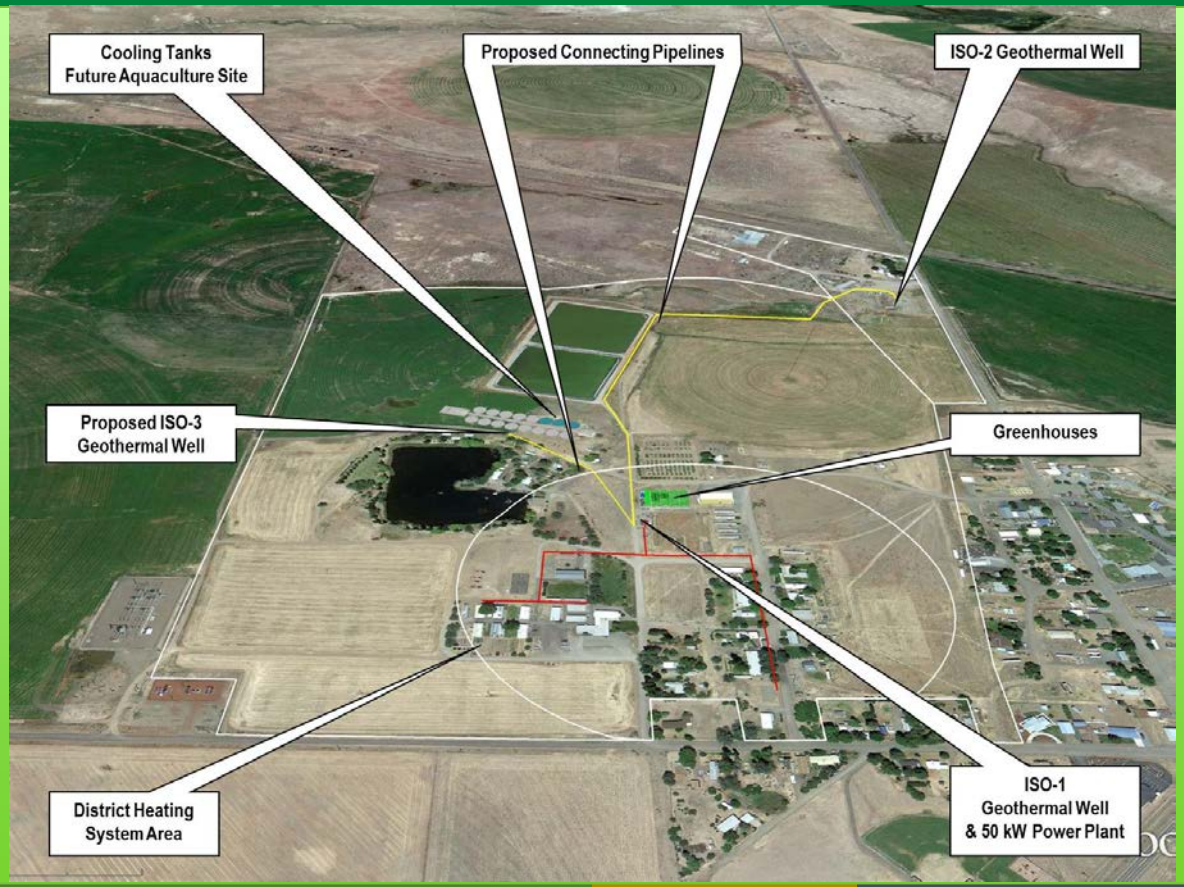


Canby Cascaded Geothermal Project
Phase 1 Feasibility

April, 2013

Principal Investigator , Dale Merrick
Presenter Name: Dale Merrick
Organization: Modoc Contracting

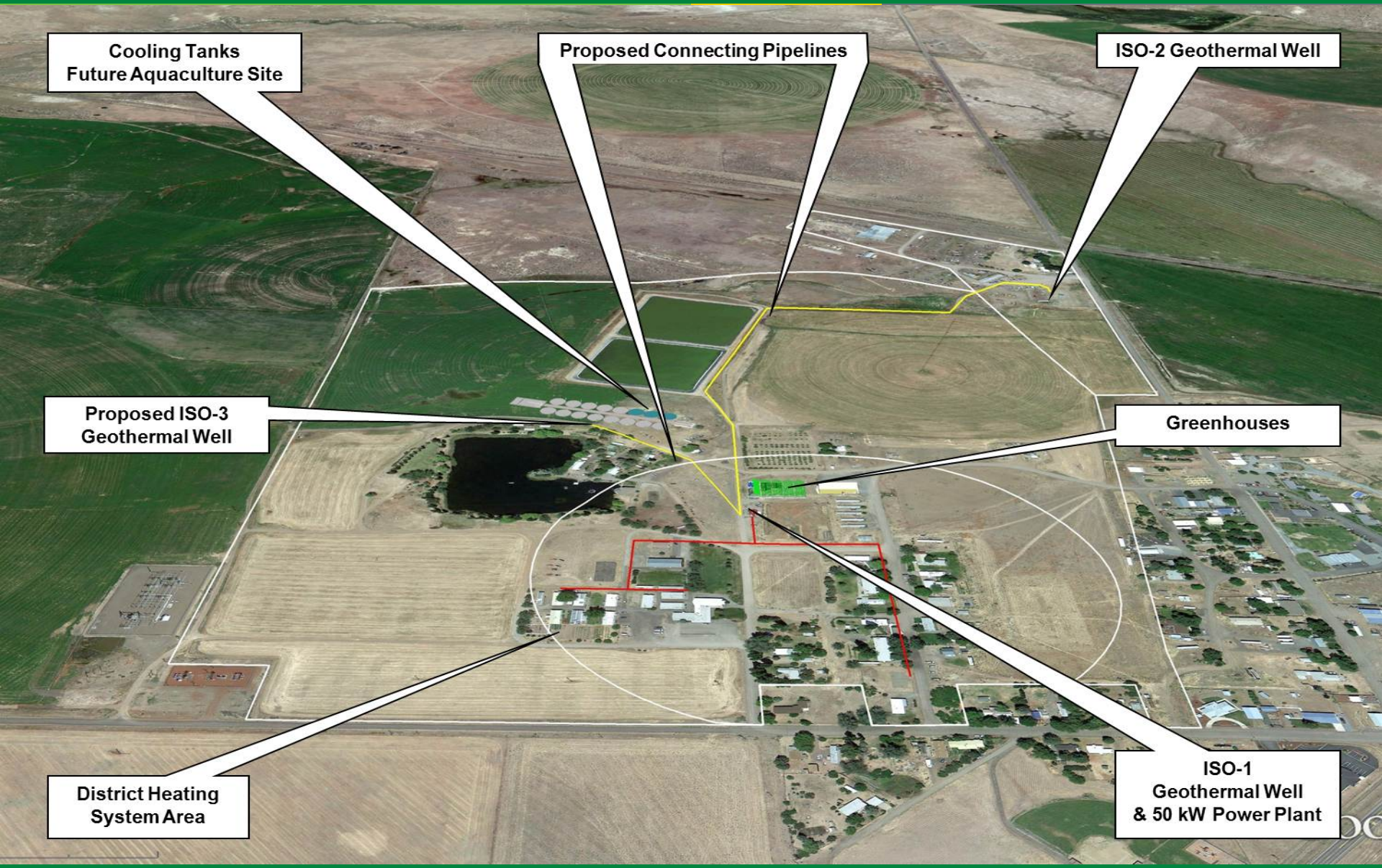
Track Name: Low Temperature Geothermal

Overview

- The Canby Project, a *community-based* cascaded geothermal development project, intends to generate geothermal power in increments of 50-kW in a community that will use warm discharge water for an existing district heating system, greenhouse operations and aquaculture development.

- Timeline
  - Phase 1 start: Feb 2011; *Phase 2 start: June 2013*
  - Phase 2 end date: December 2014
  - Phase 3 end date: June 2015
  - Percent complete: 7%

- Budget
  - Total project funding: TBD
  - DOE share: $2.0 million
  - Initial awardee share: $55,428
  - Total cost share spent: $50,000
  - Percent Phase 1 spent: 95%


Cooling Tanks
Future Aquaculture Site
Proposed Connecting Pipelines
ISO-2 Geothermal Well
Proposed ISO-3
Geothermal Well
Greenhouses
District Heating
System Area
ISO-1
Geothermal Well
& 50 kW Power Plant

Project Management/Coordination

Management activities and approaches:

- Schedule, Phase 1:

*Environmental assessment,	Mar 2011 - Aug 2012
*Injection Well siting	Jun 2011 - May 2012
*Interconnection and power sales work	Mar 2011 - July 2012
*Thermal analysis and equipment selection	Feb 2013 - Apr 2013
*Go/no go determination	Apr 2013

- Schedule, Phase 2

*Drill Injection Well, testing	Aug 2013 – Oct 2013
*Obtain County Use Permit	Oct 2013 – Jan 2014
*Install Cascaded System & Startup	Feb 2014 – Dec 2014

- Schedule, Phase 3

*Data Collection, website	Dec 2014 – Jun 2015

Collaborations

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

Project Collaborators

- Modoc Contracting, Applicant
- Merrick Consulting, project management & construction coordinator
- I'SOT, Inc. – Beneficiary community and project partner
- Brian Brown Engineering
- Evergreen Energy / Stephen Anderson, P.E.
- Panorama Environmental Consulting
- Plumas Geo-Hydrology

Objective of the Canby Cascaded Geothermal Project

- The objective is to create a net-zero energy community from a modest 205°F geothermal resource, generating power, then "cascading" the residual energy to several direct-use applications, including: an existing geothermal district heating system, and a greenhouse and aquaculture operation with subsequent re-injection of the fluids back into the geothermal reservoir.
- The Canby Project intends to prove that geothermal energy development is much more competitive in the energy market if down-stream uses of thermal energy are implemented.
- By developing value-added uses of the thermal energy, we intend to demonstrate the financial viability of this type of geothermal project.
- If successful, the project will show improved overall economics of geothermal development and serve as a model.

Relevance/Impact of Research

Barriers addressed by the Canby Project include:

ISO-2 PRODUCTION WELL DEVELOPMENT

- Well injection index increased from .2 to 1.15 gpm/psi

REDUCE DRILLING COSTS IN LOW-T GEOTHERMAL

- Use of all accumulated drilling and geophysical data for planning next well.

PUBLIC AWARENESS OF CASCADED GEOTHERMAL

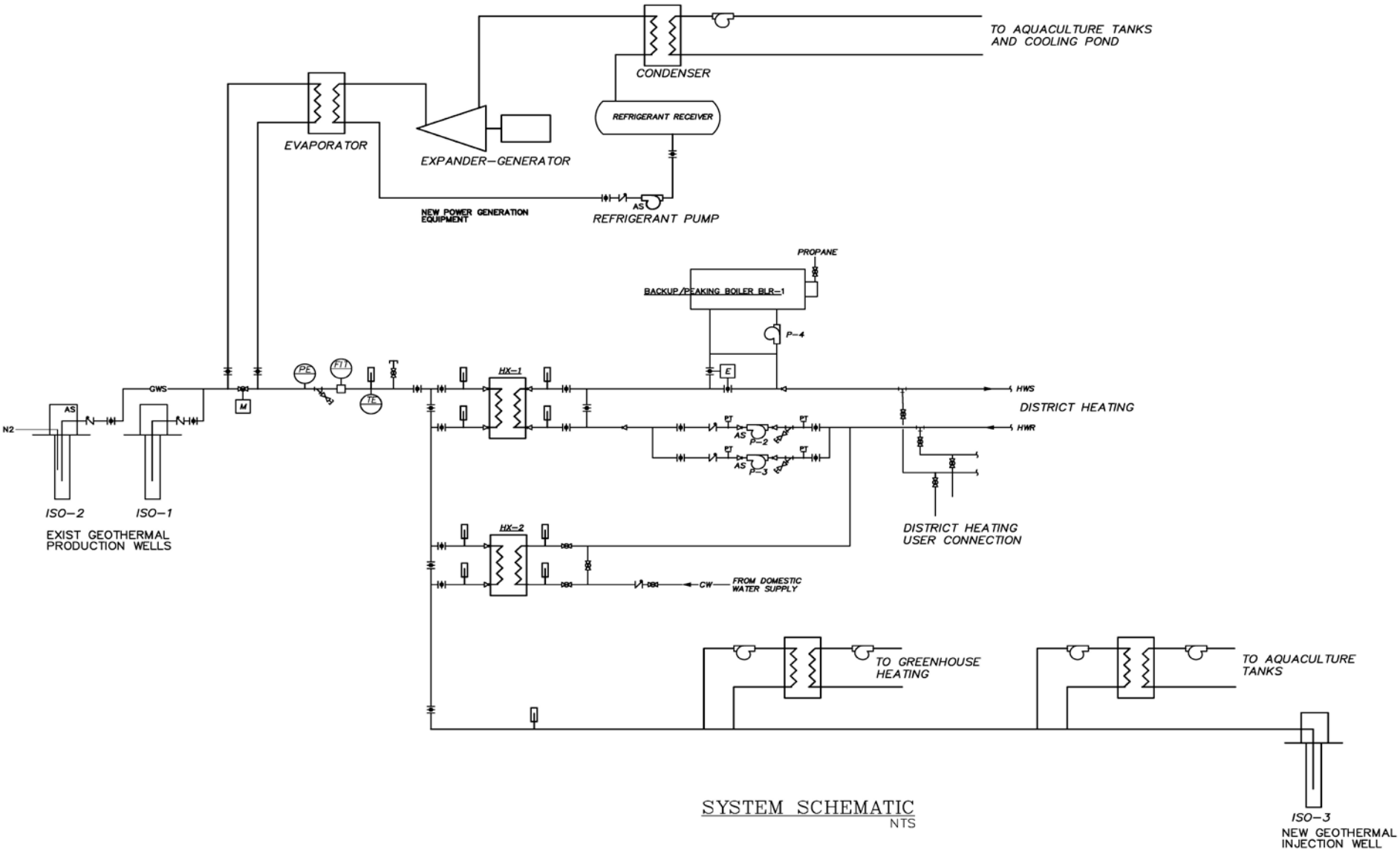
- Complete the Canby Cascaded Model.

Scientific/Technical Approach

Project highlights

- Drill site selection based groundwater chemistry, temperature logs, isotope "fingerprints" (^{2}H and ^{18}O) to site a subsequent well; a low-cost proven technique in the area.
- ISO-3 drill site selection confirmed by MT4-Ed analysis
- Development of ISO-2 through long-term high flow - high pressure injection
- Generator selection based on compatibility with available resource, capability for beneficial use of byproduct heat
- Plan on-site use of all power generated
- Ability to operate geothermal generator in parallel with existing standby generator for short-term off-grid operation
- Performed detailed thermal analysis to select appropriate equipment
- Will utilize proven equipment to assure technical feasibility

Scientific/Technical Approach



SYSTEM SCHEMATIC
NTS

Scientific/Technical Approach

Key issues

- Completion of ISO-2 well development, testing will define project capabilities in parallel with confirmation of resource
- Completed power system interconnection studies will determine the interconnection costs associated with operation as a grid-tied net-metered power generator.
- Heat and power balances show the integration of power generation in the operation of a cascaded geothermal project

Success Assessment of our Approach

- The environmental assessment has resulted in identification of few obstacles to development.
- Drill site selection strategy will be proven by drilling.
- Financial projections are being finalized to show economic viability of cascaded geothermal system.

Accomplishments/Progress to Date

- ISO-2 Well was completed to 3,852 in September 2011.
- Resource temperature ≈ 205°F.
- ISO-2 well will be developed in April 2012.
- Financial projections suggest economic viability.
- These accomplishments to date suggest that the project should be completed on schedule with economic viability.
- Technical challenges have been few to date; choosing proper equipment and facilities will be the most challenging in the future. Also, selecting the best crops and aquaculture products for commercial production will be a future challenge.

Data Sharing

Project Data Sharing

- Energy flows, temperatures, savings, and potential revenue from all applications will be posted on canbycascadedgeothermal.com in real-time as an education website and as a portal for anyone to check project development.

- Project collaborators have a close relationship with the Oregon Institute of Technology in Klamath Falls, and will share data and experience with the school.

Efforts-to-date to provide project data to the “DOE Geothermal Data Repository”

- Currently no data has been developed or made available, since the Project is in its very early stages.

Future Directions

Deployment strategy / expected outcomes

- The Canby Project is first to be a commercially viable power plant and thermal energy distribution system that will benefit the immediate community.
- Second, it is intended to be a demonstration facility that will be a model for other nearby communities in Northern California, both from a technical viewpoint but economically as well.
- Establish economic success of greenhouse vegetation and aquaculture ventures which will lead to locally grown food products and new local employment opportunities.
- Key activities for FY2013 will be to obtain all permits and approvals and to confirm project economic viability.

Planned Milestones

- A go/no-go decision will be made in April 2013.

- Phase 2 project implementation
  - Drill ISO-3 2013
  - Obtain County Use Permit 2013
  - Install Cascaded System 2014
  - Generate Project Data 2015

Summary

- Canby Geothermal will generate a cascaded geothermal system based on 50 kW increments from wells ISO-1 and ISO-2.
- A site has been selected for the ISO-3 geothermal injection well by various geophysical, geochemical, temperature and fracture analysis data.
- We expect to proceed with construction by 2013.

	CY2013	CY2014
Target/Milestone	Resource confirmation; Technical, environmental and financial feasibility study	Complete construction of power plant and thermal distribution system
Expectation	50-100 kW Power Adequate thermal energy for cascaded direct-use applications	Plant operation with power sales revenue to recover investment in time.