Sustainable Development Operations

Speaker: Garen Ewbank / *Ewbank Geo Testing, LLC*

Sustainable Development Operations (S DevOps) for Thermal Systems

- Thermal Risk Compression in Water-Loop Infrastructure
  - NY-GEO 2026 | Brooklyn, NY

Learning Objectives

1. Risk management of operations, design, and financing of thermal energy systems known as TENS.
2. Identify the structural mathematical components of TENS.
3. Connect the math with the design, then the financials.
4. Mitigating risk at each branch-design, operations, control, and financial.
5. Methods to lower the first cost and improve operations and efficiencies.

The Core Problem

- Geothermal must scale without scaling risk
  - Subsurface uncertainty drives IRR variability
  - Loop drift drives long-term EUI degradation
  - Thermal risk must be compressed

EUI Is the Controllable Variable

- EUI is the outcome metric
  - Thermal systems dominate building energy
  - Part-load performance defines annual EUI

The 50/90 Operating Reality

- The 50/90 Operating Reality
  - the loads are at 50% for 90% of the time

Heat Transfer in the Earth

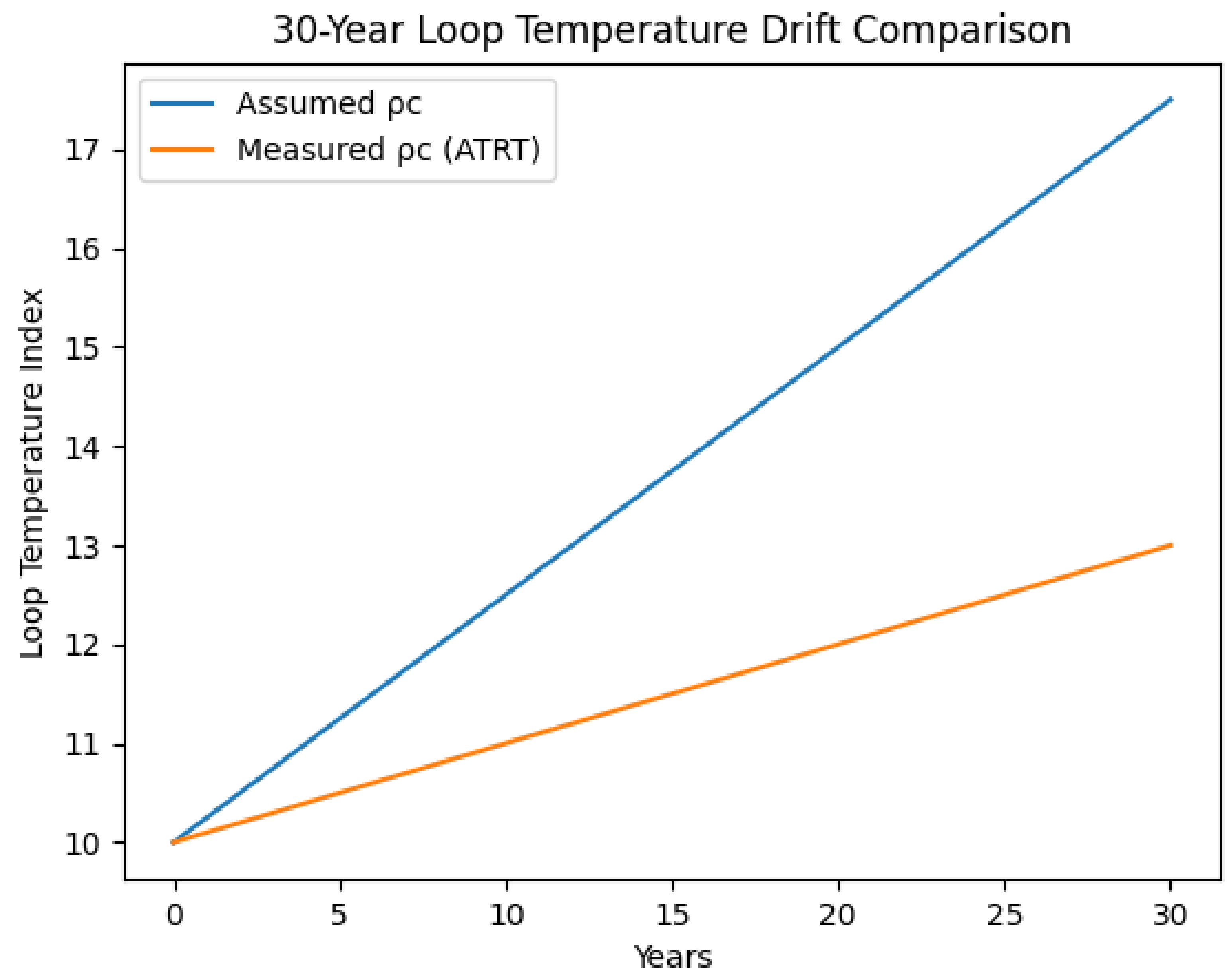
- $\partial T/\partial t = \alpha \nabla^2 T$
  - $\alpha = k / (\rho c)$
  - k → magnitude | ρc → storage | α →Heat Transfer in the Earth time behavior

Heat Transfer in the Earth

- $\partial T/\partial t = \alpha \nabla^2 T$
  - $\alpha = k / (\rho c)$
  - k, Conductivity governs **magnitude**
  - ρc, Volumetric heat capacity governs **temperature drift over time**

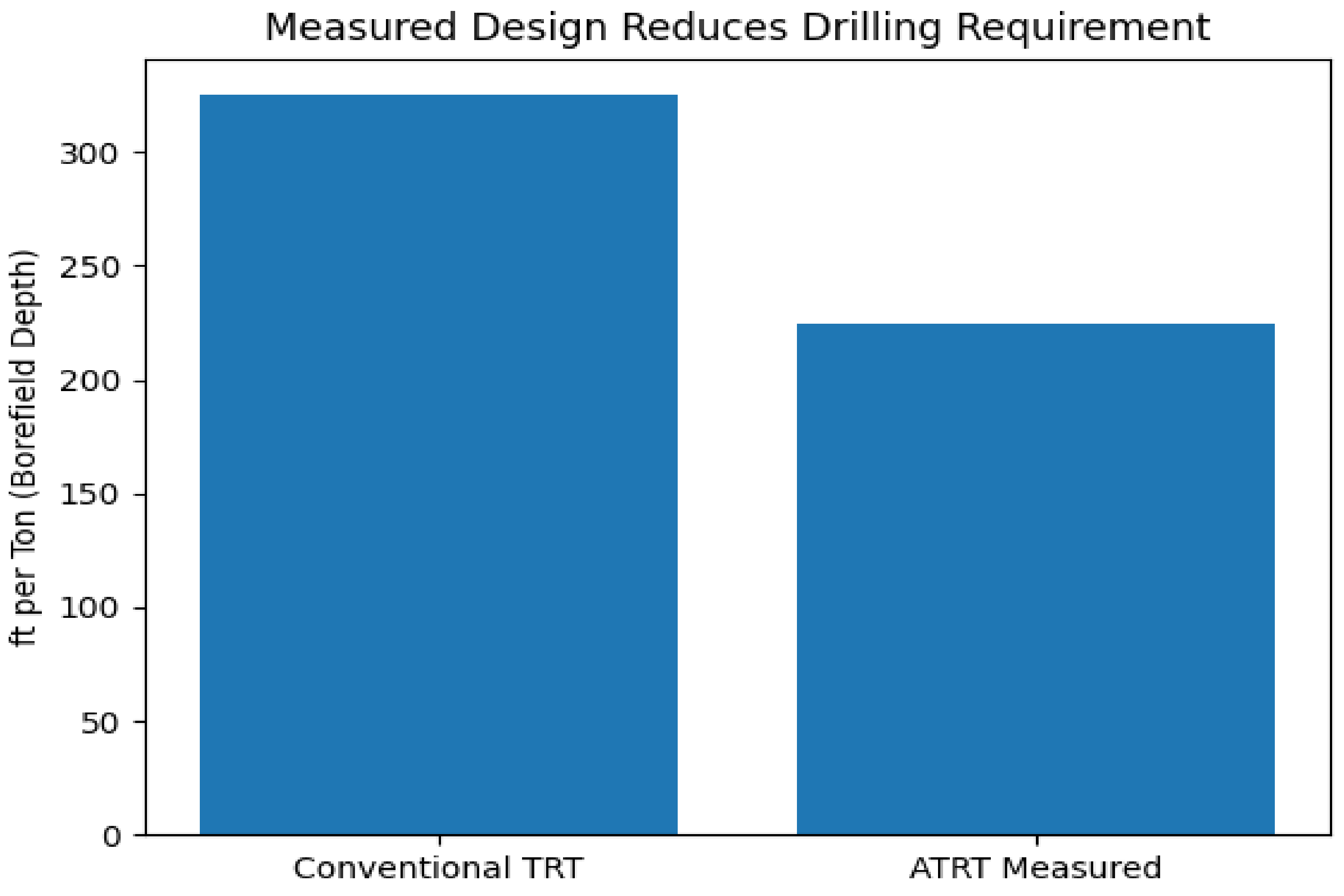
30-Year Drift Modeling (Measured vs Assumed)

- Measured ρc narrows uncertainty band
  - Assumed ρc in30-Year Drift Modeling (Measured vs Assumed) decreases long-term drift variance



Borefield Sizing Impact

- Conventional TRT midpoint: ~325 ft/ton
  - ATRT measured midpoint: ~225 ft/ton
  - Drilling reduction lowers CapEx and IRR variability



Standard TRT Limitation

- Identifies conductivity (k)
  - Assumes volumetric heat capacity (ρc)
  - Drift prediction depends on ρc

Advanced Thermal Response Testing (ATRT)

- Measures deep earth (far field) temperature, k and ρc in-situ
  - Calibrates digital twin models
  - Reduces subsurface uncertainty

Borefield Sizing Impact

- Conventional: 300–350 ft/ton
- ATRT measured: ~200–250 ft/ton (site dependent)
- Reduced CapEx and IRR variability

30-Year Thermal Drift Sensitivity Concept

- Measured ρc → Narrow uncertainty band
- Assumed ρc → Wide drift variance
- Measurement compresses thermal risk

Ambient Temperature Loops (ATL)

- 40–90°F operating band
  - Parallel building connections
  - Thermal transfer and transport spine
  - **Diversity capture**

Integrated Thermal Baseline Stack

- ATRT → Precision measurement
- GHX → Seasonal storage
- ATL → Transport spine
- Polymodal → Efficiency governor

Polymodal Heat Pump Innovation

- Integrated ASHP + WSHP
  - Dynamic multiple heat sink/source modulation
  - Transfers heat bidirectionally between the outside air and the water loop
  - Maintains stable COP envelope

Polymodal Multi-Load & Multi-Sink Modulation

- Prioritizes optimal sink/source to meet the multiple loads
- Reduces peak electric demand
- Reduces loop drift

What Is S DevOps?

- Measure → Model → Detect → Correct → Institutionalize
  - –Continuous governance of thermal infrastructure

Continuous Commissioning Framework

- 8760 monitoring
  - Portfolio COP tracking
  - Drift detection KPIs

Water Loops as Grid Assets

- Distributed thermal storage
  - Peak demand stabilization
  - Grid-responsive polymodal operation

Alignment with New York Climate Goals

Why This Matters

- Utilities: Dispatchable thermal load
- Developers: Reduced CapEx variability
- Investors: Tighter IRR bands
- Owners: Continuous EUI reduction

The Brooklyn Question

- How do we scale geothermal without scaling risk?
- How do we electrify without oversizing?
- How do we integrate thermal and power grids?

The Answer

- Measure precisely (ATRT)
  - Stabilize infrastructure (ATL)
  - Optimize dynamically (Polymodal)
  - Govern continuously (S DevOps)
  - Scale intelligently

Questions?

1. How is risk management of operations, design, and financing of thermal energy systems known as TENS handled?
2. How does the physics, math, and heat flow identify the structural mathematical components of TENS?
3. Risk of TENS operations connect the math with the design, then the financials and why is that important?
4. How is risk mitigated at each branch-design, operations, control, and financial?
5. What methods are used to lower the first cost and improve operations and efficiencies?

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