SAND2013-4623C

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Water & Energy in New Mexico

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U.S. DEPARTMENT OF ENERGY | NNSA

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Outline

- New Mexico Water Use & Trends
- Water in energy infrastructure
- Energy in water for agriculture
- Energy for public water
- Energy for water desalination
- Surety of water system

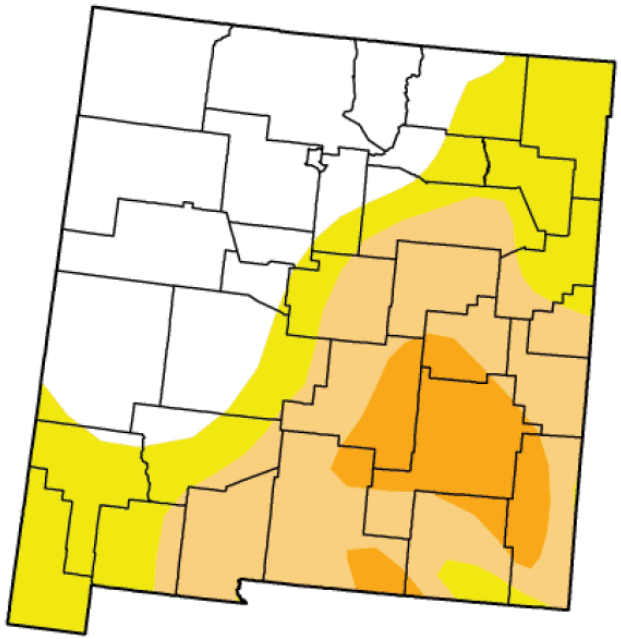
Water Use in New Mexico

2005 Annual water withdrawal in **thousand** acre-feet

Use	Surface	Ground	Ground + Surface	% of Total
Agriculture	1,731	1,345	3,076	78.6
Public Water	42	278	320	8.2
Electric Power	52	12	64	1.6
Mining	1	59	60	1.5
Livestock	3	54	57	1.5
Commercial	2	39	41	1.0
Industrial	2	16	18	0.5
Reservoir Evaporation	-	-	279	7.1
TOTAL			**3915**	**100%**

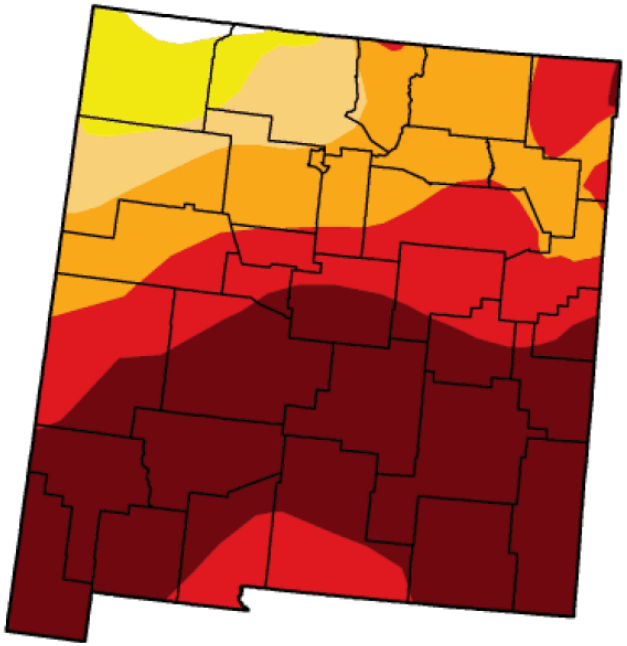
Longworth, et al. "New Mexico Water Use by Categories 2005." *New Mexico Office of the State Engineer*. <http://www.ose.state.nm.us/publications_technical_reports_wateruse.html>

NM Water Trends



June 2009

D0 - Abnormally Dry
D1 Drought - Moderate
D2 Drought - Severe
D3 Drought - Extreme
D4 Drought - Exceptional

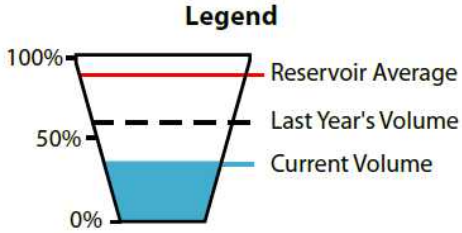


June 2011

Interstate Stream Commission. “2009-2011 Annual Report.” *New Mexico Office of the State Engineer*. <http://www.ose.state.nm.us/publications_annual_reports.html>

NM Reservoirs 2012

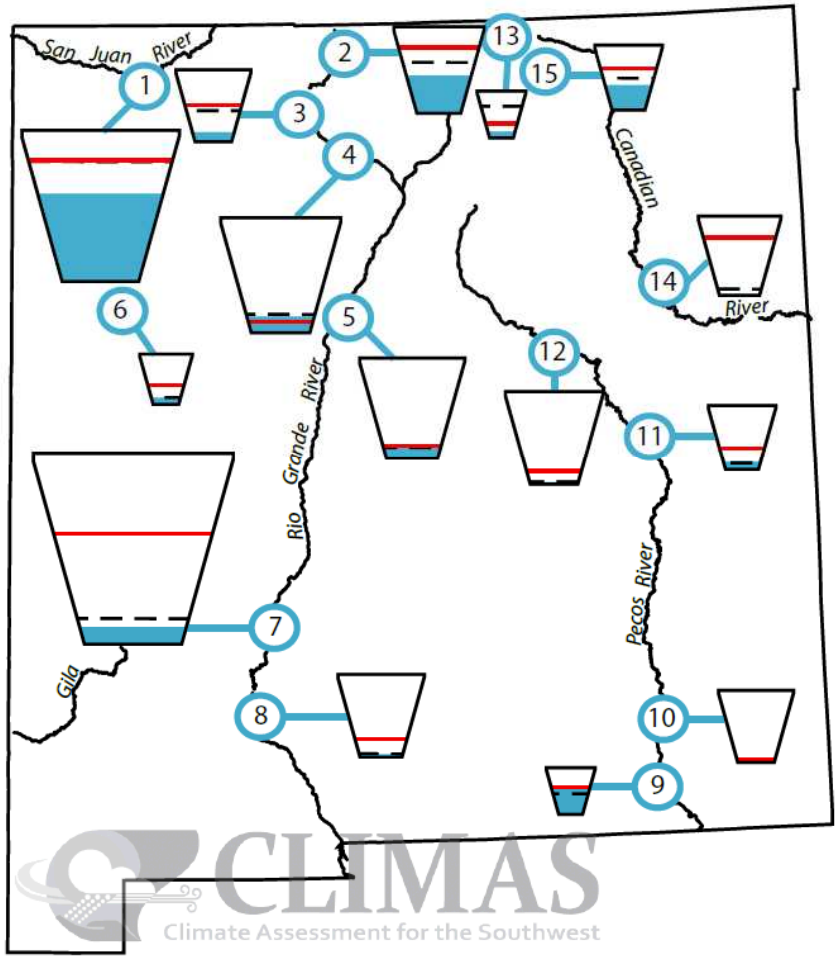
Figure 7. New Mexico reservoir volumes for December as a percent of capacity. The map depicts the average volume and last year's storage for each reservoir. The table also lists current and maximum storage, and change in storage since last month.



size of cups is representational of reservoir size, but not to scale

Reservoir Name	Capacity	Current Storage*	Max Storage*	Change in Storage*
1. Navajo	56%	956.3	1,696.0	-13.7
2. Heron	41%	165.9	400.0	-4.0
3. El Vado	5%	10.0	190.3	-13.1
4. Abiquiu	13%	155.9	1,192.8	-3.0
5. Cochiti	11%	52.9	491.0	0.4
6. Bluewater	9%	3.4	38.5	0.0
7. Elephant Butte	7%	162.1	2,195.0	39.1
8. Caballo	2%	7.5	332.0	1.0
9. Lake Avalon	60%	2.4	4.0	0.3
10. Brantley	0%	4.6	1,008.2	0.9
11. Sumner	9%	8.8	102.0	2.8
12. Santa Rosa	1%	4.8	438.3	0.0
13. Costilla	14%	2.3	16.0	0.3
14. Conchas	1%	2.0	254.2	-1.0
15. Eagle Nest	37%	29.0	79.0	0.1

*** thousands of acre-feet**



Climate Assessment for the Southwest. "New Mexico Reservoir Volumes." *The University of Arizona*. <http://www.climas.arizona.edu/swco/jan2013/new-mexico-reservoir-volumes/>

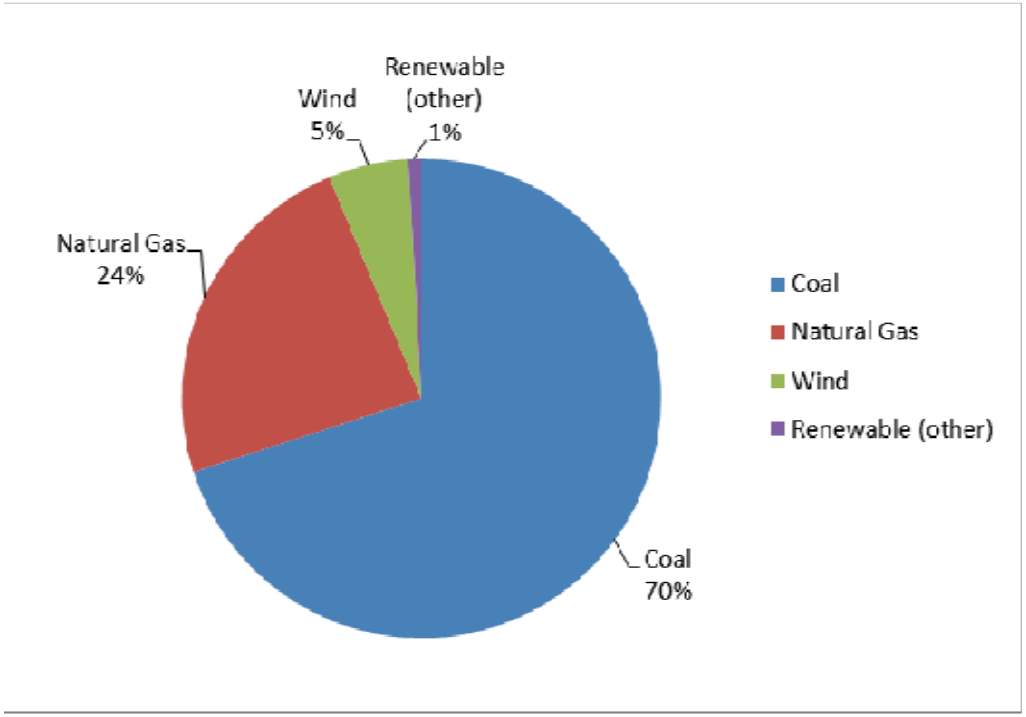
Water in Energy Infrastructure

2012 New Mexico Oil & Gas Production		
Total Oil Produced	84,5000,000	Barrels
Total Natural Gas Produced	1,250,000,000	Million Cubic Feet
Produced Water	75,000	Acre-feet

Produced water – the water extracted from the subsurface with oil and gas. It may include water from the reservoir, water that has been injected into the formation, and any chemicals added during the production/treatment process. Produced water is also called "brine" or "formation water." Some produced water is quite fresh and may be used for livestock watering or irrigation (where allowed by law).

Oil Conservation Division. "OCD Data and Statistics." *State of New Mexico Oil Conservation Division*. <http://www.emnrd.state.nm.us/OCD/statistics.html>

Electricity Generation by Source



Source	Electric energy (GWh)
Coal	27212
Natural Gas	9200
Wind	2101
Hydro, Solar, Biomass	341

- Roughly 16.5 GWh (42%) per year is exported

U.S. EIA. "State Energy Data System." *Energy Information Administration*. <http://www.eia.gov/state/seds>

Water for Electric Power

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Estimated annual water withdrawal and consumption for electricity generation

Source	Withdrawal (gal/MWh$_e$)	Consumption (gal/MWh$_e$)	Annual Diversion (acre-ft)	Annual Consumption (acre-ft)
Coal	500	480	41755	40085
Natural Gas	950	662	21458	14953
Natural Gas (CC)	150	130	847	734
Wind	0	0	0	0
Hydro	1425	1425	853	853
Solar (PV)	26	26	10	10
Biomass	500	480	27	27
TOTAL	-	-	64951	56661

Macknick, et al. "A Review of Operational Water Consumption." *National Renewable Energy Laboratory*. <http://www.nrel.gov/docs/fy11osti/50900.pdf>

Agriculture Energy & Water Use

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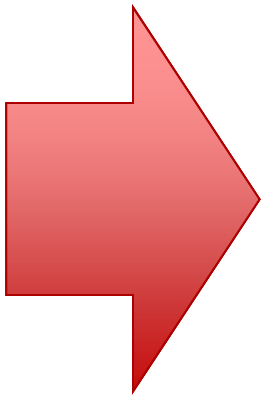
Irrigation source	Acres	% of total
Surface Water	280,000	32%
Ground Water	**464,000**	**53%**
Combination	132,000	15%
Distribution	**Acres**	**% of total**
Drip	19,000	2%
Flood	449,000	51%
Sprinkler	**408,000**	**47%**

2500 kWh per acre energy use per year for groundwater pumping and sprinkler application

APPLICATION OF WIND ENERGY
TO GREAT PLAINS IRRIGATION PUMPING
Advances in Agricultural Technology
Science and Education Administration
U.S. Department of Agriculture 1980



1,160 GWh
energy used for irrigation
~3% of state total

Energy Use for Public Water

	kWh/Million gallons	
Water Cycle Segments	**Low**	**High**
Supply and Conveyance	0	16,000
Treatment	100	1,500
Distribution	700	1,200
Wastewater Collection and Treatment	1,100	4,600
Wastewater Discharge	0	400
TOTAL	**1,900**	**23,700**
Recycled Water Treatment and Distribution for Non-potable Uses	400	1,200

Pumping:

- 540kWh/mGal @120ft
- 2000kWh/mGal @400ft

"Energy Demands on Water Resources." *Sandia National Laboratories*. <http://www.sandia.gov/energy-water/docs/121-RptToCongress-EWwEIAcomments-FINAL.pdf>

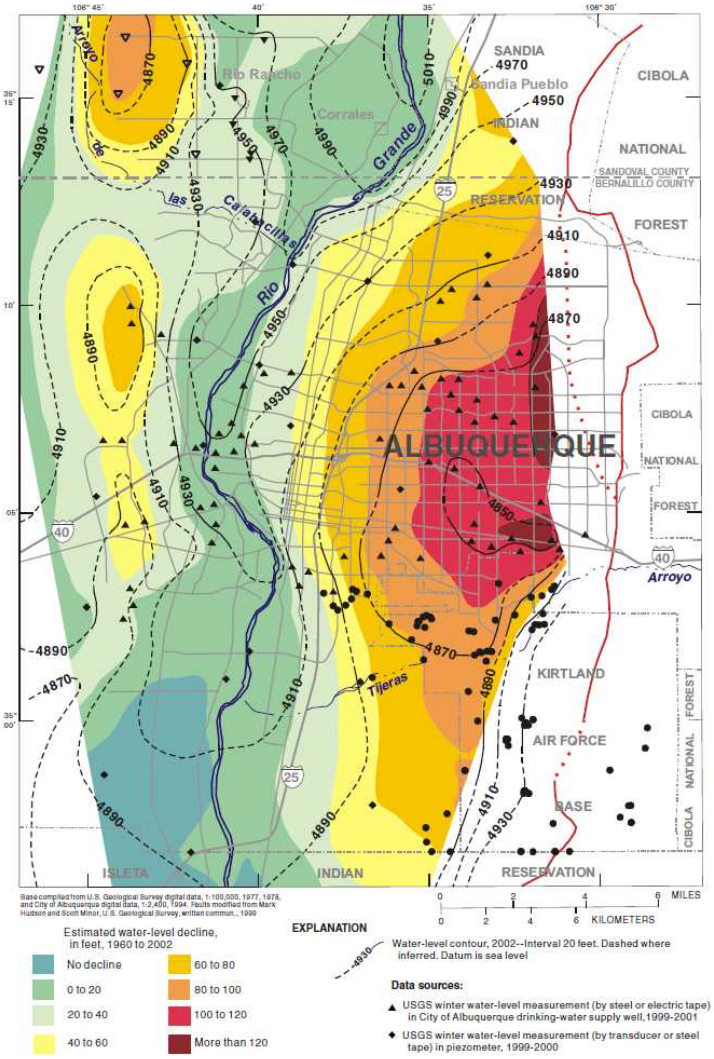
Energy Use for Public Water

- Albuquerque: Depth to water table ranges from <100 ft (Rio Grande) to 1000 ft (NE)
- Assumed an average well depth of 500 ft
- NM public water supplied from ground water withdrawal, 2005:

278,000 acre-ft/yr = 90.6 billion gal/yr

~26MW to pump from 500 ft.

=> 86 MW Wind Farm



Bexfield, et al. "Water Resources Investigations Report 02-4233." *USGS*. <http://nm.water.usgs.gov/publications/abstracts/mapreport02-4233.pdf>

Saline Aquifers Resource

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Water Salinity

Fresh <500 ppm TDS

Brackish 1000-30,000 ppm TDS

Saline >10,000 ppm TDS

Albuquerque Basin

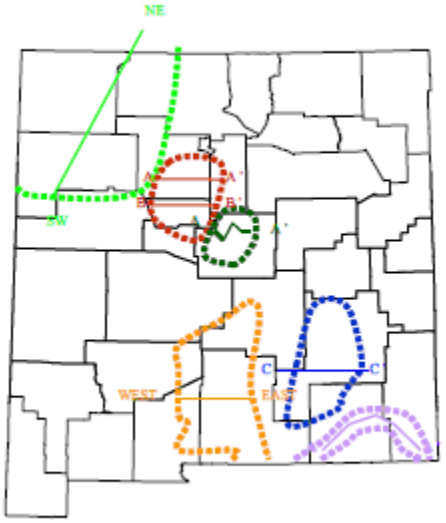
San Juan Basin

Roswell Basin

Capitan Reef aquifer

Estancia Basin

Tularosa-Salt Basin



Ground Water Type	Volume	Years of Supply at 2012 use	Average Depth
Fresh/Brackish	5 Billion Acre-feet	~1,000	1000 ft
Saline	15 Billion Acre-feet	~3,000	5,000 ft

Lansford, et al. "Evaluation of Available Saline Water Resources in New Mexico." *National Renewable Energy Laboratory.* <http://www.nrel.gov/docs/legosti/old/3597.pdf>

Energy to treat saline water

Energy and cost if **all public water** in NM came from saline aquifers (278,000 acre-ft/yr)

Source	Depth (ft)	Pumping Energy (GWh)	Desalination Energy (GWh)	Total Energy (GWh)	Annual Energy Cost (retail rate $80/MWh)
Brackish	1,000	453	453	906	$260/acre-foot
Saline	5,000	2265	906	2718	$780/acre-foot

Saline Desalination = 12% of total NM State energy use
Brackish Desalination = 4% of total NM State energy use

Desalination Committee. "Seawater Desalination Power Consumption." *Water Reuse Association.* <http://www.watereuse.org/sites/default/files/u8/Power_consumption_white_paper.pdf>

Water Economics

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TABLE 2
RECENT PRICES OF BULK WATER IN WESTERN STATES
(AF is acre-feet of consumptive use per annum in New Mexico; unknown otherwise)

STATE	PRICE RANGE (per acre-foot)	BASIN/DISTRICT	TERM
OK	$645	City of Owasso, City of Bixty	40 years
AZ	$610	City of Tucson	long-term
NM	$500	Jicarilla/Santa Contract	50 years
AZ	$308 to $726	City of Flagstaff	long-term
CA	$90 to $300	San Joaquin River Exchange Contractors Water Authority	5-yr lease
TX	$30 to $500	Lower Rio Grande	1-yr lease
CA	$20 to $185	Mohave River Basin	1-yr transfer
NE	$100 to $125	Platte Republican Resources Area	10-15 yr lease
NM	$100	Carlsbad Irrigation District	1-yr lease
CA	$70 to $125	Department of Water Resources/Yuba River	1-yr lease
NM	$17 to $100	San Juan Chama Project	various short-term
OR	$30 to $86	Klamath Basin Water Bank	1-yr lease
TX	$75 to $80	Edwards Aquifer Authority	one year?
CO	$10 to $80	Board of Water Works of Pueblo Colorado	1-yr lease
ID	$5 to $39	Magic Valley	1-yr lease
WY	$3 to $40	Boisen Reservoir	1-yr lease
AR	$9	Arkansas Valley	1-yr lease

Brown. "Beyond the Year of Water: Living Within our Water Limitations." *New Mexico Water Resources Research Institute*. <http://wrri.nmsu.edu/publish/watcon/proc52/brown.pdf>

Surety of NM Water System

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Category	Current System		Proposed System
Safety	Jet fuel leak, Extraction byproducts	=	Extraction byproducts, At least as safe as current
Security	Open reservoirs may be easier to contaminate	=	More sources means more infrastructure to protect
Reliability	Demand exceeds supply from all sources	<	More reliable, particularly during periods of drought
Sustainability	Climate change and population growth	<	Can supplement water supply for at least 1000 years
Cost Effectiveness	No need for desalination or new infrastructure	>	Pumping, desalination, well drilling, equipment, etc. ($)
Resiliency	Harder to respond to local infrastructure failure/damage	<	Greater source diversity, easier to reallocate demand

Energy Technology Solutions

- Distributed energy technology for pumping and desalinating water
  - Photovoltaic solar
  - Wind turbines
  - Natural gas microturbines
  - Natural gas fired reciprocating engines

  … must have negligible water demands

- If all else fails… go with Mr. Fusion
  - It powered the flux capacitor, after all
  - 10,600 GWh/year!

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