



**Geothermal Clean  
Energy Challenge**

# **Geothermal Clean Energy Challenge: Targeted Geothermal Audit & Conceptual Design**

## ***Statement of Work Requirements***

**May 2018**

Prepared for:

**New York Power Authority (NYPA)**

and

**New York State Energy Research and Development  
Authority (NYSERDA)**

Prepared by:

**ICF**

Additional Information: [nypa.gov](http://nypa.gov) | [nypa.gov/geothermalchallenge](http://nypa.gov/geothermalchallenge)

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## Table of Contents

1. INTRODUCTION AND BACKGROUND .....	2
2. OBJECTIVE OF THE TARGETED AUDIT & DESIGN STUDY .....	4
3. STATEMENT OF WORK FOR TARGETED AUDIT & DESIGN STUDY.....	6
3.1 PURPOSE .....	6
3.2 PROCEDURES FOR ANALYSIS .....	6
3.3 DELIVERABLES .....	9
3.4 FINAL REPORT REQUIREMENTS .....	10

### 1. INTRODUCTION AND BACKGROUND

This document provides an introduction to ASHRAE (American Society of Heating, Refrigerating and Air-conditioning Engineers) procedures for energy audits, as well as statement of work requirements for completion of a targeted geothermal audit and conceptual design study. This document contains guidance related to Stage 3 of the Geothermal Clean Energy Challenge, hereafter referred to as the “Challenge,” which was launched by the New York Power Authority (NYPA) and the New York State Energy Research and Development Authority (NYSERDA) in December 2017. The Challenge is a multi-stage program of free technical support, financial assistance and implementation services to stimulate the installation of best-in-class, large-scale geothermal systems in New York State. Stage 3 of the Challenge involves the production of audit-grade detailed design studies and business planning reports before large-scale geothermal (also called ground source heat pump, or “GSHP”) systems are deployed. This document describes certain required elements to progress through Stage 3 of the Challenge.<sup>1</sup>

The statement of work included in this document is tailored to the specific needs of candidate sites considering the installation of a GSHP to replace existing or planned conventional Heating, Ventilation, and Air-Conditioning (HVAC) equipment for one or more buildings. As such, sites may consist of new buildings to be constructed, existing facilities, or a mix of the two. Each GSHP system included in the Challenge must have a minimum capacity of 100 tons, which may be met by including a single building or multiple buildings connected to a single subsurface heat exchanger loop.<sup>2</sup>

The goal of an energy audit is to identify key measures for energy savings. ASHRAE has developed the following three audit standards with increasing rigor based on the magnitude of upgrades being considered:

- **Level I Energy Audit:** Commonly referred to as a “walk-through” audit, a Level I energy audit is used to identify facility-specific operational inefficiencies and low-cost energy savings. This rapid assessment of efficiency can also provide a list of suggested measures that warrant further investigation and can therefore help determine whether a candidate site should pursue further audits. In lieu of a walk through, all

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<sup>1</sup> The Challenge begins with applications from eligible end-user facilities that seek to evaluate GSHP systems of at least 100 tons in capacity. In Stage 1, accepted applicants receive free summary screening reports describing expected technical and financial outcomes at their potential GSHP sites. Top-ranked sites from Stage 1 advance to Stage 2, where they receive free advanced reports with additional economic details on their potential GSHP systems. After the audit and planning activities of Stage 3, eligible facilities move into Stage 4 where they can receive financing and engineering, procurement, and construction assistance for GSHP system deployment and performance monitoring.

<sup>2</sup> For additional background on ASHRAE energy audits, please see ASHRAE’s *Procedures for Commercial Building Energy Audits (2011)* and Pacific Northwest National Laboratory’s *A Guide to Energy Audits (2011)*.

## Targeted Geothermal Audit & Conceptual Design

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facilities with potential GSHP systems eligible for Stage 3 will have a GSHP site screening summary report from Stage 1 of the Challenge.

- **Level II Energy Audit:** A Level I audit will be followed up by a Level II audit, which encompasses a more detailed energy survey and analysis to highlight practical measures with reasonable payback periods and any potential capital-intensive improvements such as GSHPs. This type of audit involves a much more detailed building survey and data collection process and provides a breakdown of building energy consumption by each end use for each fuel type. As part of the analysis, a detailed building energy simulation, calibrated to historical data, will be used to model the energy savings for each measure recommended. While a calibrated building energy model is sometimes optional for a generic Level II assessment, it is required for Stage 3 of the Challenge. Because of the emphasis on GSHP, the scope of measures to be assessed must include: a geothermal HVAC system and a comparable conventional high efficiency HVAC system. For both of these measures, all other reasonably cost effective measures should be assumed to be implemented first, and taken into account when considering system sizing and energy savings calculations. The contractor shall prepare a 30% conceptual design including schematic drawings, as well as required analysis and other documentation needed to secure financial assistance from state and utility incentive programs. Please see the statement of work in Section 3 for a full description of the activities required.
- **Level III Energy Audit:** The most sophisticated and final level is a Level III audit, also known as an investment grade audit. The calibrated building energy model from the Level II targeted assessment is used to ensure that interactive effects between the suggested measures are accurately accounted for, providing a higher level of confidence in savings estimations before proceeding with construction. A Level III audit is only conducted when a site desires to analyze capital-intensive measures. An in-depth analysis requires a 60% schematic design be used to estimate cost and savings and allow a major capital investment decision to be made with confidence. Each level of audit expands on the findings from the previous level. A Level III audit, therefore, builds upon Level I and Level II audit findings. For the Challenge, the Level III Audit, including a 60% schematic design, will be performed under Stage 4 (Project Implementation), and so is not included within the scope of this targeted audit and design study. The design build contractor will be responsible for providing engineering and design, information needed to secure financing for construction and obtaining customer approval to proceed with construction. Decision to construct will be based on design build contractor's analyses and design drawings and accompanying precise economics.

### 2. OBJECTIVE OF THE TARGETED AUDIT & DESIGN STUDY

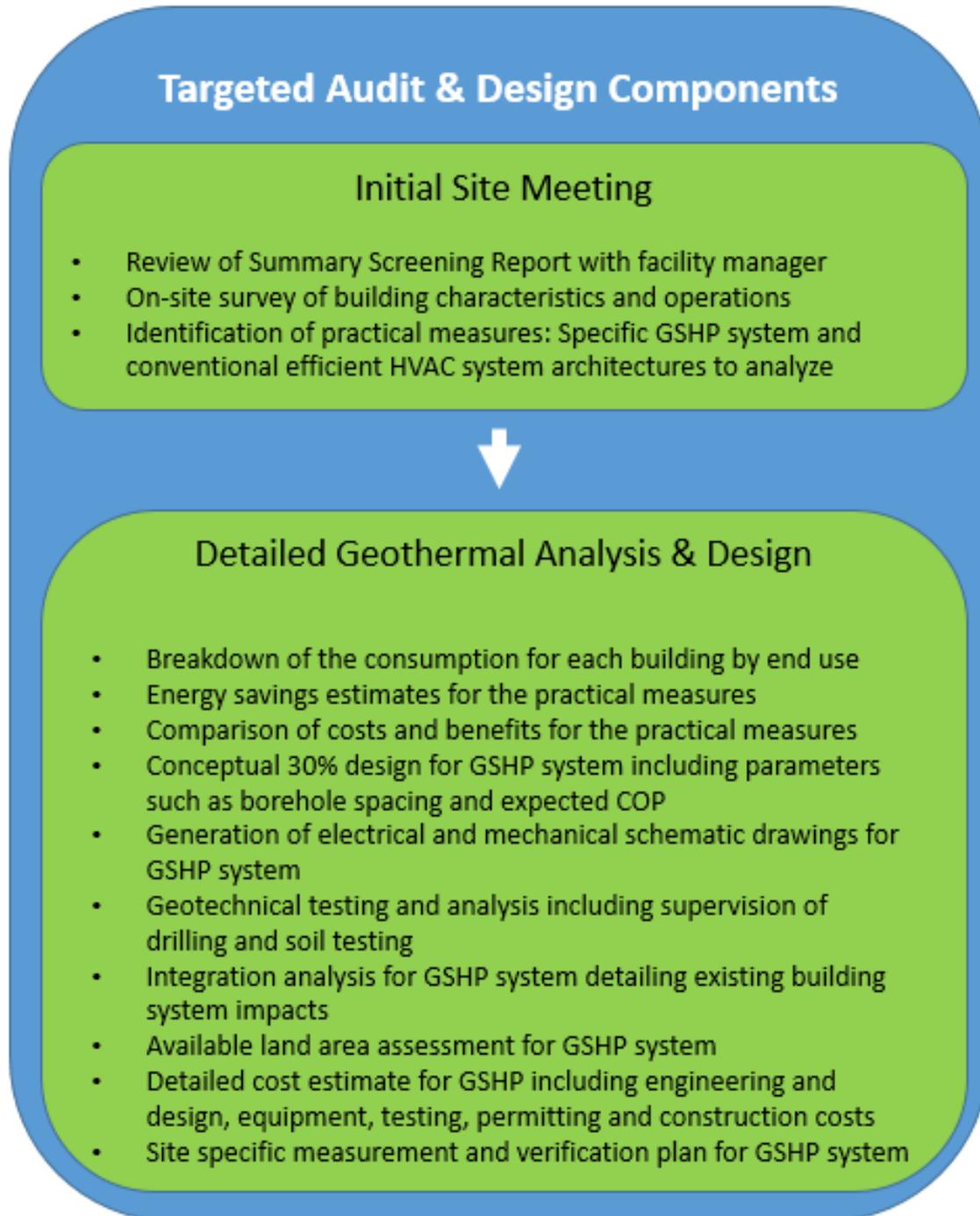
Typically, energy audits are conducted without pre-determining specific systems or energy efficiency measures. A variety of measures are evaluated and prioritized based on site conditions, budget constraints, return on investment criteria, and energy savings goals. Since this targeted audit is being conducted as part of the Geothermal Clean Energy Challenge, the evaluated energy efficiency measures must include a GSHP system design. In addition, a modern high efficiency HVAC system, such as a condensing boiler and variable speed drive chiller, must also be included in the evaluated measures. This approach will allow for a direct comparison between the energy and cost savings opportunities of a GSHP system and a more commonly used conventional HVAC system. While a capital-intensive measure, such as the installation of a GSHP system, may be more commonly analyzed as part of the Level III audit, GSHP systems are included under the scope of this targeted Level II audit due to the benefits of receiving earlier audit outcomes to inform facility investment decisions and Challenge program funding allocations.

The overall objective of the targeted audit is twofold. First, it is to analyze the cost and benefits of a GSHP system in comparison to a modern high efficiency HVAC system upgrade. Second, it is to conduct analysis of GSHP system in situ, which has the potential to receive financial and other support through the later stages of the Challenge, and prepare a detailed 30% design. A unique consideration for this targeted audit in comparison to a traditional ASHRAE Level II audit is that a candidate site may include multiple buildings that can be served by a single geothermal loop.<sup>3</sup> **Figure 1** illustrates the key components for each phase of the targeted audit. Each of the components is described in further detail in the statement of work provided in Section 3.

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<sup>3</sup> For additional background and detailed requirements on GSHP system design, please see ASHRAE's *Geothermal Heating and Cooling Design of Ground-Source Heat Pump Systems* (2014).

Figure 1. Key Components of Targeted Audit



### 3. STATEMENT OF WORK FOR TARGETED AUDIT & DESIGN STUDY

This section describes the Statement of Work for a Targeted Audit & Design Study that is required for Stage 3 of the Geothermal Clean Energy Challenge.

#### 3.1 PURPOSE

The purpose of this targeted audit and design study is to help facilities in their commitment to implementation. As this work is being performed for the Challenge, the measures to be analyzed must include a GSHP system and conventional high efficiency HVAC system. It is expected that the Contractor will work closely with each site to keep relevant stakeholders informed of progress on the audit workflow and will clarify and resolve any questions pertaining to the statement of work that may arise.

#### 3.2 PROCEDURES FOR ANALYSIS

The statement of work to be completed encompasses two key phases: An *Initial Site Meeting* and a *Detailed Geothermal Analysis & Design Study*. The activities required for each phase are described below. Prior to discussing these two phases, this section describes GSHP screening results provided to the facility in Stages 1 and 2 of the Challenge. These materials will streamline data collection for the Stage 3 targeted audit.

Because the Challenge is open to both new and existing facilities, there can be distinctions in outcomes or requirements depending whether the facility is new or existing. Any such distinctions are noted with an asterisk (\*).

Based on the Stage 1 and 2 report process, Contractors may obtain the following information from the facility or NYPA and NYSERDA upon authorization from the facility:

1. Qualitative data gleaned from the facility's Challenge application and from phone conferences and email correspondence with facility managers or other staff at the potential GSHP site.
2. A summary table of characteristics for each building present at a site that is to be connected to the potential GSHP system
3. \* For existing facilities, copies of all relevant utility bills for a minimum of a year.
4. A copy of the Stage 1 and 2 reports presented to the facility, which includes the first round estimations of savings and costs for implementing a GSHP system at the site, as well as expected financial metrics (including net present value (NPV), savings-investment ratio (SIR), and simple payback).

#### Level II Targeted Audit – Initial Site Meeting

1. Meet with facility manager/operator and building occupants to review Stage 1 and 2 reports and learn of unique issues or needs of each facility.

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## Targeted Geothermal Audit & Conceptual Design

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2. \* For existing facilities, conduct a walk-through survey and documentation review of each building to inspect and get a basic understanding of its construction, equipment, operation, and maintenance.
  - a. \* For new construction facilities, this step includes only the review of existing documentation for the planned building.
3. For each facility, identify the specific type of GSHP and conventional high efficiency HVAC measures that might be considered practical for the facility based on the constraints identified, as well as other energy efficiency measures that should be considered. All measures identified during this stage are hereafter referred to as the “practical measures.”
  - a. The GSHP system and conventional high efficiency HVAC system should be able to meet the annual and peak heating and cooling needs of all buildings included in the site.
  - b. If this does not make sense from a cost-effectiveness point of view due to high peak loading (or other defensible reasoning), the proposed GSHP system may include a supplementary backup such as a boiler. Documentation must be presented defending this conclusion.

### Level II Targeted Audit - Detailed Geothermal Analysis & Design

All work shall meet or exceed minimum requirements of the most current publication of applicable industry standards for commercial and institutional building assessments and GSHP system design.

1. \* For existing facilities, review the mechanical and electrical system design, installed condition, maintenance practices, and operating methods.
  - a. \* For new construction, this includes only a review of the mechanical and electrical system design documentation.
2. \* For existing facilities, compare key operating parameters to design levels (i.e., heating/cooling water temperature, supply air temperature, space temperature, space humidity, ventilation levels, lighting levels, operating schedules).
3. \* For each building, create a breakdown of the annual energy consumption for each fuel type (electricity, natural gas, etc.) into the unique end use components. These estimates must be provided through calibrated hourly simulation modeling utilizing industry validated software such as DOE’s EnergyPlus or Carrier HAP. At least 2 years of utility bill data will be used for calibration.
  - a. \* For new construction, model calibration is not required.
4. Create a detailed 30% conceptual design of a GSHP specific to the candidate site. The design parameters must include:
  - a. Planned GSHP size (heating and cooling tons), accounting for reduced sizing needs from the implementation of cost-effective efficiency measures
  - b. Projected minimum and maximum entering water temperatures

## Targeted Geothermal Audit & Conceptual Design

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- c. Expected Coefficient of Performance (COP)
  - d. Type of working fluid
  - e. Diagram of utility locations
  - f. Type and configuration of planned loop field including:
    - i. Distance between boreholes
    - ii. Planned depth of boreholes
    - iii. Accessibility to surface or groundwater
    - iv. Ground thermal conductivity and thermal diffusivity test
    - v. For open loop systems include water quality, pH levels, yield, and pump down
    - vi. Proper piping sizing strategy to allow for adequate flushing of closed looped systems
5. Generate a set of schematics suitable for informing a Design-Build (DB) bid scope for GSHP system implementation. The following types of drawings and other design information shall be included:
- a. Schematic of planned loop field
  - b. Electrical drawings
  - c. Mechanical drawings

*Drawings shall list all major GSHP equipment needed for the complete system, including but not limited to, heat exchangers, pumps, air handlers, regulators, dampers, wells, manifolds, chillers and motors.*
  - d. System testing and commissioning requirements
  - e. Typical DB standards for valves and other minor equipment to be provided
6. Manage the analysis of site geological conditions including procuring services for and supervising geothermal well testing. Geotechnical testing and analysis shall include studies of hydrogeology, thermal conductivity, water composition, and soil composition. The Contractor is expected to witness all drilling and soil testing.
7. Assess the impact of the integration of the GSHP system into the existing/planned building systems that will remain post installation (such as a sidewalk hydronic snow melt system). Detailed descriptions of system impacts should include parameters such as hydronic system temperature changes and system efficiency impacts. If additional new systems are planned in coordination with the GSHP system installation, those systems should be included in the analysis.
8. A review of siting considerations for the GSHP loop field and mechanical equipment including an assessment of the available land area for the GSHP system.

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## Targeted Geothermal Audit & Conceptual Design

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- Considerations should include issues related to disruption of existing site uses (e.g., parking) and potential historic or cultural sites/areas.
9. \* Generate energy and demand savings estimations for the practical measures. Contractors must utilize calibrated energy models for this portion of the analysis.
    - a. \* Model calibration is not required for new construction.
  10. Develop a site-specific measurement and verification (M&V) plan for the GSHP measure following requirements outlined for the Challenge.<sup>4</sup>
  11. Estimate the implementation cost for each measure and required monitoring, as well as the measure's impact on utility bill costs and building operations & maintenance costs. Based on these figures, produce an economic analysis of the following metrics for each measure: simple payback, NPV, Internal Rate of Return (IRR), Savings to Investment Ratio (SIR), and Modified Internal Rate of Return (MIRR). For the analyses, a 30-year life should be assumed for the GSHP system.
    - a. Prepare a detailed cost estimate for the implementation of the GSHP system including engineering and design, equipment, testing, permitting, construction, and maintenance. A detailed payback and life cycle cost analysis shall be completed based on expected upfront and operating costs.
  12. Prior to completing the analysis, meet with the client in person to discuss priorities and assist in the select implementation methods.

***Deliverable:*** Provide the final report as described in Section 3.4.

### 3.3 DELIVERABLES

The following interim and final deliverables are required for this study:

- 1) Initial site meeting findings and identified modifications report.
- 2) Final report as described in the Section 3.4. Draft and final versions of this report are required, as well as a presentation of the results.
  - a. A draft report submitted to the GSHP candidate site, NYPA, and NYSERDA for an initial round of feedback prior to the final presentation.
  - b. Final presentation to be completed in person at the GSHP candidate's site with accompanying slide deck summarizing the results.
  - c. A second-round draft submitted to the GSHP candidate site, NYPA, and NYSERDA for another round of feedback before final release of the report.
  - d. Final version of audit report incorporating first and second rounds of feedback.

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<sup>4</sup> NYPA and NYSERDA. Geothermal Clean Energy Challenge: Standardized Measurement & Verification Requirements for Ground Source Heat Pumps. May 2018. Prepared by ICF.

### 3.4 FINAL REPORT REQUIREMENTS

A final report describing the results of the analysis outlined in Section 3.2 shall be prepared. This final report should contain, but not be limited to, the following information:

1. General Overview section that includes an executive summary and background information of the project.
2. Existing Building Summary & System Analysis
  - a. Summary of defining characteristics for each building accompanied by a typical floor plan and an inventory of major energy consuming equipment by end-use.
  - b. General description of the buildings mechanical and electrical systems.
  - c. Description of winter peak load and summer peak load requirements for each GSHP system.
  - d. Overview of modeling method for end-use breakdown.
    - i. Energy model creation and calibration overview (if applicable).
  - e. Energy end-use breakdown and cost summary.
3. Energy Efficiency Measure Selection & Analysis
  - a. List of impractical measures that were considered but deemed to be unfit for the project with justification for each omitted measure.
  - b. Details of practical measures assessed, including for each:
    - i. Description of the existing condition and why excess energy is being used.
    - ii. Outline of the proposed measure and relevant characteristics.
    - iii. Description of maintenance for any existing systems that may be required prior to measure implementation.
    - iv. Description of any potential (or perceived) impacts on occupant comfort, health, and safety. For instance, reduced ventilation during after-hours use, altering building cooling set-points.
    - v. Description of potential impacts on operating and maintenance procedures as well as additional maintenance staff or training.
    - vi. Anticipated life expectancy, by component, of the recommended measure and the impact on existing equipment life.
    - vii. Description of the modeling method used and documentation of the relevant input values assumed for simulation.
4. A summary table listing estimated costs, savings and financial performance indicators (e.g., simple payback, NPV) for all practical measures. This table will

## Targeted Geothermal Audit & Conceptual Design

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provide an estimated accuracy for each measure implementation cost quoted.

5. Detailed Geothermal Design & Analysis
  - a. Description of proposed geothermal system architecture, including a summary table of design parameters. Justification for the specific type of GSHP selected shall be included.
  - b. Set of drawings (can be included in an appendix) including mechanical system, electrical system, and loop field schematics.
  - c. Detailed cost estimate breakdown and documentation.
  - d. Description of siting considerations for the GSHP loop field and mechanical equipment.
  - e. Description of modeling improvements for refined energy and demand savings calculations.
  - f. Summary table of estimated costs, saving, and financial performance indicators including simple payback, NPV, IRR, SIR, and MIRR for the proposed GSHP system for years 7, 10, 15, and 20.
  - g. Summary table of geotechnical testing results and system impacts.
  - h. Description of GSHP impacts on systems to remain post installation.
6. Additional Capital-Intensive Measures to Consider
  - a. List and description of any capital-intensive measures with potentially promising savings that were not considered within the audit scope.
7. Measurement & Verification Procedure
  - a. Identify and prioritize potential M&V methods according to the standardized requirements outlined for the Geothermal Challenge.<sup>5</sup>
8. Conclusion to include the total project budget, selected measures, and any other final recommendations.

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<sup>5</sup> NYPA and NYSERDA. Geothermal Clean Energy Challenge: Standardized Measurement & Verification Requirements for Ground Source Heat Pumps. May 2018. Prepared by ICF.