

# Geothermal Uses for Farms and Ranches

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# Up to your neck in hot water?



# Hot wells and springs in Idaho

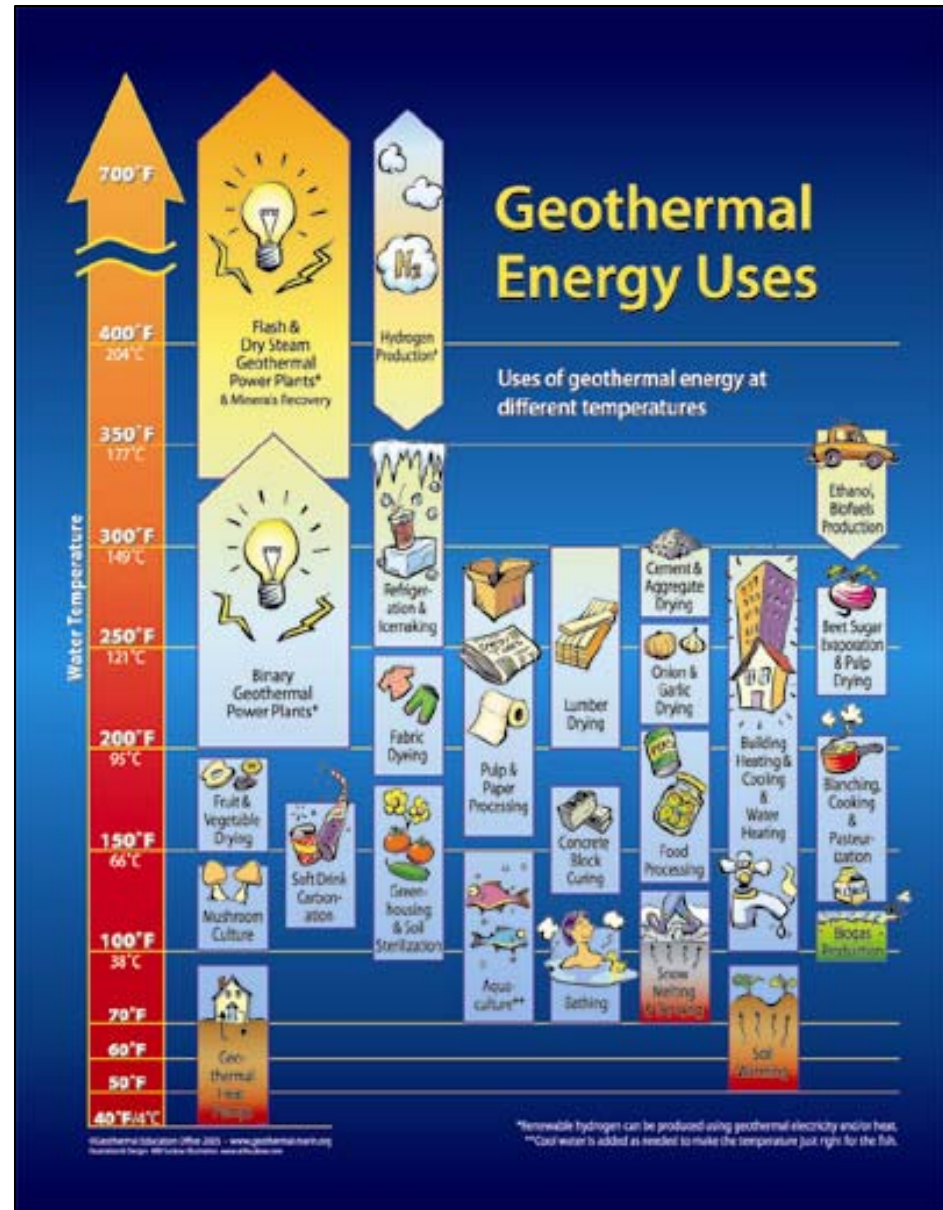
- According to the Idaho Department of Water Resources, only about 17% of the 1,057 geothermal wells and springs in Idaho are being used.
- Owyhee County
  - 297 hot springs and wells
  - Average temperature of 96.9°F
- Valley County
  - 63 hot springs and wells
  - Average temperature of 117.3°F
- 98% of geothermal water is used for irrigation.
- Considered liability – too hot to put on crops.

# Geothermal energy uses

- Geothermal heat pumps

- Soil warming
- Aquaculture
- Snow melting and de-icing
- Mushroom culture
- Greenhouses
- Soil sterilization
- Space heating and cooling
- Hot water
- Biogas production
- Pasteurization
- Food processing
- Lumber drying
- Fruit and vegetable drying
- Beet sugar evaporation

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# Possible uses for hot water

- Direct use – uses heat from water directly.
  - Aquaculture
  - Greenhouses
  - Spas and resorts
  - Industrial and agricultural processes
  - Space heating and hot water
  - Refrigeration
- Electricity generation
  - New technology can produce electricity from lower temperature water than before.

# Aquaculture I

- Geothermal aquaculture uses naturally occurring warm water to accelerate the growth of fish, shellfish, reptiles, amphibians, and aquatic plants.
- Rearing fish in controlled temperatures can boost growth rates by 50 to 100%.
- Fish and other species can be raised in simple open air earthen ponds or sophisticated fiberglass tanks.

# Aquaculture II

- Water quality is extremely critical.
  - Temperature, dissolved oxygen, nitrogenous wastes, pH, alkalinity, hardness, carbon dioxide, salinity, chlorine, and hydrogen sulfide
- The maximum pond area that can be developed depends on the maximum heat available from the resource.

# Aquaculture III

- Temperature of water determines which species can be raised.

<b>Species</b>	<b>Tolerable Extremes (°F)</b>	<b>Optimum Growth (°F)</b>	<b>Growth period to market size (months)</b>
Lobsters	32-88	72-75	24
Salmon (Pacific)	40-77	59	6-12
Catfish	35-95	82-87	6-24
Tilapia	47-106	72-86	12
Trout	32-89	63	6-8
Shrimp	40-104	75-87	6-8



# Aquaculture IV

- Cost of establishing business depends on:
  - Size of project
  - Species raised
  - Whether a well already exists

# Aquaculture V

- U.S. imports of edible fishery products in 2005 valued at \$12.1 billion.
- 2.3 million metric tons of edible fish imported in 2005.
- Shrimp imports accounted for 30% of total edible imports = \$3.6 billion.
- Fresh or frozen freshwater fillets and steaks imports (includes catfish and Tilapia) = \$461 million.

# Aquaculture VI

- Good market outlook
  - Consumers
    - Health conscious
    - Low-calorie, healthy source of protein
    - Traceability
    - Locally produced
  - Fill a void in fish supply
    - Wild-caught decline
    - Contamination

# Aquaculture VII

- There are 10 geothermal Tilapia farms in Idaho.
- Farm price for Tilapia is twice that of trout.
- Most Tilapia sold in live markets.
- U.S. growers do best in the live market.
- “Ethnic” Americans consume 70-80 pounds of seafood/year compared to 15 pounds/year for “non-ethnic” Americans.

# Fish Breeders of Idaho, Inc.

- In business since 1973.
- Employs 20 people.
- Wellhead temperature of 90-95°F.
- 4,500 gpm flow for entire farm.
- Raises blue and channel catfish, Tilapia, trout, alligators, and sturgeon (caviar).
- Produces 500,000 lbs of fish on ½ acre of water surface.
- Sold 600 alligator hides to Gucci in Europe @ \$300-hide to make up to \$20,000-purses.
- Benefits from working with UI Extension and USDA Agricultural Research Service.

# Fish Breeders of Idaho, Inc.

- One second-foot of water = 450 gal./min.
  - Irrigation 50 acres wheat \$15,000 gross.
  - \$100,000 catfish and Tilapia.
  - \$800,000 alligators.
  - \$12 million angel fish.
- Cost to heat water would be \$3 million per month in the winter.
- Need to think of geothermal as heat rather than water.

# Fish Breeders of Idaho, Inc.



Photos: Ted Clutter and *Idaho Mountain Express*

# Greenhouses I

- Greenhouse heating is one of the most common uses of geothermal resources.
- A wide variety of plants are grown in geothermal greenhouses:
  - Tree seedlings; roses, carnations, lilies, and other flowers; tomatoes, lettuce, cucumbers, and other vegetables (hydroponic and otherwise); poinsettias; potted plants; and flower and vegetable bedding plants.



# Greenhouses II

- Need to determine the heating requirements = function of the temperature difference between the inside and the outside, and construction materials.
- Greenhouses can be made of glass, plastic film, fiberglass or rigid plastics, or a combination of materials.
- Glass greenhouses are the most expensive to build.
- Glass offers the highest light quality but the lowest energy efficiency.

# Greenhouses III

- Capital costs vary by project size, location, material used, and whether a well currently exists.
- Commercial greenhouses range from 1 to 30 acres in size.
- Greenhouse costs including equipment, excluding drilling, average about \$17.00/ft<sup>2</sup>.

# Greenhouses IV

- Market outlook good.
- Barriers to entry relatively low.
- Industry is highly fragmented.
- Net investment not prohibitive.
- Geothermal saves about 80% of fuel costs—about 5% to 8% of total operating costs.
- 30-acre Burgett Greenhouse's annual cost savings by using geothermal heat compared to natural gas is about \$1.8 million.

# Wards' Greenhouse, Inc.

- Established in 1966.
- 15 people work full-time; 30 people part-time on a seasonal basis.
- In 2005, sales of bedding plants, hanging baskets, and poinsettias totaled \$1.6 million.
- Geothermal provides 36 billion Btu/year.
- Ward's plans to invest about \$13 million in 2008 to build a second, larger geothermal greenhouse which would cover 16 acres and provide 58 full-time and 40 part-time jobs.

# Spas and resorts

- About 30 resorts in Idaho use geothermal water.
- Idaho Rocky Mountain Ranch in Stanley.
- Terrace Lakes Recreational Ranch in Garden Valley.

# Is there a resort in your future?



# Agricultural processes

- Applications include food dehydration and milk pasteurization.
- Dehydration of vegetables and fruits is the most common industrial use of geothermal energy.
- Temperatures range from 86-356°F.

# Space and water heating

- Space heating of an individual building is fairly easy to justify economically, provided the heating load is large enough.
- Adapting an existing system to use geothermal heat is a straightforward process.
- Domestic hot water heating requires higher temperature water than space heating.



# Refrigeration

- Geothermal energy may be used for cooling through the absorption cycle process.
- Chena Absorption Chiller
- Uses 165°F water.
- Keeps Aurora Ice Museum at Chena Hot Springs Resort in Alaska “on ice” year-round.



# Small-scale power generation

- Chena Hot Springs Resort – Chena, Alaska.
- ~ 400-kW “Chena Chiller” geothermal power plant (two 225-kW plants).
- Generates electricity from 162.5°F water.
- The lowest temperature used anywhere in the world to produce power.
- 1<sup>st</sup> 225-kW plant started generating electricity in July 2006. 2<sup>nd</sup> installed 11/06.

# Chena Chiller I

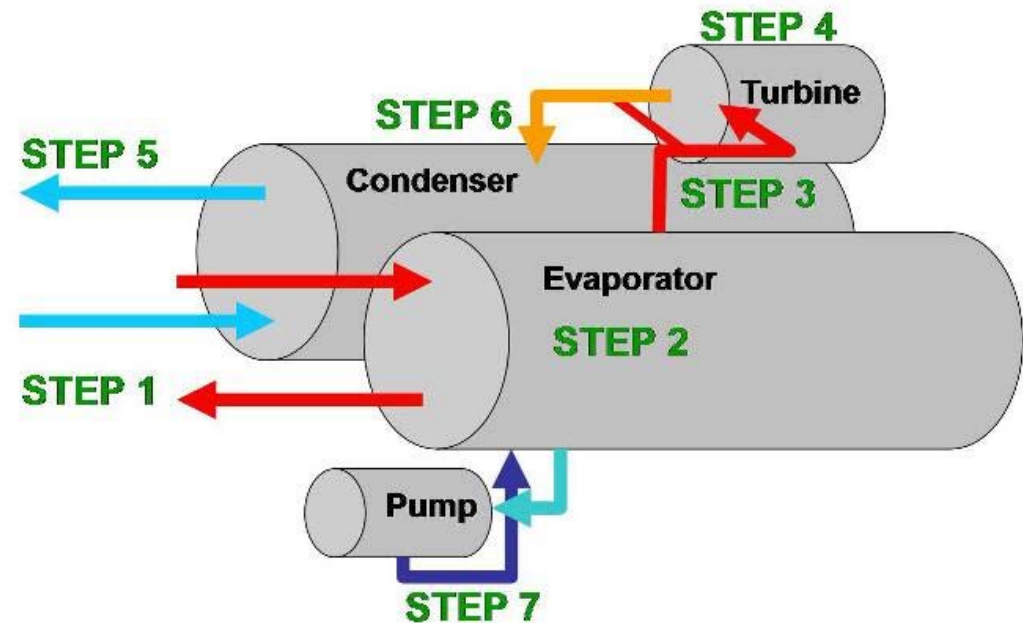
- Designed and built by United Technologies Corporation (UTC).
- Runs a refrigeration cycle in reverse to generate power.
- Technology can operate off any heat source, with a minimum of 100°F temperature differential between the heat source and sink.

# Chena Chiller II

- Geothermal plant will save the resort \$365,000 a year in diesel fuel costs.
- Cuts electricity costs from 30¢/kWh to 5-7¢/kWh.
- Total cost of the project, including onsite infrastructure, is \$5 million (25%-Department of Energy, 25%-UTC, remainder-Chena Hot Springs Resort and Alaska Energy Authority).
- UTC invested \$25 million on R&D.
- ~ \$280,000 is UTC's target price for 225-kW plants (\$1250/kW)
- 1 MW plant will be available in 18 months.

# Chena Chiller: How it works

1. Hot water enters evaporator at 165°F (480gpm).
2. Hot water boils R-134a refrigerant.
3. R-134a vapor routed to turbine.
4. Turbine blades connected to generator spin producing electricity.
5. Cold water (40°F-45°F) from cooling well enters condenser.
6. R-134a re-condenses back into a liquid.
7. Liquid R-134a returns to evaporator. Cycle starts again.



# Chena Chiller III



# Conclusion

- Geothermal can be developed for a variety of commercial uses on the farm or ranch.
- Geothermal saves money, energy, and the planet.
- The geothermal energy used by 60 direct uses in Idaho = 807.4 billion Btu of energy per year, or 237 million kWh.
- Geothermal direct uses in Idaho offset 109,000 tons of carbon dioxide per year = 230,000 barrels of oil.

# Now what?

- Developing and financing a geothermal small business...

