Subject: Abstract for 2018 SMU Power Plays Conference, 10-11 January 2018

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President & Founder, Good Earth Mechanics, LLC

Organization: Good Earth Mechanics, LLC

Title: Converting Geopressured-Geothermal Reservoirs into Renewable Energy Systems

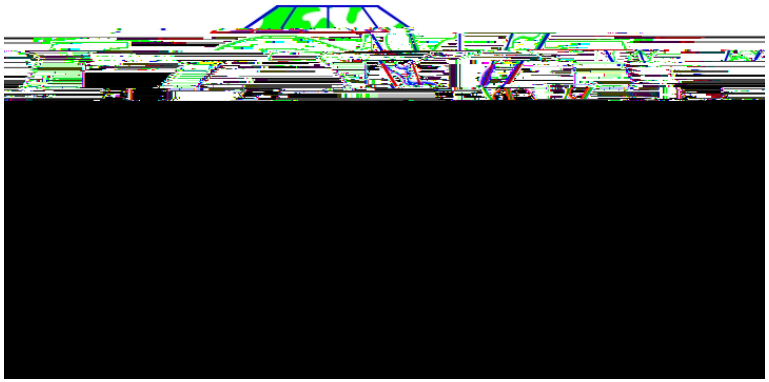
Format: Prefer oral presentation

Presenter:

George Nitschke has 23 years' experience in the aerospace industry and 12 years' experience drilling oil, gas, and geothermal wells in the U.S. and abroad. Nitschke holds patents in Geopressured-Geothermal (GPGT) systems and was a principal contributor to the U.S. Department of Energy's GPGT consortium. Nitschke formed Good Earth Mechanics in 2007 to promote the optimal conversion of the GPGT resource into Salinity Gradient Solar Pond (SGSP) systems to help solve the integrated water and energy challenges in the U.S and abroad.

Abstract:

Geopressured-Geothermal (GPGT) brine reservoirs have an immense energy potential: heat exchange, gas and pressure recovery are available from the hot, high-pressure, gas-cut brine waters. According to U.S. Geological Survey estimates, there are 5,700 quads of recoverable gas and 11,000 quads of available thermal energy in the Gulf Coast GPGT basin alone; for comparison, the U.S. *total annual energy consumption* is ~100 quads. Disposal of the spent GPGT brine water, after energy recovery, is a limitation to high-rate production and recovery of the GPGT energy resource. Good Earth Mechanics, LLC (GEM) is developing a solution to this limitation: utilizing the GPGT end-brine for large-scale construction of Salinity Gradient Solar Ponds (SGSP) versus, for example, down-hole reinjection. The SGSP systems produce fully dispatchable, cost-competitive energy in perpetuity, effectively converting the GPGT resouronjnne Gphnle, f1rgy solution. The talk will review GEM's GPGT-SGSP conversion technology and provide a progress-update on the efforts to commercialize that technology.



# Converting Geopressured -Geothermal Brine Reservoirs into Fully -Dispatchable Renewable Energy Systems

2018 SMU Power Plays Conference

11 January 2018

# Overview

## Presentation Outline

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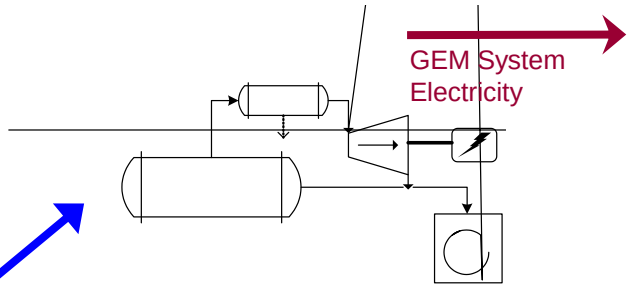
# The GPGT Resource

Geopressured-Geothermal (GPGT) energy is an immense energy resource that remains virtually untapped throughout the world

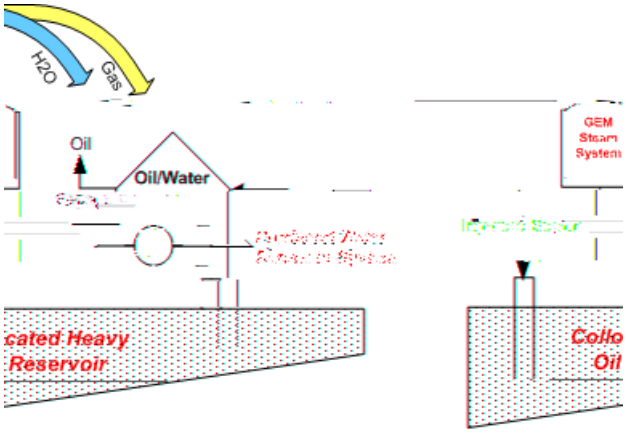
- High pressure, high temperature, gas cut, brine reservoirs
  - wellhead pressure: 10004000 psi
  - brine temperature: 250400 °F
  - GPGT brines contain 2100 scf/bbl natural gas
  - normally found at depths greater than 10,000 feet
  - can be produced at high flow rates: 20,00040,000 bbl/day (vertical borehole)
  - outstanding flow longevity (Dept. of Energy flow tests, Gulf Coast region)
  - GPGT brines contain 15,000200,000 ppm dissolved solids, typically 85% NaCl
  - USGS: 5,700 quads of gas and 11,000 quads of thermal energy in the Gulf Coast GP

# The GPGT Resource

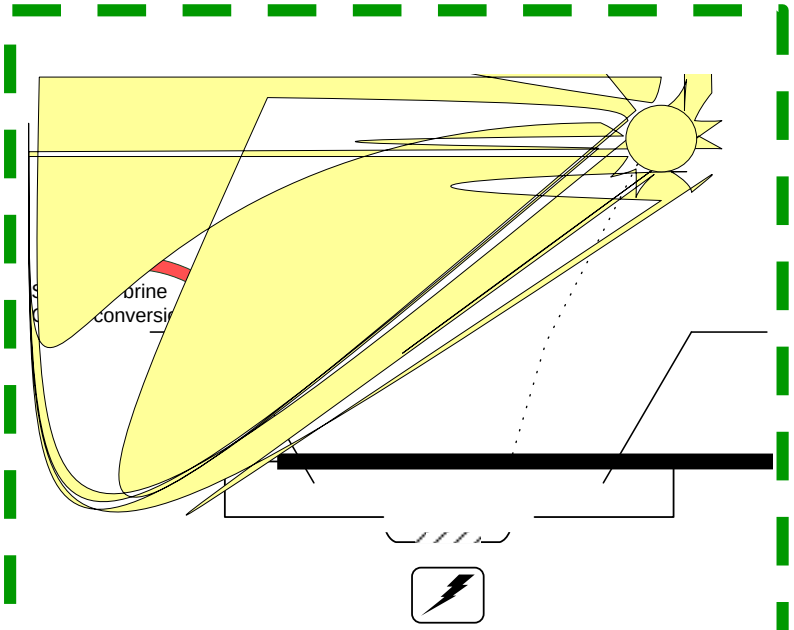
# Overall GEM GPGT Conversion








Short Term
GPGT Well Life



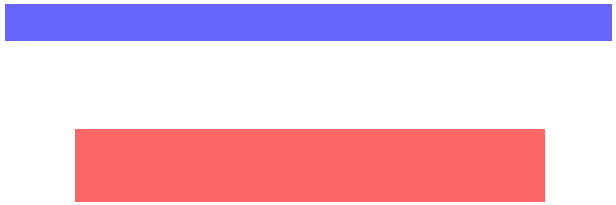
Long Term
Perpetual

U.S. Patents 7,845,406 B2 and 8,707,697 B2

# Salinity Gradient Solar Ponds: Discovered Natural Phenomena
## Engineered to Maximize Heat Collection & Storage

Solar energy is absorbed at the pond bottom, heating the adjacent fluid, which is prevented from buoying to the surface and releasing the heat to the ambient due to density stratification

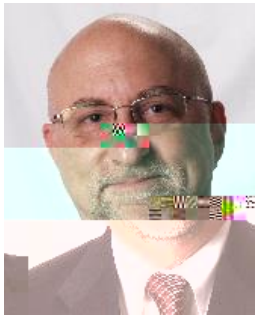
‡Collector / storage / delivery all in one
‡Robust, large• o ^ š Z Œ u o š š Œ Ç _
‡Baseload or on-demand renewable energy



The near-boiling hot brine of the bottom layer is circulated through an off-the-shelf heat engine that uses the thermal energy to t 1 09u9 0 5/MCID 18>> BDC q 0.000010729 0 720 54a3> 04 Tf o.39

# The GEM Salinity Gradient Solar Pond Team:
## World Recognized SGSP Leadership

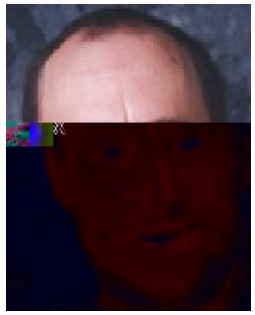
George Nitschke
President & Founder



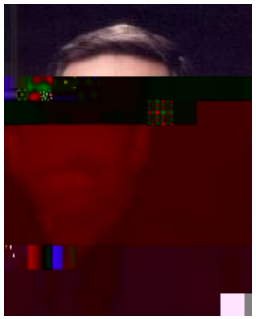
Peter Gross
Business Development

Dennis Duke
Field Operations

Huanmin Lu
Chief SGSP Scientist



John Walton
SGSP Environmental



Andrew Swift
SGSP & Wind Energy

Herbert Hein, Jr.
SGSP Project Mngmnt

- 16+ years SGSP development at the University of Texas El Paso (UTEP)
- Engineering data & models
- Proprietary practices & processes
- Patent pending methods & components
- Key vendor relationships
- Evaluated by NREL Commercialization Assistance Program favorable review

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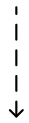
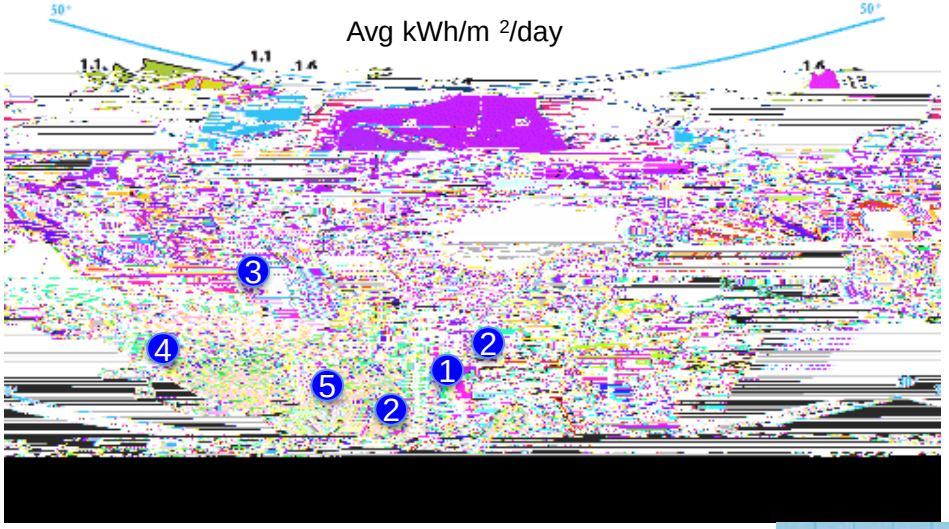
http://www.goodearthmechanics.com/pdfs/JSEE%20Paper%20Lu%20SP.pdf

Designed for Optimal Performance



cutaway of typical berm

# Large Global Potential for SGSP




GEM U.S. SGSP Project Launch Sites

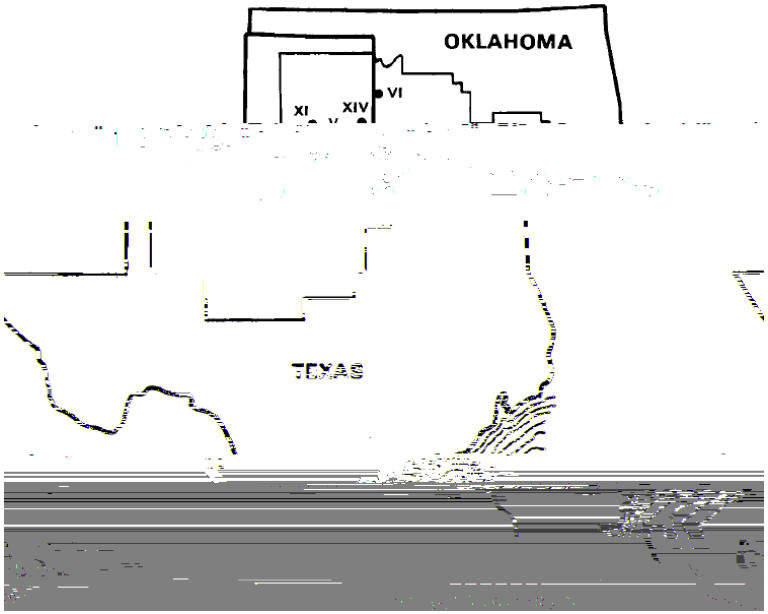
1. TX/OK River Basins
2. TX/OK E&P Recycling
3. Delta, UT
4. Salton Sea, CA
5. White Sands, NM

Govt-sponsored engineering analyses support SGSP for all these regions

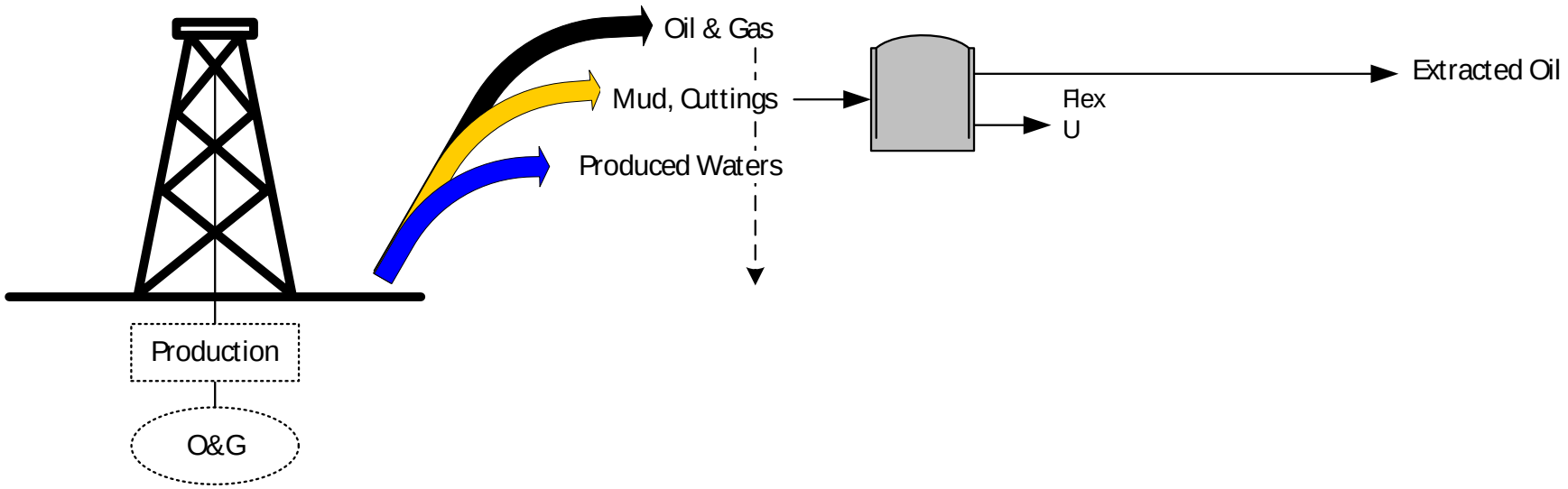
| Good SGSP Conditions | |
|---|---|
| General Location | +/- 40 qatitude |
| Solar Insolation | !3.3 kWh/sm/day |
| Landprint | 60-90 acres/MW (baseload) |
| Salt | Readily available |
| Water | Seawater/Brackish OK |

# Chloride Control on the Red & Brazos Rivers

## Regional Deployment in TX & OK



# Deep River Group Integrated Approach:
## E&P Waste Recycle




- Utilize all E&P waste streams
- Negate induced seismicity
- Distributed power for E&P
- Long-term solution
- Representative example

| | | |
|---|---|---|
| Produced Water Flow Rate | 150,000 | bpd |
| Produced Water TDS | 120,000 | ppm |
| Concentration Ratio (for 10 ppg brine) | 2.49 | |
| Recovered H2O | 89,759 | bpd |
| Required Wellhead Gas | 3,129 | Mcf/day |

| | | |
|---|---|---|
| SGSP MW Build Rate (base-load equiv.) | 6.40 | MW/yr |
| SGSP Land Requirement (per MW) | 90 | acres/MW |
| SGSP Land Requirement (per yr) | 576 | acres/yr |

DeepRiver Group: http://www.deeprivergrp.com/

# Summary: GEM Renewable Technologies

## GPGT Conversion & SGSP Systems

Zero-

# U.S. Energy Flow in Quadrillion BTUs
## (thanks to Lawrence Livermore)