PNM 2023-2042 IRP: Transmission (1 of 2)

STEERING MEETING #5

SEPTEMBER 13, 2022

DISCLOSURE REGARDING FORWARD LOOKING STATEMENTS

The information provided in this presentation contains scenario planning assumptions to assist in the Integrated Resource Plan public process and should not be considered statements of the company's actual plans. Any assumptions and projections contained in the presentation are subject to a variety of risks, uncertainties and other factors, most of which are beyond the company's control, and many of which could have a significant impact on the company's ultimate conclusions and plans. For further discussion of these and other important factors, please refer to reports filed with the Securities and Exchange Commission. The reports are available online at www.pnmresources.com.

The information in this presentation is based on the best available information at the time of preparation. The company undertakes no obligation to update any forward-looking statement or statements to reflect events or circumstances that occur after the date on which such statement is made or to reflect the occurrence of unanticipated events, except to the extent the events or circumstances constitute material changes in the Integrated Resource Plan that are required to be reported to the New Mexico Public Regulation Commission (NMPRC) pursuant to Rule 17.7.4 New Mexico Administrative Code (NMAC).

MEETING GROUND RULES

THE FOCUS OF THE MEETING IS THE DEVELOPMENT OF THE 2023 IRP

01 

- Questions and comments are welcome – One Person Speaks at a Time

02 

- Reminder; today's presentation is not PNM's plan or a financial forecast, it is an illustration of the IRP process

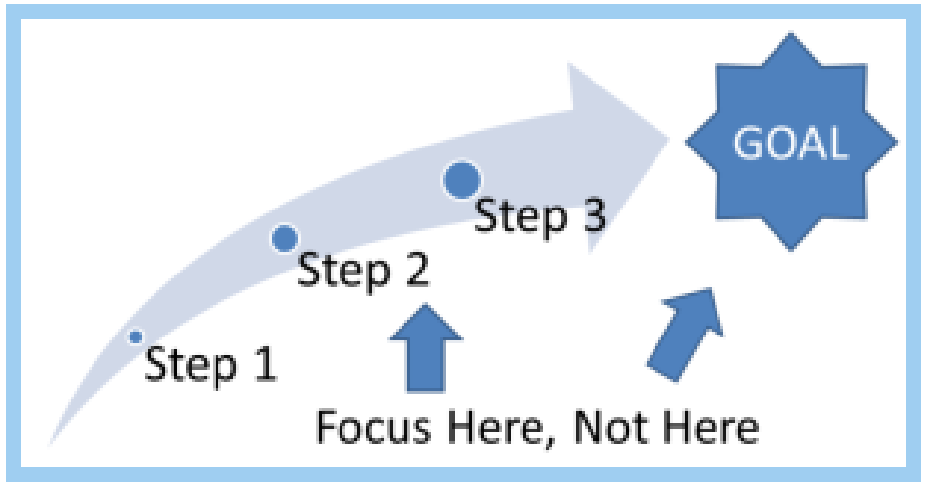
03 

- When asking a question, please speak clearly and slowly as all questions will be logged and labeled with the person and organization responsible for asking the question

04 

- These meetings are about the 2023 IRP, questions and comments should relate to this IRP. Any questions or comments related to other regulator proceedings should be directed towards the specific filing.

THE FOCUS OF THE MEETING IS THE DEVELOPMENT OF THE 2023 IRP



The technical sessions are about discussing the advantages and disadvantages regarding the application of different technical methodologies within the IRP modeling framework.

We are not here to focus on the results or drive towards a specific result. **We all know where we are going: 100% Carbon Free by 2040. The focus in the IRP development is how do we get there in the best way possible for PNM's customers and New Mexico.**

AGENDA

PNM Transmission Engineering

- Transmission System Overview
- Role of Transmission in Energy Transition
- PNM's Transmission System and Capability
- Transmission - Regulatory Construct
- The Transmission/Generation Challenge
- Transmission Strategy Going Forward
- Transmission in IRP

E3

- Transmission in Utility Integrated Resource Planning

PNM Integrated Resource Planning and transmission teams

- PNM Transmission Modeling for IRP – 2020 & 2023
- Nodal Transmission Modeling

PNM
Transmission Engineering

Laurie Williams - Director, Transmission and Substation Engineering

Tom Duane - Manager, Transmission Planning

INTRODUCTIONS

Laurie Williams
Director, Transmission and Substation Engineering

- Ms. Williams directed the Transmission and Substation Engineering teams for the last 1.5 years. She has over 30 years of experience in utility industry including Transmission Planning, Integrated Resource Planning, and NERC Compliance.
- She provides direction for PNM's Transmission Planning and Contracts, Protection – Controls –Communications Engineering, Transmission Line and Substation Design and Engineering, and Strategic Asset Management including Cyber and Physical Security for the transmission system.

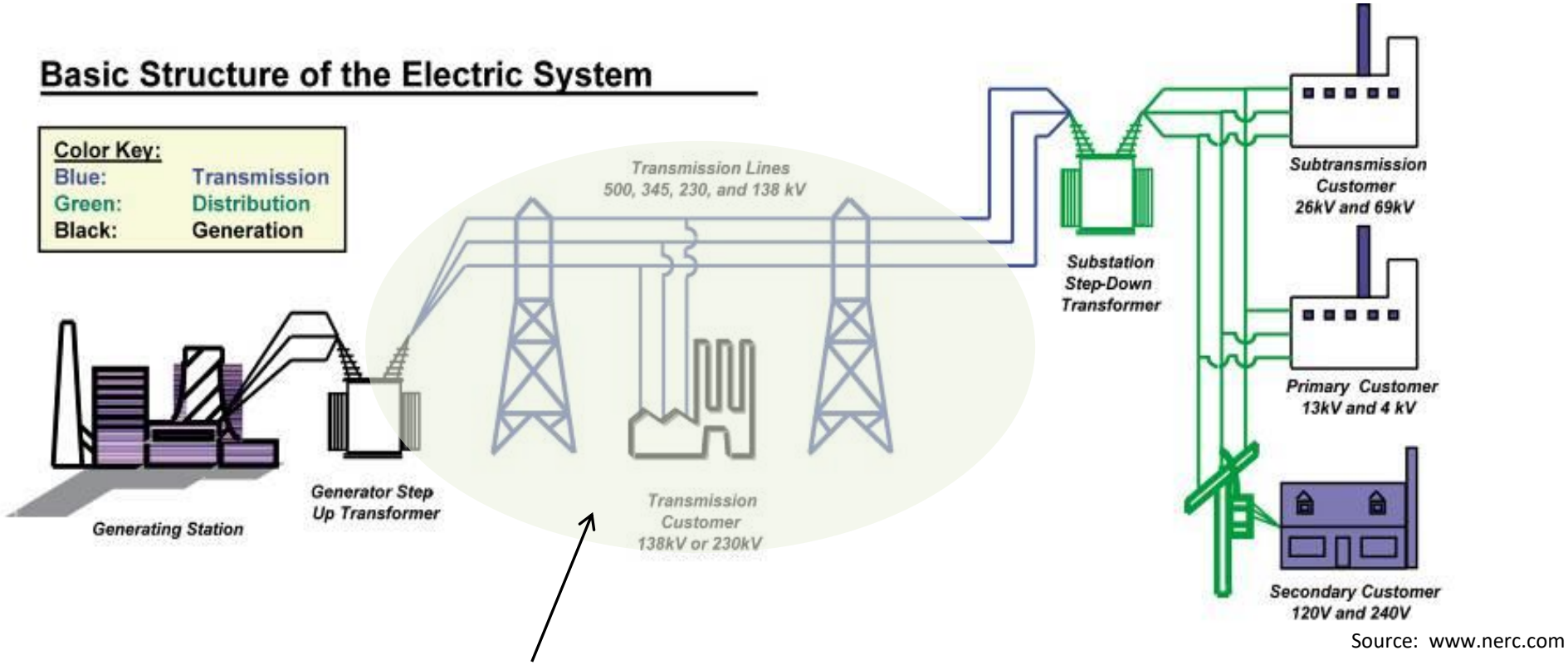
Tom Duane
Manager, Transmission Planning

- Mr. Duane has managed the PNM transmission planning department over the last ten-years. He has supported transmission system analysis and expansion for over 25 years including representation of PNM in regional planning and stakeholder forums.
- Mr. Duane has significant experience in the electric industry that includes providing technical support and guidelines for system operations as well as generation development activities through production cost analysis, market analysis and corporate modeling input.

Transmission Overview and the Role of Transmission in the Energy Transition

Laurie Williams

COMPONENTS OF THE GRID



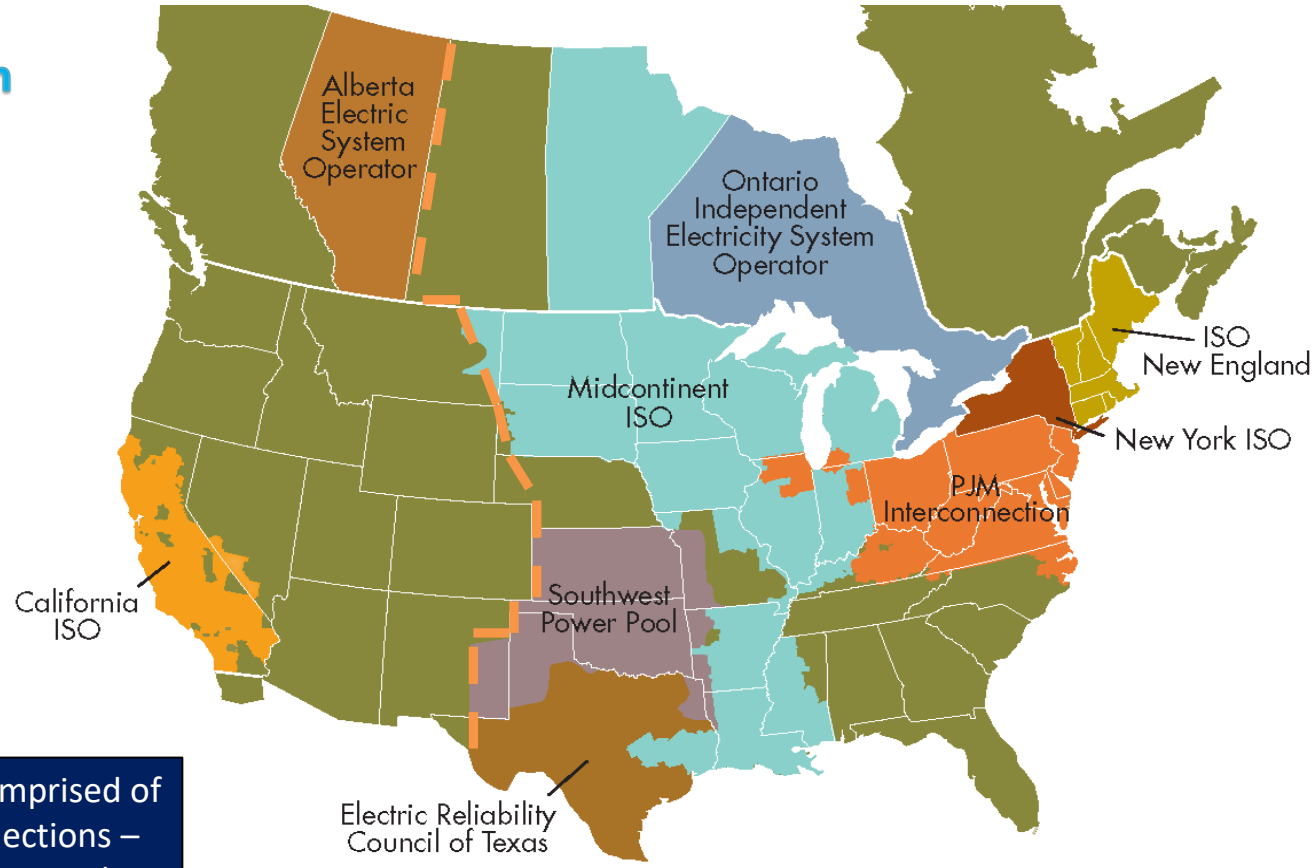
Source: www.nerc.com

PNM Transmission Voltage Levels include 115kV, 230kV, 345kV and 500kV

CURRENT US GRID – INTERCONNECTIONS AND REGIONAL TRANSMISSION OPERATORS

Western Interconnection

Home to roughly 250,000 MW of generating capacity



Eastern Interconnection

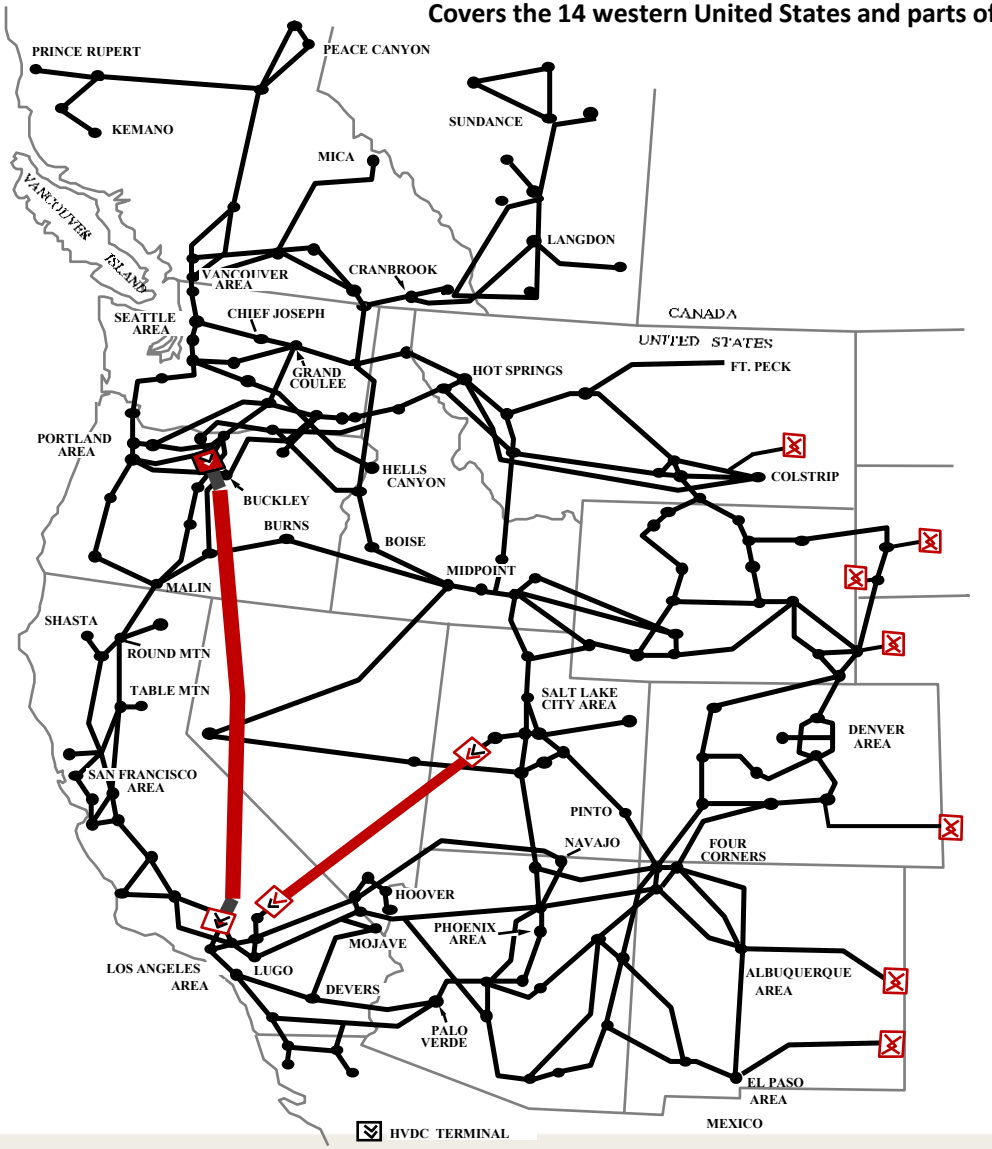
home to roughly 700,000 MW of generating capacity

US Transmission Grid – Comprised of 3 Synchronous Interconnections – largely independent of one another

Much of the system is organized “RTOs”

THE WESTERN INTERCONNECTION

Covers the 14 western United States and parts of Canada and Mexico



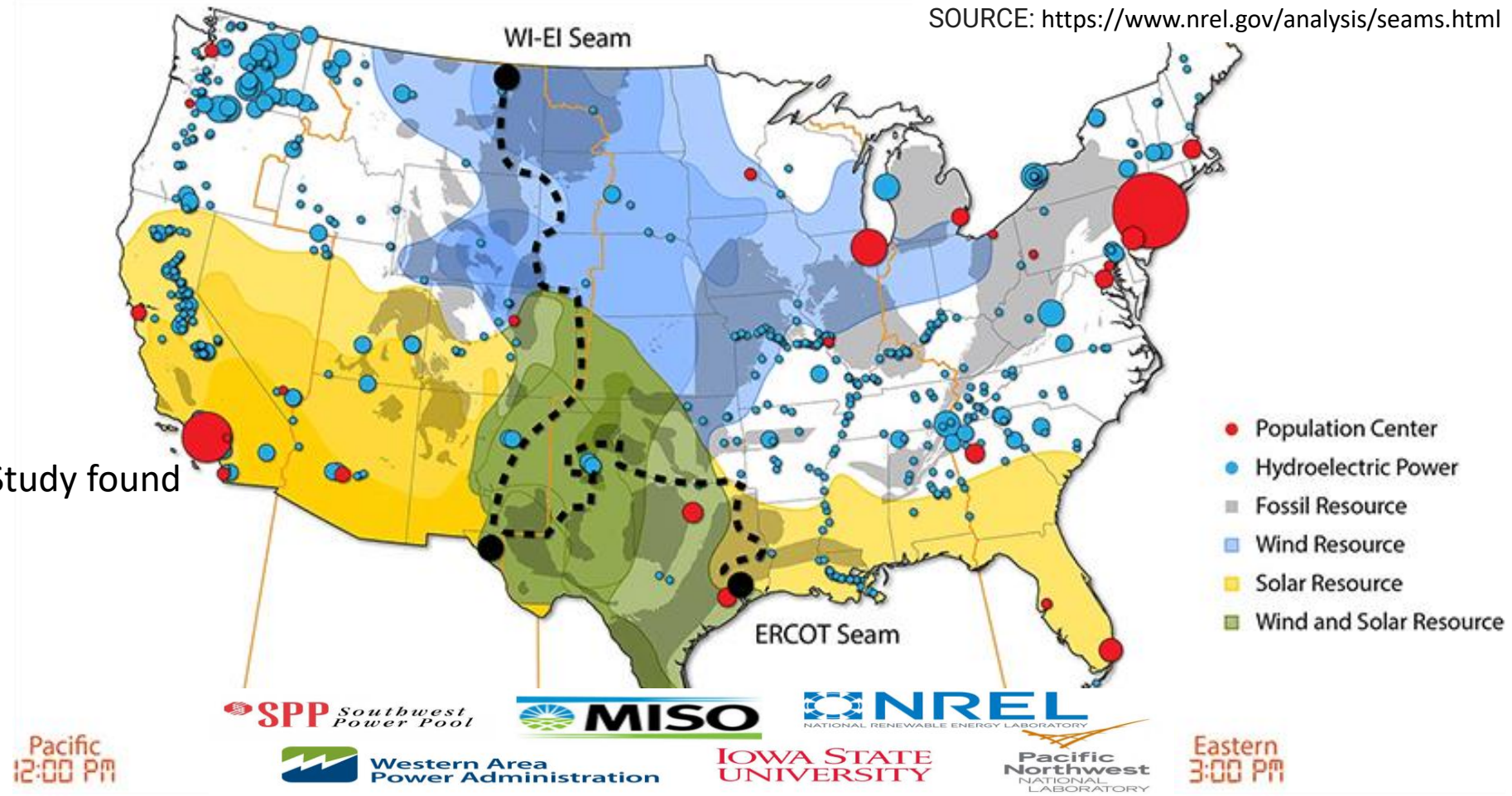
Key Characteristics:

- 1.6 million square miles, over 110k miles of transmission, population of approx. 74 million, ~165 GW peak
- Many Balancing areas (38) and transmission providers (55)
- **Only California in ISO/RTO**
- Historically Bilateral transactions dominate – now resource constrained and EIM becoming more prominent
- Historically economy of scale drove remote jointly-owned base load plants and long transmission lines to connect to load centers
- 2 High Voltage DC lines (serving So. California)
- **7 back-to-back High Voltage DC ties to eastern interconnection allow only 1,320 MW to move between the Eastern and Western grids**

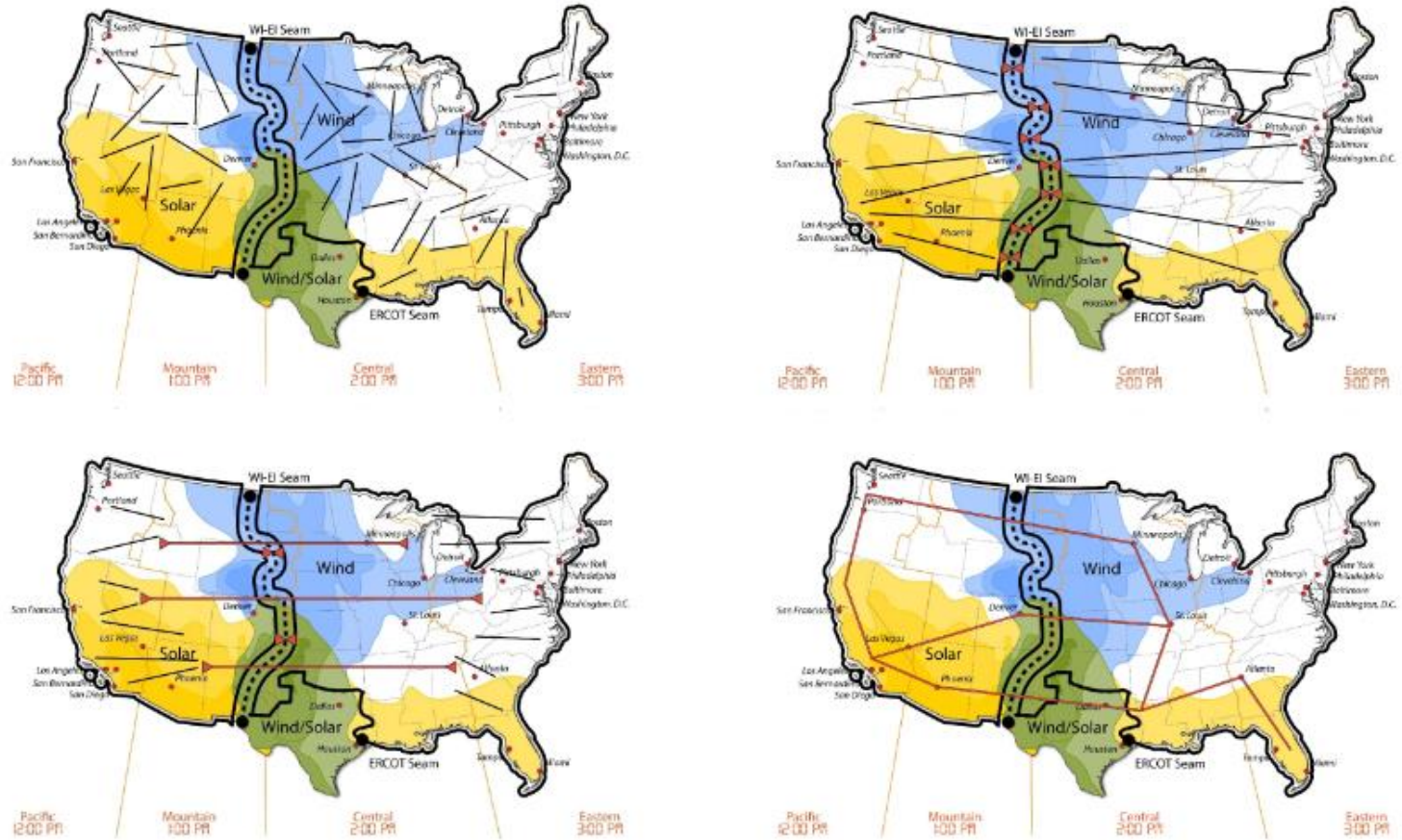
NREL SEAMS STUDY - COMPREHENSIVE ECONOMIC AND RESOURCE ADEQUACY ANALYSIS

SOURCE: https://www.nrel.gov/analysis/seams.html

Study found



NREL SEAMS STUDY METHODOLOGY



Transmission designs in the capacity expansion work. Top left: Design 1. Top right: Design 2a. Bottom left: Design 2b. Bottom right: Design 3.

Modeled transmission and generation co-optimized for four different transmission designs

STUDY METHODOLOGY

Scenario	Key Assumption Differences
Base Case	AEO 2017 gas price, existing state RPS laws
Low Gas Price	AEO 2017 High Gas Resource (gas prices regionally and temporally varying around $4/mmbtu)
High Gas Price	AEO 2017 Low Gas Resources (gas prices varying around $6/mmbtu)
High AC Trx Cost (1.5x)	50% higher than base transmission cost. Base transmission cost from [16]
High AC Trx Cost (2x)	Double the base transmission cost
No Retirements	Model does not retire any generating units beyond announced retirements
Low-Cost Renewables	ATB 2017 Low Cost projections for wind and solar
High VG	Least-cost generation mix when using a carbon cost from $3/tonne in 2024 to $45/tonne in 2038**

Description of the Scenarios*
*Acronyms used here include Energy Information Administration (EIA) Annual Energy Outlook (AEO); Renewable Portfolio Standard (RPS); Annual Technology Baseline (ATB) (atb.nrel.gov); Variable Generation (VG);
Transmission (Tx)
**: The study Technical Review Committee recommended this approach (consistent with cost estimates in [17]) as a proxy for potential growth in wind and solar in light of uncertainty in traditional deployment forecasts

- The four conceptual transmission designs were studied under eight different grid environments
- A total of 32 total capacity expansion model runs were made
- Scenarios vary in terms of technology cost, fuel price, and policy assumptions
- Refer to preprint article for numbered references

COST/BENEFIT RESULTS

Summary of Benefit/Cost Results from CGT-Plan Model

Base Scenario

Capacity or Cost Item	D1	ΔD2a	ΔD2b	ΔD3
Transmission Investment Cost, $B	40.03	2.57	6.76	8.19
Generation Investment Cost, $B	555.23	3.6	10.44	4.17
Operational cost, $B	2376.50	-8.79	-21.70	-15.30
35-yr Net Cost change, $B	-	-2.62	-4.5	-2.94
35-yr B/C ratio	-	2.02	1.66	1.36

High VG Scenario

Capacity or Cost Item	D1	ΔD2a	ΔD2b	ΔD3
Transmission Investment Cost, $B	71.69	16.79	15.6	28.86
Generation Investment Cost, $B	741.38	6.83	8.02	7.95
Operational Cost, $B	2563.3	-41.97	-52.45	-59.85
35-year Net Cost change , $B	NA	-18.35	-28.83	-23.04
35-year B/C Ratio	NA	2.09	2.89	1.80

Note: D1 results are shown as absolute costs; D2a, D2b, and D3 results are shown relative to D1.
In the High VG case, carbon costs are included in the optimization but not the net costs or B/C ratio

KEY NREL FINDINGS

- The power system can balance generation and load
- Additional transmission enabled lower total installed capacities (especially in the High VG scenario)
- There are substantial positive benefit-cost ratios for increasing the transfer capability between the interconnections
- Cross-seam transmission has a substantial impact on the location of wind and solar generation additions
- Wind shifts to the Eastern Interconnection and solar to the Western Interconnection
- Additional benefits and costs may exist (e.g., frequency response and resilience to extreme events)
- **Findings repeated in NREL's North American Renewable Integration Study** https://www.nrel.gov/analysis/naris.html
    - Interregional transmission expansion achieves up to $180 billion in net benefits – "Transmission plays an important role in minimizing costs."

PRINCETON'S "NET-ZERO AMERICA" STUDY

- Lays out five pathways by which the United States could decarbonize the entire economy in the next 30 years
- According to the research, the United States will need to expand its electricity transmission systems by 60% by 2030 and may need to triple it by 2050

> *"The current power grid took 150 years to build. Now, to get to net-zero emissions by 2050, we have to build that amount of transmission again in the next 15 years and then build that much more again in the 15 years after that. It's a huge amount of change."*
>
> -Jesse Jenkins, Co-Principal Investigator, Senior Research Scientist, Andlinger Center for Energy and the Environment, Princeton University

Source: https://acee.princeton.edu/acee-news/net-zero-america-report-release/

THE BOTTOM LINE

Transmission is key to achieving the energy transition efficiently across the US

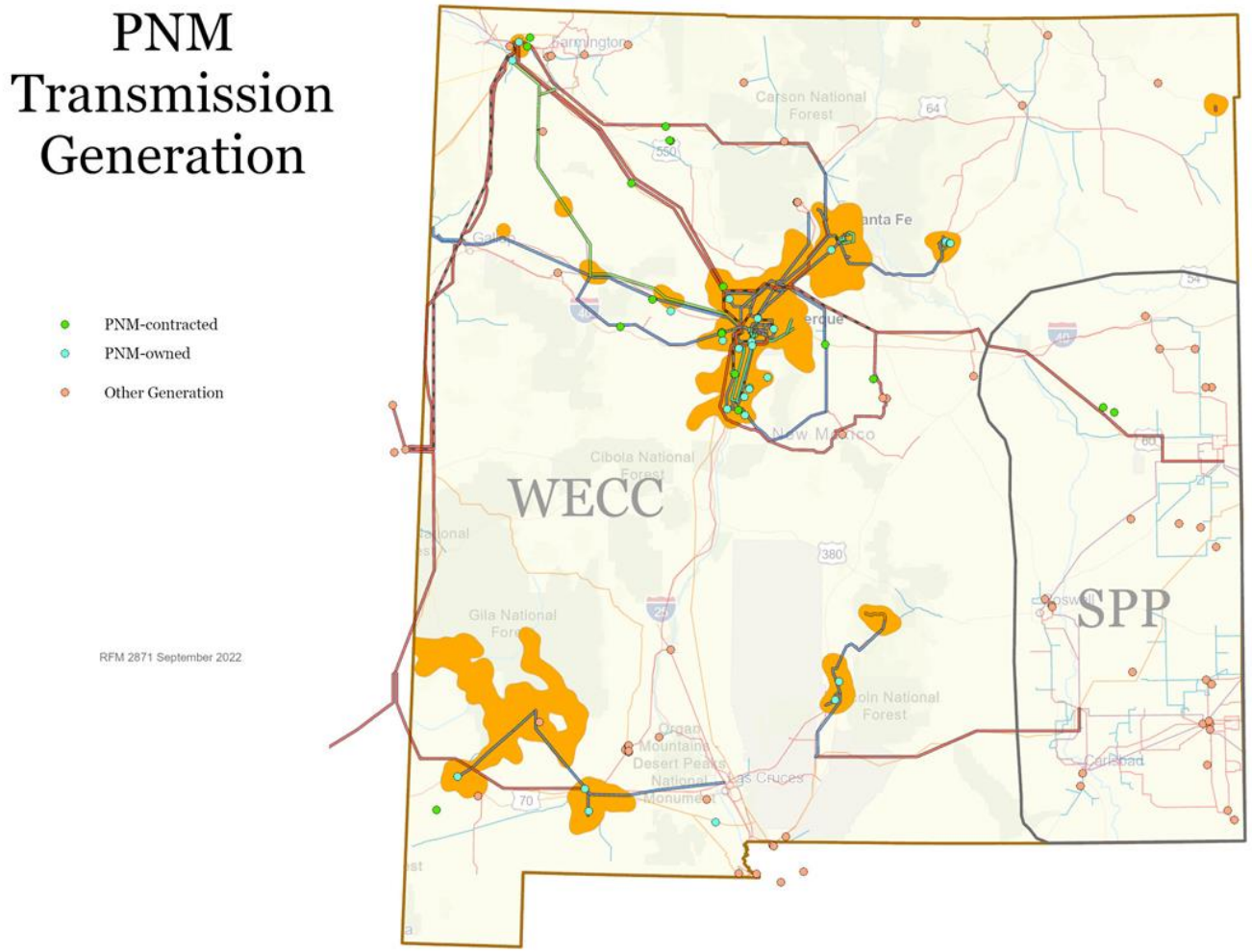
****

Broader use of Distribution will also be critical to success

PNM Transmission System Overview

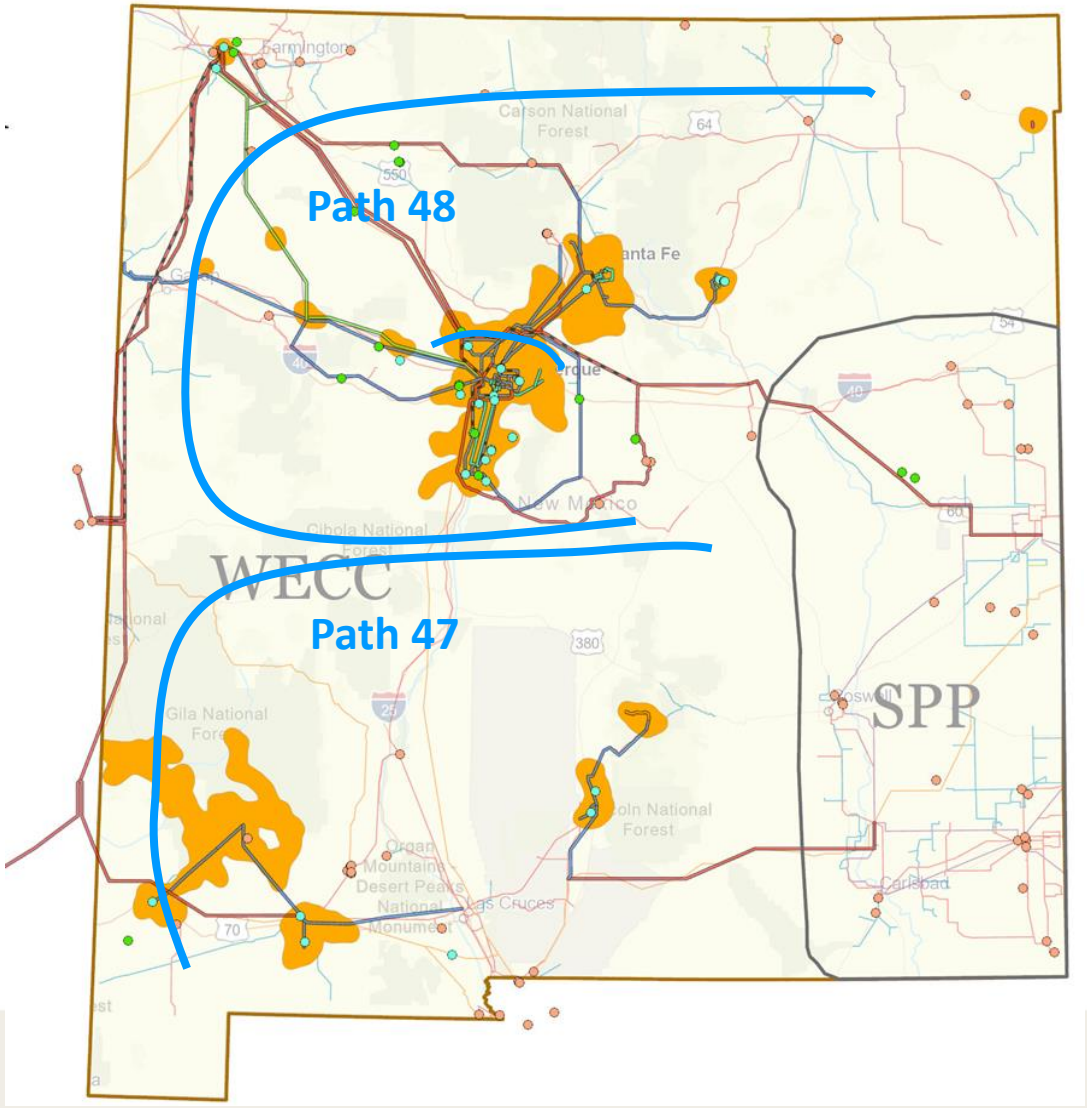
Tom Duane

NEW MEXICO SYSTEM OVERVIEW

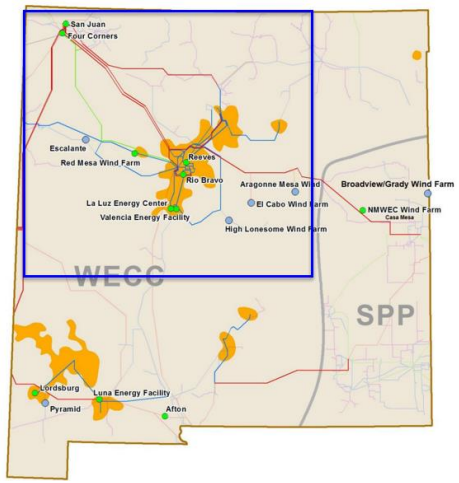


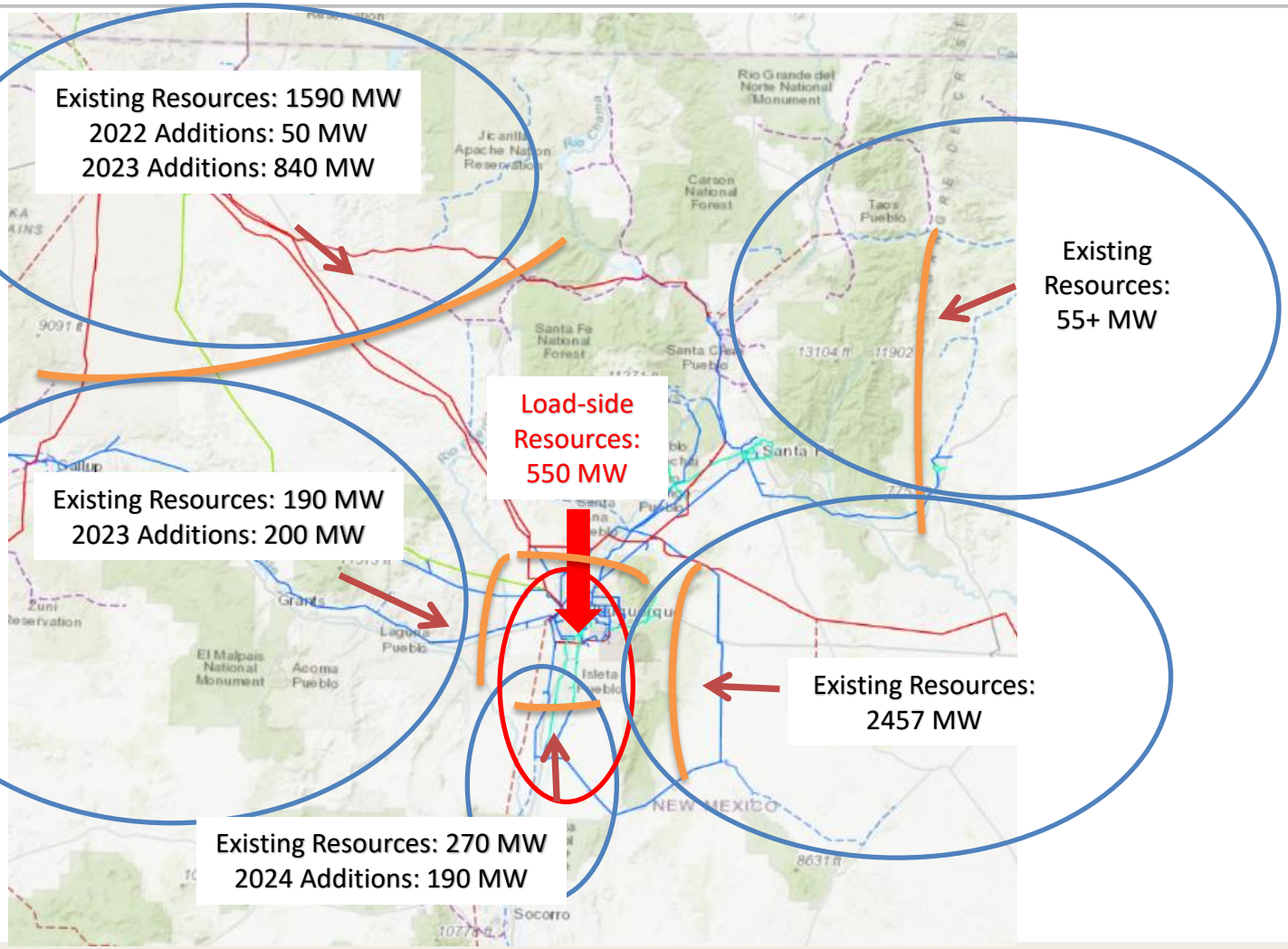
- Lines shown in red are the primary backbone transmission lines in NM
- Lower voltage lines provide a portion of the transmission capability to deliver resources and distribute power to outlying smaller load areas distant from Albuquerque and El Paso

TRANSMISSION LIMITATIONS: HISTORICAL CONSTRAINTS FOR GENERATION DELIVERY

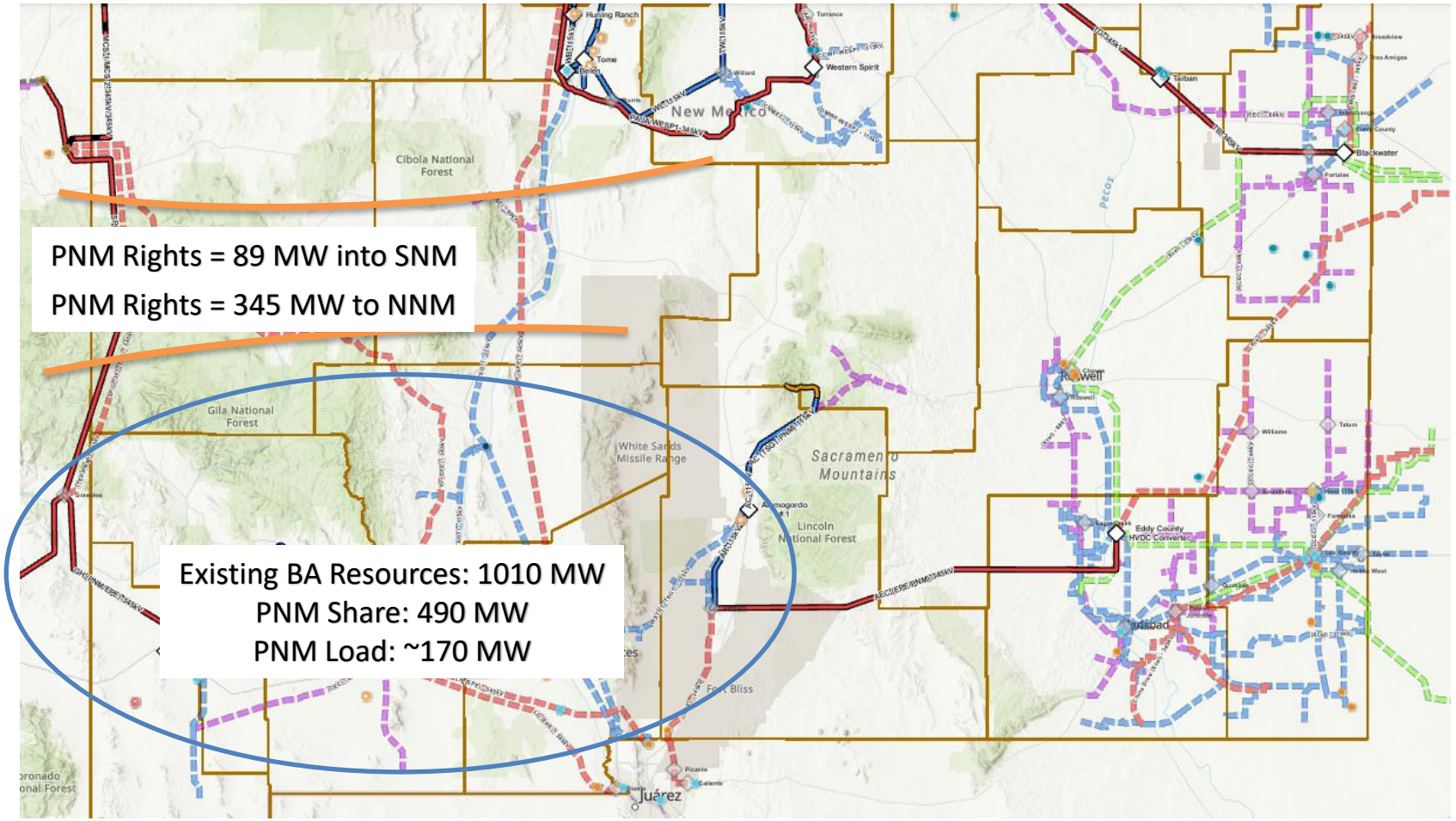


NORTHERN NM LIMITATIONS FOR GENERATION DELIVERY



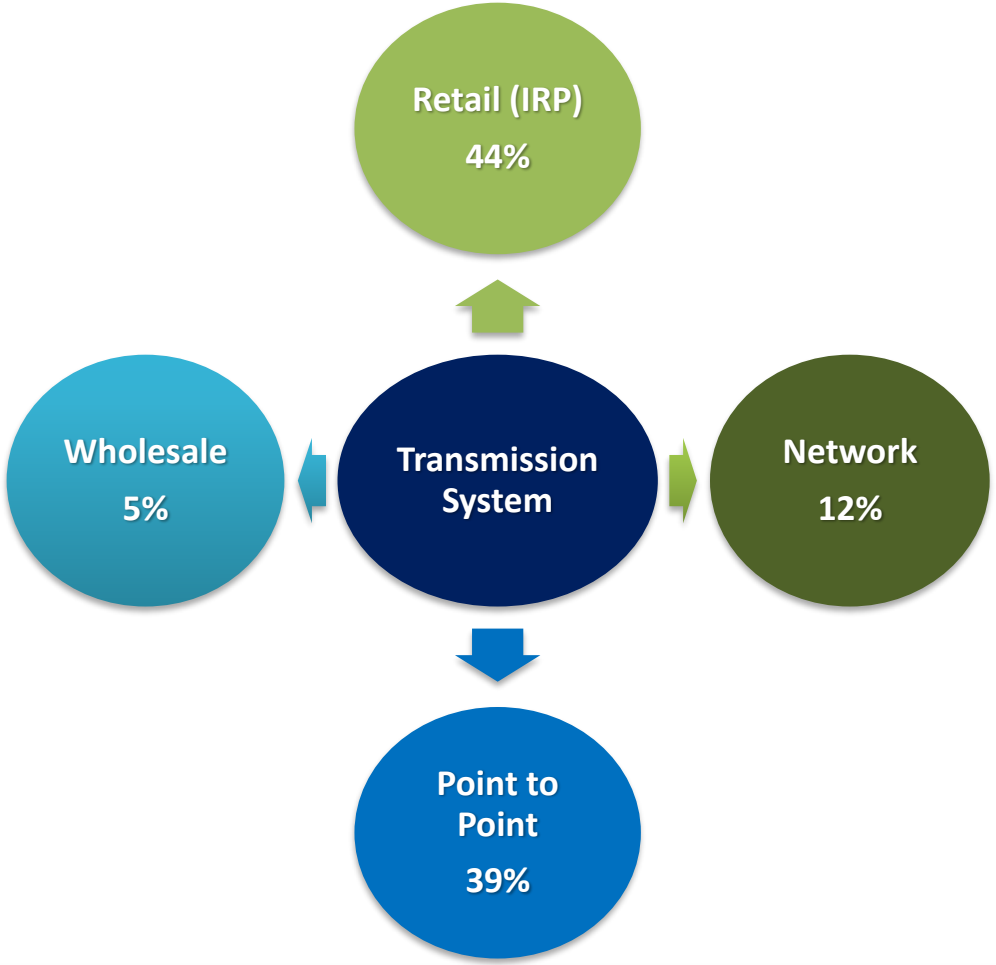


SOUTHERN NM LIMITATIONS FOR GENERATION DELIVERY



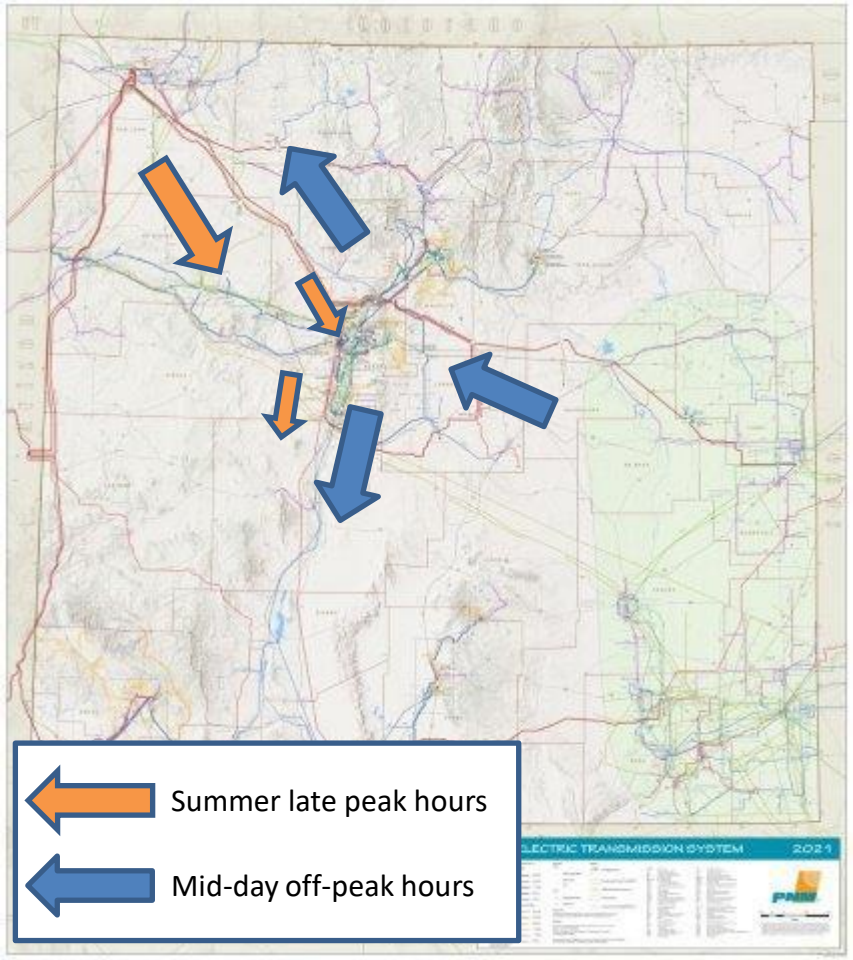
PNM TRANSMISSION SYSTEM USAGE

- Transmission grid serves all customers alike whether wholesale (utility-scale power delivery) or retail (services retail electric load customers)
- PNM plans and constructs its system to meet *all* forecasted customer needs, not just those covered by IRP
- Point-Point transmission service expected to exceed PNM retail usage starting in 2022



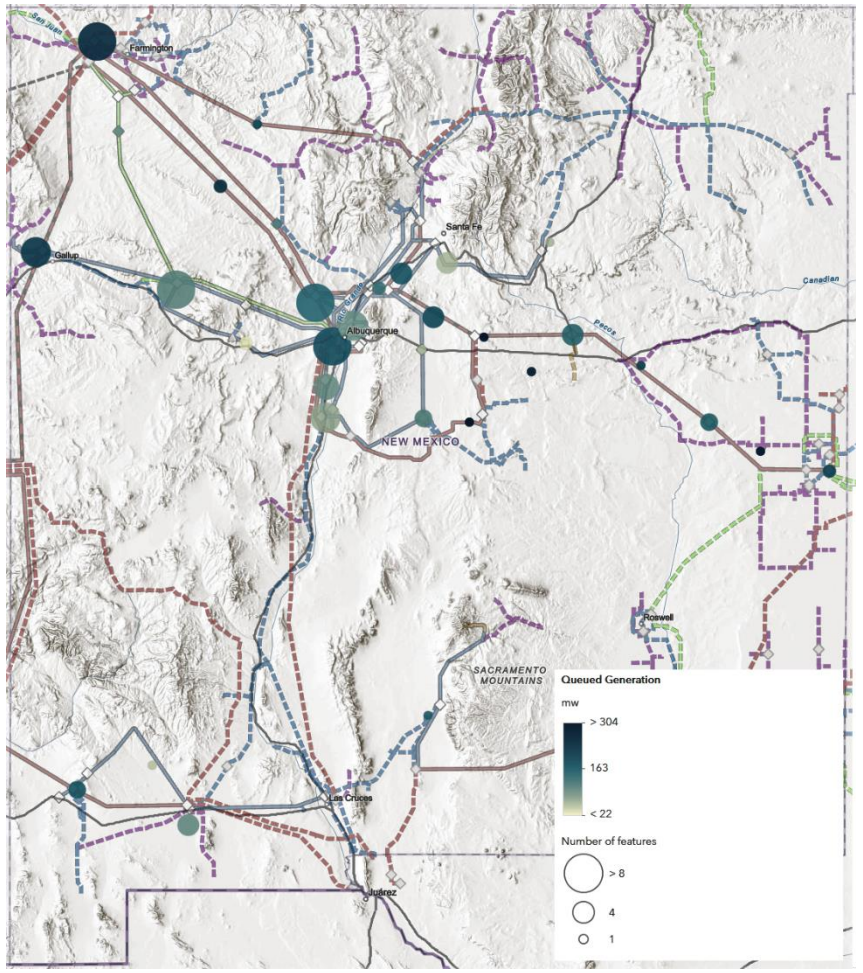
WHAT'S GOING ON TODAY?

- **Flows on major transmission change direction frequently**
  - Major lines loading in historical north to south direction with low wind conditions and late summer peak hours
  - Daytime hours during other months and high wind conditions flows are occurring at high levels in a south to north direction
- **North and South interdependence**
- **Fully subscribed in almost every location**
- **Southern NM Flows**
  - Flows can be in or out of southern New Mexico also depending on renewables and market price and season
  - Historical import levels are seen infrequently due in large part to gas generation in southern New Mexico, but historical transfer capability obligations remain
- **Generation resources are much smaller, more geographically diverse, and greater in numbers**
  - Transmission additions are much less efficient in this paradigm



INTERCONNECTION REQUESTS: GEOGRAPHIC DIVERSITY

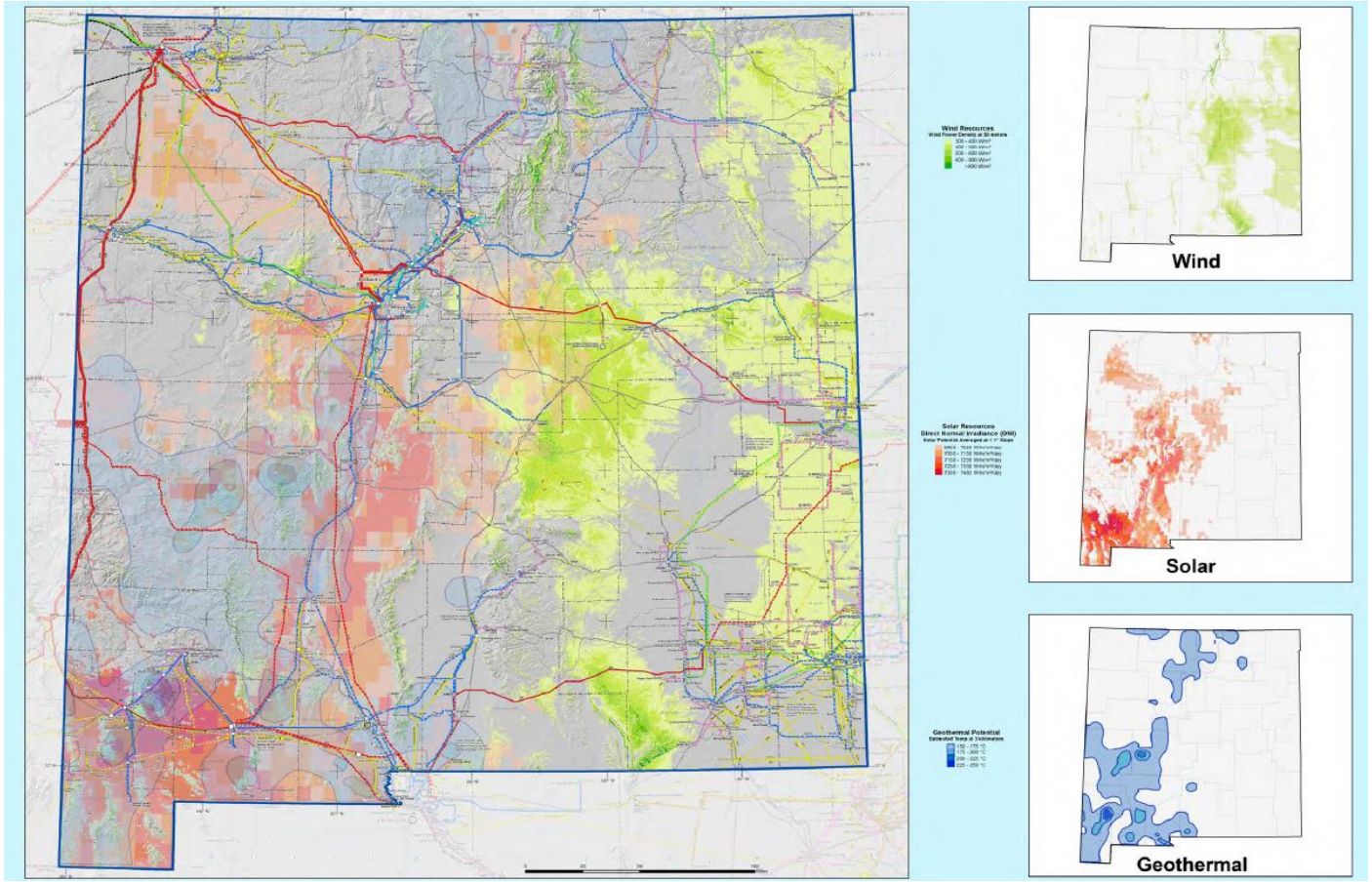
- Primarily shows interconnection points. Generation ties of up to 40 miles may also be part of some requests.
- Larger circles represent more requests
- Darker circles represent more MWs requested.



NEW MEXICO RENEWABLE RESOURCES

- New Mexico is ranked second in the nation for potential solar-generated electric power production and tenth in wind potential.* Western grid rank is higher.

- Access to Eastern NM wind resources is dependent on existing and new transmission facilities.

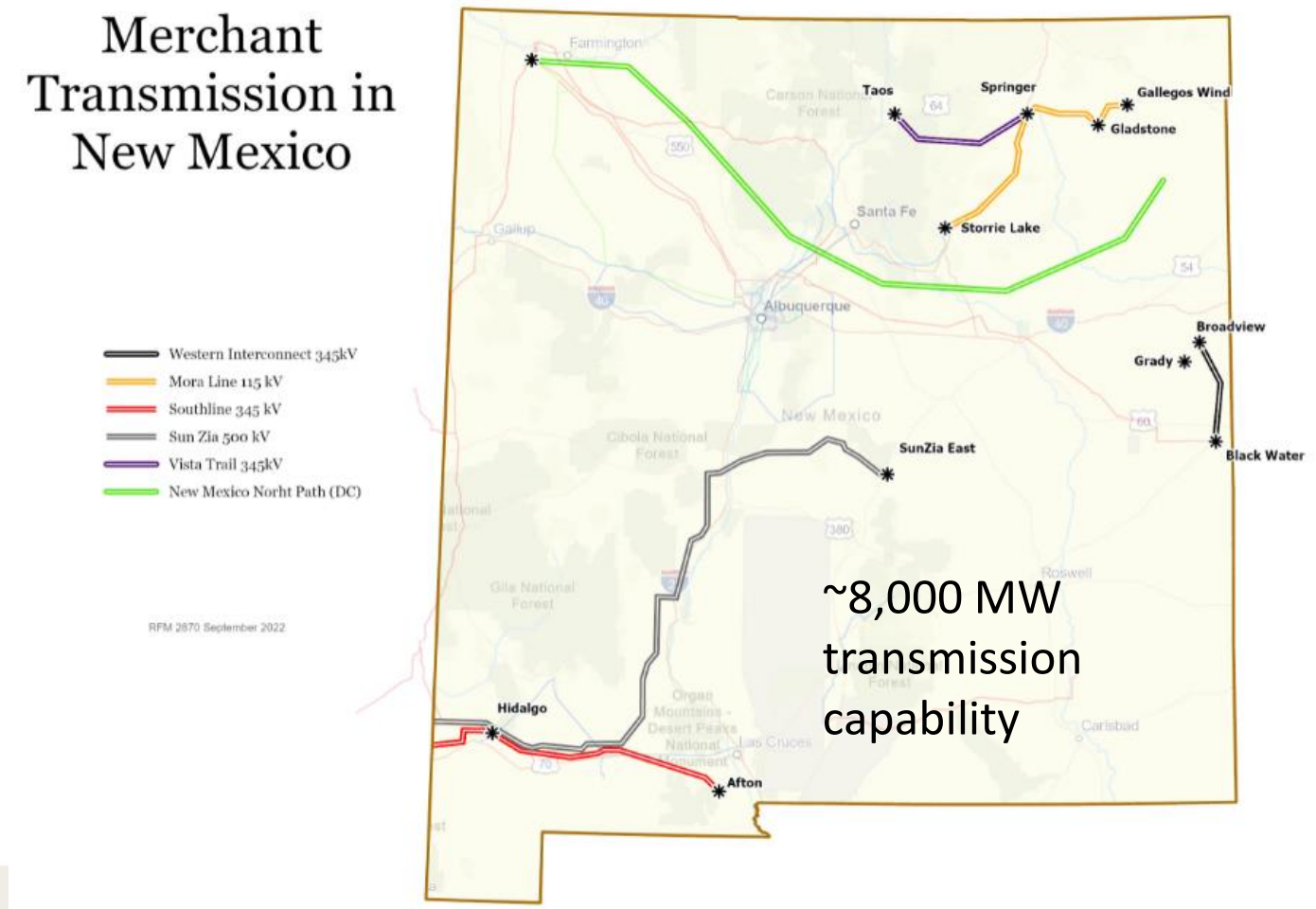


*New Mexico State Land Office
https://www.nmstatelands.org/divisions/commercial-resources/renewable-energy/#:~:text=New%20Mexico%20has%20an%20abundance,and%20tenth%20in%20wind%20potential.

MERCHANT TRANSMISSION IN NEW MEXICO

Will these help NM retail customers?

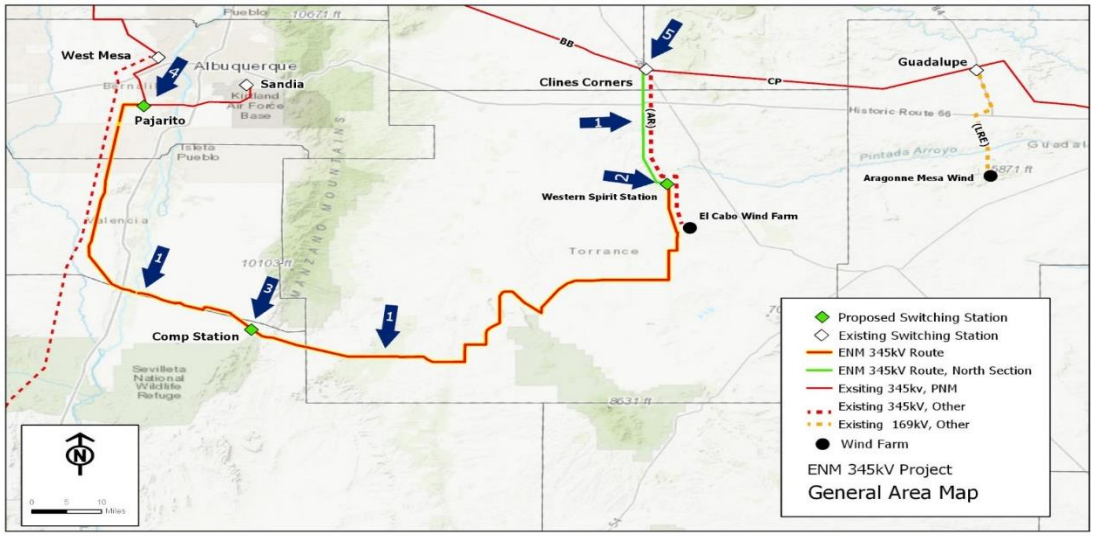
Largest projects are HVDC and may not add load serving capability for retail loads



RECENT TRANSMISSION AND RENEWABLE ENERGY EXPANSION IN NEW MEXICO

- "BB2" Line - 362 MW Incremental Capacity -Second BA-Clines Corners Line - $110M
- Western Spirit Line – 800 MW Incremental Capacity - $365M

Both projects improved access to wind resources



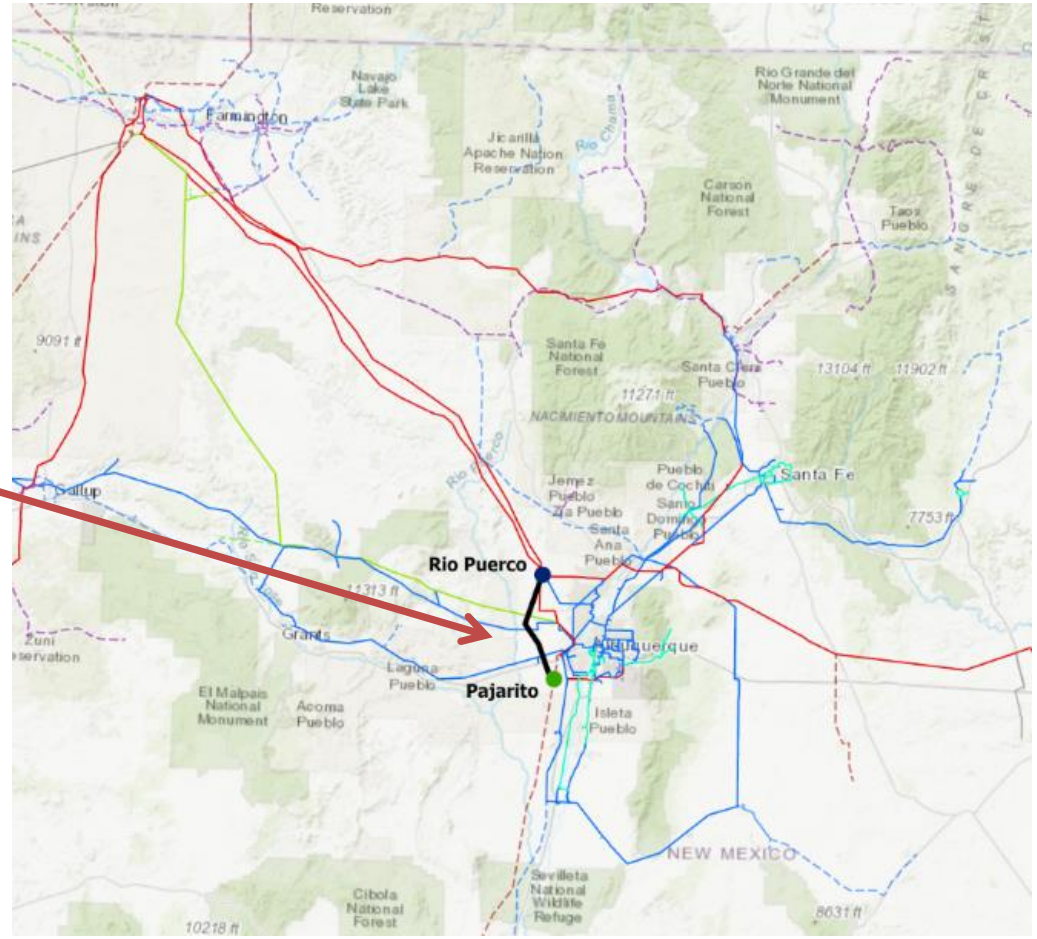
Project elements:

1. New 345kV transmission line - WST/RETA constructed
2. New switching station - WST/RETA constructed
3. New compensation station - WST/RETA
4. New switching station PNM constructed
5. Expansion of existing switching station - PNM constructed

PNM Resources

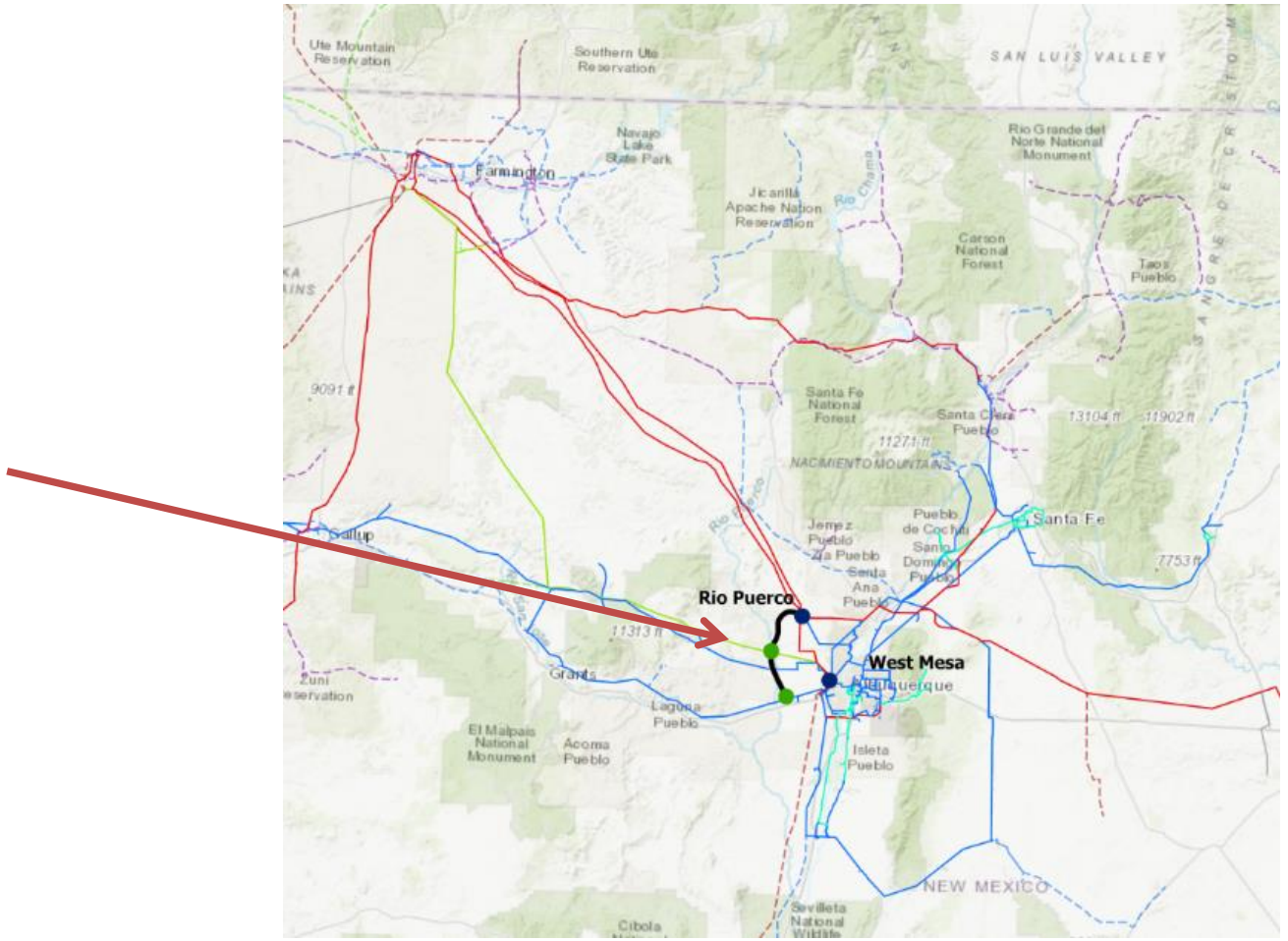
TRANSMISSION IMPROVEMENT FOR ALL OPTIONS

- Expand stations and build Rio Puerco-Pajarito 345 kV line (30 miles)
- Cost ~$90M; Permitting/CCN - 5 years



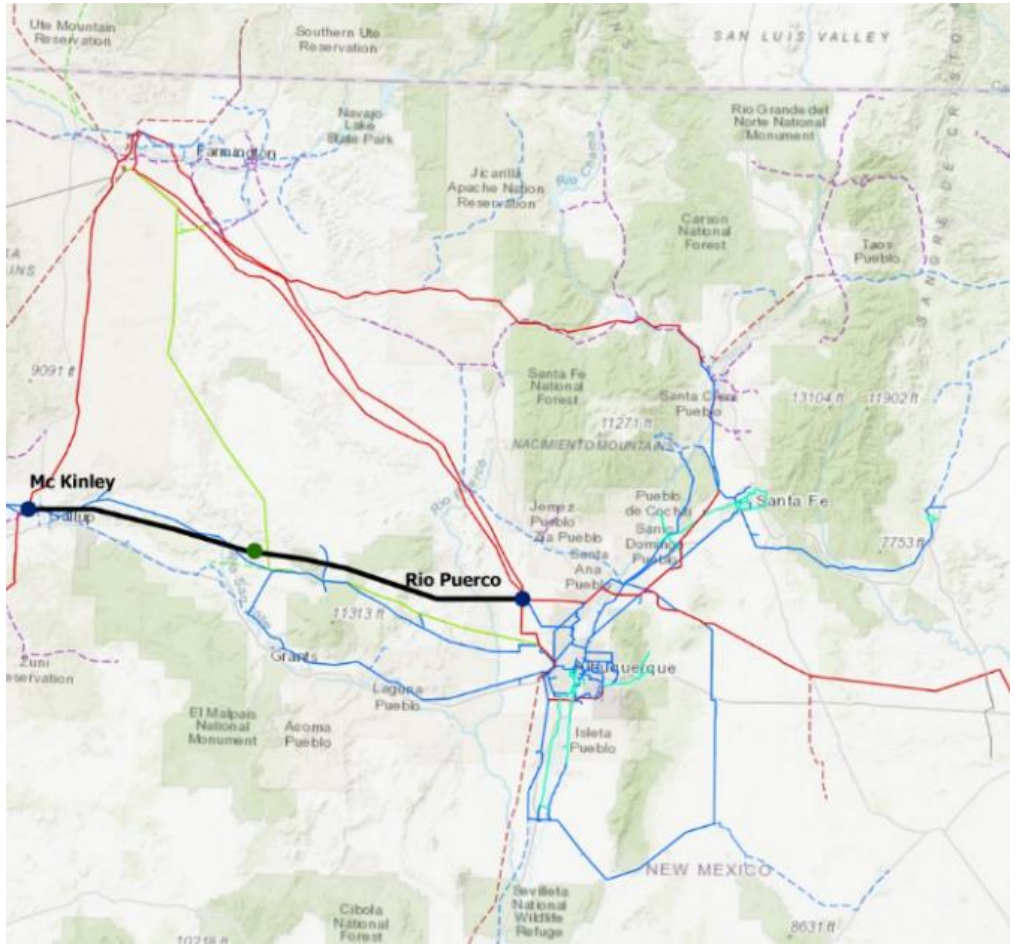
TRANSMISSION EXPANSION FOR WESTERN ABQ SOLAR RESOURCES

- 200 MW
- Expand station Rio Puerco 115 kV station and build 115 kV line from Rio Puerco to two new stations on the KM and BW lines.
- Reconductor/rebuild existing KM & BW lines to West Mesa
- Cost ~$87M; Permitting - 4 years



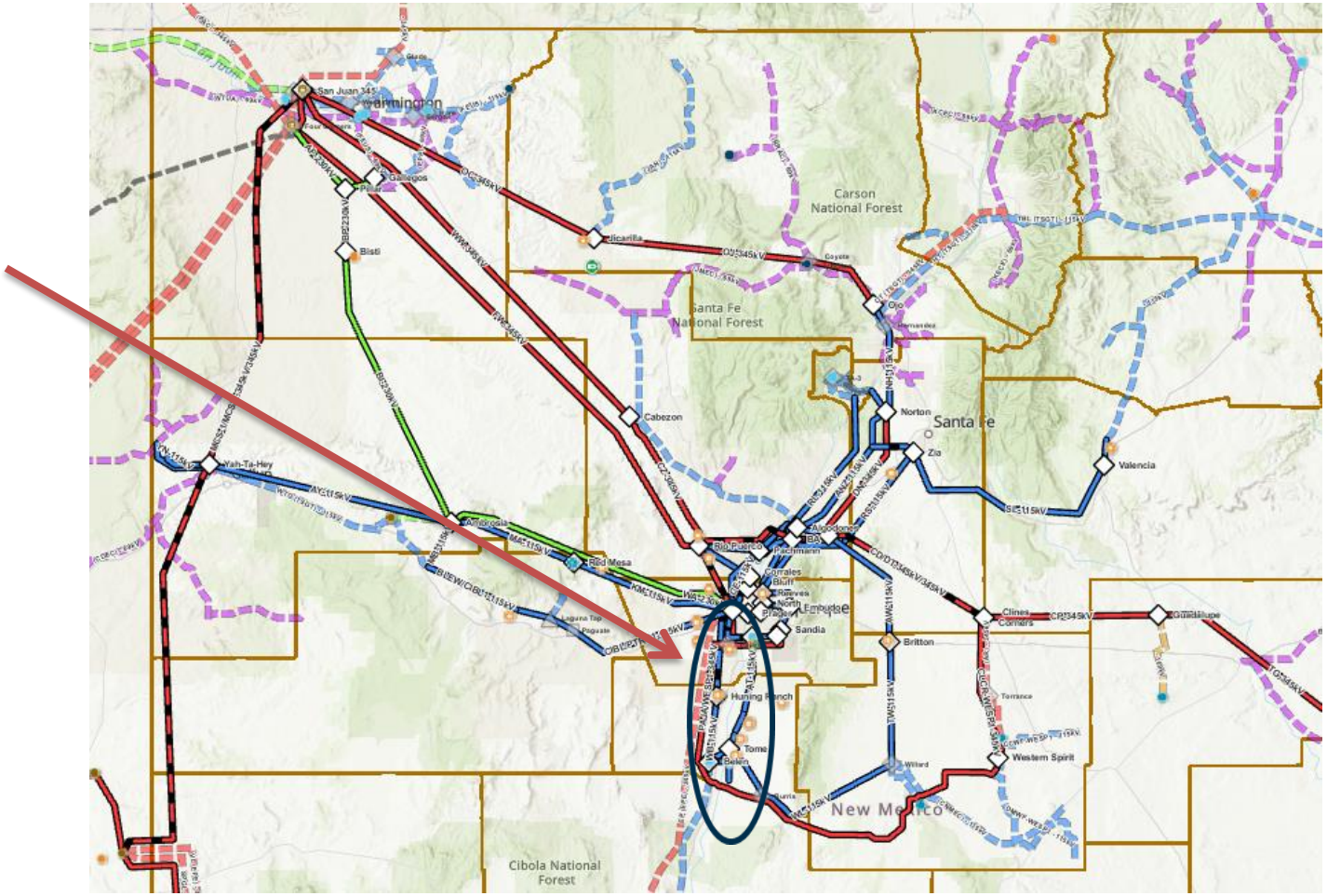
TRANSMISSION EXPANSION FOR WESTERN NM SOLAR RESOURCES

- 600 MW
- Expand McKinley-Rio Puerco 345 KV stations
- Build McKinley-Rio Puerco 345 kV (125 mi.)
- Install two 345 kV switchable shunt reactors
- Install 345/115 kV transformer and new 345 kV &115 kV stations
- Cost ~$442M; ROW/Permitting/CCN- 7 years due



TRANSMISSION EXPANSION FOR SOUTH OF ABQ SOLAR RESOURCES

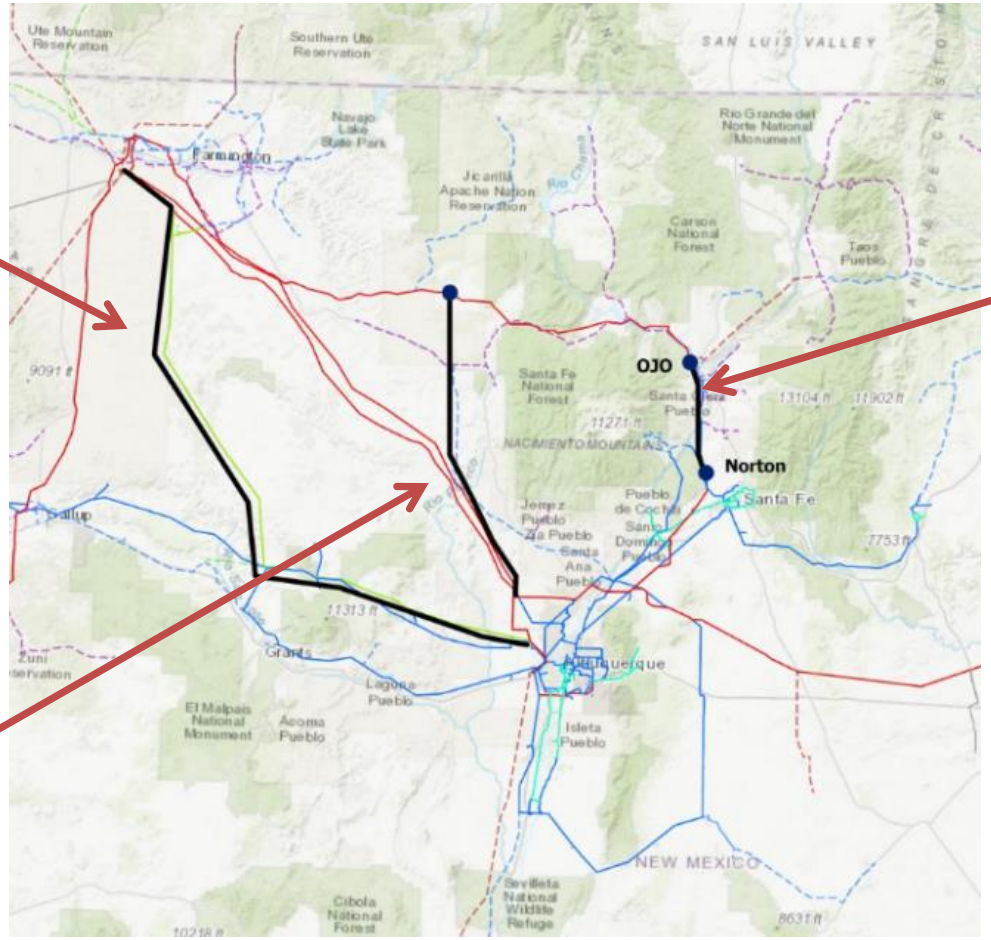
- 200-300 MW
- Convert BP 46 kV line to 115 kV
- Huning-Belen Line Additions
- Cost ~$100M; Permitting – 3-4 years
- Driven by for Sky Ranch Solar



TRANSMISSION EXPANSION FOR NORTHERN NM RESOURCES

- 600 MW
- Expand Four Corners and West Mesa 345 KV stations
- 345 kV stations and 345/230 kV transformers at Pillar, Bista and Ambrosia
- Install two 345 kV switchable shunt reactors
- Rebuild Four Corners-West Mesa 230 KV to 345 kV line (180 mi.)
- Cost $558M; Permitting/CCN- 5+ years

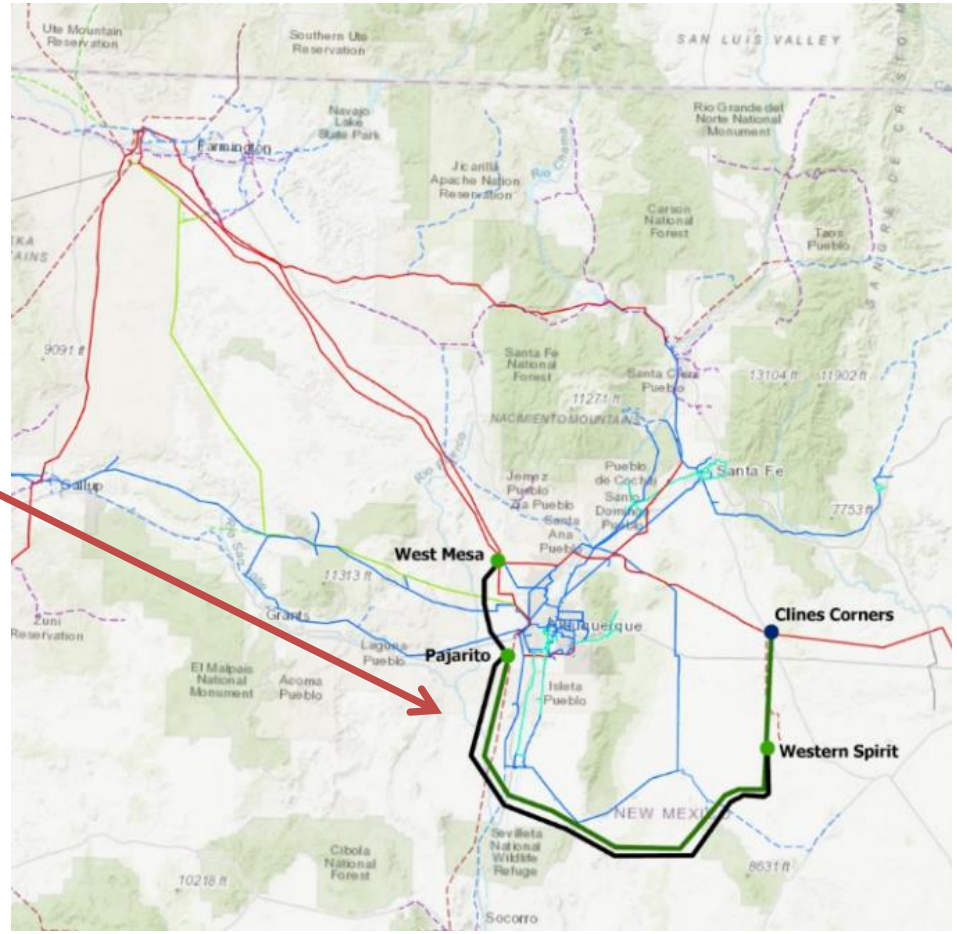
- 600 MW
- Expand Rio Puerco station 345 KV station
- OJ West 345 kV station
- Install two 345 kV switchable shunt reactors
- Build J West-Rio Puerco 345 kV line (80 mi.)
- Cost $232M; Permitting/CCN- 5+ years



- 600 MW
- Expand Ojo and Norton 345 KV stations
- Build Ojo-Norton 345 kV line (34 mi.)
- Cost ~$121M; ROW/Permitting/CCN- 5+ years

TRANSMISSION EXPANSION FOR EASTERN NM WIND RESOURCES

- 800 MW
- Expand Western Spirit & Pajarito 345 KV stations
- Build Western Spirit-Pajarito 345 kV (135 mi.)
- Install 345 kV series compensation
- Install two 345 kV switchable shunt reactors
- Cost ~$373M; Permitting/CCN- 5+ years



Transmission: Regulatory Construct

Laurie Williams

NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION (NERC)

Develops and enforces Reliability Standards for all users, owners, and operators of the bulk power system in continental United States (Also, Canada and portion of Baja California, Mexico)

- Approximately 880 requirements governing operations, planning, and security (physical and cyber)
- All new and existing transmission *must* meet certain performance criteria designed to ensure grid reliability and resilience
- Reduce hazards to transmission all way from line outages and breaker failures to extreme events, geomagnetic disturbances, and electromagnetic transient phenomena
    - Inverters and lack of inertia fundamentally changing system operations
- NERC requirements regularly audited and can carry fines >$1M/day/violation

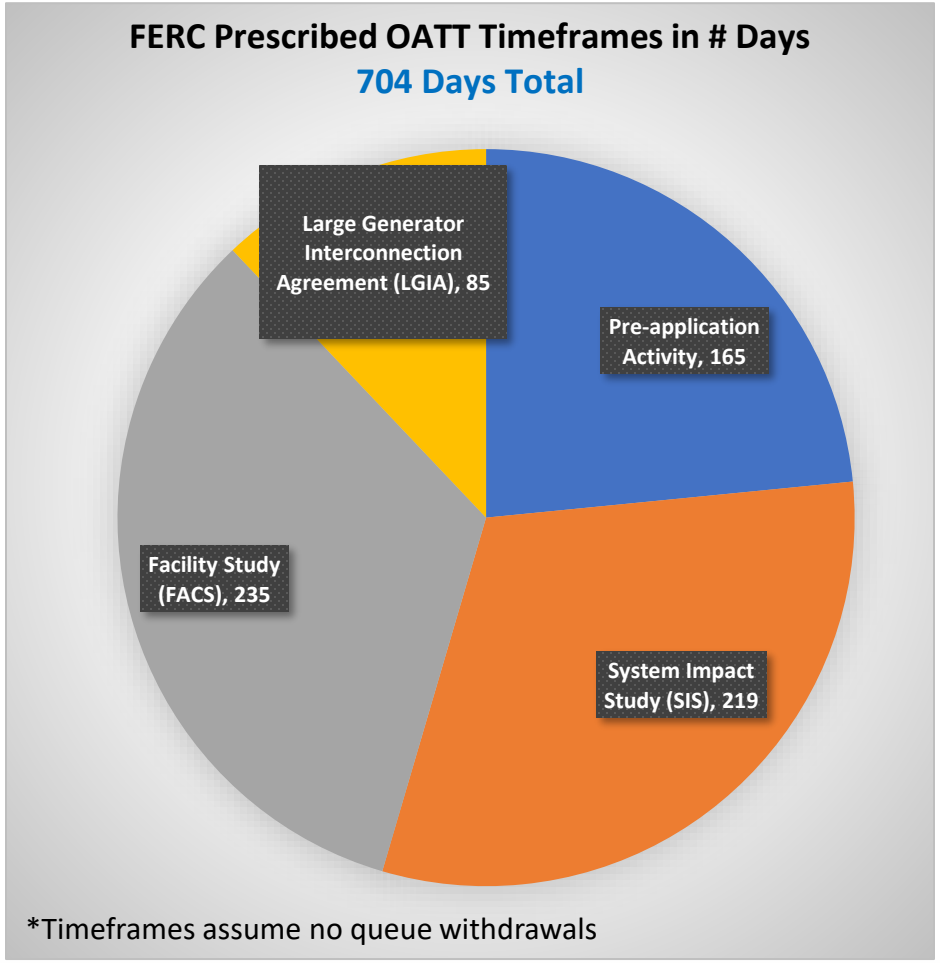
FEDERAL ENERGY REGULATORY COMMISSION (FERC)

Federal agency that regulates the interstate transmission of natural gas, oil, and electricity

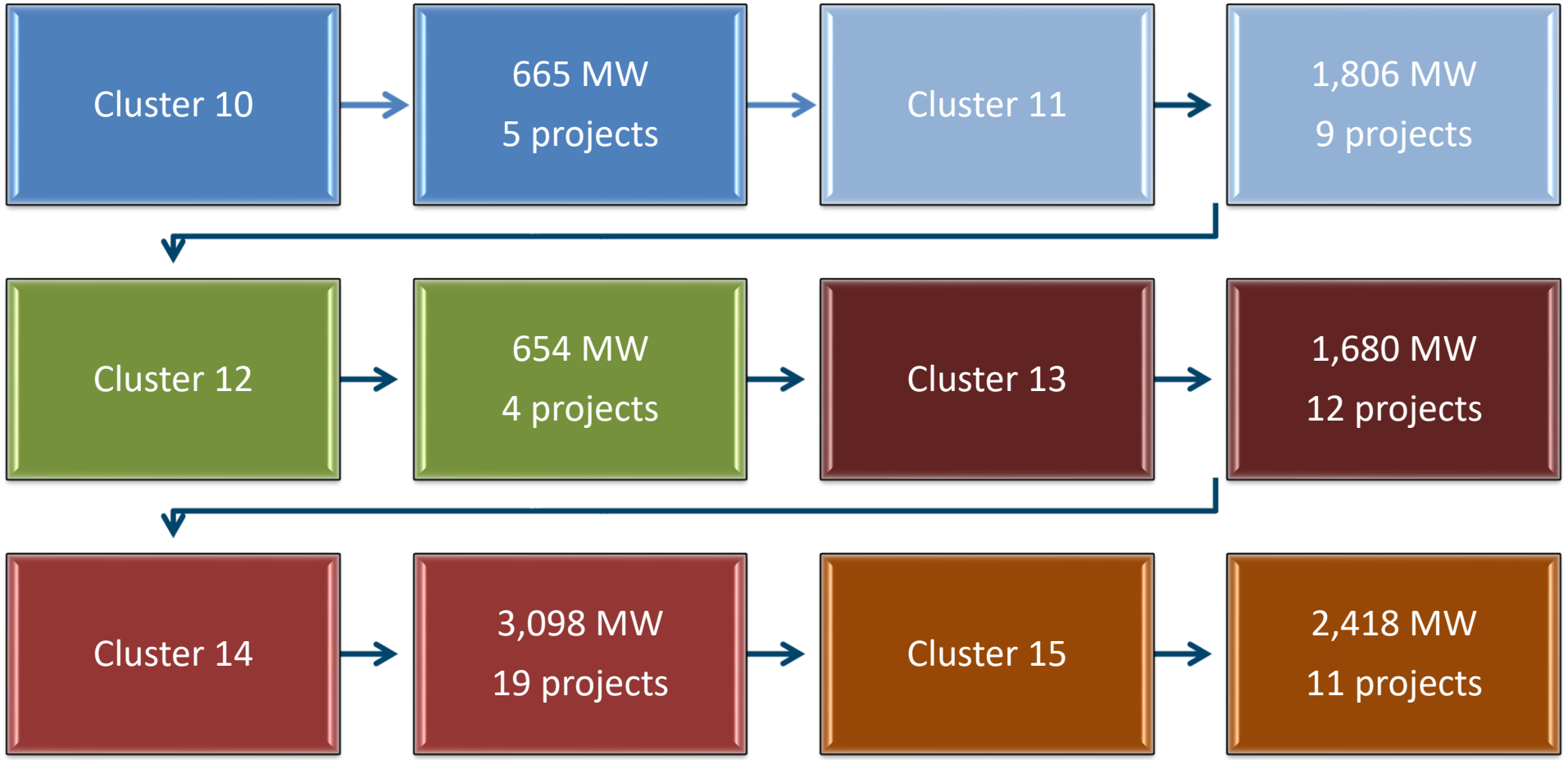
- FERC governs <u>all</u> interconnection and wholesale transmission service for the U.S. interstate transmission grid – including PNM's
- Governance achieved through FERC Orders and codified in Open Access Transmission Tariff (OATT)
- All generators that want to connect to transmission system can if they follow the OATT process
- **Utilities must fund the generator's interconnection facilities to its transmission system and/or provide any requested available transmission service**
- ***Investment focused on specific interconnections thus far to meet FERC obligations***

FERC OPEN ACCESS TRANSMISSION (OATT) PROCESS

- FERC governs interconnection to grid
- Transmission function must treat generation function commensurate with outside developers
- Interconnector has 3 years to provide Notice to Proceed or forfeit queue position
- Timelines are lengthy in large part due to project conception and development
  - Transmission Construction time 18 months – 5 years *typical*
  - Timelines longer due to permitting, access and easement agreements, and Supply Chain



CURRENT FERC LARGE GENERATOR INTERCONNECTION STUDY QUEUES FOR PNM SYSTEM

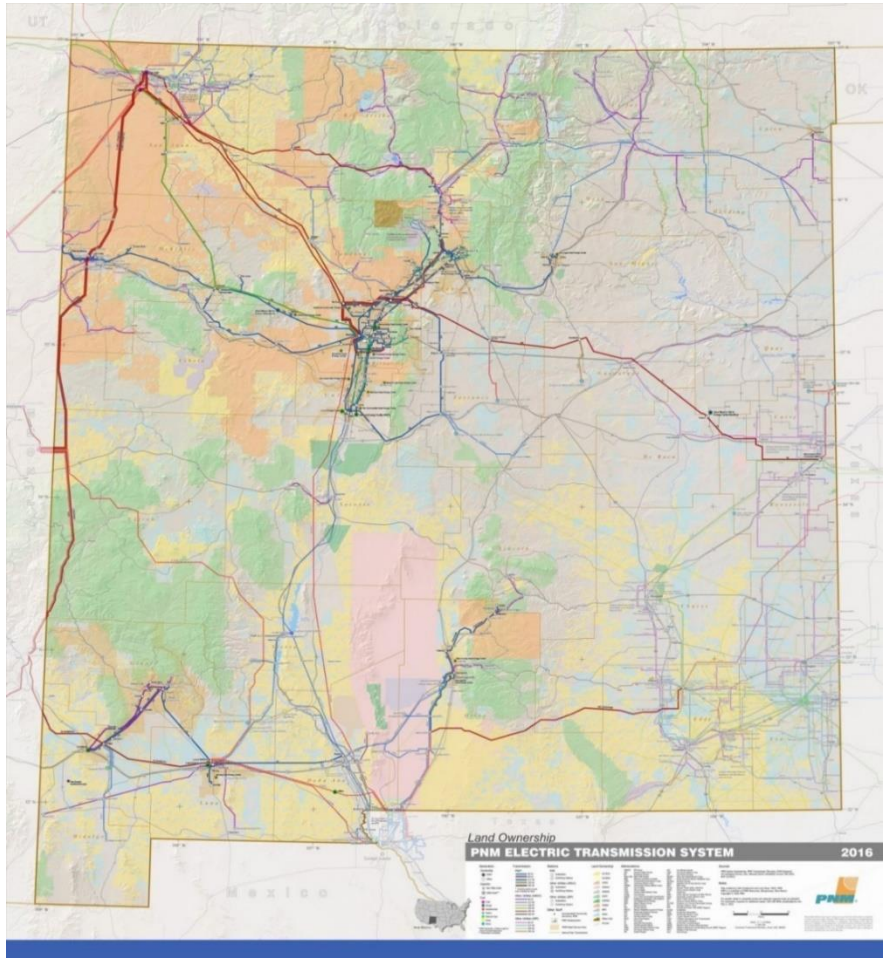


SITING AND PERMITTING CHALLENGES

NM Land Ownership / Management:

- US Forest Service
- Tribal Lands
- NM State
- Military
- US Bureau Land Management

+ Many local, county, city regulatory entities and many private landowners



RENEWABLE ENERGY TRANSMISSION AUTHORITY (RETA)

RETA was created by New Mexico lawmakers to facilitate the development of electric transmission and storage projects. The result is that power can be moved across New Mexico and exported out of New Mexico.

- Established in 2007 to plan, finance, develop and acquire high voltage transmission lines and storage projects in order to promote economic development in New Mexico.
- RETA is one of several state-level transmission authorities in the United States and only the second to have issued Bonds. RETA sponsored projects must transmit at least 30% of its power from renewable resources. RETA's current projects are planned to have 100% of their power originate from renewable resources.
- New Mexico has some of the most extensive and valuable wind and solar resources in the United States yet has limited transmission capacity to access them. RETA was formed to aggressively help develop transmission and storage to cultivate this unique opportunity.
- RETA is working with developers to deliver clean electricity from wind and solar resources to both in-state and export markets.

FROM NM RETA 2021Annual Report
https://nmreta.com/wp-content/uploads/2021/12/Annual-Report_2021_Final.pdf

RENEWABLE ENERGY TRANSMISSION AUTHORITY (RETA)

NM RETA commissioned a Transmission Study in 2020 and an updated its findings in 2022, which included:

- For NM to capitalize on its enormous renewable generation potential, we must find ways to transmit it outside of NM
- **While utility-scale storage technology is developing rapidly, the best solution for New Mexico now is making significant upgrades to our transmission network**
- The most economic approach for customers in New Mexico in the future is to become part of a Regional Transmission Organization
- Developers of new transmission know what to build and where to build it - Laws and policies must be changed to allow this to happen
- Analysis shows that the simplest way to deliver our renewable energy west is with a new transmission corridor across New Mexico
- Built to route power from fossil plants to population centers, New Mexico's grid severely limits renewable electricity delivery to both in-state and export customers, also greatly constraining the development of renewable generation within New Mexico

"Building transmission capacity is key to enabling a renewable energy future."

FROM NM RETA 2022 NEW MEXICO RENEWABLE ENERGY TRANSMISSION AND STORAGE UPDATE
https://nmreta.com/wp-content/uploads/2022/03/010522-RETA-Executive-Summary-FINAL.pdf

ROAD TO A WESTERN RTO

- Members of the Western Markets Exploratory Group (WMEG)
- Twenty-five member participants – encompasses most of west less CA
- Created 2021 - exploring a staged approach to new market services including day-ahead energy sales, transmission system expansion, power supply and grid solutions, and existing and emerging public policies
- Many currently participating in EIM and the ongoing development of day-ahead markets
- Studies to define potential benefits of an organized western market(s)

Arizona Electric Power Cooperative	Arizona Public Service	Avista Corp.	Balancing Authority of Northern California	Black Hills Energy
Bonneville Power Administration	Chelan County PUD No. 1	El Paso Electric Company	Idaho Power	Los Angeles Department of Water & Power
Northwestern Energy	NV Energy	PacifiCorp	Platte River Power Authority	Portland General Electric
Public Service New Mexico	PUD #2 of Grant County	Puget Sound Energy	Salt River Project	Seattle City Light
Tacoma Power	Tri-State Generation & Transmission Association	Tucson Electric Power	Western Area Power Administration	Xcel Energy Colorado

WESTERN MARKET INITIATIVES

CAISO Energy Imbalance Market or “EIM”

Western Markets Exploratory Group or “WMEG

- EIM saved PNM customers $12M in 2021 and project the ~ same in 2022
- A Western-wide ISO/RTO could help continue to leverage resource diversity to lower costs and/or improve reliability for carbon-free grid
- RTO establishment will take several years but must be done on an appropriately diverse scale
  - Smaller market efforts like Mountain West have failed due to insufficient footprint

DRIVERS FOR TRANSMISSION EXPANSION

NERC/WECC Reliability Standards Require Annual Adequacy studies	• Jurisdictional and Network Customer Needs – Core *load growth generally minimal*
Generator Interconnection Procedures (OATT Process)	• Renewable Energy Requirements, La Joya wind, San Juan replacement resources etc.
Transmission Service Requests (OATT Process)	• Avangrid (transmission service from Clines Corners to FC), etc.
Wires-to-Wires Interconnections (OATT Process)	• Western Interconnection, Mora Line, Western Spirt, etc.
Regional Planning Requirements	• FERC Orders 890 and 1000 – Regional Transmission Plan created every 2 years –biannual stakeholder meetings open to public – Notices posted on PNM OASIS – *"Meeting Notices and Meeting Materials"* • WestConnect Mtgs: Posted on WestConnect.com

The IRP/Transmission Challenge and PNM Strategy Going Forward

Laurie Williams

THE IRP/TRANSMISSION CHALLENGE

- IRP's purview includes retail exclusively while PNM's transmission system is used for both retail and wholesale customers
- FERC Rules dictate investment in generator interconnections that are often geographically disparate
    - May not tend toward the best long-term transmission solutions
- FERC Rules prohibit sharing on specific transmission customer information (Non-retail uses)
- Find ways to help drive for regional and more wholistic solutions that meet the needs of the region and all sets of customers

PNM'S TRANSMISSION STRATEGY

- Seek opportunities for regional transmission efforts that increase system reliability and/or enable additional market value and strategic joint transmission expansion.
- Optimize and develop potential increases to system throughput to enable capture of renewable potential in New Mexico. Partner with others to capture NM renewable energy potential for benefit of the region through RETA partnership, WestConnect or other forums.
- Jointly develop and utilize nodal models – transmission constrained economic dispatch modeling to continue to improve evaluation of transmission in the IRP
- Find solutions for operational challenges to system from inverter-based resources using new technology to aid in reduction of harmonics, address the loss of system inertia, and manage charging load(s). Partner with the National Labs/EPRI and others to broaden the expertise to aid in resolution of these technical operational challenges.
- Maximize use of the transmission infrastructure through use of dynamic line ratings and other strategies to maximize potential utilization of current transmission assets.
- Continuously improve the Large and Small Generator Interconnection Processes and ensure the process is within FERC guidelines.
- Participate in policy change efforts with FERC to improve federal interconnection procedures.
- Leverage partnerships with trade organization(s) and neighboring entities to influence FERC and other federal and state policies necessary for timely and comprehensive transmission development to support the energy transition.
- Expand integration of non-wires solutions for the transmission system.
- Pursue legislative opportunities to aid in resolution of substantive challenges for transmission and energy transition.
- Design and build substations and transmission lines with expandability capability.

Transmission presentation to be continued at Steering Meeting #6 on September 28, 2022

NEAR TERM SCHEDULE

FUTURE MEETING TIME & LOCATION

When: September 28, 2022

Topic: Public Advisory Steering Meeting #6: Transmission 2/Modeling Inputs 1/Scenario Form

Start Time: 9:00 AM

Location: Virtual

MAKE SURE WE HAVE UP TO DATE CONTACT INFORMATION FOR YOU

www.pnm.com/irp for documents

IRP@pnm.com for e-mails

Register your email on sign-in sheets to receive alerts of upcoming meetings and notices that we have posted to the website.

Thank you