

**DATA CENTERS + POROSITY STORAGE™
RESERVOIRS = WASTE THERMAL ENERGY USE +
WATER CONSERVATION = VALUED RESOURCES**

prepared for the:

**2026 Data Center World Innovation
Challenge Powered by ABB**

presented by:

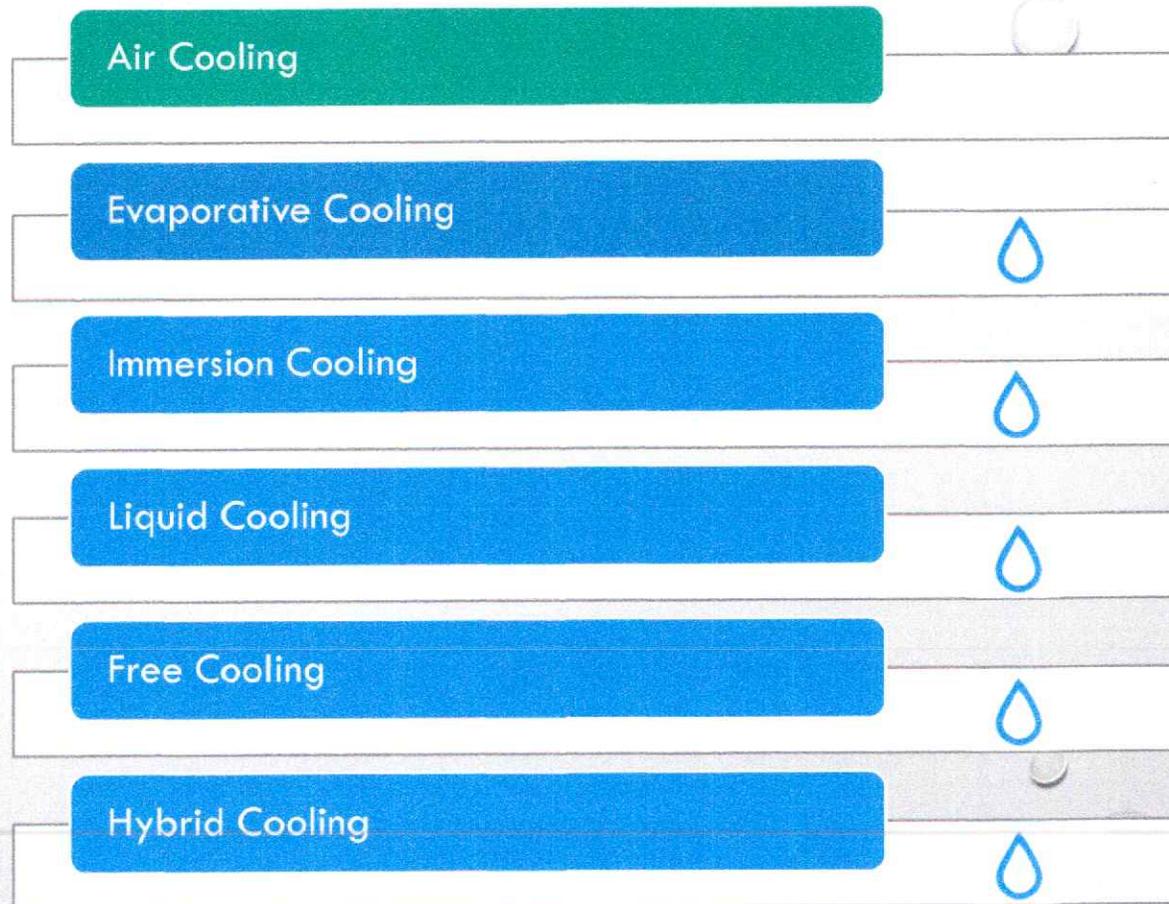
John Yelenick, LINLI Construction, Inc., dba Porosity Storage™

Richard A. Gordon, GAI Consulting Engineers Inc., dba GEOen™

Porosity Storage™ Reservoirs

- A PSR is an in-ground water storage reservoir;
- A PSR creates “dominion and control” of appropriated water rights;
- A PSR is hydrologically separate from the original surrounding deposit;
- A PSR permits the storage of hi-temp ($\leq 180^{\circ}\text{F}$ or $\leq 82^{\circ}\text{C}$), lo-temp ($\geq 3^{\circ}\text{F}$ or $\geq 2^{\circ}\text{C}$), or for any temperature in between.

How Data Centers are Cooled



= Can Be Combined With Porosity Storage (PS)

Porosity Storage™ (PS™) Waste Thermal Energy Management

PS™ is a low-cost technology for storing water in shallow in-ground reservoirs.

When waste thermal energy is combined with a PS™ in-ground water reservoir, water cost savings can approach 80% and 43% of the electrical energy converted to thermal energy.

The sell of waste thermal energy by a PS™ third party, or investor group, provides access to alternative financing with the potential to reduce water and energy cost by more than 50%.

Thermal Waste Energy Market

District heating, agriculture, commercial developments, residential developments, provide third party sustainable cost savings potential for waste energy from Data Centers.

Agricultural Impact

Controlled Environment Greenhouses (CEG)

Heating/Cooling Systems

Humidity Control

CO2 Control

Greenhouse Root Warming Systems

Aquaponics

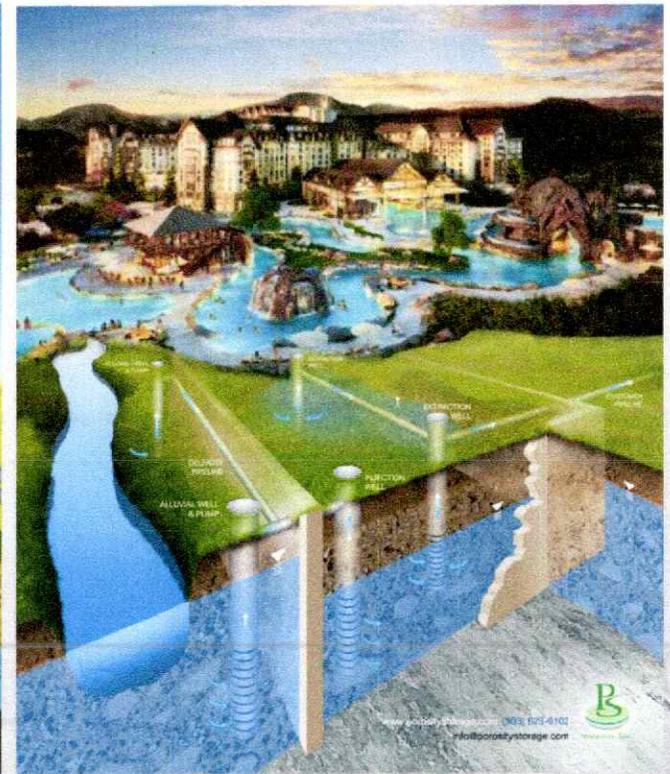
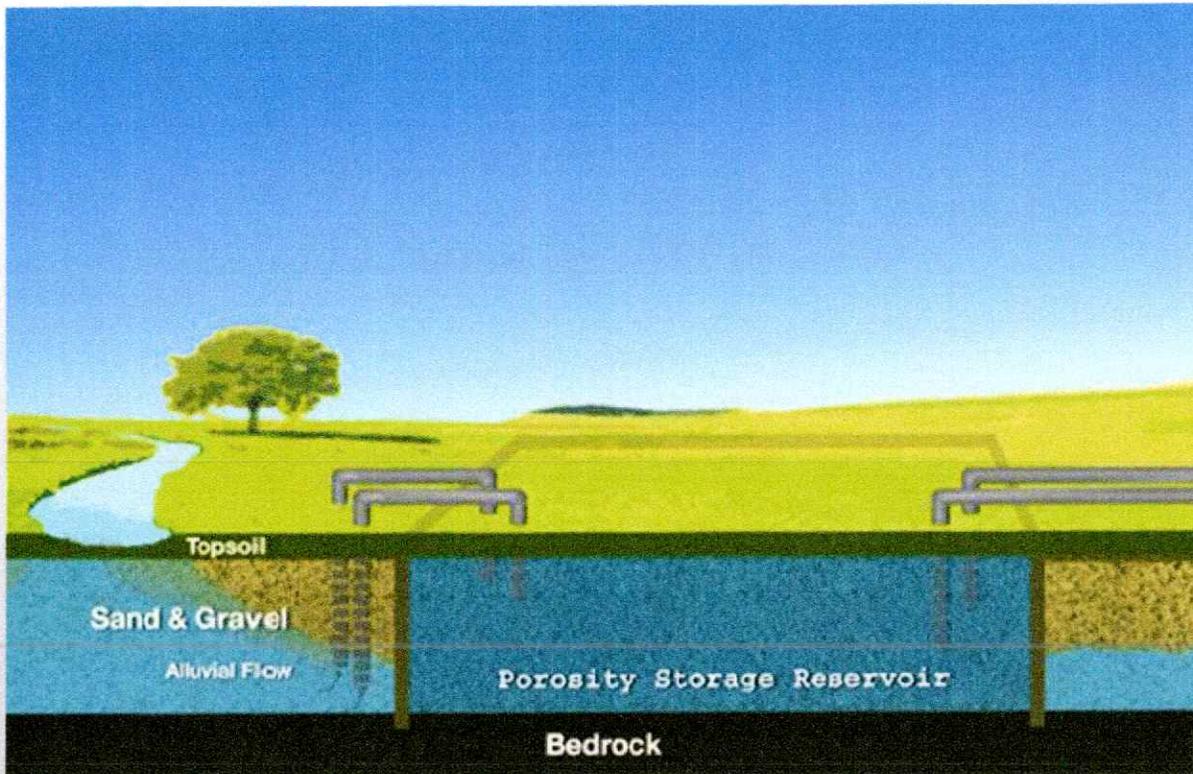
Hydroponics

Fish Production

CEG Crops

**Cannabis, Hemp, Hops,
Tomatoes, Leafy Greens,
Fruit Berries, etc.**

Porosity Storage™ Reservoirs



Compatibility of Heat Pump Systems

- Water and Multi-Source Heat Pump systems (WSHP/MSHP) exploit renewable energy resources;
- The WSHP and MSHP systems can recover waste energy from combined heat and power (CHP) systems, sea water, contaminated shallow ground applications for industrial process, agricultural, greenhouses, and communities;
- Solar thermal systems for heating energy;
- Fluid cooler systems for low temperature energy recovery;
- Modeling results demonstrate an energy savings between 20 % and 70 % in cooling and heating operating modes;
- WSHP and MSHP systems are suitable for the electrification and decarbonization process in the building sector.

Legal Issues Related to Porosity Storage™ Reservoirs

- **Must capture, possess, and control the water it intends to put into the aquifer;**
- **Must not injure other water use rights, either surface or underground, by appropriating the water for recharge;**
- **Must not injure water use rights, either surface or underground, as a result of recharging the aquifer and storing water;**
- **Must show that the storage will not tortiously interfere with overlying landowners' use and enjoyment of their property;**

Legal Issues (continued)

- Must not physically invade the property of another by activities such as directional drilling, or occupancy by recharge structures or extraction wells, without proceeding under the procedures for eminent domain;
- Must have the intent and ability to recapture and use the stored water;
- Must have an accurate means for measuring and accounting for the water stored and extracted from storage in the aquifer.

Porosity Storage™ Reservoir Features

- No or Minimal Evaporation Losses;
- Difficult to Contaminate;
- Prevents Contamination of Ground Water;
- Low Permitting Requirements;
- Conjunctive use of the Ground;
- Surface Use, Landscaping (parking, etc.);
- Short Project Completion Time;
- Scalable;
- Environmentally Friendly;
- Legal Issues Resolved;
- Hi-temp (>120°F) Energy Storage;
- Lo-temp (>34 °F) Energy Storage;
- Standard Range Energy Storage Cells (55°F - 85°F);
- Maintains Soil Fertility.

Porosity Storage™ Reservoir Considerations

- Geological Constraints;
- Depth to Bedrock;
- Material in Reservoir (porosity);
- Poor Chemical Properties;
- Ground Water Limitations;

Capacity Determination of a Porosity Storage™ Reservoir

- Geological requirements: bedrock less than 100-feet in depth;
- Sand, gravel or sand/gravel bed material;
- 20% to 60% of volume in ground reservoir;
- Ex: 100ft wide x 100ft length x 100ft depth = 1,000,000 cf
- @20% = 200,000 cf of water storage = 1,496,104 gal;
- At a 20F temperature differential, energy storage = 1,496,104 x 8.34 lb/gal x 20 °F = 250 million btu.



Construction of a Porosity Storage™ Reservoir

- Slurry Wall's;
- Standing Water Columns;
- Production/Injection Wells;
- [HTTPS://WWW.YOUTUBE.COM/WATCH?V=MZIUYM43P1O](https://www.youtube.com/watch?v=MZIUYM43P1O)
- [HTTPS://WWW.YOUTUBE.COM/WATCH?V=1TCW25JSUWI](https://www.youtube.com/watch?v=1TCW25JSUWI)

Slurry Wall Installation

- Trench Depth: 125+ ft deep;
- Trench Width: 12" – 48" wide;
- Speed: 200-500 linear feet/day;
- Benefits: In-situ mixing, complete homogenized wall from top to bottom; secure bottom seal; no voids or windows;
- Safety: Fast installation with minimal equipment movement and personnel on site;
- Results: Superior wall with consistent mixing from top to bottom and NO POSSIBILITY OF VOIDS.



Slurry Wall Installation (section)



Cost Advantage

Utility Rebates
Water and
Power

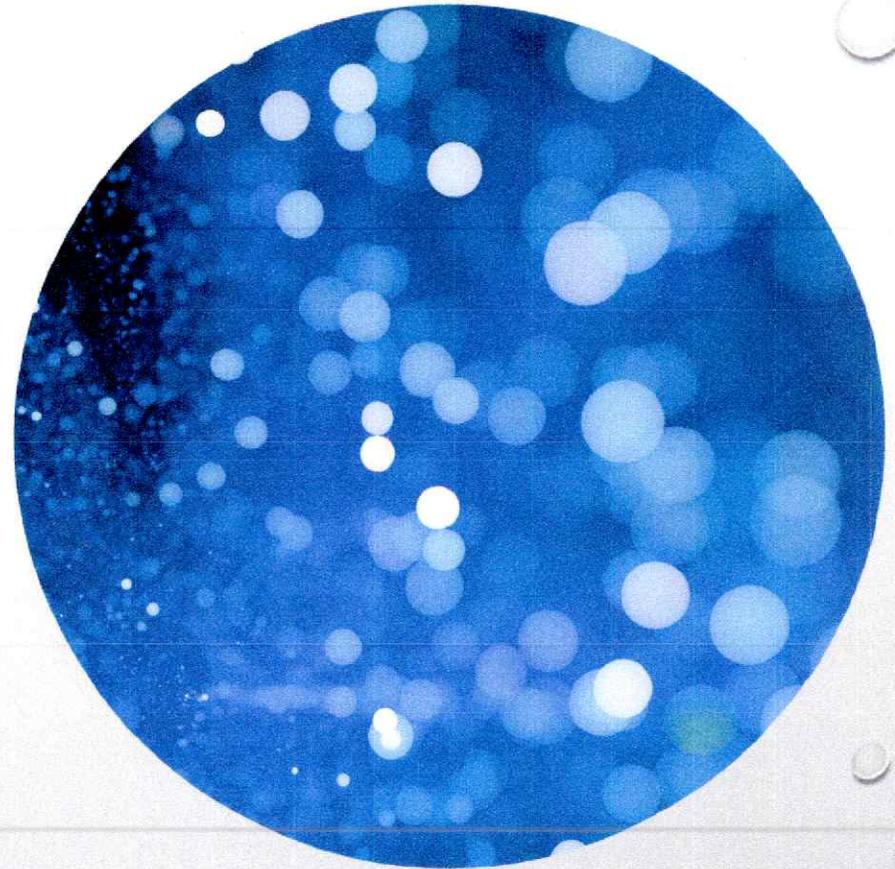
Accelerated
Depreciation

Reduced
Water Cost

Reduced
Energy Costs

CO2
Sequestering
Credits

Sale of Waste
Thermal
Energy



HEAT EXCHANGERS FOR A POROSITY STORAGE™ RESERVOIR

- EXTRACTION AND REINJECTION PUMPING SYSTEM;
- STANDING WATER COLUMNS;
- ENERGY EXCHANGE TANKS;
- VERTICAL STACKED COILED HEAT EXCHANGERS.



Site Water Consumption Analysis

- Withdrawal Gallons (million): 431.8
 - Discharge Gallons (million): 86.8
 - Consumption Gallons (million): 345.0
 - Consumption Gallons (hcf): 461,200.0
 - Percent Cooling Consumption (hcf): 79.9 %
 - Annual Cooling Water Consumption
 - Annual Site PS Savings (80%): **\$852,290.0**
- | | |
|----------------------|---------------|
| Cost (@ \$2.31/hcf): | \$1,065,362.0 |
|----------------------|---------------|
- 24-Hour Data Center Operation
 - 100 Tons of Evaporative Cooling Tower Capacity
 - 252 Gallons/Hour Evaporated
 - 6,048 Gallons/Day or 2,207,520 Gallons/Year
 - Using PS consumes 0 Gallons/Year
 - **For every 1,000 tons of data center cooling, PS™ saves 22.1 million gallons of potable water annually**

Site Electric Energy Consumption

- Composite, Banded Rate Structure (\$/kWh) 0.175
- Annual Site Consumption (kWh): 105,690,000
- Annual Site kWh Cost (\$): 18,495,750
- Annual Site kWh Cooling Cost (\$): 7,398,300
- **Annual Potential Site PS Savings (\$): 2,959,320**

(average for 11 sites)

Energy Consumption Reduction

- **A 50% TO 100% INCREASE IN COOLING EFFICIENCY, CORRESPONDING TO A 30% TO 50% REDUCTION IN COOLING ENERGY COST CAN TRANSLATE INTO A 40-400% ANNUAL ROI**
- **GARTNER REPORTS THAT, ON AVERAGE, DATA CENTER DOWNTIME COSTS \$5,600 PER MINUTE**

(average for 11 sites)

Authors Patents for Porosity Storage TM Reservoirs

- October 2013: Multi-source Heat Exchange System Employing a Ground-energy Storage System for Controlled Environment Enclosures: Gordon et al.
- January 2017: Geothermal Heat Exchange Using Coiled Heat Exchangers in Water Column: Gordon et al. (patent being refiled)
- July 2015: Underground Storage Heating and Cooling (USHC) System: (PS Systems, Inc.)
- December 2011: Maintaining Dynamic Water Storage in Underground Porosity Reservoirs (PS Systems, Inc.)
- July 2011: Bank-sided Porosity Storage Reservoirs (PS Systems, Inc.)
- March 2007: Direct Recharge Injection of Underground Water Reservoirs (PS Systems, Inc.)
- January 2005: Underground Alluvial Water Storage Reservoir and Method (PS Systems, Inc.)

Thankyou from Porosity Storage™ and Geothermal Energy and Environmental Services

- Gordon and Associates, Inc., dba GEOen
- [Richard A. Gordon, P.E.](#)
- 4993 NW Lavender Circle
- Corvallis, OR 97330
- (541) 602-0710
- ragordon@peak.org
- LINLI Construction, Inc., dba Porosity Storage™
- [John J. Yelenick, President](#)
- 3650 South Dahlia
- Denver, Colorado 80237
- (303) 332-6828
- JohnYelenick@gmail.com