



ENERGY PIPELINE

COVERING THE OIL AND GAS INDUSTRY IN COLORADO



WORKING RELATIONSHIP

TECHNOLOGY AND CONVERSATIONS
HAVE IMPROVED INTERACTIONS
BETWEEN AGRICULTURE
AND THE OIL INDUSTRY



WATER PURITY

Water study shows
no contamination
from oil-gas drilling

OPPORTUNITY KNOCKS

Internships help open
door to energy industry,
even in a downturn

HANDS-ON TRAINING

Noble Energy's outdoor
training facility brings industry
to community's fingertips

JUNE | VOL 2 | ISSUE 10

\$4.99



TECH TALK

CAN HORIZONTAL WELLS ENHANCE OPPORTUNITIES FOR SMALL GEOTHERMAL POWER?

BY GARY BEERS • FOR ENERGY PIPELINE

FEASIBILITY FOR GEOTHERMAL POWER GENERATION

Electrical power generation from co-produced fluids using binary-cycle power plants has been demonstrated at the Rocky Mountain Oilfield Testing Center in Wyoming, and at the Huabei Oilfield near Beijing, China.

Research investigating the feasibility and profitability of implementing co-production at the oilfields of the Los Angeles Basin was published in 2012 ("Power Generation Potential From Co-produced Fluids in the Los Angeles Basin," Kara Bennett, Stanford Geothermal Program, Stanford University). The key conclusion is co-production is feasible when at least 82,000 barrels of produced water are generated each month with a minimum temperature of 170 Fahrenheit.

Let's consider - under what general conditions would a co-production facility utilizing produced water from the Wattenberg Field, specifically the Niobrara Formation, be feasible?

According to the study, power generation is feasible if the temperature is high enough and the flow is large enough. The temperature of the Niobrara Formation is in the range of 240 to 260 F, which is above the minimum of 170 F, but within the past decade, a vertical well in Weld County has typically generated about 30 barrels per month of produced water. At this rate, approximately 2,700 wells would be needed to supply the above minimum volume. The logistics to link flows from this many wells could render a potential co-production project infeasible.

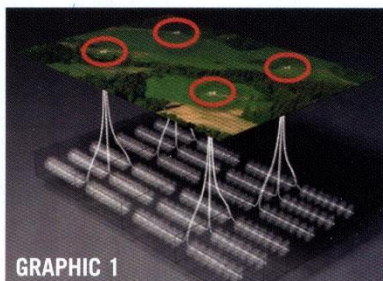
However, the recent widespread installation of horizontal wells is a game-changer for the rate of

produced-water generation and could contribute to the feasibility of a co-production facility. The technological marvel of horizontal drilling has been extensively used by oil/gas companies due to substantial cost savings and reductions in the environmental footprint. But, little recognition has surfaced about the change in the generation of produced water and how this change can provide increased opportunities for beneficial uses.

THE SETUP OF HORIZONTAL WELLS

The technological marvel of horizontal drilling has been extensively used by oil/gas companies due to substantial cost savings and reductions in the environmental footprint.

The oilfields around Greeley are dominated by widespread horizontal wells drilled 1,000's feet into oil/gas formations from "super pads" at the surface, where there are 10 to 30 or more wellheads. An artistic rendering of this arrangement is shown in Graphic 1. As an example of the real-world



GRAPHIC 1

Drilling pads allow widespread underground development by concentrating wellheads at the surface.

Source: Energy Institute of America.



For over 50 years, **GARY BEERS** has worked in numerous fields of environmental science as a consultant, regulator and educator. This career included senior management position with major consulting, nonprofit and public organizations. He has founded several successful firms to capture emerging resource management markets. One of his latest ventures, EnviroScienceINFO, provides content for public media.

TRUCKLOGIC[®].COM

QUALITY BRAND TRUCK ACCESSORIES

FREE SHIPPING & DELIVERY
GUARANTEED LOWEST PRICE
FLEET VOLUME DISCOUNTS
SHOP ONLINE 24/7
SHOP OUR STORE & SHOWROOM
31 YEARS OF EXPERIENCE
INSTALLATION AVAILABLE
LARGE INVENTORY
FAMILY OWNED SINCE 1983
EXPERT CUSTOMER SERVICE

GRILLE GUARDS

TOOL BOXES

FUEL TANKS

SLIDING DOORS

TONNEAU COVERS

FLOOR LINERS

1000'S OF ACCESSORIES FOR YOUR TRUCK

800.545.4605 Call Us
Store & Showroom
56 S Jason ST #8 • Denver, CO 80223
www.trucklogic.com

FEATURING THESE FAMOUS BRANDS & 100'S MORE

RANCH HAND **HUSKY LINERS** **WARN**

WeatherTech[®] Floor Mats **K&N PERFORMANCE FILTERS**

DELTA PRO **weather guard**

WESTIN **TRUXEDO**

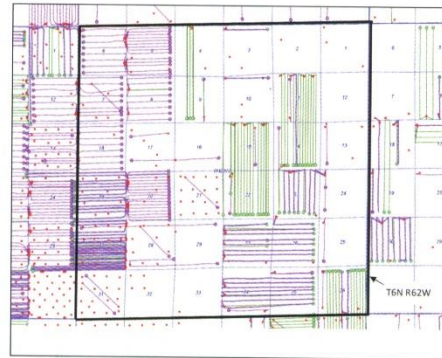
UNDERCOVER **YETI COOLERS** **SAFE POWER**

Proudly Serving the Energy Industry

A+ RATED ACCREDITED BUSINESS **SINCE 1983**

Truck Logic.com • Division of Meadow Creek Truck Supply Inc.

GRAPHIC 2



Existing and planned horizontal wells.

Source: Colorado Oil and Gas Conservation (COGCC).

situation, the actual layout of approximately 232 horizontal wells in T6N R62W, which is 15 miles east of Greeley, is shown in Graphic 2.

INCREASE IN PRODUCED WATER

Obviously, a horizontal well extending 4,000 to 10,000 feet into an oil-bearing formation will generate more produced water than a vertical well crossing several hundred feet of the same formation. But how much more?

For an answer, water production data from Section 20 (Graphic 2) is examined. The monthly average for the 17 horizontal wells, during August 2014 to February 2015, is 485 bbls/mo/well. Data from four vertical wells, during an eight-month period (in 2011), provides an average of 24 bbls/mo/well. Thus, a horizontal well generates about 20 times more produced water than a vertical well.

CAN HORIZONTAL WELLS CAN ENHANCE OPPORTUNITIES FOR SMALL GEOTHERMAL POWER PLANTS?

As mentioned above, 82,000 bbls/mo of produced water was the minimum rate needed for a potential facility to be considered feasible. The existing and planned horizontal wells identified in Section 20 (Graphic 2) can be projected to provide an estimated 112,520 bbls/mo.

Since the projected flow of produced water from these horizontal wells clearly exceeds the minimum rate, it is an interesting proposition to further consider the feasibility of this 36-square-mile area supporting a small geothermal power plant.

LET'S SEE HOW IT WORKS IN BOWMAN COUNTY, N.D.

Field testing of the feasibility of using the heat from produced water to turn electricity-generating turbines is starting in the Cedar Creek Oilfield in southwestern North Dakota. The 250-kilowatt geothermal generator has the potential to contribute an extra \$100,000 annually per well, according to estimates from the U. S. Energy Department.

The project ("Electric power Generated from Co-Produced Fluids from Oil and Gas Wells") has been underway since 2010 at the University of North Dakota with involvement of a major oil company and geothermal technology companies. Details about the project are available online at <https://www4.eere.energy.gov/geothermal/project>.

DIFFERENT APPROACHES TO GENERATING SUFFICIENT VOLUMES OF PRODUCED WATER

While the Weld County and Bowman County oilfields may be feasible for locating geothermal facilities and involve horizontal wells, key factors pertaining to the generation of produced waters are different. Under these factors, the approach in Bowman County is to locate wells that generate high volumes of produced water and propose siting geothermal plants in these locations. A stumbling block to this approach is the profitability of a well decreases as the water:oil ratio increases and these wells may be among the first to be shut-down when economic conditions decline. The Project Officer for the North Dakota Project indirectly referred to this issue in the following statement included in the 2013 annual talk for peer review.

The top producing oil wells in the Madison-Lodgepole formation do not yield sufficient water to be economic as a co-produced system. If the wells were produced solely for water at rates water wells in the Lodgepole are now to produce, the power production would be significant.

A different approach is available in Weld County and should result in a more sustainable basis for siting geothermal plants. Super pad development is based on placing many horizontal wells in oil-rich formations and extracting the oil under favorable economic conditions. This scaling up of the extraction process has the concurrent effect of concentration large volumes of produced water where the water:oil ratios are low in the formation. Consequently, sufficient volumes of produced water for use in geothermal plants are expected to be co-located with the more profitable wells - which contributes to a sustainable arrangement.

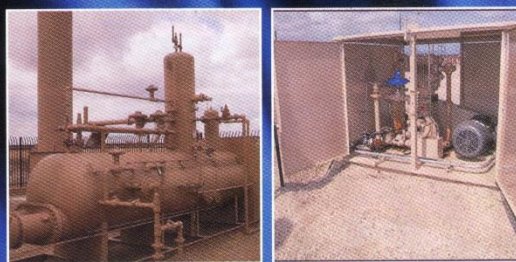
The 'hidden' benefit of horizontal wells from super pads could be the creation of a sustainable, beneficial use for produced water. Extending this thought a little further, why not use the generated electricity for onsite treatment of produced water to a quality level suitable for agricultural use and/or discharge to streams.

Think about it ♦



INNOVATORS IN SEPARATION AND EMISSION CONTROL

Combining the best products with experienced service, Trinity Energy Solutions, Inc. is the premiere end to end supplier of High Efficiency Production and Emission Control Separators, Traditional Separators, Vapor Recovery and Flash Gas Compressors, Pigging Valves, Combustion Equipment, Valves, and more industry leading products for you to turn to for your needs in the oilfield and natural gas field.



PO Box 200489, Evans, CO • 80620
970-506-2723 • 970-506-0749
www.trinityenergysolutions.com