to El Paso's transmission system, it has to get through the 200 MW gateway at Eddy Substation near Carlsbad.

PNM's Existing System

Figure 12 provides a high level diagram of PNM's existing transmission system which can be described as a long transmission corridor from its primary generation supply at Four Corners and San Juan to New Mexico's largest load centers in Albuquerque and Santa Fe/Los Alamos. To the east, a long transmission line connections the Albuquerque load center with SPS's transmission system.

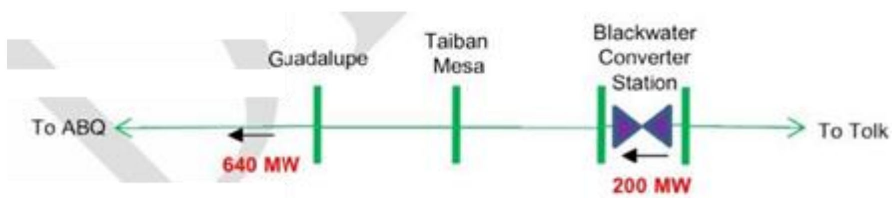
Figure 12. PNM's existing transmission system



The transmission system is limited in its ability to transfer energy based on studies performed by PNM that ensure reliable system operation. This is called “Total Transfer Capability” and it describes the physical limitations of the transmission system. For generation developers in eastern New Mexico that want to interconnect on PNM’s system on the 345 kV transmission line between Albuquerque and Texas and access Four Corners, that physical limitation is a constraint.

Below is a diagram of MNM’s 345 KV line between Albuquerque and Texas that shows the east-to-west Total Transfer Capability of the line segments. The line is limited to 200 MW from Texas because the Blackwater station that acts as a gateway between Texas and New Mexico is limited to 200 MW. PNM has determined that the Total Transfer Capability of the line is 640 MW, so developers that want to interconnect to the line downstream of Blackwater can do so up to 640 MW total.

Figure 13. PNM’s 345 KV line between Albuquerque and Texas



PNM has noted that the Total Transfer Capability of the line downstream of Blackwater can be increased by roughly 400 MW by installing voltage control equipment at Guadalupe.

The second constraint that a developer with a generation project in eastern New Mexico has to face is the ability to acquire Transmission Service from PNM to Four Corners. Transmission Service is contractual right to utilize PNM’s transmission capacity consistent with the Total Transfer Capability. Transmission Service is acquired from PNM on a first-come, first-served basis. Requests for firm Transmission Service on PNM’s system to Four Corners is best described as standing room only. The table below summarizes requests for Transmission Service to Four Corners.

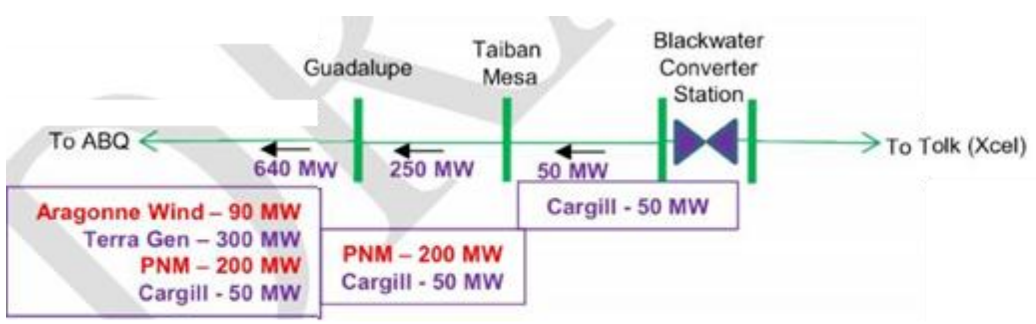
Figure 14. Requests for Transmission Service to Four Corners PNM's existing Transmission Service commitments

Queue Positions	Customer	MW	Notes
1 and 2	Cargill	375	125 MW and 200 MW (BW to FC)
3 and 4	Arabella Wind	300	170 MW and 130 MW (Guad to FC)
5	Cargill	100	BW to FC
6 and 7	Arabella Wind	300	170 MW and 130 MW (Guad to FC)
8 to 18	Berrendo Wind	1,100	11 requests for 100 MW each (ABQ to FC)
19	INVM	70	Storie Lake to San Juan
20 to 24	Iberdrola	500	5 requests for 100 MW each
25 to 28	EnXco	800	4 requests for 200 MW each (Ojo to FC)
29 to 36	EnXco	1,600	8 requests for 200 MW each (ABQ to FC)
37	EnXco	200	Storie Lake to Four Corners
38	EnXco	200	Willard to Four Corners
39 to 40	EnXco	400	2 requests for 200 MW each (ABQ to FC)
41 to 44	EnXco	800	4 requests for 200 MW each (Guad to FC)
45	Terra Gen	300	Blackwater to Four Corners
46 to 60	Power Network New Mexico	1,500	15 requests for 100 MW each (ABQ to FC)
	Total	8,545	

One of the main issues associated with acquiring Transmission Service is that those that have already acquired Transmission Service (which is allotted on a first-come, first-served basis) have the right under FERC's standard Open Access Transmission Tariff (OATT), under which PNM operates, to defer taking service year-to-year up to five years. The result is Transmission Service is over-subscribed while operationally, the transmission capacity is under-utilized. As a result, the "Available Transmission Capacity" (Total Transmission Capacity minus Transmission Service Commitments = Available Transmission Capacity) is nonexistent.

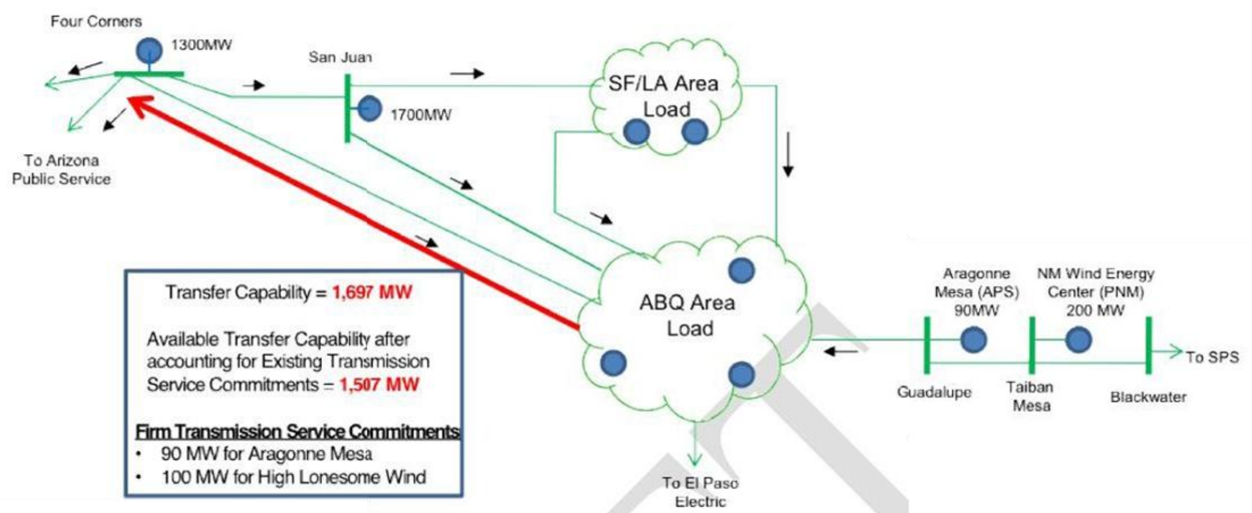
Below is a diagram illustrating PNM's existing Transmission Service commitments on the transmission path from Blackwater to Albuquerque (ABQ).

Figure 15. PNM's existing Transmission Service commitments



Note that the Transmission Service commitments highlighted in red are operational today. Those in purple have been deferred. The option to defer on a year-to-year basis is allowed under PNM's OATT for up to five years. Both Cargill and Terra Gen have exercised their options to defer service the last few years. But because entities have acquired the Transmission Service even though they don't use it, the Available Transmission Service is 0 MW (Total Transfer Capability 640 MW minus Existing Transmission Commitments 640 MW = 0 MW) except for when PNM markets Available Transmission Service on a short-term basis.

Figure 16. PNM's system



Below is a diagram of PNM's system illustrating the Total Transfer Capability from Albuquerque to Four Corners and the current Transmission Service commitments currently utilizing that Transmission Service.

Note that although PNM has 8,545 MW of requests for Transmission Service to Four Corners, only 190MW of the 1,697 MW of Transfer Capability is actually being utilized. From a contractual perspective, the path is over-subscribed. From an operational perspective the path is under-utilized.

For developers that have generation in eastern New Mexico connecting to PNM's transmission system that want to transfer energy east to Texas, the Total Transfer Capability is again limited to 200 MW (the limit of the gateway at Blackwater. Independent transmission developers have proposed transmission projects that traverse New Mexico.

These include:

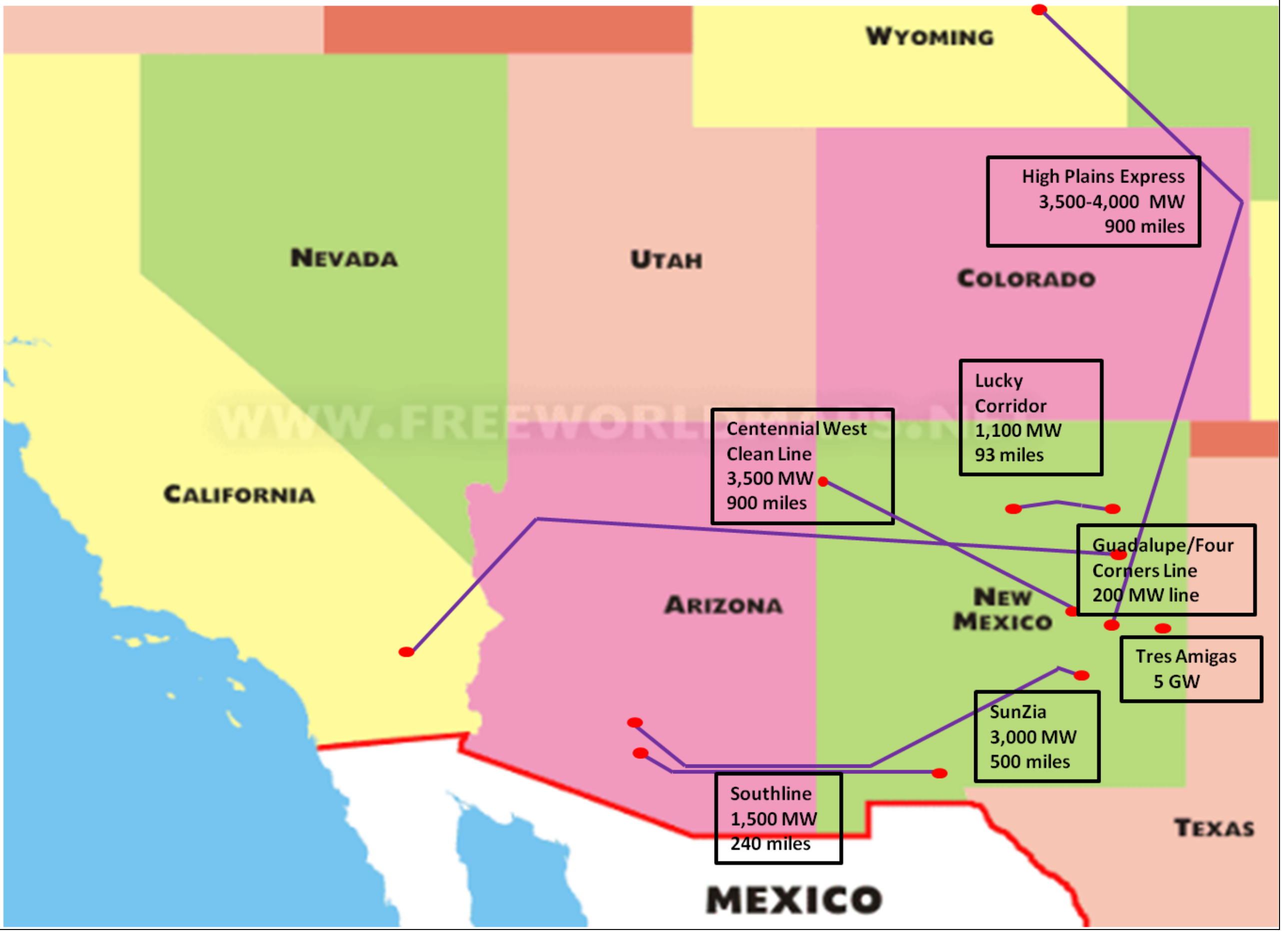
- Lucky Corridor Transmission Line
- SunZia Transmission Line
- Tres Amigas Super Station
- High Plains Express
- Centennial West Clean Line
- Southline

The diagram on the next page is a high level illustration of those projects.

Conclusion

The need for transmission in New Mexico is clear. The existing transmission system is not designed for the needs of the 21st century. The approach needs to incorporate existing capabilities melded with proposals for new transmission in an integrated fashion.

Figure 17. Proposed Transmission projects by independent transmission developers



Attachment E

The Erie Canal: A Brief History[19]

Begun in 1817 and opened in its entirety 1825, the Erie Canal is considered the engineering marvel of the 19th Century. When the federal government concluded that the project was too ambitious to undertake, the State of New York took on the task of carving 363 miles of canal through the wilderness with nothing but the muscle power of men and horses.

Once derided as "Clinton's Folly" for the Governor who lent his vision and political muscle to the project, the Erie Canal experienced unparalleled success almost overnight. The iconic waterway established settlement patterns for most of the United States during the 19th century, made New York the financial capital of the world, provided a critical supply line which helped the North win the Civil War, and precipitated a series of social and economic changes throughout a young America.

Explorers had long searched for a water route to the west. Throughout the 18th and 19th centuries, the lack of an efficient, safe transportation network kept populations - and trade - largely confined to coastal areas. At the beginning of the nineteenth century, the Allegheny Mountains were the Western Frontier. The Northwest Territories that would later become Illinois, Indiana, Michigan and Ohio were rich in timber, minerals, and fertile land for farming. It took weeks to reach these precious resources. Travelers were faced with rutted turnpike roads that baked to hardness in the summer sun. In the winter, the roads dissolved in a sea of mud.

An imprisoned flour merchant named Jesse Hawley envisioned a better way: a Canal from Buffalo on the eastern shore of Lake Erie to Albany on the upper Hudson River, a distance of almost 400 miles. Long a proponent of efficient water transportation, Hawley had gone bankrupt trying to get his product to market from what is now Rochester. Sent to debtor's prison as a result, Hawley wrote a series of essays which were published in the Genesee Messenger beginning in 1807, describing in great detail the route, costs, and benefits of what would become the Erie Canal.

Hawley's essays caught the eye of Assemblyman Joshua Forman, who submitted the first State legislation related to the Erie Canal in 1808, calling for a series of surveys to be made examining the practicality of a water route between Lake Erie and the Hudson River. Forman even traveled to Washington to make a case for federal support for the Canal, at which point Thomas Jefferson described the proposal as "a little short of madness."

In 1810, Thomas Eddy, Treasurer of the Western Inland Lock Navigation Company and State Senator Jonas Platt, hoping to get plans for the Canal moving forward, approached influential Senator De Witt Clinton -- former mayor of New York City and a rising political star -- to enlist his support. On March 13th, a measure was introduced in the State Senate naming a Canal Commission and directing the commissioners to survey a route for the Canal which would connect the Hudson River to the Great Lakes. With Clinton's support, the measure passed, and the Erie Canal era had begun.

Though Clinton had been recruited to the Canal effort by Eddy and Platt, he quickly became one of the Canal's most active supporters, and went on to tie his very political fate to the success of the Canal. Today, De Witt Clinton and the story of the Erie Canal are inextricably linked, and there is no doubt that Governor Clinton grasped at the time the revolutionary impact the Canal would have once it opened:

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[19] *History Channel Website. See: www.historychannel.com/*

“The city will, in the course of time, become the granary of the world, the emporium of commerce, the seat of manufactures, the focus of great moneyed operations,” said Clinton. “And before the revolution of a century, the whole island of Manhattan, covered with inhabitants and replenished with a dense population, will constitute one vast city.”

Though the War of 1812 created a lengthy interruption in the project’s progress, Clinton and his fellow Canal proponents continued to work to build support for the waterway. In 1816, as a sitting Canal Commissioner, DeWitt Clinton submitted a formal petition to a joint committee of the New York State Senate and Assembly to create a canal system between the Hudson River and Lake Erie. This document, known as the "New York Memorial", generated a series of public meetings in support of the Canal’s construction and effectively began the movement in the state to build the waterway. Ultimately, over one hundred thousand New Yorkers would sign the petition, helping to build a ground swell of public support for the project.

On April 15th, 1817, the New York State Legislature finally approved construction of the Erie Canal, which Jesse Hawley had written so compellingly about just a decade earlier. The bill authorized $7 million for construction of the 363-mile long waterway, which was to be 40 feet wide and four feet deep. Construction would begin on July 4th, in Rome, NY and would take eight years. Also in 1817, Clinton would leverage his success championing the Canal’s construction into the Governor’s office, his election culminating his meteoric political rise over the years.

The completion of the Erie Canal spurred the first great westward movement of American settlers, gave access to the rich land and resources west of the Appalachians and made New York the preeminent commercial city in the United States.

In 1825, Governor Dewitt Clinton officially opened the Erie Canal as he sailed the packet boat Seneca Chief along the Canal from Buffalo to Albany. After traveling from the mouth of the Erie to New York City, he emptied two casks of water from Lake Erie into the Atlantic Ocean, celebrating the first connection of waters from East to West in the ceremonial "Wedding of the Waters".

The effect of the Canal was both immediate and dramatic, and settlers poured west. The explosion of trade prophesied by Governor Clinton began, spurred by freight rates from Buffalo to New York of $10 per ton by Canal, compared with $100 per ton by road. In 1829, there were 3,640 bushels of wheat transported down the Canal from Buffalo. By 1837 this figure had increased to 500,000 bushels; four years later it reached one million. In nine years, Canal tolls more than recouped the entire cost of construction.

Within 15 years of the Canal's opening, New York was the busiest port in America, moving tonnages greater than Boston, Baltimore and New Orleans combined.

The impact on the rest of the State can be seen by looking at a modern map. With the exception of Binghamton and Elmira, every major city in New York falls along the trade route established by the Erie Canal, from New York City to Albany, through Schenectady, Utica and Syracuse, to Rochester and Buffalo. Nearly 80% of upstate New York's population lives within 25 miles of the Erie Canal.

The Erie Canal's success was part of a Canal-building boom in New York in the 1820s. Between 1823 and 1828, several lateral Canals opened including the Champlain, the Oswego and the Cayuga-Seneca.

Between 1835 and the turn of the century, this network of Canals was enlarged twice to accommodate heavier traffic. Between 1905 and 1918, the Canals were enlarged again. This time, in order to accommodate much larger barges, the engineers decided to abandon much of the original man-made channel and use new techniques to

"Canalize" the rivers that the canal had been constructed to avoid the Mohawk, Oswego, Seneca, Clyde and Oneida Lake. A uniform channel was dredged; dams were built to create long, navigable pools, and locks were built adjacent to the dams to allow the barges to pass from one pool to the next.

Figure 18. Population Density Map

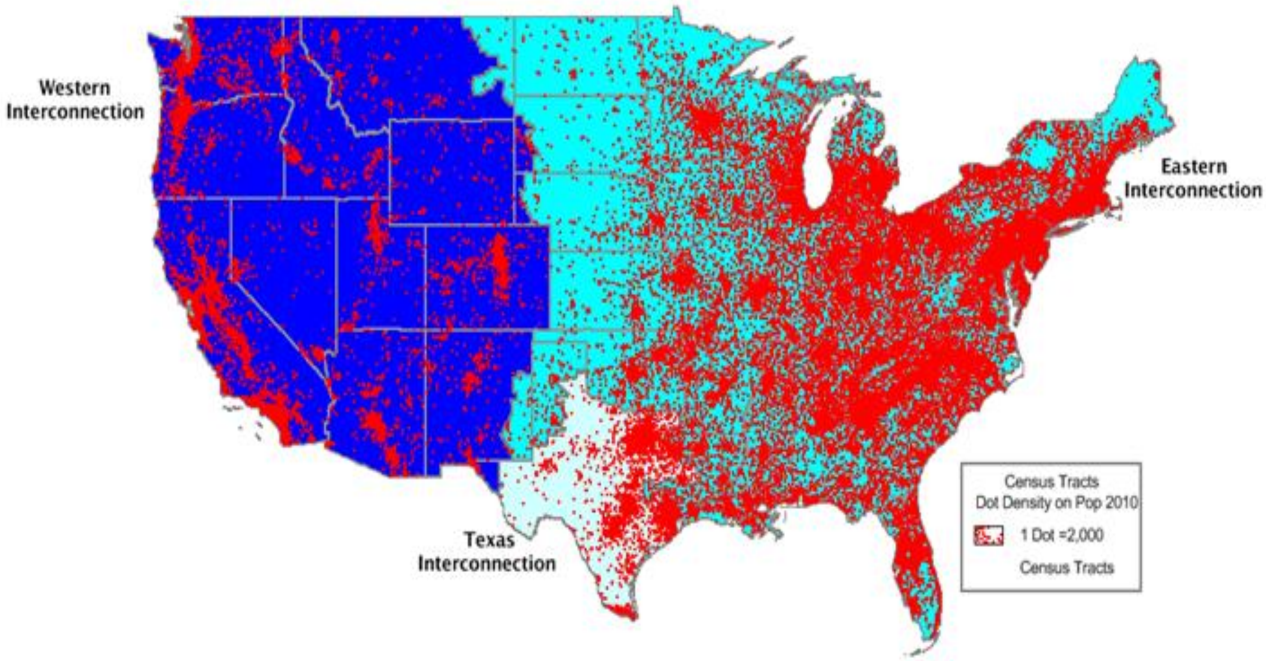

Table 6. State Population – Rank, Percent Change, and Population Density: 1980 to 2010

State	Rank				Percent change			Population per square mile of land area [1]		
	1980	1990	2000	2010	1980–1990	1990–2000	2000–2010	1990	2000	2010
United States	**(X)**	**(X)**	**(X)**	**(X)**	**9.8**	**13.1**	**9.7**	**70.4**	**79.7**	**87.4**
Alabama	22	22	23	23	3.8	10.1	7.5	79.8	87.8	94.4
Alaska	50	49	48	47	36.9	14.0	13.3	1.0	1.1	1.2
Arizona	29	24	20	16	34.8	40.0	24.6	32.3	45.2	56.3
Arkansas	33	33	33	32	2.8	13.7	9.1	45.2	51.4	56.0
California	1	1	1	1	26.0	13.8	10.0	191.0	217.4	239.1
Colorado	28	26	24	22	14.0	30.6	16.9	31.8	41.5	48.5
Connecticut	25	27	29	29	5.8	3.6	4.9	678.8	703.3	738.1
Delaware	47	46	45	45	12.1	17.6	14.6	341.9	402.1	460.8
District of Columbia	(X)	(X)	(X)	(X)	–4.9	–5.7	5.2	9,941.3	9,370.6	9,856.5
Florida	7	4	4	4	32.7	23.5	17.6	241.3	298.0	350.6
Georgia	13	11	10	9	18.6	26.4	18.3	112.6	142.3	168.4
Hawaii	39	41	42	40	14.9	9.3	12.3	172.6	188.6	211.8
Idaho	41	42	39	39	6.7	28.5	21.1	12.2	15.7	19.0
Illinois.	5	6	5	5	(Z)	8.6	3.3	205.9	223.7	231.1
Indiana.	12	14	14	15	1.0	9.7	6.6	154.8	169.7	181.0
Iowa	27	30	30	30	–4.7	5.4	4.1	49.7	52.4	54.5
Kansas.	32	32	32	33	4.8	8.5	6.1	30.3	32.9	34.9
Kentucky	23	23	25	26	0.7	9.6	7.4	93.4	102.4	109.9
Louisiana	19	21	22	25	0.4	5.9	1.4	97.7	103.4	104.9
Maine.	38	38	40	41	9.2	3.8	4.2	39.8	41.3	43.1
Maryland	18	19	19	19	13.4	10.8	9.0	492.5	545.6	594.8
Massachusetts.	11	13	13	14	4.9	5.5	3.1	771.3	814.0	839.4
Michigan	8	8	8	8	0.4	6.9	–0.6	164.4	175.8	174.8
Minnesota	21	20	21	21	7.4	12.4	7.8	55.0	61.8	66.6
Mississippi	31	31	31	31	2.2	10.5	4.3	54.9	60.6	63.2
Missouri	15	15	17	18	4.1	9.3	7.0	74.4	81.4	87.1
Montana.	44	44	44	44	1.6	12.9	9.7	5.5	6.2	6.8
Nebraska	35	36	38	38	0.5	8.4	6.7	20.5	22.3	23.8
Nevada	43	39	35	35	50.1	66.3	35.1	10.9	18.2	24.6
New Hampshire	42	40	41	42	20.5	11.4	6.5	123.9	138.0	147.0
New Jersey	9	9	9	11	5.2	8.9	4.5	1,051.1	1,144.2	1,195.5
New Mexico	37	37	36	36	16.3	20.1	13.2	12.5	15.0	17.0
New York	2	2	3	3	2.5	5.5	2.1	381.8	402.7	411.2
North Carolina	10	10	11	10	12.8	21.4	18.5	136.4	165.6	196.1
North Dakota	46	47	47	48	–2.1	0.5	4.7	9.3	9.3	9.7
Ohio	6	7	7	7	0.5	4.7	1.6	265.5	277.8	282.3
Oklahoma	26	28	27	28	4.0	9.7	8.7	45.9	50.3	54.7
Oregon.	30	29	28	27	7.9	20.4	12.0	29.6	35.6	39.9
Pennsylvania	4	5	6	6	0.2	3.4	3.4	265.6	274.5	283.9
Rhode Island	40	43	43	43	5.9	4.5	0.4	970.6	1,014.0	1,018.1
South Carolina.	24	25	26	24	11.7	15.1	15.3	116.0	133.5	153.9
South Dakota.	45	45	46	46	0.8	8.5	7.9	9.2	10.0	10.7
Tennessee	17	17	16	17	6.2	16.7	11.5	118.3	138.0	153.9
Texas	3	3	2	2	19.4	22.8	20.6	65.0	79.8	96.3
Utah	36	35	34	34	17.9	29.6	23.8	21.0	27.2	33.6
Vermont	48	48	49	49	10.0	8.2	2.8	61.1	66.1	67.9
Virginia.	14	12	12	12	15.8	14.4	13.0	156.7	179.2	202.6
Washington	20	18	15	13	17.8	21.1	14.1	73.2	88.7	101.2
West Virginia	34	34	37	37	–8.0	0.8	2.5	74.6	75.2	77.1
Wisconsin	16	16	18	20	4.0	9.6	6.0	90.3	99.0	105.0
Wyoming	49	50	50	50	–3.4	8.9	14.1	4.7	5.1	5.8

X Not applicable. Z Less than 0.05 percent. [1] Persons per square mile were calculated on the basis of land area data from the 2010 census.

Source: U.S. Census Bureau, United States Summary: 2000 (PHC-3-1), <http://www.census.gov/prod/cen2000/phc3-us-pt1.pdf>; 2010 Census Redistricting Data (P.L. 94-171) Summary File, <http://www.census.gov/rdo/data/2010_census_redistricting_data_pl_94-171_summary_files.html>.

U.S. Census Bureau, Statistical Abstract of the United States: 2012