



COLORADO
OIL & GAS
ASSOCIATION

Oil and Gas Development: Water challenges and opportunities



▶▶▶ Overview

- Oil & Gas requires reliable water supplies
- Consumes a small portion
- Comprehensive regulations
- Relationship with agriculture
- Economic benefits

▶▶▶ Amount of Water

- The amount of water needed depends on the geologic basin, the formation, and the well.
 - Raton Basin, approximately 50,000 to 300,000 gallons may be for a shallow coalbed methane well
 - Piceance Basin, approximately 800,000 to 2 million gallons for a deeper tight sand gas well.
 - DJ Basin, approximately 250,000 gallons may be used to frac a vertical well, while up to 5 million gallons may be used to frac a horizontal well.
 - (Niobrara wells consistently demonstrate use of ~2.5 million gallons)

▶▶▶ Sources of Water

- Use of Water Must be Legally Allowed
 - Municipal lease/purchase (industrial uses)
 - Changed water rights (e.g. temp agricultural to industrial)
 - Fully consumed water (leased/purchase effluent)
 - Produced water (non-trib or decreed trib & augmented)
 - Non-tributary (landowner & operator agreement)

Source - COGCC

▶▶▶ Colorado Water Use

Sector	2010 Use (Acre-Feet/Yr) ⁴	Percent of State Total
Total	16,359,700	
Agriculture	13,981,100	85.5%
Municipal and Industrial	1,218,600	7.4%
Total All Others	1,160,000	7.1%
Breakdown of "All Others"		
Total All Others	1,160,000	
Recreation	923,100	5.64%
Large Industry	136,000	0.83%
Thermoelectric Power Generation	76,600	0.47%
Hydraulic Fracturing	13,900	0.08%
Snowmaking	5,300	0.03%
Coal, Natural Gas, Uranium, and Solar Development	5,100	0.03%
Oil Shale Development	0	0.00%

▶▶▶ Estimated Water Use

Projection of Annual Demand for Hydraulic Fracturing (Acre-Feet ²) ³					
2010	2011	2012	2013	2014	2015
13,900	14,900	16,100	16,900	17,800	18,700

- 2015: 0.10% of total water use

One Acre Foot is Approximately 326,000 Gallons

Source: COGCC

▶▶▶ Water Requirements

- Natural gas has one of the lowest water usage rates per MMBTU

Water requirements for various energy resources

Energy Resource ¹	Range of Gallons of Water Used per MMBTU of Energy Produced
Deep Shale Natural Gas	0.84 – 3.70 ²
Coal (no slurry transport)	2 – 8
Coal (with slurry transport)	13 – 32
Nuclear (uranium ready to use in a power plant)	8 – 14
Conventional Oil	8 – 20
Synfuel - Coal Gasification	11 – 26
Oil Shale	22 – 56
Tar Sands	27 – 68
Synfuel - Fisher Tropsch (from coal)	41 – 60
Enhanced Oil Recovery (EOR)	21 – 2,500
Biofuels (Irrigated Corn Ethanol, Irrigated Soy Biodiesel)	> 2,500

¹Source: “Deep Shale Natural Gas: Abundant, Affordable, and Still Water Efficient”, GWPC, 2010.

²The transport of natural gas can add between zero and two gallons per MMBTU.

▶▶▶ Water for Electricity

Table 7. Closed-loop cooling power generation with carbon capture water use consumption

Power Plant Type	Average Gallons of Water Consumed in Power Plant per MWh of Electricity Produced (no CCS)	Average Gallons of Water Consumed in Power Plant per MWh of Electricity Produced (with CCS)	Increase Due to Carbon Capture
Natural Gas Combined Cycle (NGCC)	190	217	+ 14%
Integrated Gasification (SynGas from Coal), Combined Cycle (IGCC)	330	376	+ 14%
Coal/ Biomass Steam Turbine	420	563	+ 34%
Nuclear Steam Turbine	590	590	N/A
Concentrating Solar	750	750	N/A
Geothermal Steam	1,400	1,400	N/A
Hydroelectric	4,500*	4,500*	N/A

**Due to direct evaporation from holding reservoir*

Note, wind turbines, photovoltaic solar panels and direct combustion natural gas turbines (noncombined cycle) have negligible water demands .

▶▶▶ Baseline Water Sampling

- Pre and Post-drilling water samples taken around new well starts
- Increased transparency & accountability for industry
- Database Active



▶▶▶ Recycling Rates

- Front Range: ~50% produced water and >90% flowback water
- Piceance Basin: 99% produced and flowback water
- Southern Basins: Wells produce more water than gas, fresher than other basins

▶▶▶ Disposal

- 60% Underground Injection Wells
- 20% Lined Open-Air Pits
- 20% Surface Discharge: rivers and streams, dirt roads



▶▶▶ Final thoughts

- Estimated 16,000 acre-feet (2012)
- Each acre-foot of water produced \$1.85 million in economic activity



▶▶▶ Thank you!

Questions?

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