# Green Energy Life Cycle Assessment Tool v2 (GELCAT2)

**WaterRF Project No. 4464**

**AWWA Sustainable Water Management Conference 2016**

**Presented by:**
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**March 8, 2016**

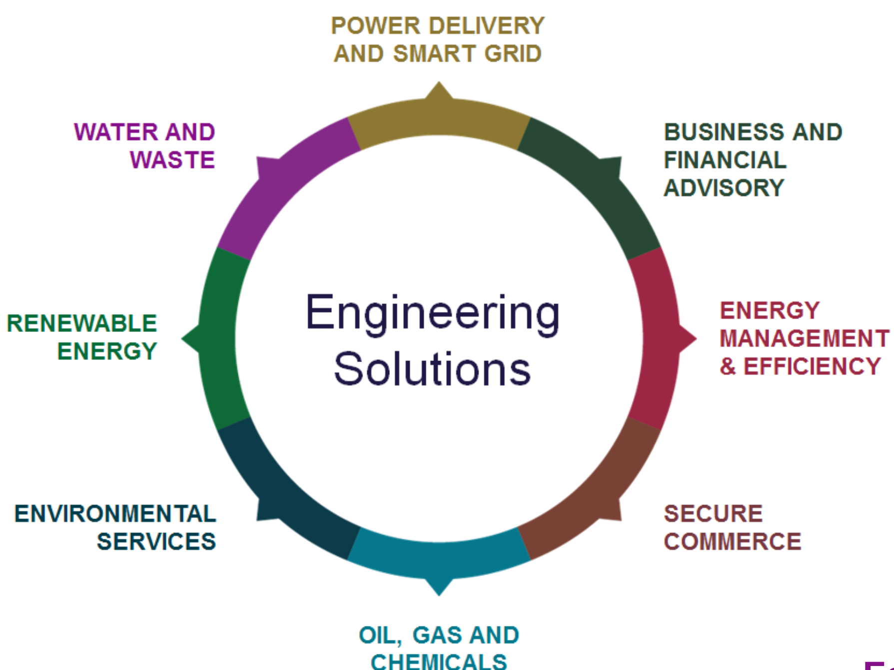
leidos

# Agenda

- About Leidos
- GELCAT Background
- Project Objectives
- Project Process
- GELCAT2 Tour
- Questions

# About Leidos

- National Security, Health, Engineering
- HQ in Reston, VA
- About 19,000 employees
- About $5 billion in revenues




**Engineering and Technical Services**

- Energy benchmarking
- Energy audits
- Assistance for energy codes, EO111 compliance
- Building energy simulation modeling
- Building energy systems design
- Building energy systems commissioning
- Technology assessments and feasibility studies
- Energy master planning and climate action plans
- Portfolio management and incentive program assistance
- Data monitoring and analysis
- Training

**Sustainable Solutions**

- Policy analysis, compliance, and strategic planning
- Sustainability consulting services and LEED certification
- Green process improvements
- Environmental, health, and safety management systems
- Corporate social responsibility programs
- Corporate training
- Enterprise risk management
- Supply chain strategies

**For more information visit leidos.com/engineering**

# GELCAT Background

- Microsoft Excel®-based renewable energy screening tool
- Originally developed for wastewater utilities with funding from the Water Environment Research Foundation (WERF)
- Expanded for use by wastewater and water utilities with funding from the Water Research Foundation (WaterRF)
- Used to evaluate economic viability and energy, environmental, and social benefits/costs of selected renewable energy technologies
- Represented technologies include:
  - Photovoltaic systems – *original*
  - Wind turbine generators – *original*
  - Hydro-turbine generators – *expanded!*
  - Geothermal heating and cooling systems – *new!*

## Project Objectives

- Incorporate two new modules – micro hydro turbines and geothermal heat pumps
- Develop a framework to identify and evaluate the environmental and social costs and benefits associated with renewable energy projects
- Incorporate formats and information that account for any water-utility specific considerations, not present in the original tool
- Beta-test and validate to ensure proper function and reliable results

# Project Process (1 of 4)

- Task 1: Recruit Utilities to Test GELCAT
  - Philadelphia Water Department (PA)
  - Florida Keys Aqueduct Authority (FL)
  - Mohawk Valley Water Authority (NY)
  - Birmingham Water Works Board (AL)
  - Ann Arbor Public Service Area (MI)
  - Southern Nevada Water Authority (NV)
  - Water One (KS)
  - Denver Water (CO)
  - Honolulu Water (HI)
  - Madison Water Utility (WI)
  - Santa Rosa Water Utilities (CA)

- Task 2: Perform Tests and Document Results
  - Utilities asked to use real data for testing to support validation efforts
  - Comments received from 8 of the 11 utilities
  - Outcome: Set of prioritized recommendations for incorporation into tool

# Project Process (2 of 4)

- Task 3: Develop New Modules
  - Develop building heating and cooling requirements estimation method (geothermal module only).
  - Literature search to obtain system performance and cost data, as well as modeling approaches. Development of typical installation configurations and operating scenarios for the most likely applications of the technologies at water treatment plants.
  - Review of suggested technologies and configurations to be modeled with WaterRF
  - Develop and document calculation algorithms for estimating the energy impacts of the system
  - Code the module within the GELCAT structure (MS Excel/Visual Basic).
  - Internal testing of the module and de-bugging

# Project Process (3 of 4)

- Task 4:  Develop Co-benefits Evaluation Framework
  - Identify specific co-benefits, costs and potential impacts of renewable energy projects
  - For each co-benefit, identify and document considerations for evaluation
  - Develop scoring methodology and user guidance to translate qualitative and quantitative technology impacts into comparable metrics

- Task 5:  Test GELCAT2 Beta Version
  - Same general process as Task 2 with focus and emphasis on new modules (Task 3) and co-benefits framework (Task 4)
  - Outcome: Set of prioritized recommendations for incorporation into tool

# Project Process (4 of 4)

- Task 6: Finalize GELCAT2 Release Version
  - Incorporate beta test recommendations into tool
  - Final internal testing and de-bugging

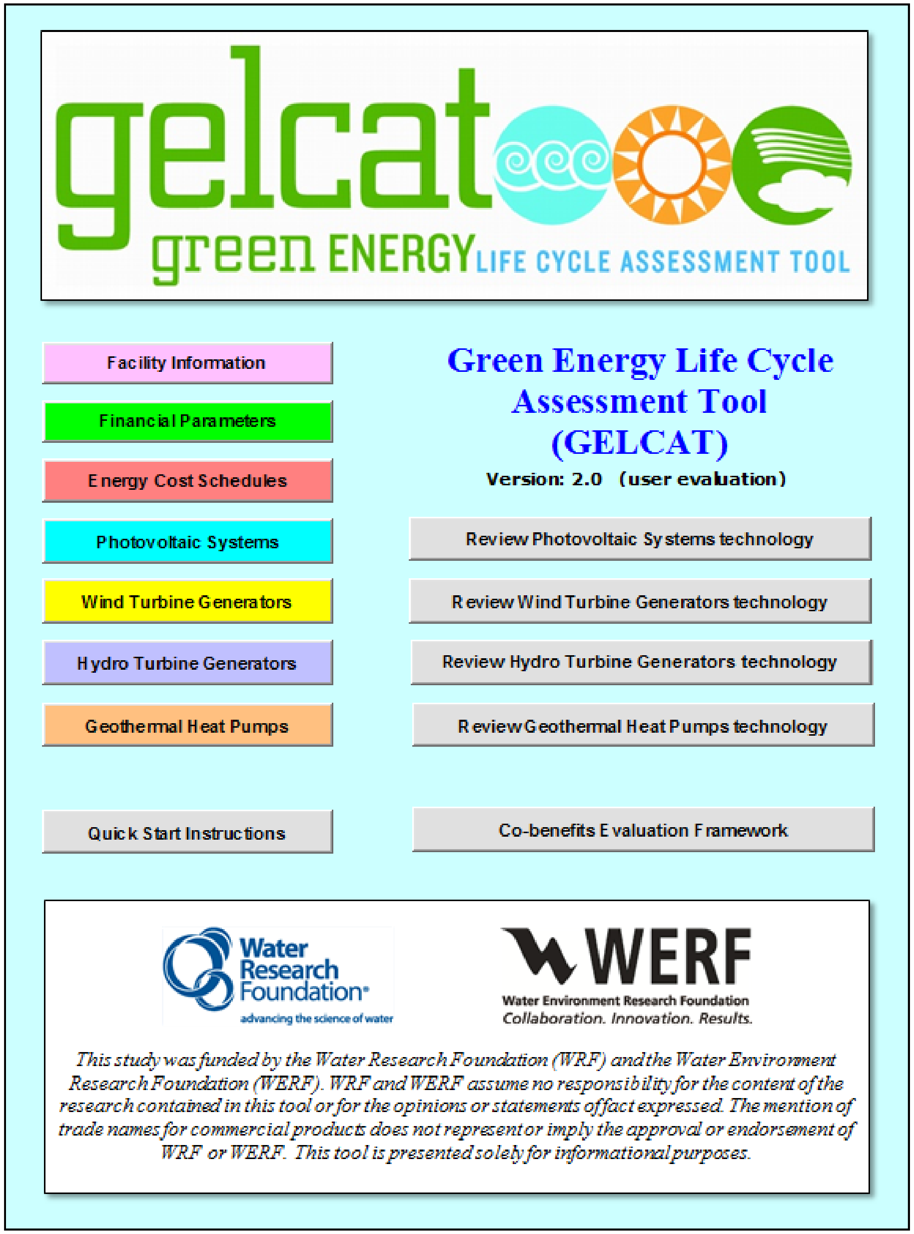
- Task 7: Prepare User Manual and Case Studies
  - Develop user manual for GELCAT2 according to general format of GELCAT User’s Manual

- Current Project Status
  - Addressing final comments on the tool and user manual

# GELCAT2 Tour

# Dashboard

- Main landing screen
- Navigation hub
- Quick-start instructions
- Technologies overviews
- Modules
- Co-benefits framework



# Facility Information

## Facility Information

**Site Name:** Processing Plant XYZ

**Project or Application:** Green Energy Project

**City:** CHITTENANGO

**State:** NY

**Zip:** 13037

**CO2e Emissions Rate:** 1,259 lb-CO2e/MWh

### Monthly Details of Electricity Usage

**Year or Years Data Represents:** 2015

| Month | Number of Days in Billing Period | Consumption (kWh) | Peak Demand (kW) | Facility Demand (kW) | Total Electricity Cost ($) | $/kWh |
|---|---|---|---|---|---|---|
| Jan | 31 | 1,075,000 | 2,200 | 2,400 | $117,035 | $0.1089 |
| Feb | 28 | 1,075,000 | 2,150 | 2,350 | $108,032 | $0.1005 |
| Mar | 31 | 1,025,000 | 2,675 | 2,675 | $109,118 | $0.1065 |
| Apr | 30 | 1,150,000 | 2,680 | 2,680 | $103,643 | $0.0901 |
| May | 31 | 1,050,000 | 2,680 | 2,680 | $111,817 | $0.1065 |
| Jun | 30 | 1,075,000 | 2,855 | 2,855 | $184,190 | $0.1713 |
| Jul | 31 | 1,200,000 | 2,850 | 2,850 | $169,620 | $0.1414 |
| Aug | 31 | 1,050,000 | 2,825 | 2,825 | $212,688 | $0.2026 |
| Sep | 30 | 1,170,000 | 2,800 | 2,800 | $187,704 | $0.1604 |
| Oct | 31 | 1,075,000 | 2,750 | 2,750 | $133,565 | $0.1242 |
| Nov | 30 | 1,050,000 | 2,134 | 2,234 | $122,536 | $0.1167 |
| Dec | 31 | 1,200,000 | 2,175 | 2,325 | $107,181 | $0.0893 |
| | Annual | 13,195,000 | 2,855 | 2,855 | $1,667,129 | $0.1265 |

Graph of Consumption | Graph of Peak Demand | How to use this form | Print | Back

# Financial Parameters

## Financial Parameters

| | | |
|---|---|---|
| Number of Years to be Evaluated: | 20 | years |
| Utility Buyback Rate for Electricity: | .0825 | $/kWh |
| Escalation Rate for Utility Buyback Rate for Electricity: | 2 | % per year |
| Escalation Rate for Cost of Electricity: | 2.5 | % per year |
| Escalation Rate for Cost of Fuel: | 3 | % per year |
| Escalation Rate for Maintenance Costs: | 1.5 | % per year |
| Escalation Rate for Renewable Energy Credits: | 1 | % per year |
| Discount Rate / Cost of Money (for Net Present Value calculation): | 4.5 | % per year |

| | | | | | |
|---|---|---|---|---|---|
| Federal Tax Rate: | 20 | % | | | |
| State Tax Rate: | 6 | % | | | |
| Federal Tax Credit: | 0 | % of capital cost in year 0 | | | |
| Federal Production Tax Credit: | 0 | $/kWh for years | 1 | thru | 5 |
| State or Utility Capacity Incentives: | 0 | $/kW | | | |
| State or Utility Production-based Incentives: | 0 | $/kWh for years | 1 | thru | 5 |
| Greenhouse Gas Credits: | 0 | $/lb-CO2e | 0 | $/MWh | |
| Renewable Energy Credits: | 0 | $/MWh | | | |

Depreciation Schedule Federal

Depreciation Schedule State

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# Energy Cost Schedule

## Electricity Costs

Use this schedule for Electricity Cost

- Average Rates Schedule ☐
- Electricity Time of Use Schedule ☑
- Electricity Block Rate Schedule ☐
- Demand Schedule
- Miscellaneous Costs
- Seasons

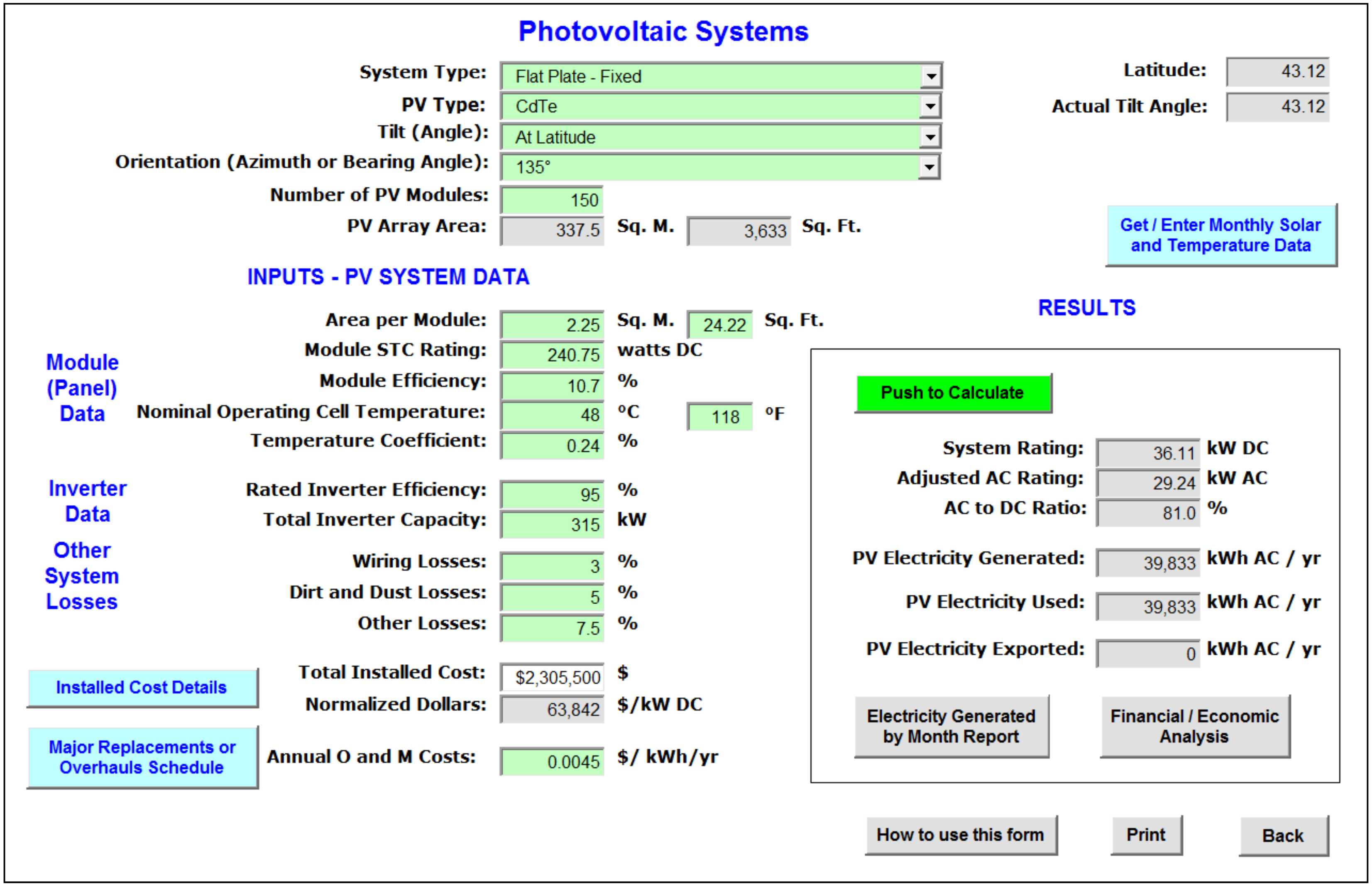
## Electricity Time of Use Schedules

- Summer Schedule Monday - Friday
- Summer Schedule Weekends and Holidays
- Winter Schedule Monday - Friday
- Winter Schedule Weekends and Holidays

## Summer Schedule Monday - Friday

| | Start Hour | End Hour | Energy Charge ($/kWh) | Demand Charge ($/kW) |
|---|---|---|---|---|
| Off-Peak: | 12 PM | 8 AM | 0.10 | 15.68 |
| Mid-Peak: | 8 AM | 12 PM | 0.12 | 15.68 |
| On-Peak: | 12 PM | 6 PM | 0.16 | 15.68 |
| Mid-Peak: | 6 PM | 9 PM | 0.12 | 15.68 |
| Off-Peak: | 9 PM | 12 AM | 0.10 | 15.68 |

# Photovoltaic Systems – User Inputs (1 of 2)



# Photovoltaic Systems – User Inputs (2 of 2)

## Monthly Solar Radiation and Temperature

**System Type:** Flat Plate - Fixed

**Tilt (Angle):** At Latitude

**Choose Nearest Location**

SYRACUSE

**Latitude:** 43.12

**Actual Tilt Angle:** 43.12

Determine Magnetic Declination

**Orientation (Azimuth or Bearing Angle):**

135°

| Month | Average Daily Insolation (kWh/m2) | Average Daytime Temperature (°F) | Coincident Peak Demand Factor |
|---|---|---|---|
| Jan: | 2.45 | 26.4 | 4 % |
| Feb: | 3.21 | 28.5 | 10 % |
| Mar: | 3.97 | 38.1 | 15 % |
| Apr: | 4.49 | 50.7 | 21 % |
| May: | 4.78 | 63.5 | 30 % |
| Jun: | 5.00 | 72 | 40 % |
| Jul: | 5.12 | 76.7 | 38 % |
| Aug: | 4.85 | 74.6 | 35 % |
| Sep: | 4.30 | 66.4 | 30 % |
| Oct: | 3.41 | 54.8 | 13 % |
| Nov: | 2.08 | 42.4 | 8 % |
| Dec: | 1.84 | 31.3 | 3 % |

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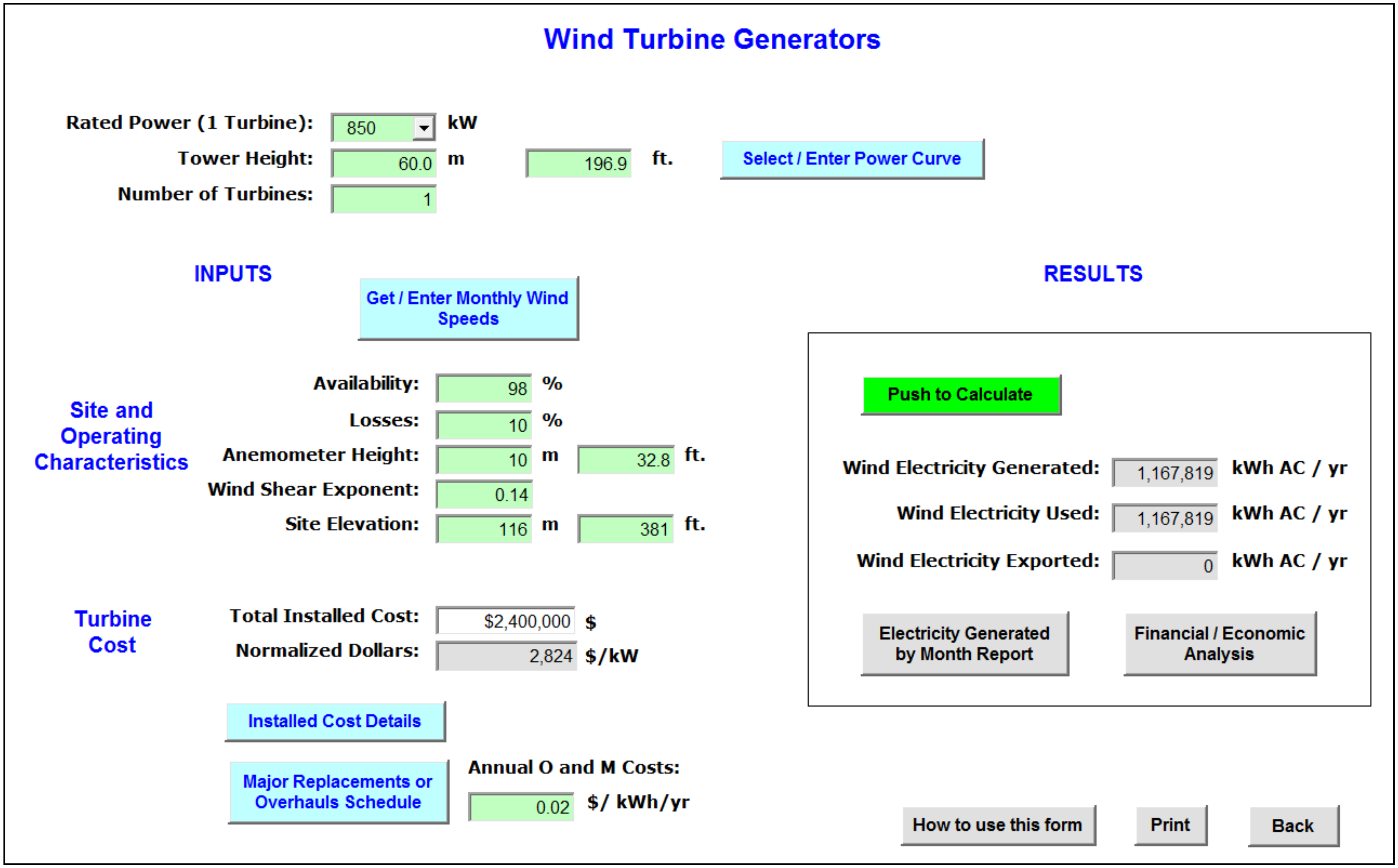
# Wind Turbine Generators – User Inputs (1 of 3)



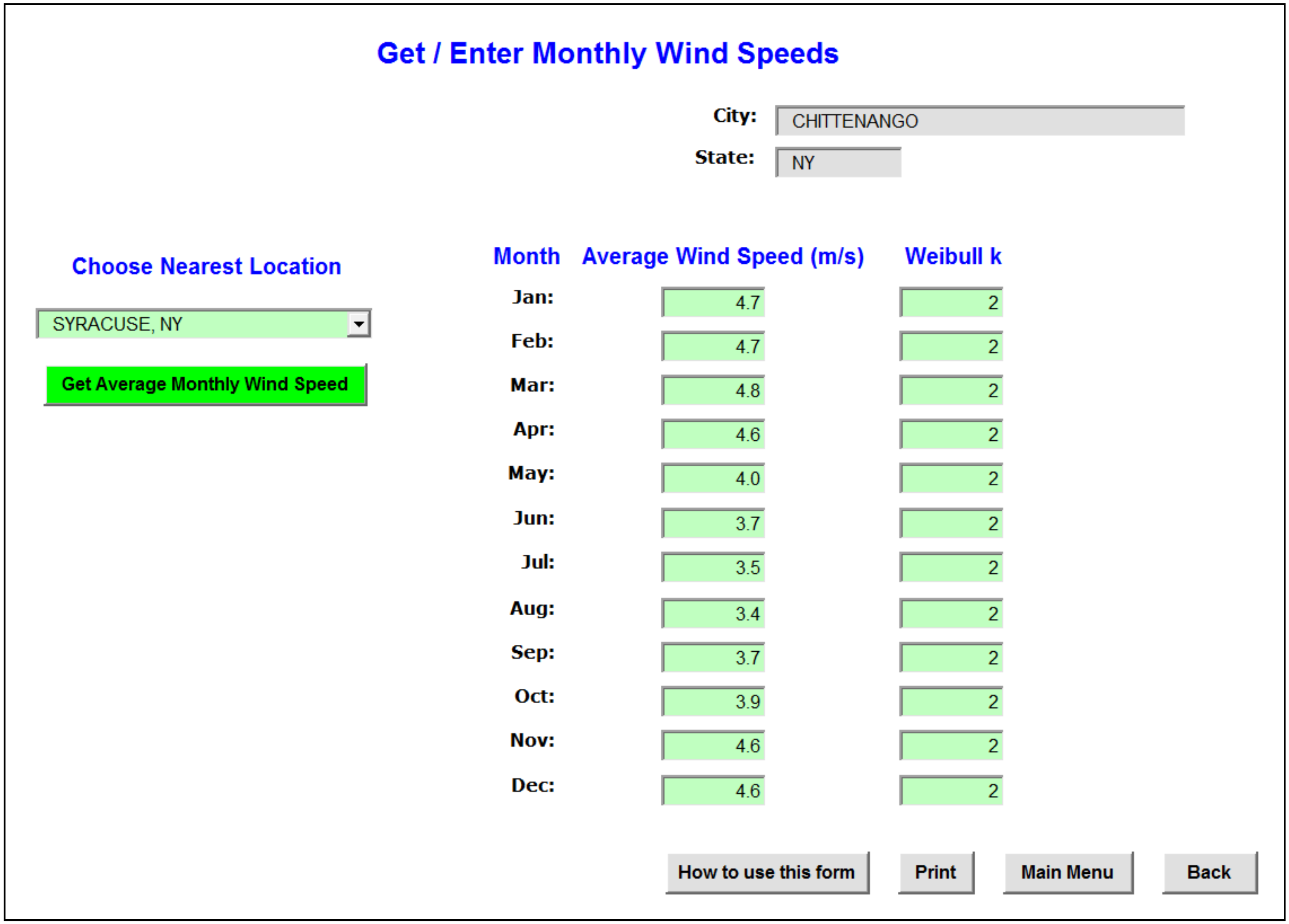
# Wind Turbine Generators – User Inputs (2 of 3)

## Wind Power Curve

**Rated Power:** 850 kW

| Wind Speed Bin (m/s) | Wind Turbine Power, at Sea Level, 15 C (kW) | Wind Speed Bin (m/s) | Wind Turbine Power, at Sea Level, 15 C (kW) |
|---|---|---|---|
| 1 | 0 | 11 | 650 |
| 2 | 0 | 12 | 760 |
| 3 | 0 | 13 | 810 |
| 4 | 30 | 14 | 850 |
| 5 | 80 | 15 | 850 |
| 6 | 120 | 16 | 850 |
| 7 | 200 | 17 | 850 |
| 8 | 290 | 18 | 850 |
| 9 | 420 | 19 | 850 |
| 10 | 520 | 20 | 850 |

# Wind Turbine Generators – User Inputs (3 of 3)



## Get / Enter Monthly Wind Speeds

City: CHITTENANGO

State: NY

Choose Nearest Location

SYRACUSE, NY

Get Average Monthly Wind Speed

| Month | Average Wind Speed (m/s) | Weibull k |
|---|---|---|
| Jan: | 4.7 | 2 |
| Feb: | 4.7 | 2 |
| Mar: | 4.8 | 2 |
| Apr: | 4.6 | 2 |
| May: | 4.0 | 2 |
| Jun: | 3.7 | 2 |
| Jul: | 3.5 | 2 |
| Aug: | 3.4 | 2 |
| Sep: | 3.7 | 2 |
| Oct: | 3.9 | 2 |
| Nov: | 4.6 | 2 |
| Dec: | 4.6 | 2 |

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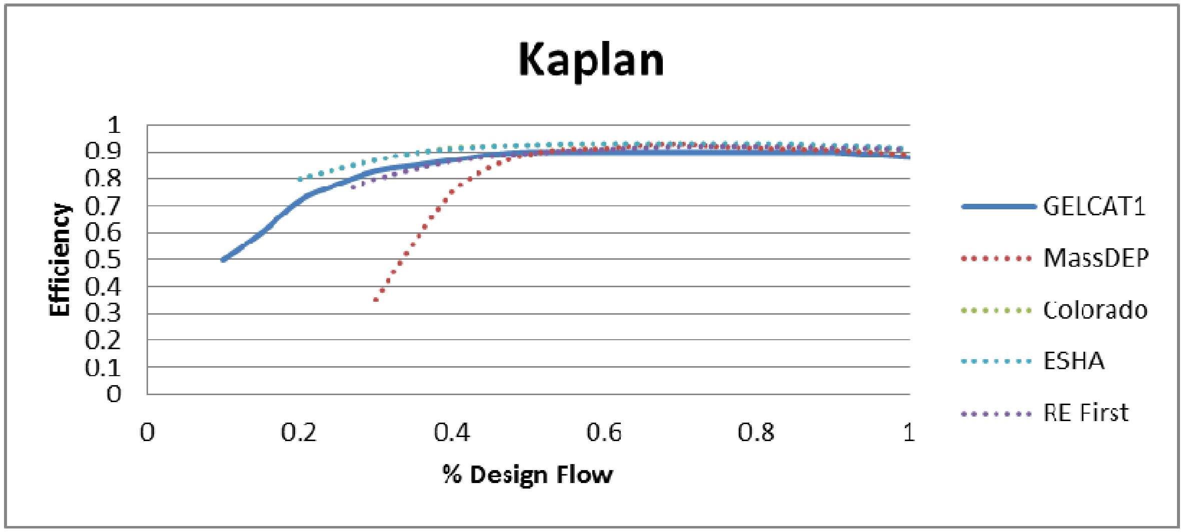
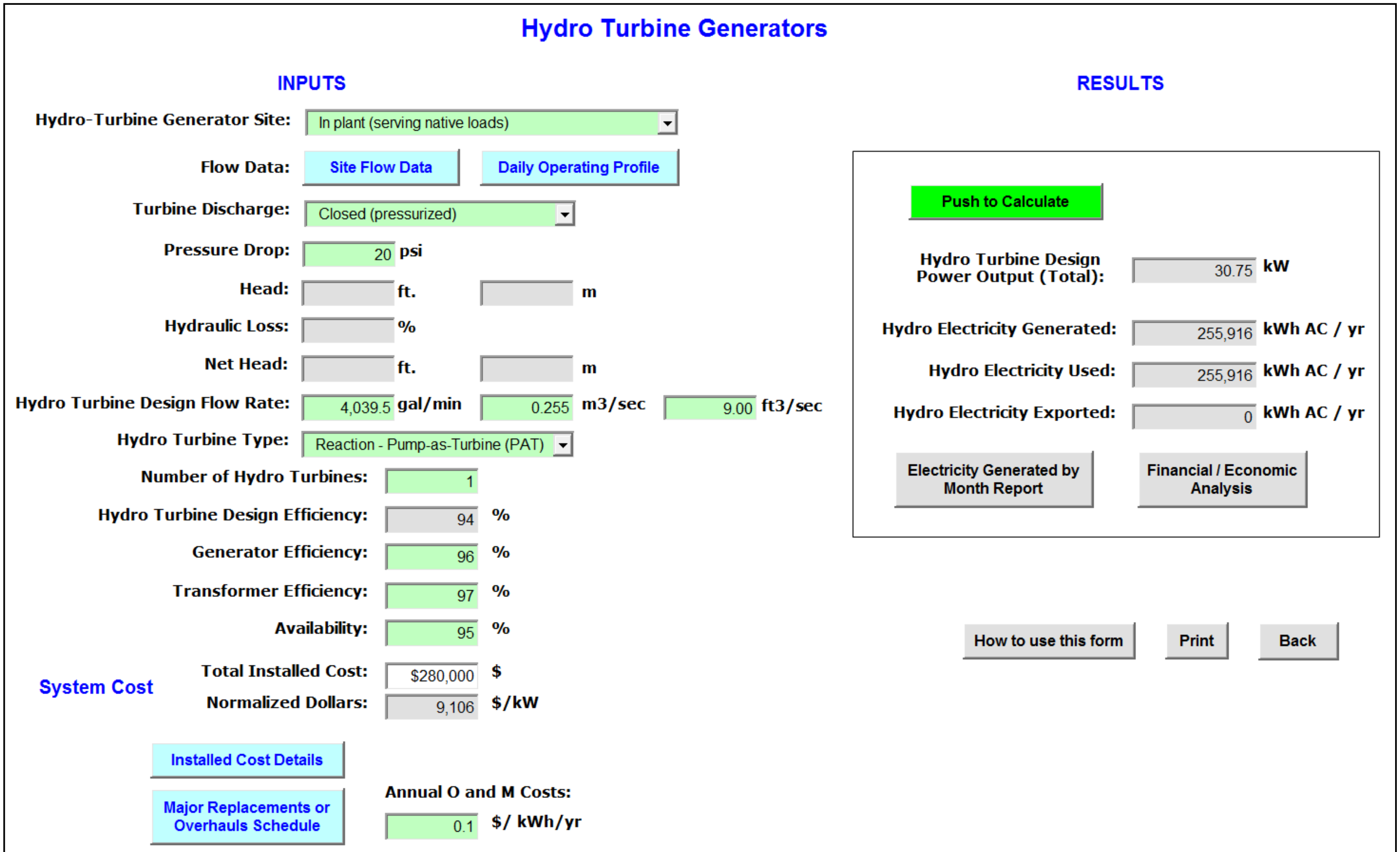
# Hydro Turbine Generators - Improvements

- Modify user input fields to accommodate in-conduit projects
- Add Pump-as-Turbine (PAT) to turbine technology options
- Add Design Flow Rate input field in units of cubic feet per second
- Retain turbine efficiency curves from GELCAT
- Increase visible digits to accommodate micro and pico hydro
- Improve and expand help content to include specific considerations for water utilities



# Hydro Turbine Generators – User Inputs (1 of 2)



# Hydro Turbine Generators – User Inputs (2 of 2)

## Site Flow Data

| | Average Flow (GPM) | Peak Flow (GPM) | Min Flow (GPM) |
|---|---|---|---|
| Jan | 58,333 | 116,667 | 29,167 |
| Feb | 54,167 | 108,333 | 27,083 |
| Mar | 50,000 | 100,000 | 25,000 |
| Apr | 54,167 | 108,333 | 27,083 |
| May | 52,083 | 104,167 | 26,042 |
| Jun | 37,500 | 75,000 | 18,750 |
| Jul | 37,500 | 75,000 | 18,750 |
| Aug | 33,333 | 66,667 | 16,667 |
| Sep | 33,333 | 66,667 | 16,667 |
| Oct | 35,417 | 70,833 | 17,708 |
| Nov | 45,833 | 91,667 | 22,917 |
| Dec | 52,083 | 104,167 | 26,042 |
| Annual | 45,268 | | |

## Daily Operating Profile

| Hour | % of Average Flow | | Hour | % of Average Flow | |
|---|---|---|---|---|---|
| 12 - 1 AM | 50 | % | 12 - 1 PM | 100 | % |
| 1 - 2 AM | 50 | % | 1 - 2 PM | 100 | % |
| 2 - 3 AM | 50 | % | 2 - 3 PM | 100 | % |
| 3 - 4 AM | 50 | % | 3 - 4 PM | 100 | % |
| 4 - 5 AM | 50 | % | 4 - 5 PM | 100 | % |
| 5 - 6 AM | 50 | % | 5 - 6 PM | 100 | % |
| 6 - 7 AM | 100 | % | 6 - 7 PM | 125 | % |
| 7 - 8 AM | 200 | % | 7 - 8 PM | 125 | % |
| 8 - 9 AM | 175 | % | 8 - 9 PM | 125 | % |
| 9 - 10 AM | 150 | % | 9 - 10 PM | 100 | % |
| 10 - 11 AM | 125 | % | 10 - 11 PM | 100 | % |
| 11 - 12 PM | 100 | % | 11 - 12 AM | 75 | % |

Use Standard Profile for WW Treatment

Use Industrial Profile for WW Treatment

Note: Default profiles are not available for potable water facilities due to high variability and must be entered manually

# Hydro Turbine Generators – Generation Report

## Electricity Generated by Month

**Site Name:** Processing Plant XYZ

**Project or Application:** Green Energy Project

**System Type:** Reaction - Pump-as-Turbine (PAT)

Graph

| Month | Consumption (kWh) | Peak Demand (kW) | Peak Demand Reduction (kW) | Electricity Generated (AC) (kWh) | Consumption - Electricity Generated (kWh) | Generated Electricity Used by Facility (kWh) | Generated Electricity Exported to the Grid (kWh) |
|---|---|---|---|---|---|---|---|
| Jan | 1,075,000 | 2,200 | 31 | 21,735 | 1,053,265 | 21,[illegible] | [illegible] |
| Feb | 1,075,000 | 2,150 | 31 | 19,632 | 1,055,368 | 19,[illegible] | [illegible] |
| Mar | 1,025,000 | 2,675 | 31 | 21,735 | 1,003,265 | 21,[illegible] | [illegible] |
| Apr | 1,150,000 | 2,680 | 31 | 21,034 | 1,128,966 | 21,[illegible] | [illegible] |
| May | 1,050,000 | 2,680 | 31 | 21,735 | 1,028,265 | 21,[illegible] | [illegible] |
| Jun | 1,075,000 | 2,855 | 31 | 21,034 | 1,053,966 | 21,[illegible] | [illegible] |
| Jul | 1,200,000 | 2,850 | 31 | 21,735 | 1,178,265 | 21,[illegible] | [illegible] |
| Aug | 1,050,000 | 2,825 | 31 | 21,735 | 1,028,265 | 21,[illegible] | [illegible] |
| Sep | 1,170,000 | 2,800 | 31 | 21,034 | 1,148,966 | 21,[illegible] | [illegible] |
| Oct | 1,075,000 | 2,750 | 31 | 21,735 | 1,053,265 | 21,[illegible] | [illegible] |
| Nov | 1,050,000 | 2,134 | 31 | 21,034 | 1,028,966 | 21,[illegible] | [illegible] |
| Dec | 1,200,000 | 2,175 | 31 | 21,735 | 1,178,265 | 21,735 | 0 |
| Annual | 13,195,000 | 2,855 | 31 | 255,916 | 12,939,084 | 255,916 | 0 |

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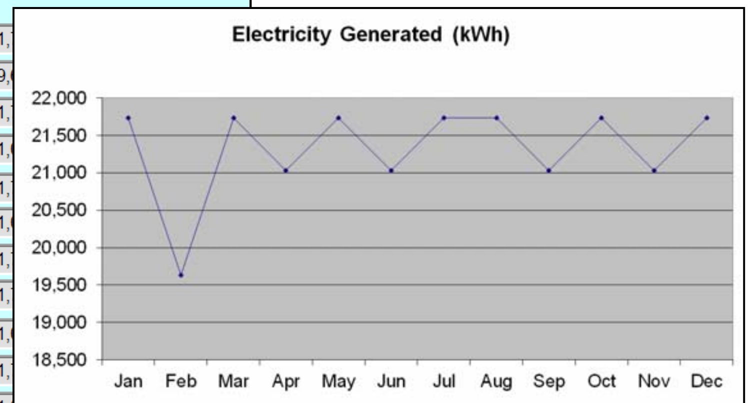

# Hydro Turbine Generators – Financial Analysis

## Financial / Economic Analysis

**Technology Evaluated:** Hydro Turbine Generators

| | | |
|---|---|---|
| Installed Cost: | $280,000 | $ |
| Federal Tax Credit: | $56,000 | $ |
| Capacity Incentives: | $0 | $ |
| Net System Cost: | $224,000 | $ |
| Annual Output: | 255,916 | kWh/yr |
| CO2 Equivalents Emissions Reduction: | 322,198 | lbs/yr |
| Greenhouse Gases and Renewable Energy Credits: | 0 | $/yr |
| Average Peak Demand Reduction: | 31 | kW/month |
| Value of Demand Reduction: | $738 | $/yr |
| Annual Electricity Generated Used at Facility: | 255,916 | kWh/yr |
| Percentage of Annual Electricity Used by Facility that is Generated: | 1.9 | % |
| Net Annual Electricity Exported: | 0 | kWh/yr |
| Net Operating Savings (Year 1): | $11,922 | $ |
| Net Present Value (20 years): | $263,059 | $ |
| Simple Payback Period: | 18.8 | years |
| Internal Rate of Return: | 7.0 | % |

Cash Flow by Year Report | Sensitivity Analysis

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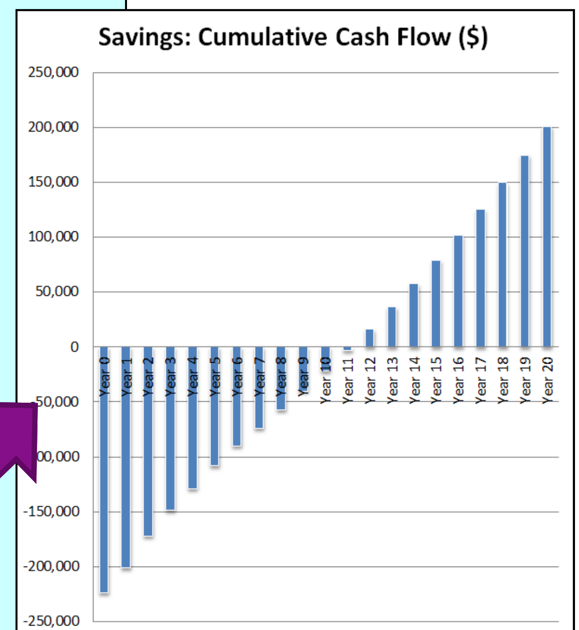

## Geothermal Heat Pumps - Overview

- New module
- Specific technology modeled is ground source heat pump
- Model requires inputs on building to be served by system to calculate heating and cooling loads.
- Two methods are provided to the user for load and system input requirements that differ in terms of the amount of building characteristic data that is needed.
- In order to estimate the economics of the investment, comparison to an alternative or baseline (conventional new or existing) system is needed.

# Geothermal Heat Pump: User Inputs (1 of 2)

## Geothermal Heat Pumps

### 1. Input Building and Location

| | | |
|---|---|---|
| Building Area (excl. parking): | 200,000 | (Sq. Ft) |
| Percent Heated: | 100 | (%) |
| Percent Cooled: | 100 | (%) |
| Balance Point Temperature: | 50 | (deg. F) |
| Zip Code: | 13037 | |
| City/State: | CHITTENANGO, NY | |
| Weather Station: | Syracuse-Hancock Intl AP 725190 | |
| Latitude: | 43 | (deg. N) |
| Longtitude: | 76 | (deg. W) |
| Climate Zone: (2003 CBECS) | 1 | |

Existing Heating & Cooling System(s)

### 2. Input Geothermal Heat Pump System Efficiency

| | |
|---|---|
| Heating COP: | 3.6 |
| Cooling EER: | 17.1 |

### 3. Select Load Method: 1

Load Method 1: Built-Up Estimate

| | |
|---|---|
| Building Shape: | wide rectangle |
| Percent Exterior Glass: | 11 to 25 percent |
| Window Glass Type: | Multi-layer glass |
| Number of Floors: | 4 |
| Number of Underground Floors: | 1 |
| Floor to Ceiling Height: | 8 |
| Freestanding Building: | Yes |
| Average Occupied Hours/Day: | 10 |
| Average Occupied Days/Week: | 6 |
| Outside Air Exchange Rate (per Hour): | Low for Office (3 ACH) |
| Unoccupied Outside Air Exchange Rate: | Low for Office (3 ACH) |

Load Method 2: Annual End-Use Estimate

| | | |
|---|---|---|
| Annual Cooling Load EUI: | 30 | (kBtu/SF) |
| Annual Heating Load EUI: | 30 | (kBtu/SF) |

**Annual Load Projections (MMBtu):**

Heating: 5,172 Cooling: 3,229

### 4. Select System Size Method: 2

System Size Method 1: Installed Capacity

Installed Cooling Capacity: (don't include redundant/backup) 70 (tons)

System Size Method 2: Typical Sizing per Area

Typical Cooling Capacity by Building Type: Typical Office (350 SF/Ton)

**Capacity Projection:** 571 (tons)

### 5. Input Geothermal Heat Pump System Cost 1

Method 1: Simple Unit Installed Cost Estimate

2,500 ($/ton)

Method 2: Detailed Installed Cost Estimate

Installed Cost Details

**Installed Cost Summary:**

| | | |
|---|---|---|
| Unit Cost: | 2,500 | ($/ton) |
| Total Installed Cost: | 1,428,571 | ($) |
| **Annual O&M Costs:** | 20 | ($/yr-ton) |

### 6. RESULTS

Push to Calculate | View Load Analysis

**Existing Heating & Cooling System(s)**

| | | | | |
|---|---|---|---|---|
| Electricity: | 259,102 | (kWh) | 20,728 | ($) |
| Natural Gas: | 64,820 | (therm) | 129,636 | ($) |
| Total: | 7,366 | (MMBtu) | 150,364 | ($) |

**Geothermal Heat Pump**

| | | | | |
|---|---|---|---|---|
| Electricity: | 609,886 | (kWh) | 48,791 | ($) |

**Annual Savings**

| | | | | |
|---|---|---|---|---|
| Electricity: | -350,784 | (kWh) | -28,063 | ($) |
| Natural Gas: | 64,820 | (therm) | 129,636 | ($) |
| Total: | 5,285 | (MMBtu) | 101,574 | ($) |

**Equivalent Full-Load Hours (EFLH)**

| | | | |
|---|---|---|---|
| Heating: | 1,006 | Flag: | 2,000 |
| Cooling: | 471 | Flag: | 1,500 |

Financial / Economic Analysis

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# Geothermal Heat Pump: User Inputs (2 of 2)

## Existing System / Baseline System Description

### 1. Heating & Cooling Fuel

**Fuel Name:** Natural Gas  **Fuel:** therm

*Conversion Factor:* (therm/MMBtu) 10.000  *Fuel Emission Factor:* (lb/therm) 11.709

| Mont | Consumption: (therm) | (MMBtu) | Total Cost: ($) | Unit Cost: ($/MMBtu) |
|---|---|---|---|---|
| Jan | 9000 | 900 | 18000 | 20.0000 |
| Feb | 9000 | 900 | 18000 | 20.0000 |
| Mar | 6000 | 600 | 12000 | 20.0000 |
| Apr | 6000 | 600 | 12000 | 20.0000 |
| May | 6000 | 600 | 12000 | 20.0000 |
| Jun | 3000 | 300 | 6000 | 20.0000 |
| Jul | 3000 | 300 | 6000 | 20.0000 |
| Aug | 3000 | 300 | 6000 | 20.0000 |
| Sep | 6000 | 600 | 12000 | 20.0000 |
| Oct | 6000 | 600 | 12000 | 20.0000 |
| Nov | 6000 | 600 | 12000 | 20.0000 |
| Dec | 9000 | 900 | 18000 | 20.0000 |
| Annual | 72,000 | 7,200 | 144,000 | 20.0000 |

**Average Utility Rate:** ($/therm) 2.00  Converted Rate: ($/MMBtu) 20

### 2. Energy Efficiency and GHG/Carbon Credits

**Energy Efficiency Credits:** ($/MMBtu) 0  EE Credits Escalation: (% per year) 0

**GHG/Carbon Credits:** ($/lb) 0  GHG Credits Escalation: (% per year) 0

### 3. Fraction of Space Heated by Each System/Fuel

| Heating System | Electric | Natural Gas |
|---|---|---|
| Furnaces | | |
| Boilers with Water Loop Heat Pumps: | | |
| Boilers: | | 0.8 |
| Packaged Heating Units: | | 0.2 |
| Individual Space Heaters: | | |
| Air-Source Heat Pumps: | | |
| Variable Refrigerant Flow Heat Pump: | | |
| Other: | | |

### 4. Fraction of Space Cooled by Each System/Fuel

| Cooling System | Electric | Natural Gas |
|---|---|---|
| Packaged | 0.2 | |
| Res Type Central A/C: | | |
| Individual Room A/C: | | |
| Water Loop Heat Pumps with Heat Rejection: | | |
| Air-Source Heat Pumps: | | |
| Variable Refrigerant Flow Heat Pump: | | |
| Air Cooled Chiller: | 0.8 | |
| Water Cooled Chiller: | | |
| Absorption Chiller: | | |
| Evaporative Cooler: | | |
| Other: | | |

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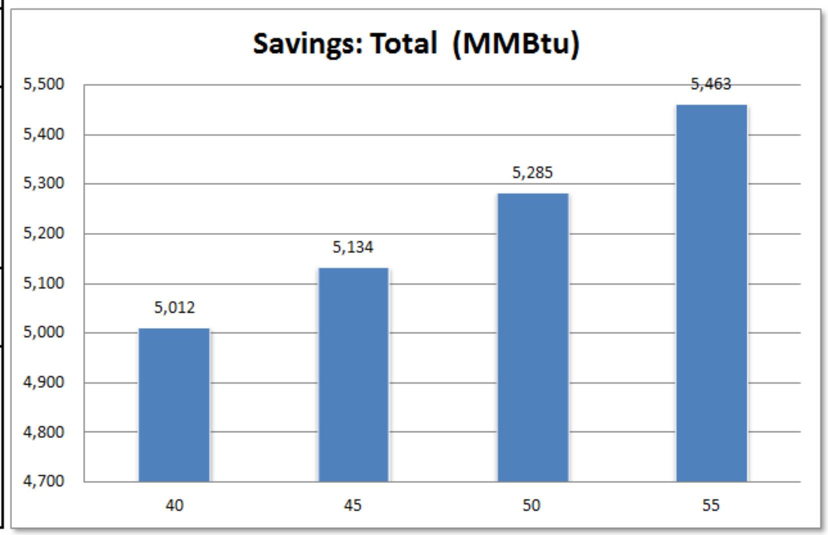
# Geothermal Heat Pump: Load Analysis / BPT

**Summary of GHP Load Analysis Output at Balance Point Temparature (BPT) Scenarios** Created at: 3/7/2016 10:59

| | Annual Output Variables | Current BPT 50 | BPT_40 40 | BPT_45 45 | BPT_50 50 | BPT_55 55 |
|---|---|---|---|---|---|---|
| Financial Overview: | Installed Cost (Dollar) | 1,428,571 | 1,428,571 | 1,428,571 | 1,428,571 | 1,428,571 |
| | Annual Savings (Dollar) | 101,574 | 96,553 | 98,784 | 101,574 | 104,886 |
| | Simple Payback (Year) | 14.1 | 14.8 | 14.5 | 14.1 | 13.6 |
| Existing System (Baseline): | Electricity (kWh) | 259,102 | 298,409 | 277,494 | 259,102 | 243,071 |
| | Electricity (kW) | 548 | 548 | 548 | 548 | 548 |
| | Electricity Cost (Dollar) | 20,728 | 23,873 | 22,199 | 20,728 | 19,446 |
| | Natural Gas (therm) | 64,818 | 60,850 | 62,664 | 64,818 | 67,291 |
| | Natural Gas Cost ($) | 129,636 | 121,700 | 125,328 | 129,636 | 134,582 |
| | Total (MMBtu) | 7,366 | 7,103 | 7,213 | 7,366 | 7,558 |
| | Total Cost (Dollar) | 150,364 | 145,573 | 147,527 | 150,364 | 154,028 |
| Geothermal Heat Pump: | Electricity (kWh) | 609,886 | 612,750 | 609,292 | 609,886 | 614,269 |
| | Electricity (kW) | 419 | 419 | 419 | 419 | 419 |
| | Electricity Cost (Dollar) | 48,791 | 49,020 | 48,743 | 48,791 | 49,142 |
| Savings: | Electricity (kWh) | (350,784) | (314,341) | (331,798) | (350,784) | (371,198) |
| | Electricity (kW) | 129 | 129 | 129 | 129 | 129 |
| | Electricity Cost (Dollar) | (28,063) | (25,147) | (26,544) | (28,063) | (29,696) |
| | Natural Gas (therm) | 64,818 | 60,850 | 62,664 | 64,818 | 67,291 |
| | Natural Gas Cost (Dollar) | 129,636 | 121,700 | 125,328 | 129,636 | 134,582 |
| | Total (MMBtu) | 5,285 | 5,012 | 5,134 | 5,285 | 5,463 |
| | Total Cost (Dollar) | 101,574 | 96,553 | 98,784 | 101,574 | 104,886 |

How to | Detail Visual Load Analysis | Back to GHP Main Menu




**Monthly Energy Report at BPT: 50**

| Month | Existing Electricity (kWh) | Existing Electricity (kW) | Existing Electricity Cost ($) | Existing Natural Gas (therm) | Existing Natural Gas Cost ($) | Existing Total (MMBtu) | Existing Total Cost ($) | Geothermal Heat Pump Electricity (kWh) | Geothermal Heat Pump Electricity (kW) | Geothermal Heat Pump Electricity Cost ($) | Savings Electricity (kWh) | Savings Electricity (kW) | Savings Electricity Cost ($) | Savings Natural Gas (therm) | Savings Natural Gas Cost ($) | Savings Total (MMBtu) | Savings Total Cost ($) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jan | 0 | 0 | 0 | 15,293 | 30,587 | 1,529 | 30,587 | 99,350 | 419 | 7,948 | (99,350) | (419) | (7,948) | 15,293 | 30,587 | 1,190 | 22,639 |
| Feb | 0 | 0 | 0 | 14,199 | 28,398 | 1,420 | 28,398 | 92,242 | 389 | 7,379 | (92,242) | (389) | (7,379) | 14,199 | 28,398 | 1,105 | 21,019 |
| Mar | 5,897 | 48 | 472 | 9,077 | 18,154 | 928 | 18,626 | 63,265 | 249 | 5,061 | (57,368) | (200) | (4,589) | 9,077 | 18,154 | 712 | 13,565 |
| Apr | 10,430 | 85 | 834 | 3,532 | 7,064 | 389 | 7,898 | 30,545 | 97 | 2,444 | (20,115) | (11) | (1,609) | 3,532 | 7,064 | 285 | 5,455 |
| May | 29,907 | 245 | 2,393 | 142 | 284 | 116 | 2,677 | 22,717 | 179 | 1,817 | 7,190 | 66 | 575 | 142 | 284 | 39 | 860 |
| Jun | 47,679 | 391 | 3,814 | 0 | 0 | 163 | 3,814 | 34,744 | 286 | 2,779 | 12,936 | 105 | 1,035 | 0 | 0 | 44 | 1,035 |
| Jul | 66,869 | 548 | 5,350 | 0 | 0 | 228 | 5,350 | 48,727 | 401 | 3,898 | 18,142 | 147 | 1,451 | 0 | 0 | 62 | 1,451 |
| Aug | 55,237 | 452 | 4,419 | 0 | 0 | 188 | 4,419 | 40,251 | 331 | 3,220 | 14,986 | 121 | 1,199 | 0 | 0 | 51 | 1,199 |
| Sep | 33,354 | 273 | 2,668 | 306 | 613 | 144 | 3,281 | 26,295 | 200 | 2,104 | 7,059 | 73 | 565 | 306 | 613 | 55 | 1,177 |
| Oct | 6,992 | 57 | 559 | 1,761 | 3,523 | 200 | 4,082 | 16,538 | 48 | 1,323 | (9,546) | 9 | (764) | 1,761 | 3,523 | 144 | 2,759 |
| Nov | 2,738 | 22 | 219 | 6,189 | 12,378 | 628 | 12,597 | 42,199 | 169 | 3,376 | (39,462) | (147) | (3,157) | 6,189 | 12,378 | 484 | 9,221 |
| Dec | 0 | 0 | 0 | 14,318 | 28,635 | 1,432 | 28,635 | 93,012 | 392 | 7,441 | (93,012) | (392) | (7,441) | 14,318 | 28,635 | 1,114 | 21,194 |
| Total | 259,102 | 548 | 20,728 | 64,818 | 129,636 | 7,366 | 150,364 | 609,886 | 419 | 48,791 | (350,784) | 129 | (28,063) | 64,818 | 129,636 | 5,285 | 101,574 |

# Geothermal Heat Pump: Financial Analysis

## Financial / Economic Analysis

Technology Eva

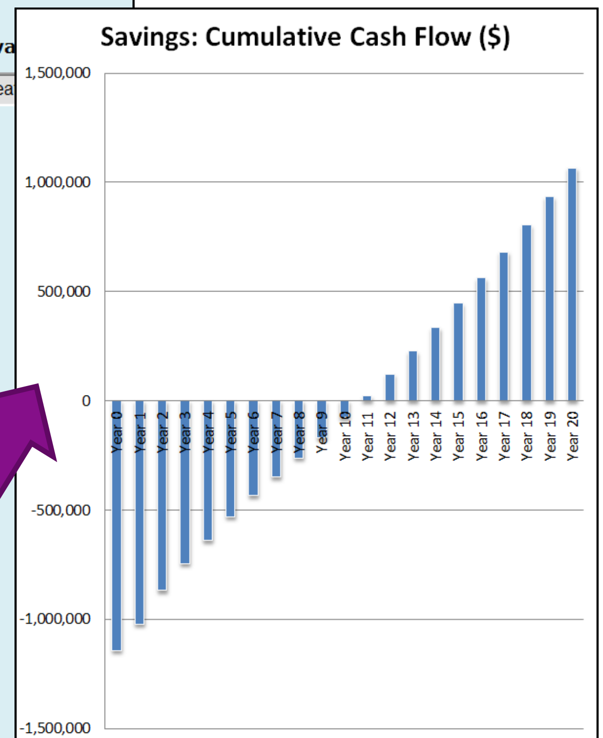
Geothermal Hea

| | | |
|---|---|---|
| Installed Cost: | $1,428,571 | $ |
| Federal Tax Credit: | $285,714 | $ |
| Net System Cost: | $1,142,857 | $ |
| Annual Energy Savings*: | 5,285 | MMBtu/yr |
| Annual Electricity Savings*: | -350,784 | kWh/yr |
| Annual Natural Gas Savings*: | 64,820 | therm/yr |
| Energy Efficiency Credits: | $0 | $/yr |
| Summer Peak Demand Savings: | 147 | kW |
| Winter Peak Demand Savings*: | -419 | kW |
| CO2 Equivalents Emissions Reduction (Net): | 317,341 | lbs/yr |
| Greenhouse Gases / Carbon Credits (Year 1): | 0 | $/yr |
| Net Operating Savings* (Year 1): | $65,725 | $ |
| Net Present Value (20 years): | $1,373,217 | $ |
| Simple Payback Period: | 17.4 | years |
| Internal Rate of Return: | 7.3 | % |

Cash Flow by Year Report | Sensitivity Analysis

How to use this form | Print | Back

Note: * Negative Savings indicates
additional consumption, demand, or cost



# Co-benefits Evaluation Framework: Overview

- New module
- Written guidance and scoring tool
- Considerations for qualitative assessment of co-benefits (i.e. project impacts other than costs/savings and GHGs)
- Co-benefits captured in Framework:
  - Relationship With Other Initiatives
  - Job Creation
  - Energy Security
  - Human Health
  - Environmental Impacts
  - Environmental Policy Compliance or Goal Achievement
  - Leadership

# Co-benefits Framework: Scoring Guidance

- Job Creation:

| Scoring Level | Primary Consideration | Secondary Consideration | Tertiary Consideration |
|---|---|---|---|
| **Low – 0 to 3** | Project will cause a net loss of jobs, or create few if any new jobs. | Any newly created jobs are temporary and relatively short term. | Most or all newly created jobs are overseas. |
| **Medium – 4 to 7** | Project will create a moderate number of new jobs. | Some newly created jobs are temporary and relatively short term while others are permanent or temporary but long-term. | Most or all newly created jobs are domestic but few if any are local. |
| **High – 8 to 10** | Project will create a significant number of new jobs. | Most or all newly created jobs are permanent or temporary but long-term. | Most or all newly created jobs are local. |

- Human Health:

| Scoring Level | Primary Consideration | Secondary Consideration |
|---|---|---|
| **Low – 0 to 3** | Significant number of negative impacts with limited or no positive impacts | Positive impacts are localized and/or negative impacts are widespread |
| **Medium – 4 to 7** | Moderate number of positive and/or negative impacts | Positive and negative impacts are approximately regional |
| **High – 8 to 10** | Significant number of positive impacts with limited or no negative impacts | Positive impacts are widespread and/or negative impacts are localized |

# Co-benefits Framework: Scoring Tool

Review Co-benefits Evaluation Framework Guidance

Back

**Project Scoring Matrix** - Use the cells in the table to weight the co-benefits according to their relative importance and score the green project options according to their performance or impact relative to each co-benefit. Additional co-benefits may be entered in the gray column as indicated by the red text. Green energy project options should be named in the header of the green cells as indicated by the red text. A total score is calculated for the baseline scenario and each green energy project in the last row of the table. Projects receiving the highest scores are the best performers with respect to co-benefits.

| Co-benefit | Relative Importance of Co-benefit (scale 0-10) | Baseline/Business-as-Usual Scenario | Green Energy Project Scoring (scale 0-10) | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | Micro Hydro Project A | Solar PV Project B | [ENTER GREEN ENERGY PROJECT NAME HERE] | [ENTER GREEN ENERGY PROJECT NAME HERE] | [ENTER GREEN ENERGY PROJECT NAME HERE] | [ENTER GREEN ENERGY PROJECT NAME HERE] | [ENTER GREEN ENERGY PROJECT NAME HERE] | [ENTER GREEN ENERGY PROJECT NAME HERE] |
| Relationship to Other Existing or Planned Initiatives | 5 | 4 | 5 | 5 | | | | | | |
| Job Creation | 6 | 2 | 6 | 7 | | | | | | |
| Energy Security | 8 | 2 | 9 | 7 | | | | | | |
| Human Health | 10 | 2 | 9 | 9 | | | | | | |
| Environmental Impacts | 10 | 3 | 9 | 8 | | | | | | |
| Environmental Policy Compliance or Goal Achievement | 10 | 8 | 10 | 10 | | | | | | |
| Leadership | 7 | 3 | 9 | 9 | | | | | | |
| [ENTER ADDITIONAL CO-BENEFITS HERE] | | | | | | | | | | |
| [ENTER ADDITIONAL CO-BENEFITS HERE] | | | | | | | | | | |
| [ENTER ADDITIONAL CO-BENEFITS HERE] | | | | | | | | | | |
| [ENTER ADDITIONAL CO-BENEFITS HERE] | | | | | | | | | | |
| [ENTER ADDITIONAL CO-BENEFITS HERE] | | | | | | | | | | |
| **TOTAL SCORE** | | **199** | **476** | **456** | **0** | **0** | **0** | **0** | **0** | **0** |

WaterRF Project No. 4464

# Thank you!

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