GEOTHERMAL IN PNM’S 2026 IRP

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Having 16 years of experience completing research for hot dry rock geothermal energy technologies, Luke has a relevant background for this analysis. His specialty is rock fracture characterization and techno-economics. The goal today is to foster equitable and sustainable energy development for future generations.

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OBJECTIVE & MOTIVATION

PNM’s Geothermal Capital Cost Metrics are Out of Date – Let’s Fix That Together

EGS Capital Cost	
Current IRP Estimate	Updated IRP Estimate
$15,700/kW	$6,100/kW
Geographic Limitations	Geographic Limitations
Available by 2033	Available by 2030

Hydrothermal Capital Cost	
Current IRP Estimate	Updated IRP Estimate
– Missing –	$5,100/kW
	Geographic Limitations
	Available by 2030

WHAT IS GEOTHERMAL?

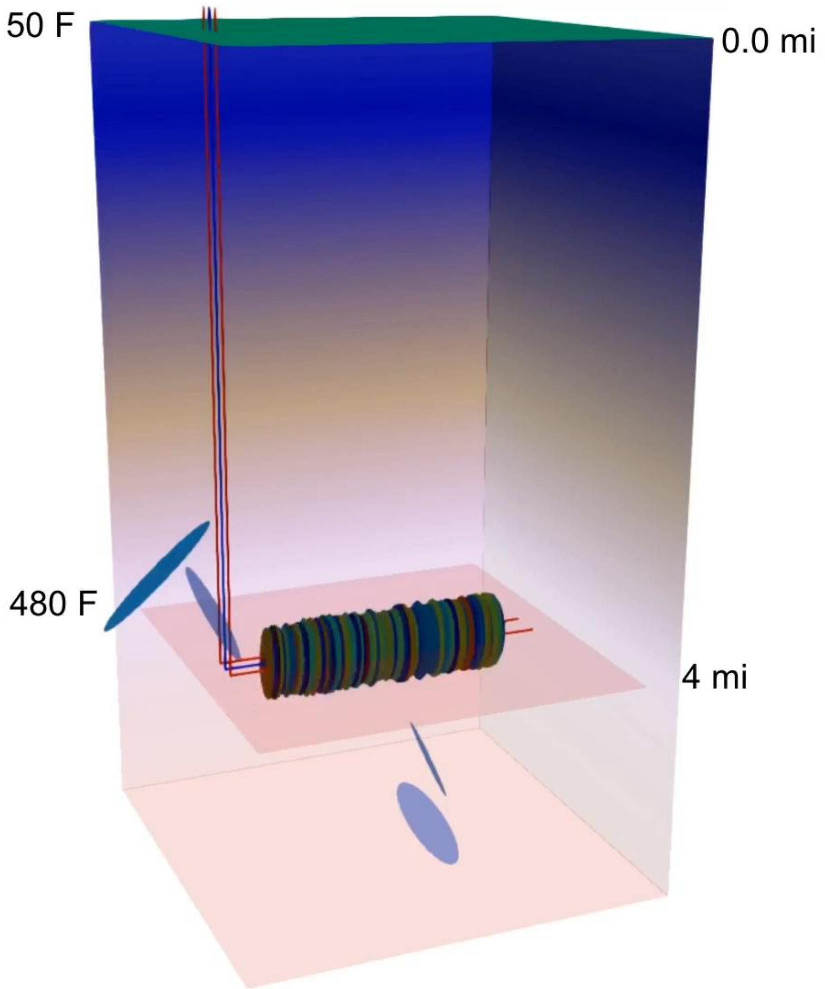
Department of Energy – Office of Geothermal

- Renewable Energy from Earth's Crust
- Tiny Footprint / Tiny Ecological Impact
- Local Jobs / Oil and Gas Supply Chains
- Baseload / Dispatchable / Always-On
- No Fuel / Zero-Carbon Heat and Power
- Incentives / Investors / Long Service Life
- Bipartisan Support / State and Federal

WHAT IS "EGS"?

What it looks like

Enhanced Geothermal Systems (EGS)



Example Pilot Project

- Three well pattern
- Sand-propped EGS
- 2.5 to 4.0 miles deep
- 7.5+ MW per triplet
- 100 MW per wellsite
- 30+ year lifespan
- 400+ °F (200+ °C)
- $50,400,000 capital
- *$6,720/kW ±25%*

Lightning Dock Hydrothermal Plant, NM: Photo by Frash, 2025

Geothermal Wells LLC
From 0 to 1 GW by 2028

WHERE WE CAN BUILD

If we drill down 2.5 miles or more

New Mexico's Heat is Excellent

North Border

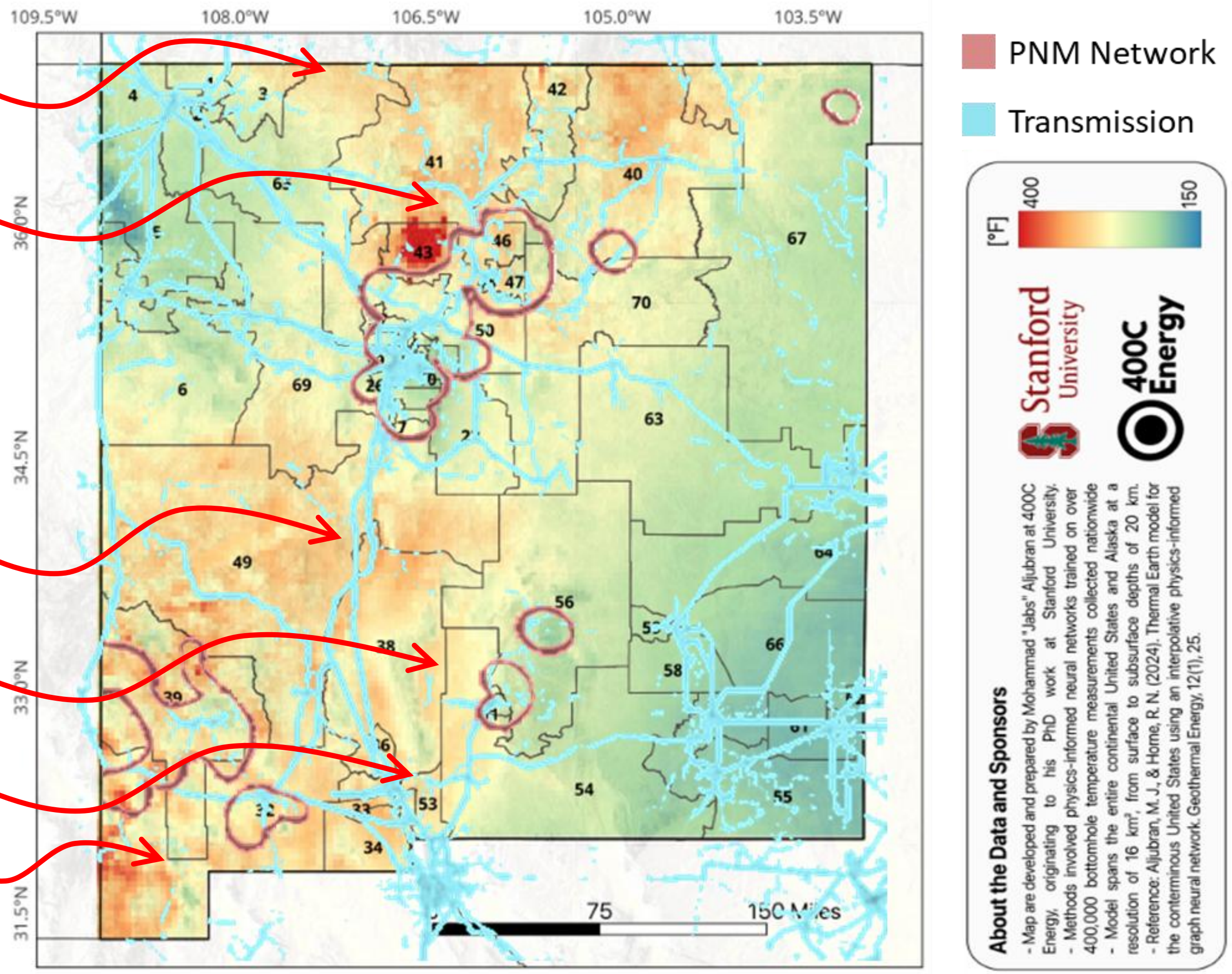
Northern

Rio Grande Rift

White Sands

South Central

Southwest



ENHANCED GEOTHERMAL CAPEX

From Lowry et al. (2017) drilling cost estimation

Current Estimate for PNM's IRP

What has changed since 2017

Today Drilling Costs 72% Less

NREL's 2033 forecast is based on 2017

Scenario	Well Cost ($/ft)	Capex ($/kW)
Conservative Scenario	$884	$18,700
Moderate Scenario	$404	$11,705
Advanced Scenario	$187	$7,206

Updated forecast for 2023-2025

Scenario	Well Cost ($/ft)	*Capex ($/kW)
Blue Mountain, NV (2023)	$1,051	$11,100
Cape Station, UT (2025)	$432	$5,500
Undisclosed (2025)	$250	$3,600

Recommendation

Current IRP Estimate		Updated IRP Estimate
$15,700/kW	→	$6,100/kW
Geographic Limitations		Geographic Limitations
Available by 2033		Available by 2030

NREL, 2024b (https://atb.nrel.gov/electricity/2024b/geothermal)
Lowry et al., 2017 (https://www.osti.gov/servlets/purl/1394062)
Akindipe and Witter, 2024 (https://pangea.stanford.edu/ERE/pdf/IGAstandard/SGW/2025/Akindipe.pdf)
Horne et al., 2025 (https://www.nature.com/articles/s44359-024-00019-9)
*Estimated cost forecasts are inferred from published data and GeoDT

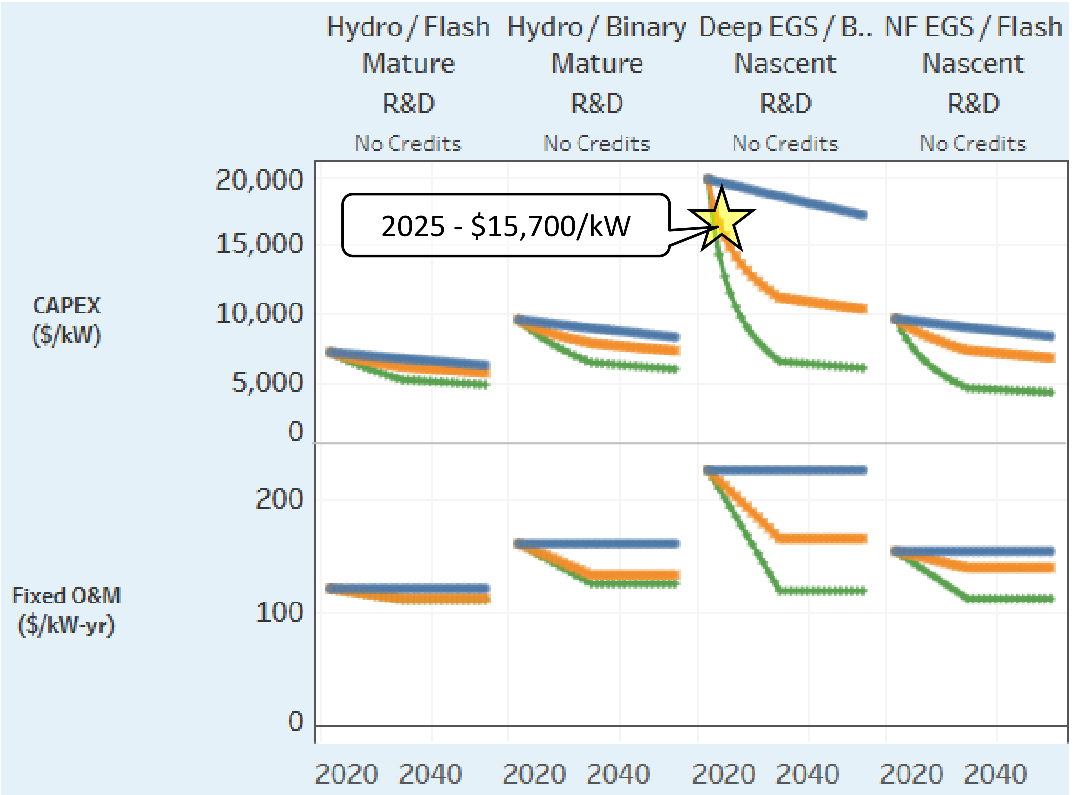
GEOTHERMAL BASELINE COST

From NREL's 2024b Annual Technology Baseline Report

Current Estimate for PNM's IRP

GeoVision (2019) serves as the basis of NREL's analysis

Based on 2017 Analysis



Key Assumption – Lowry et al. 2017 Drilling Cost

Scenario	ROP (ft/hr)	Bit Life (hr)	EGS Flow Rate (kg/s)
Conservative	25	50	60 binary
Moderate	50	100	60 flash/80 binary
Advanced	100	200	80 flash/110 binary

"The 10% (3% in 2021 ATB plus 7% in 2024 ATB) reduction in the baseline drilling cost would correspond to a slightly higher ROP and longer bit life than the GeoVision baseline assumptions displayed here. Updated analysis to create a new baseline cost curve in the Well Cost Simplified model **will be implemented in a future ATB cycle** using updated industry drilling performance values (Norbeck and Latimer, 2023)."
– NREL 2024

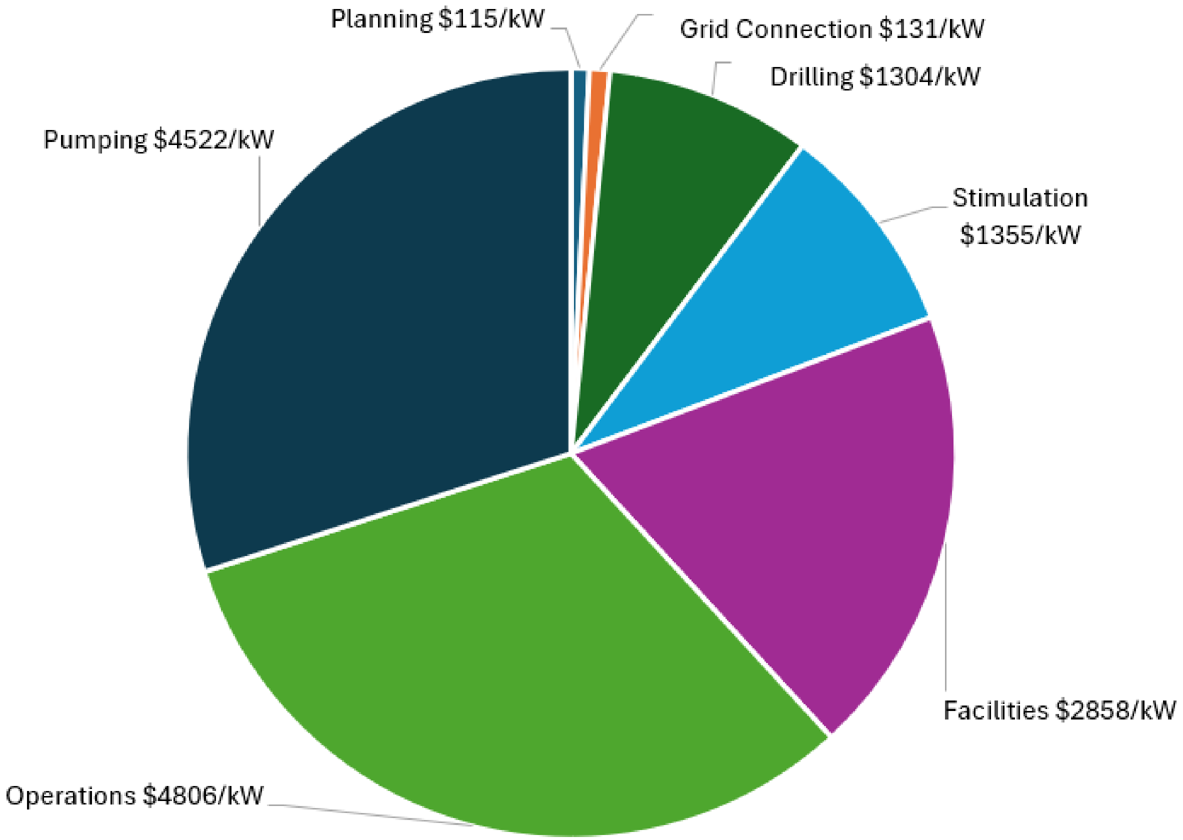
Important! *This was optimistic in 2017, but drilling costs today are already 72% less than the conservative scenario*

NREL, 2024b (https://atb.nrel.gov/electricity/2024b/geothermal)

EGS GEOTHERMAL CAPITAL COST

Lifecycle cost modeling for Enhanced Geothermal Systems

Cost Breakdown for a 30.5 MW Facility



Background Information

Assumptions

Goal

Bottom-up EGS economics

Key Metrics

1. *Planning:* $3,500,000
2. *Facilities:* $2,500/kW x 30,500 kW
3. *Drilling:* $220/ft x 19,800 ft x 9 wells
4. *Stimulation:* $5.2M/well x 9 wells
5. *Connection:* $1M/mi x 4 mi
6. *Capex:* $5,800/kW
7. *Opex*: 2% Capex/yr x 30 years

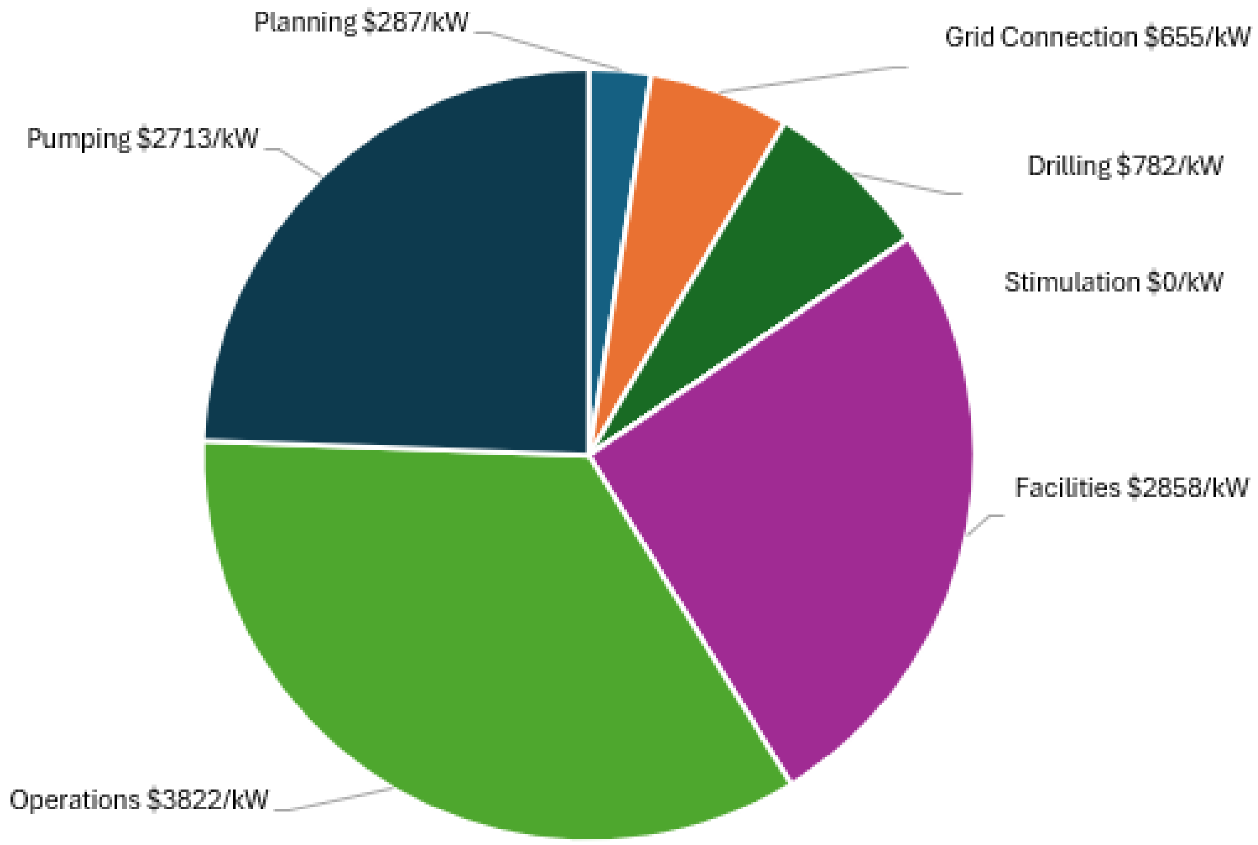
*Calculated using GeoDT (https://github.com/lfrash/GeoDT) for EGS project with 9 wells, 55 C/km resource, 0.06 m3/s flow per injector, 10% fluid loss – excludes IRA

Geothermal Wells LLC
From 0 to 1 GW by 2028

HYDROTHERMAL CAPITAL COST

Lifecycle cost modeling for Hidden Hydrothermal

Cost Breakdown for a 30.5 MW Facility



Background Information

Assumptions

Goal

Bottom-up EGS economics

Key Metrics

1. *Planning:* $8,750,000
2. *Facilities:* $2,500/kW x 30,500 kW
3. *Drilling:* $430/ft x 8,900 ft x 6 wells
4. *Stimulation:* ---
5. *Connection:* $1M/mi x 20 mi
6. *Capex:* $4,600/kW
7. *Opex*: 2% Capex/yr x 30 years

*Calculated using GeoDT (https://github.com/lfrash/GeoDT) for EGS project with 9 wells, 55 C/km resource, 0.06 m3/s flow per injector, 10% fluid loss – excludes IRA

BASELOAD ENERGY SOURCES

10 MW Baseload *14,600 homes*	CAPEX *\$/kW*	OPEX *¢/kWh*	Fuel *¢/kWh*	Footprint *acre*	Water *cfs*	CO_2 *car-yr*	Cost *\$/MWh*	Byproduct *type*
EGS Geothermal	**\$4,700[IRA]**	**¢2.3**	**¢0.0**	**4**	**0.30[NaCl]**	**29**	**\$68[IRA]**	**None**
Hydrothermal	**\$3,300[IRA]**	**¢1.9**	**¢0.0**	**8**	**0.10[NaCl]**	**29**	**\$64[IRA]**	**Lithium**
Nuclear	\$9,400[IRA]	¢3.5	¢0.3	3	0.17[NaCl]	340	\$166[IRA]	Radiation
Wind + Storage	\$2,200	¢2.3	¢0.0	9	-	210	\$84	Blades
Solar + Storage	\$2,300	¢1.2	¢0.0	200	0.00	780	\$91	Panels
Gas	\$1,300	¢3.4	¢0.3	410	0.09	9400	\$71	Saltwater
Coal (No CCS)	\$4,100	¢4.1	¢0.6	240	0.20	16000	\$109	Hazardous
Biomass	\$9,400	¢6.9	¢1.0	35000	0.24	4400	\$82	Char
Hydroelectric	\$7,000	¢1.5	¢0.0	3300	-	420	\$99	Land

**Levelized cost of electricity calculated with 7.7% weighted average cost of capital (WACC)*
[IRA] Includes 40% Investment Tax Credits from the US Inflation Reduction Act
***Nominal values provided, actual numbers vary ±40% by location*
[NaCl] Non-potable water can be used instead of fresh water

RISE IN GEOTHERMAL ACTIVITY

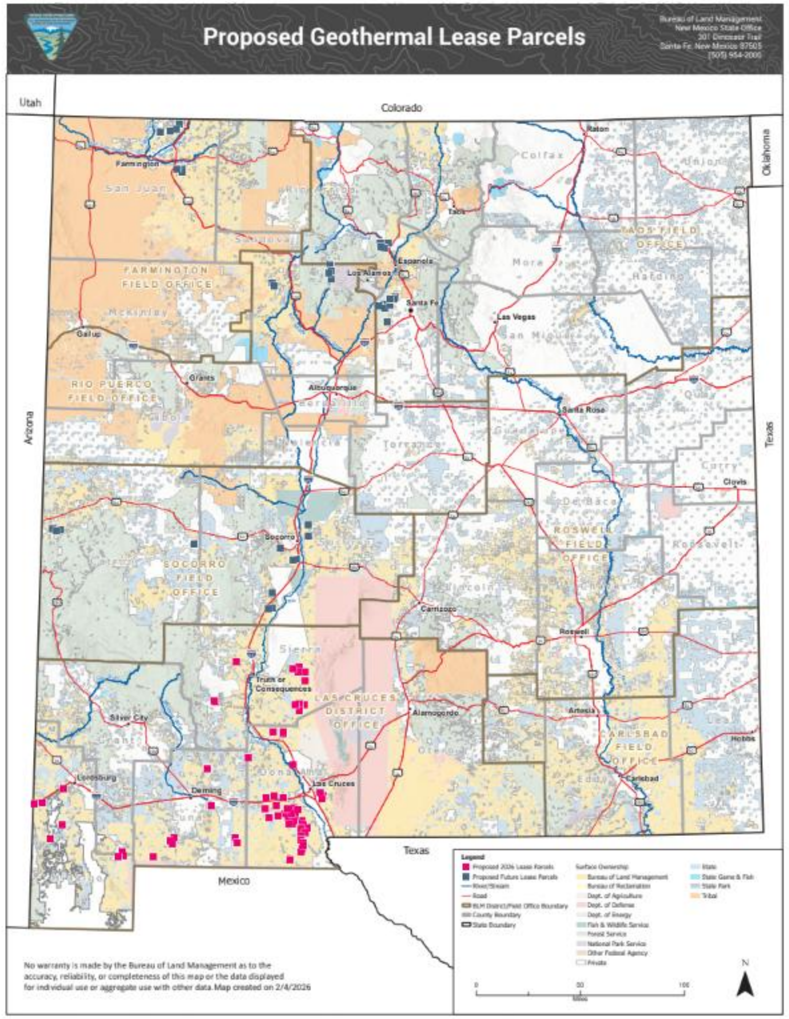
Grants / Incentives / Investment / Good for People / Good for Environment

Major Investments Signal Technology Readiness

- 2025 Geothermal Drilling Cost Curves Update
- NLR 2025 US Geothermal Market Report
- National lab projects enhanced geothermal cost could decline to $100/MWh by 2035
- ORMAT signs 150MW geothermal PPA w NV Energy
- XGS Energy and Meta to develop 150 MW geothermal power-project in New Mexico
- BLM GT Lease Map
- DOE Announces $171.5 Million to Help Expand U.S. Geothermal Energy

Leasing activity in New Mexico

Hot Locations for Power



CONCLUSION

Let’s give geothermal a fair shot in the energy mix

Geothermal Energy is a golden opportunity for New Mexico

EGS Capital Cost	
Current IRP Estimate $15,700/kW	Updated IRP Estimate $6,100/kW

Hydrothermal Capital Cost	
Current IRP Estimate – Missing –	Updated IRP Estimate $5,100/kW