**U.S. DEPARTMENT OF ENERGY** | Energy Efficiency & Renewable Energy



# Pioneering Heat Pump Project

May 3, 2010

**Principal Investigator**
**Prof. Dave Aschliman**
**Indiana Institute of Technology**

Ground Source Heat Pumps > Technology Demonstration

## Indiana Tech Pioneering Heat Pump Project

**Timeline**
- Project start date:       1/29/2010
- Project end date:        9/30/2014
- Percent complete:        15%

**Budget**
- Total Project Cost:       $ 2,679,182
- DOE Funding Level:       $ 1,339,591
- Indiana Tech Level:        $ 1,339,591
- FY10 Planned:             $ 1,836,774

**Barriers**
- Aggressive Schedule:  May – August, 2010

**Partners**
- WaterFurnace International & Primary Engineering

## Objectives of Indiana Tech Pioneering Heat Pump

### Innovation

- To install and monitor an innovative WaterFurnace geothermal system that is technologically advanced and evolving
- To generate hot water heating from a heat pump that uses non-ozone depleting refrigerant $CO_2$

### Demonstration

- To demonstrate the energy efficiency of this system ground source heat pump system
- To demonstrate the environmental safety of this type of technologically advanced system

## Objectives of Indiana Tech Pioneering Heat Pump

### Demonstration (continued)

- To demonstrate the cost effectiveness of this geothermal system
- To demonstrate the feasibility to replicate the system throughout the United States

### Data Analysis & Marketing

- To collect data to prove the benefits of the system
- To share the results of data collection and research analysis
- To market the efficacy of geothermal systems, including this unique approach

# Scientific/Technical Approach

- Indiana Tech (Professors and Students), WaterFurnace International, and Primary Engineering will Monitor, Test, and Analyze the Geothermal System

- Daily, Monthly, and Annual Data Analysis is Required

- Daily Data Collection Includes:
  - Total power usage for all heat pumps in Administration Building and Zollner Engineering Center
  - Total power usage in the pump house
  - Total number of Heating Degree Days and total number of Cooling Degree Days

# Scientific/Technical Approach

- Twice per Day, the Following Data are Collected for One Water-to-Air Heat Pump and One $CO_2$ Water-to-Water Heat Pump
  - Compressor $\qquad$ Temperature & Pressure
  - Condenser $\qquad$ Temperature & Pressure
  - Expansion device $\qquad$ Temperature & Pressure
  - Evaporator $\qquad$ Temperature & Pressure
  - Tertiary loop $H_2O$--in $\qquad$ Temperature
  - Tertiary loop $H_2O$--out $\qquad$ Temperature
  - Building $H_2O$ or air--in $\qquad$ Temperature
  - Building $H_2O$ or air--out $\qquad$ Temperature
  - Power--instantaneous $\qquad$ Kilowatts

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- Monthly and Annual Data Collection Includes:
  - Total power usage for all heat pumps in Administration Building and Zollner Engineering Center
  - Total power usage in the pump house
  - Total number of Heating Degree Days and total number of Cooling Degree Days

- Planned Milestones for FY10 are On-Schedule and Include:
  - Open Bids                                       April 29, 2010
  - Begin pump house construction        May 2010
  - Install well fields                             May – August, 2010
  - Install equipment in Admin Building    June 2010
  - Install equipment in Zollner Building   Fall 2010

Technical Accomplishments for Pioneering Heat Pump

- Phase 1 Feasibility Study and Engineering Design Tasks have been Completed
  - Feasibility is determined
  - Engineering/Design work is completed
  - Permits required to proceed to Phase 2 are approved
  - Bid Solicitation is completed

- Geothermal System Design is Completed. Design Includes Ground Loop, Pump House, Vertical Wells, and Changes to Administration Building and Zollner Engineering Center

## Technical Accomplishments for Pioneering Heat Pump

- Campus Distribution Ground Loop Design Includes:
  - 2,000 feet of 12 inch diameter ductile iron pipe
  - 30,000 gallons of water with no glycol

- Vertical Well Design Includes:
  - Approximately 40 wells under parking lot
  - Approximately 10 wells adjacent to Administration Building
  - 400 feet deep
  - 1.25 inch diameter polyethylene pipe

- Pump House Design Includes:
  - 4-20 hp pumps
  - Redundant design

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## Technical Accomplishments for Pioneering Heat Pump

- Administration Building Changes Include:
  - 8 water-to-air heat pumps
  - R-410 A refrigerant
  - 30 tons of cooling
  - 1 heat pump with temperature and pressure sensors

- Zollner Engineering Center Changes Include:
  - 5 water-to-water heat pumps
  - 4 of 5 using R-410A refrigerant
  - 1 of 5 using $CO_2$ refrigerant
  - 100 tons of cooling
  - $CO_2$ heat pump with temperature and pressure sensors

# Project Management/Coordination

- Project has three investigators with Dave Aschliman from Indiana Tech serving as the principal investigator

- Investigators are: Carl Huber from WaterFurnace International and Michael Lubbehusen from Primary Engineering

- Program Tasks and Responsibilities are Listed Below

| Program Tasks | Aschliman | Lubbehusen | Huber |
|---|---|---|---|
| Coordination | X | | |
| System Design | | X | X |
| System Construction | | X | |
| System Operation | X | | |
| System Analysis | | | X |
| Education | X | | |
| System Improvement | X | X | X |
| Marketing | X | X | X |

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- Key Project Management Tasks Include:
  - Biweekly design meetings          Completed
  - Biweekly construction meetings    May – December 2010
  - Monthly data review meetings      May 2010 – September 2014
  - Quarterly project review meetings Begin March 2011

- Monthly Data Summary Uploaded to National Geothermal Data System Beginning January 2011

- ## Deployment Strategy and Deployment Needs

  - Monitor the Completion of Construction Milestones with Aggressive Schedule:  May – August, 2010

  - Continue to Develop Strategy to Collect, Analyze, and Summarize Geothermal System Data

  - Continue Development of $CO_2$ Water-to-Water Heat Pump

  - Integrate Geothermal System Operation and Data Analysis into Energy Engineering Curriculum

  - Begin Marketing Discussions

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Indiana Tech Pioneering Heat Pump Project

- Phase 1--Geothermal System Design is Completed

- Phase 2 & Phase 3--Tasks, Schedules, and Budgets are Planned

- Management Team is Leading the Project

- Problems are Addressed as They Develop

- Project Milestones are Completed on Schedule

- Construction is Scheduled for 2010