



From Hot Water to Hydrogen

Renewable Energy Projects at Chena Hot Springs Resort

Bernie Karl, Proprietor, Chena Hot Springs Resort

Prepared for the Geothermal Energy Association





The New Chena Hot Springs

- Purchased by Connie Karl in 1998

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CHENA HOT SPRINGS RESORT Alaska

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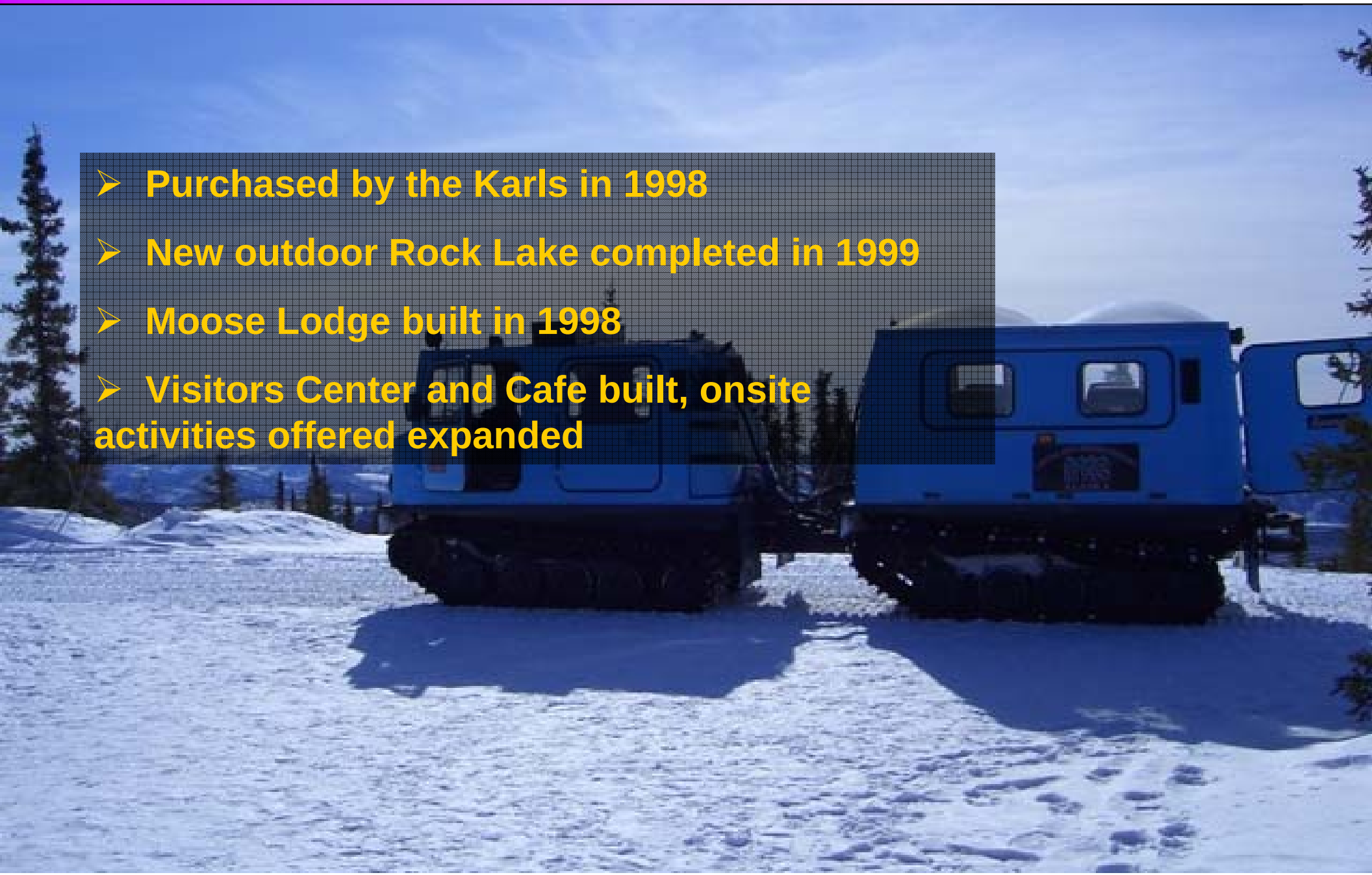

- Purchased by the Karls in 1998
- New outdoor Rock Lake completed in 1999
- Moose Lodge built in 1998
- Visitors Center and Cafe built, onsite activities offered expanded

Aurora Viewing

Aurora Viewing


CHENA
HOT SPRINGS
RESORT
Alaska

Sleigh Rides

Dog Mushing

Chena Hot Springs Resort
Alaska


Hiking


Snow machining


Skiing


Wildlife Viewing


Flightseeing

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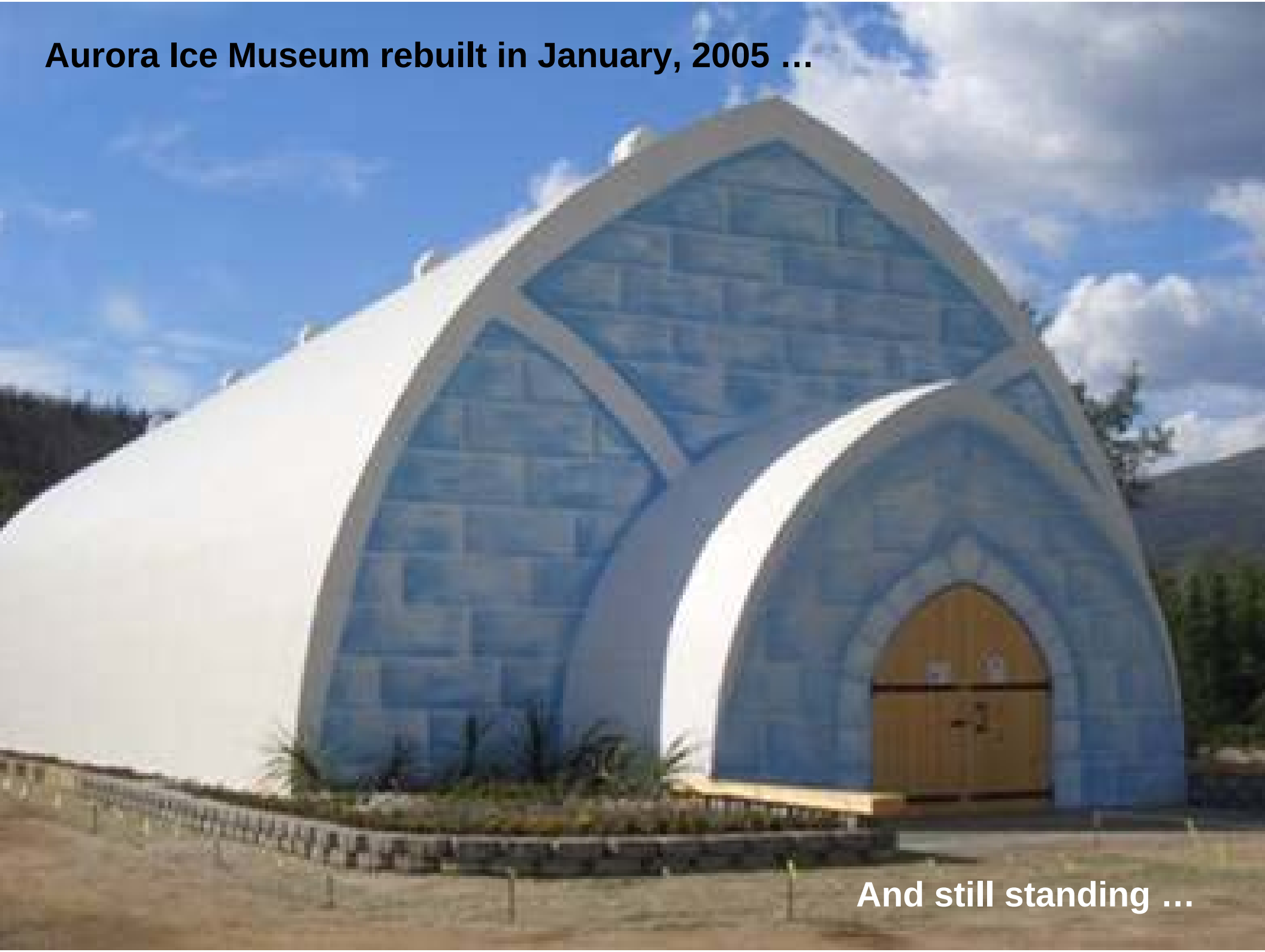
- **Aurora Ice Museum**

1st Aurora Ice ‘Hotel’ completed in January, 2004 …

1st Aurora Ice ‘Hotel’ melted in June, 2004 …

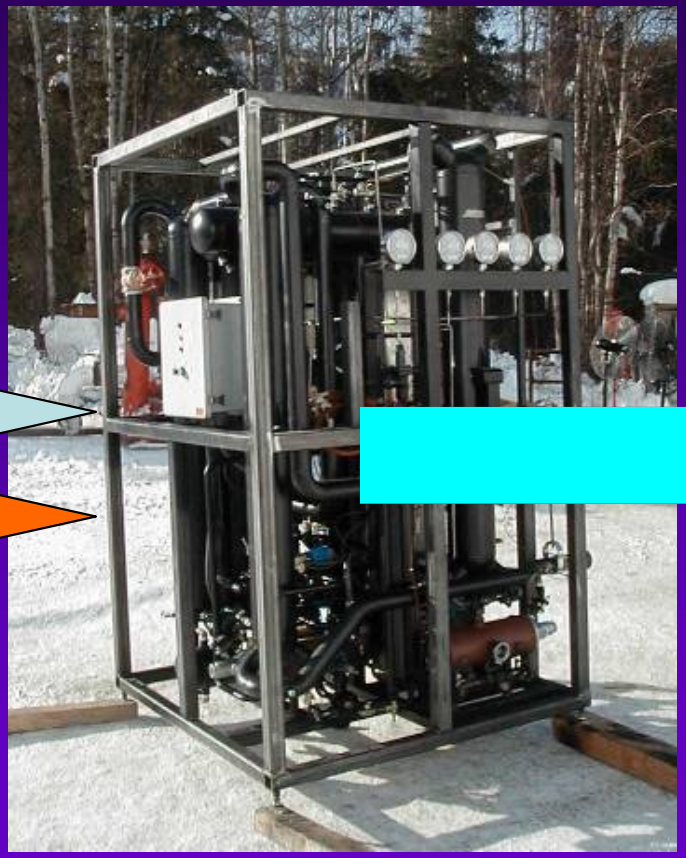
Voted as dumbest business idea of 2004 by Forbes Magazine

'I had a frozen asset, and I turned it into a liquid asset' **--** Bernie Karl


Aurora Ice Museum rebuilt in January, 2005 …
And still standing …

CHENA HOT SPRINGS ABSORPTION CHILLER

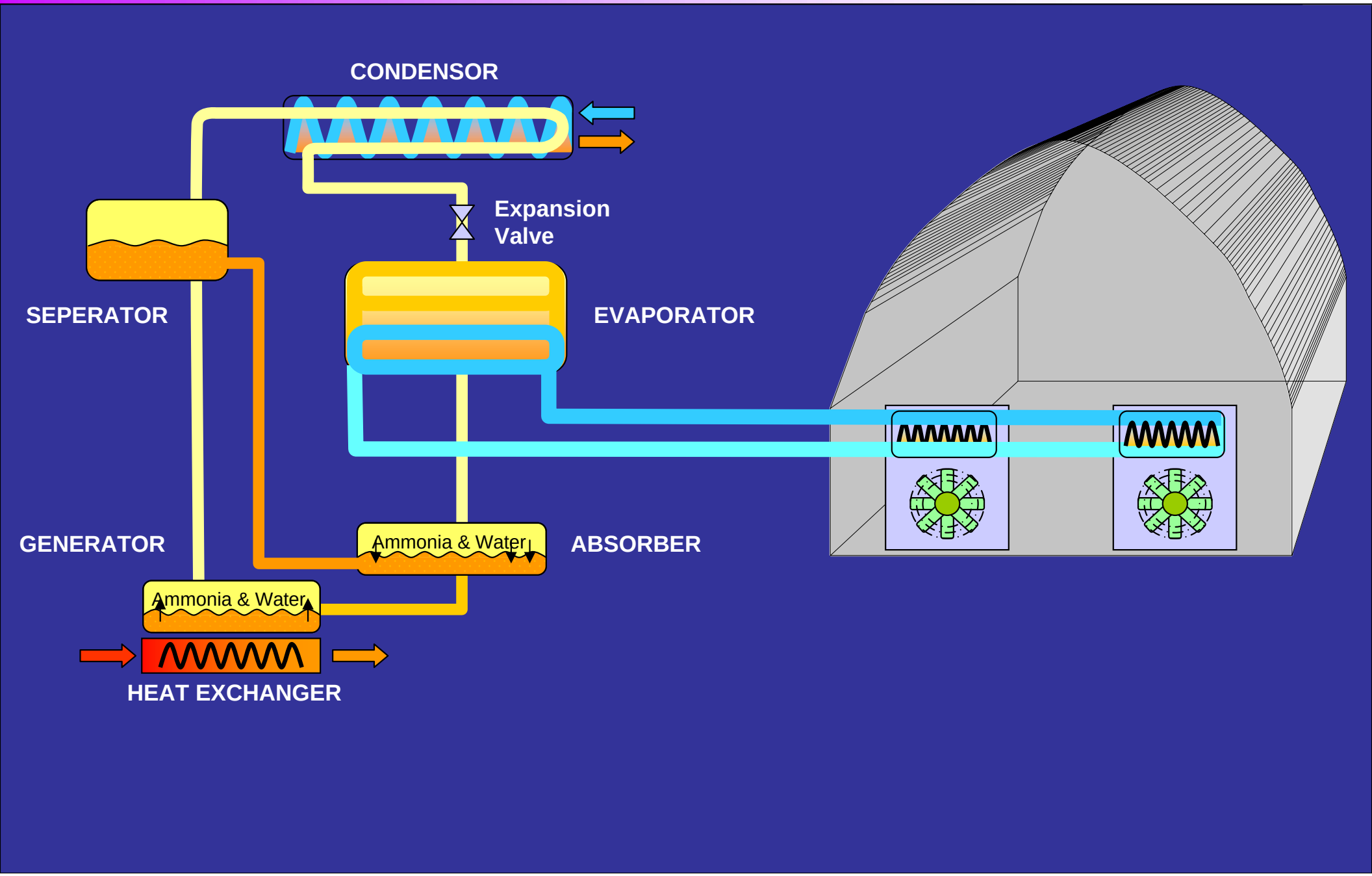
Monument Creek Provides Cooling Water (~40F)



Geothermal Wells Provide Hot Water (~165F)

Approximately 15 tons of Refrigeration Required for Ice Museum (180,000 BTU per hour)

CHENA HOT SPRINGS ABSORPTION CHILLER



Chena Hot Springs

CHENA HOT SPRINGS RESORT
Alaska

Chena Hot Springs

- Semi remote site
- Electric Power 30¢/kWhr
- Load 180kW-400kW

Chena Hot Springs

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- Electric Power 30¢/kWhr
- Load 180kW-400kW

- $1000/day in diesel fuel at $2.50 per gallon
- $365,000 per year in fuel costs at today's price

Chena Hot Springs VISION:

To become a self-sustaining community in terms of energy, food, heating and fuel to the greatest possible extent

Chena Hot Springs MISSION:

To encourage renewable energy and sustainable community development throughout Alaska

To make Alaska a leader in renewable energy development

Forming Partnerships with:

- *University of Alaska (Horticulture, Geophysical Institute, Mining, Geology)*
- *Department of Energy*
- *Alaska Energy Authority*
- *Denali Commission*
- *United Technologies Corporation*
- *Golden Valley Electric Association*
- *REAP (Renewable Energy Alaska Project)*

District Heating

- First geothermal well drilled in March 1998

District Heating

- First geothermal well drilled in March 1998
- All buildings on property are heated geothermally using ~300gpm of 165°F water
- Estimated yearly savings of $183,000 in heating fuel coats

Moose Lodge, 20,000ft² heated solely with geothermal district heating system

Chena Geothermal Power Plant

Chena Power Plant

United Technologies

UTC Fire & Security
Security &
Fire Protection

Pratt & Whitney
Aircraft Engines,
Gas Turbines &
Space Propulsion

Carrier
Heating, Cooling
& Refrigeration

Otis
Elevators,
Escalators &
People Moving
Systems

UTC divisions span many markets and industries…

UTC Research Center
– Technology
Advancement

UTC Power
Fuel Cells & PureCycle

Hamilton Sundstrand
Aerospace & Industrial

Sikorsky
Helicopters

United Technologies

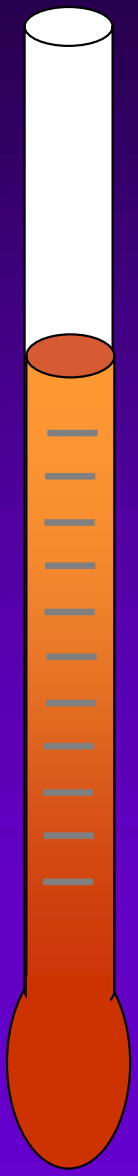
Carrier
Heating, Cooling & Refrigeration

UTC Research Center – Technology Advancement

UTC Power
Fuel Cells & PureCycle

Conventional Wisdom for Absorption Chilling & Power Generation Cycles:

$$T \geq 230^{o}F$$



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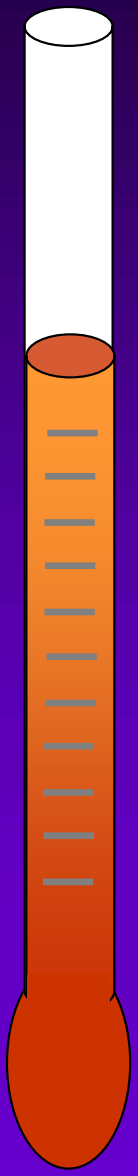
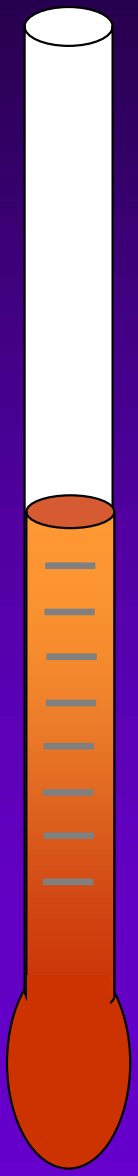
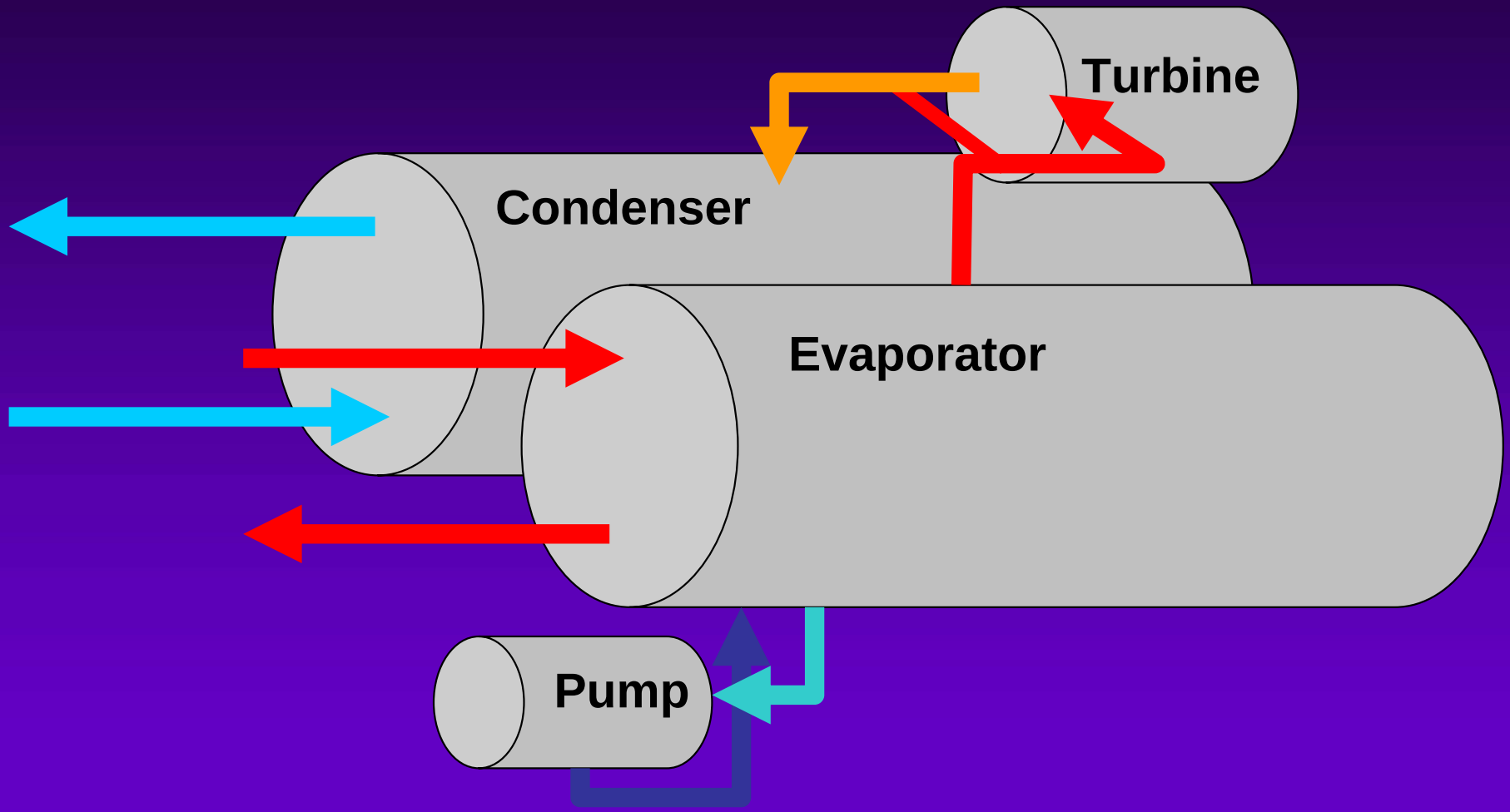


Conventional Wisdom for Absorption Chilling & Power Generation Cycles:

$$T \geqq 165^{\circ}F$$



Chena Power Plant



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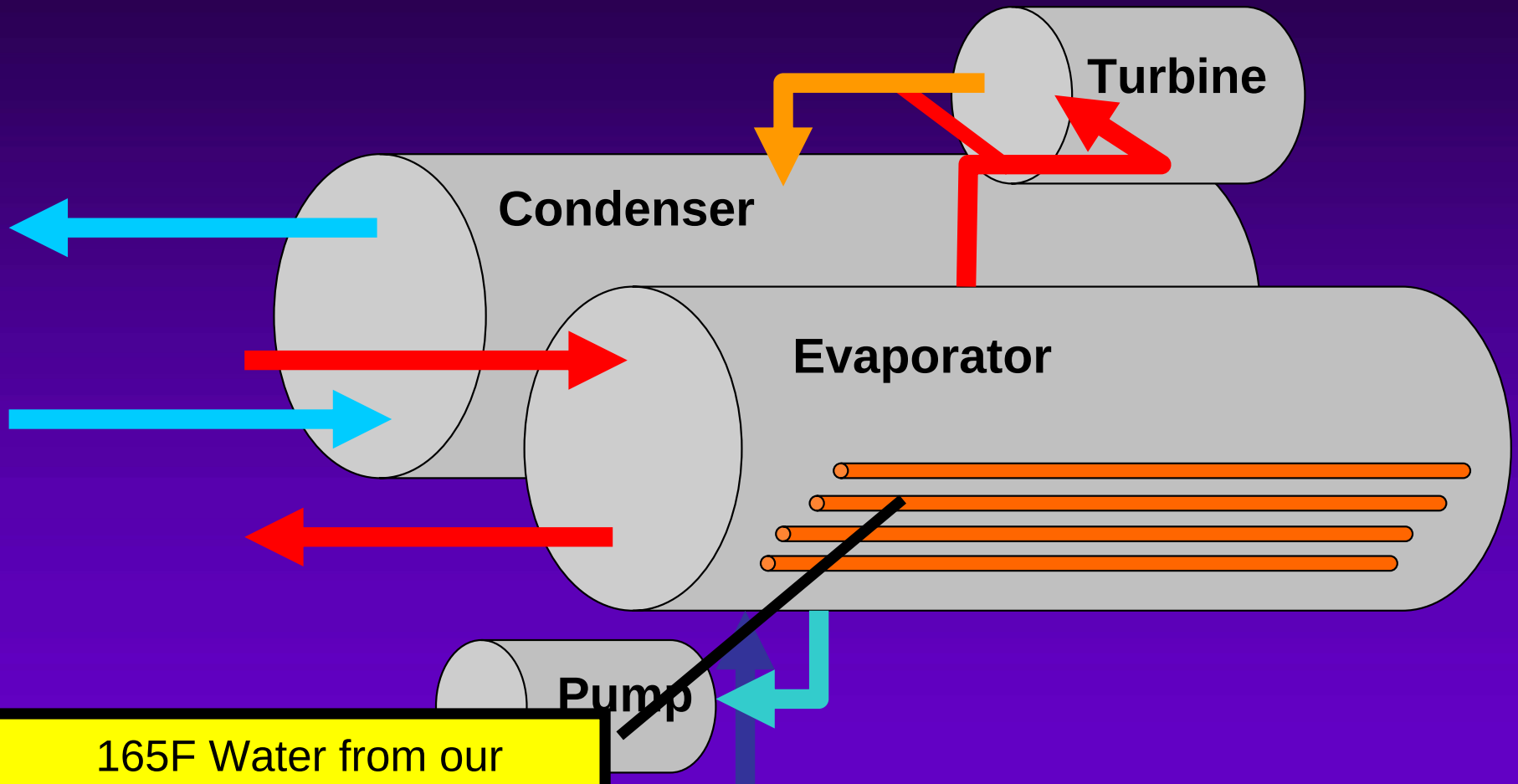
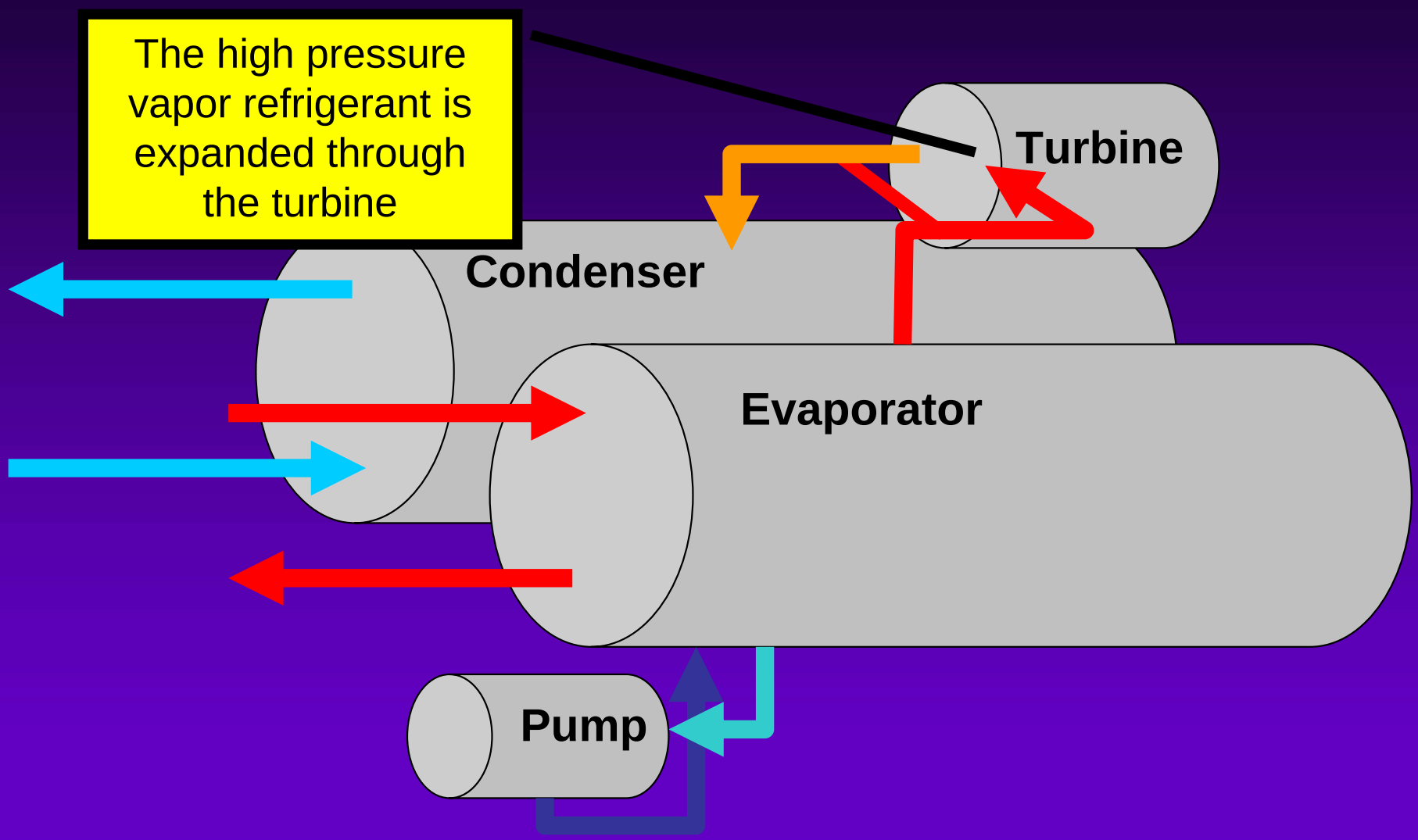


165F Water from our production well enters the evaporator and boils the refrigerant

Chena Power Plant



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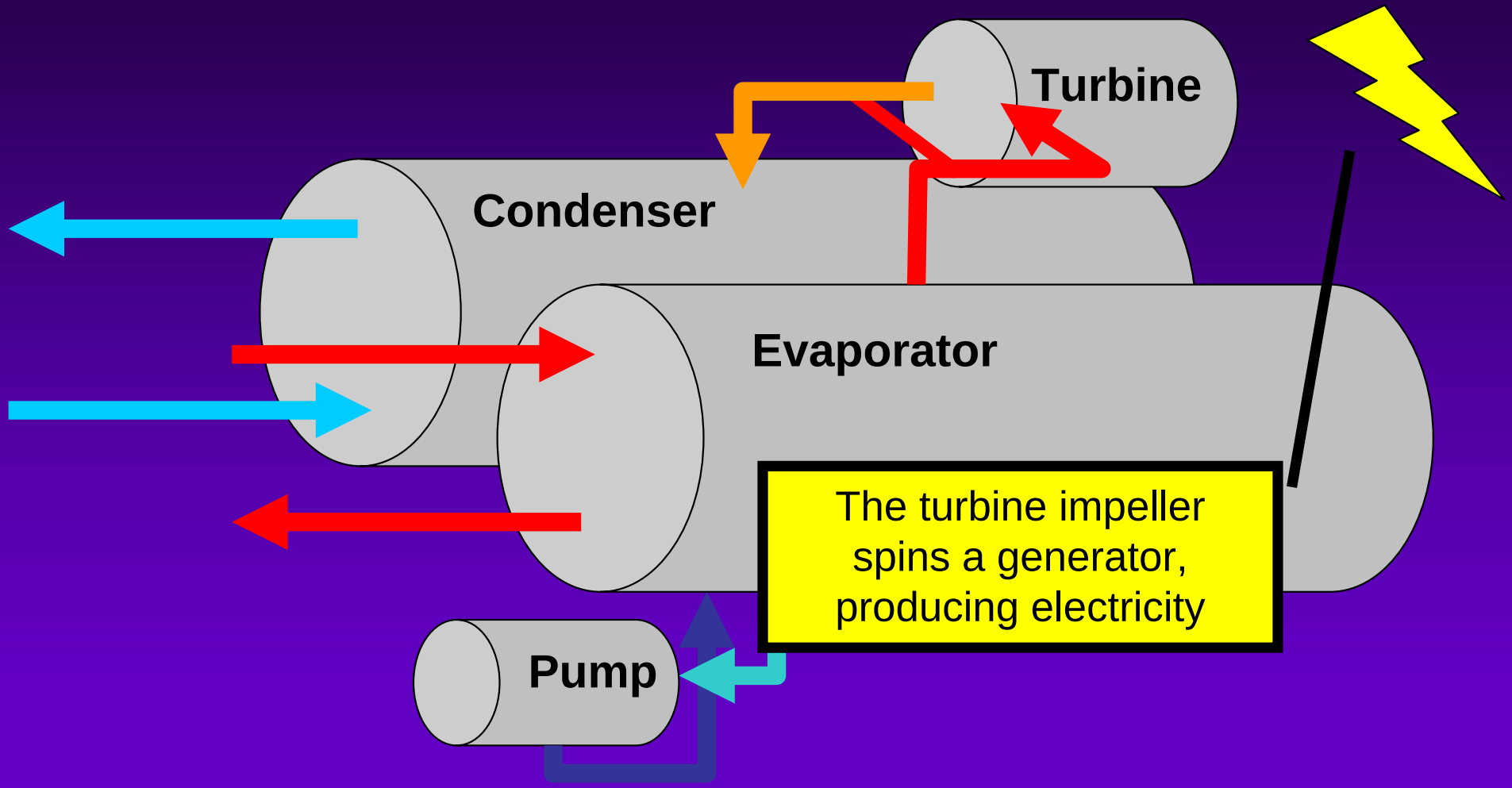

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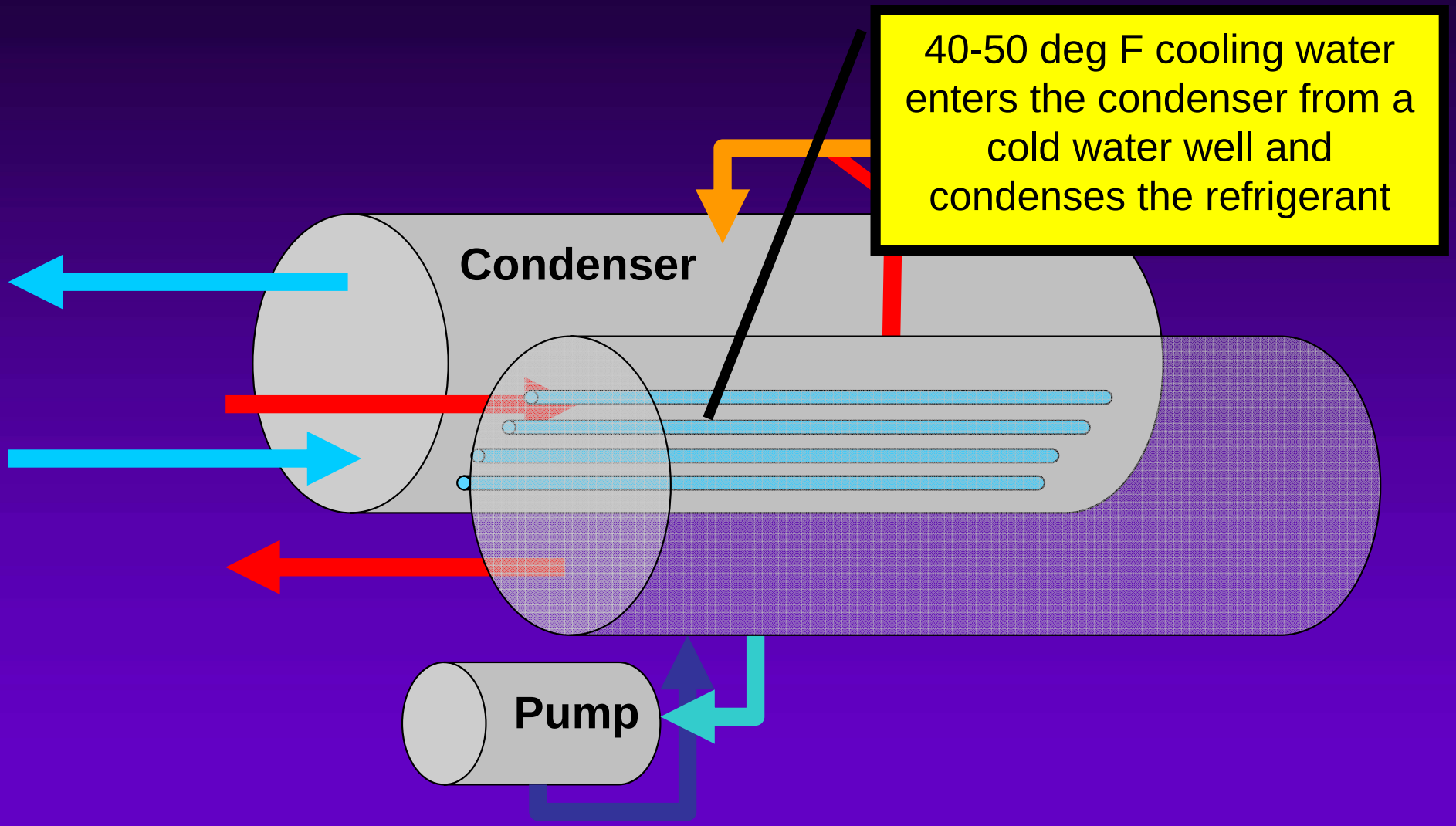

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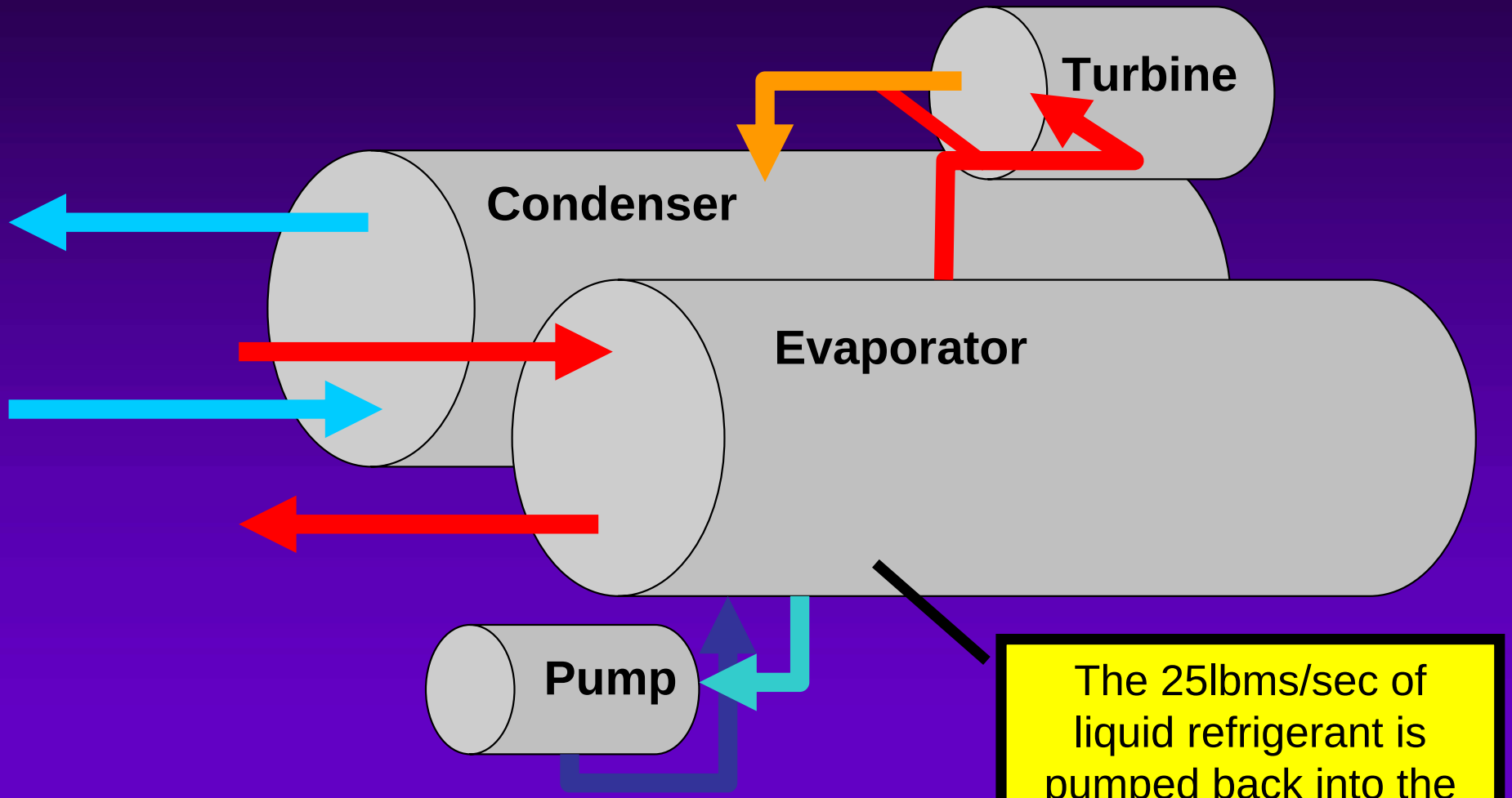


The 25lbms/sec of liquid refrigerant is pumped back into the evaporator at high pressure

Chena Power Plant

CHENA HOT SPRINGS RESORT Alaska

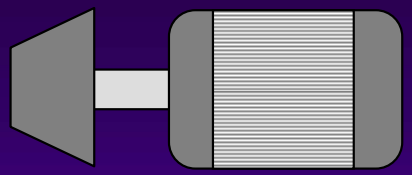
Battery and UPS System

UPS System (MGE)

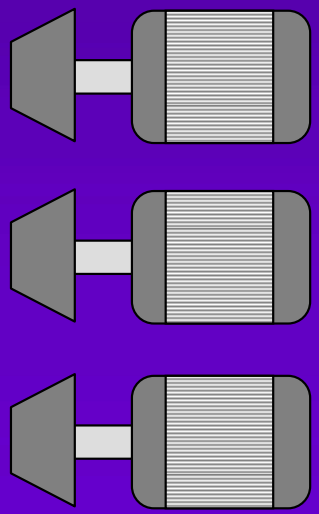
Batteries 3MW Total

Battery and UPS System

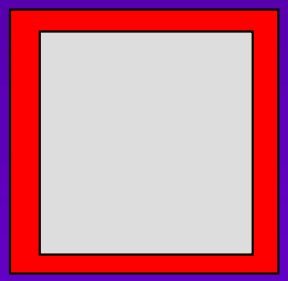
ORIGINAL CONFIGURATION



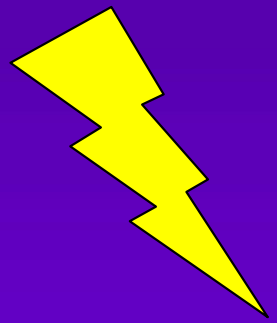
400kW Diesel Genset



200kW Cat 3306Diesel Gensets

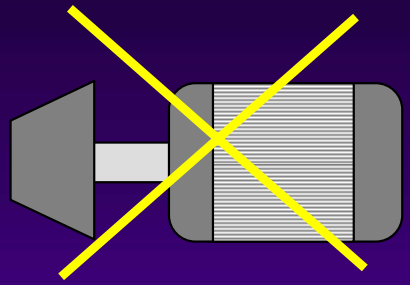


Inverter/Batteries 480VDC/480AC



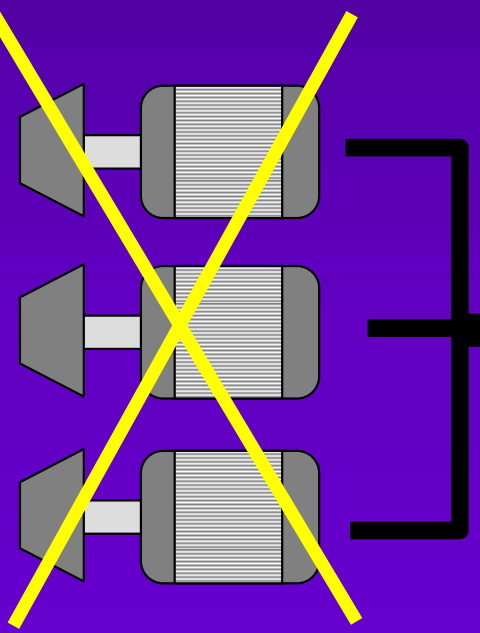
480VAC Output

Battery and UPS System



400kW Diesel Genset

Excess Power to Charge Batteries



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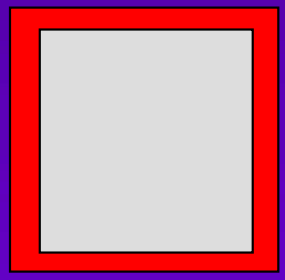

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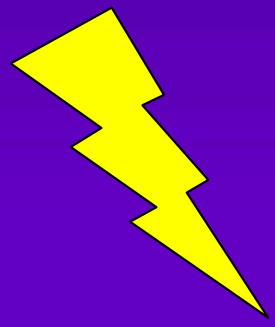


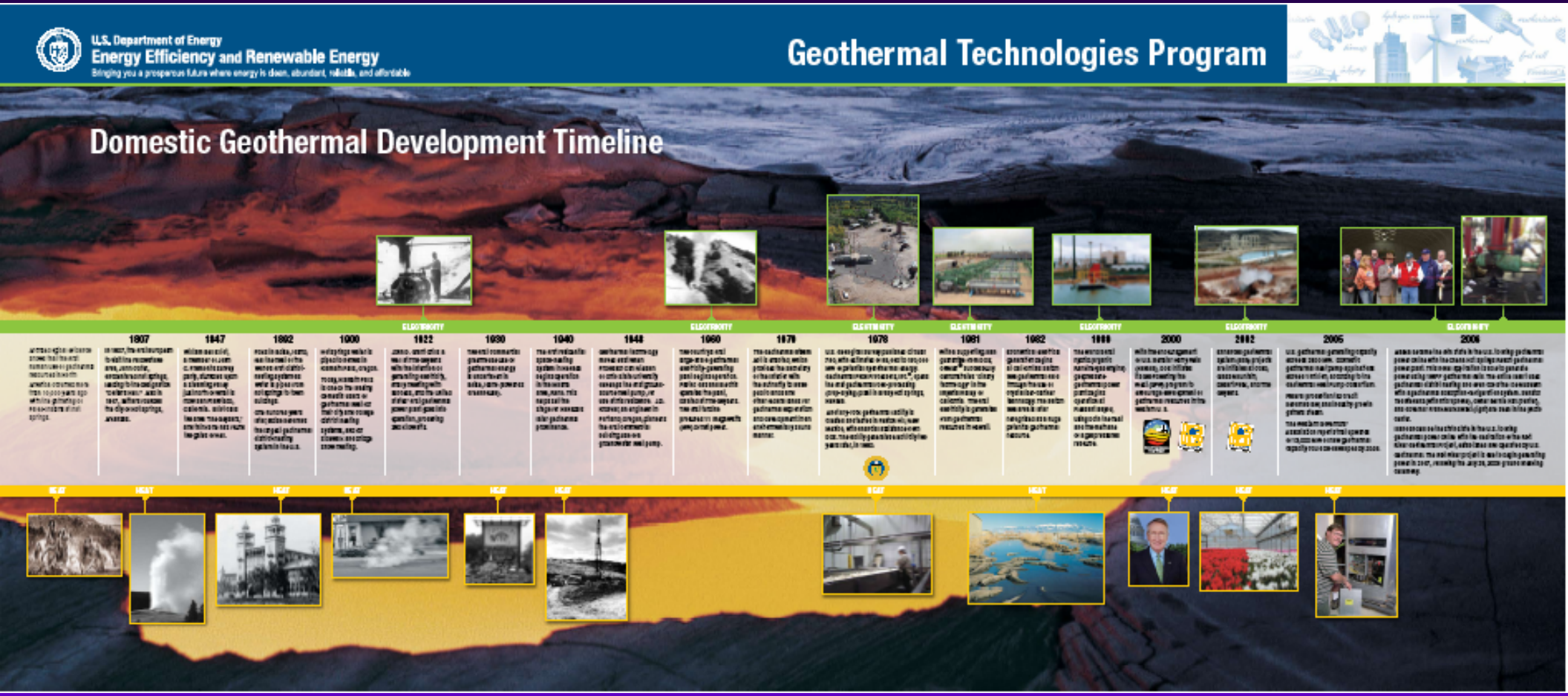
480VAC Output

Project Economics

- Power Plant Cost is $1300/kW installed
- Infrastructure costs an additional $1.8 million
- Big expenses included UPS system and 7000ft of pipeline
- Maintenance costs are expected to stay the same or decrease (currently ~$50,000/year)
- Payback period calculated to be 4 to 5 years

August 20th Official Opening – Chena Geothermal Power Plant

DOE Geothermal Timeline



DOE Geothermal Timeline

FAIRBANKS

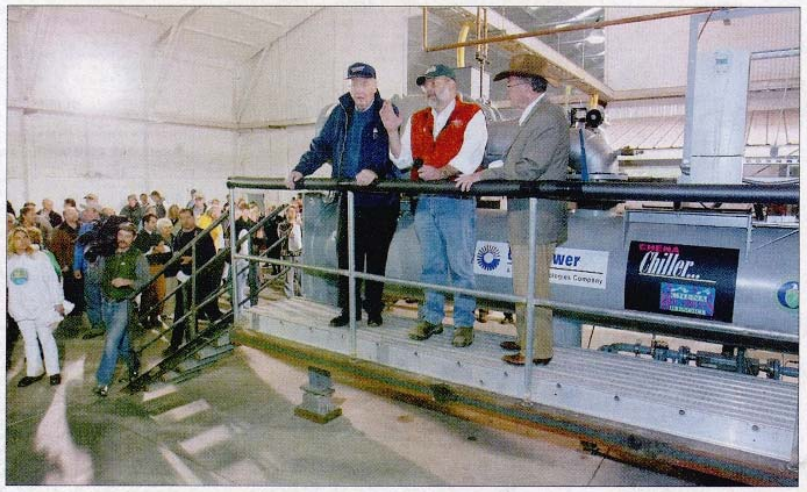
Daily News-Miner

The voice of Interior Alaska since 1903

MONDAY, AUGUST 21, 2006

www.newsminer.com

RENEWABLE ENERGY FAIR



Sam Harrel/News-Miner

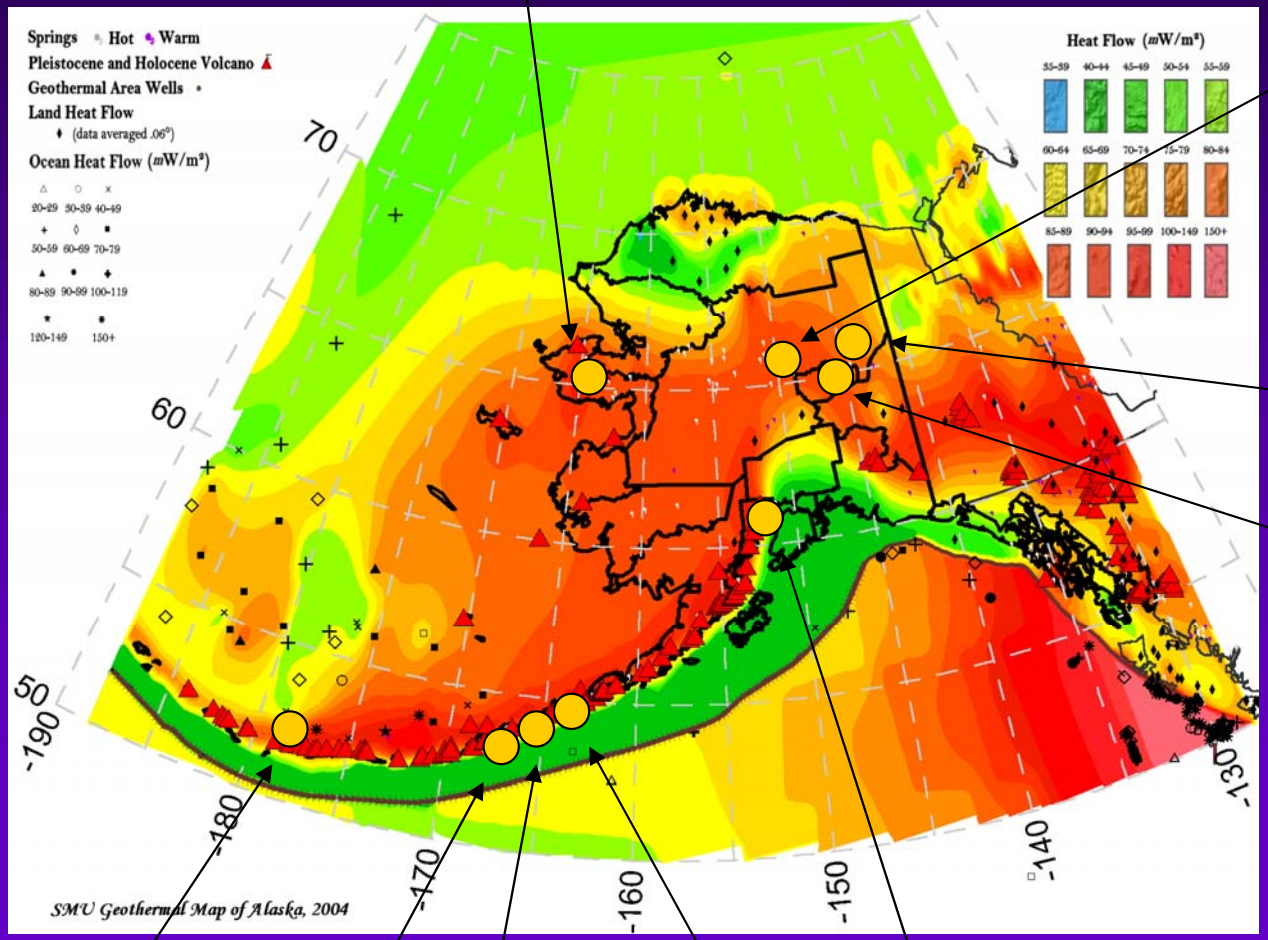
SPECIAL GUESTS—Chena Hot Springs Resort owner Bernie Karl, center, stands with U.S. Sen. Ted Stevens, right, and Gov. Frank Murkowski as Karl talks about the new 200 kilowatt geothermal power plant Sunday during ribbon cutting ceremonies at the resort. Karl says this is the first of several units to be put on line at the resort, ending its dependence on diesel-generated electricity.

The big chill

Geothermal power plant unveiled at Chena Hot Springs

Geothermal Resources of Alaska

Pilgrim Hot Springs



Manley Hot Springs

Circle Hot Springs

Chena Hot Springs

Adak

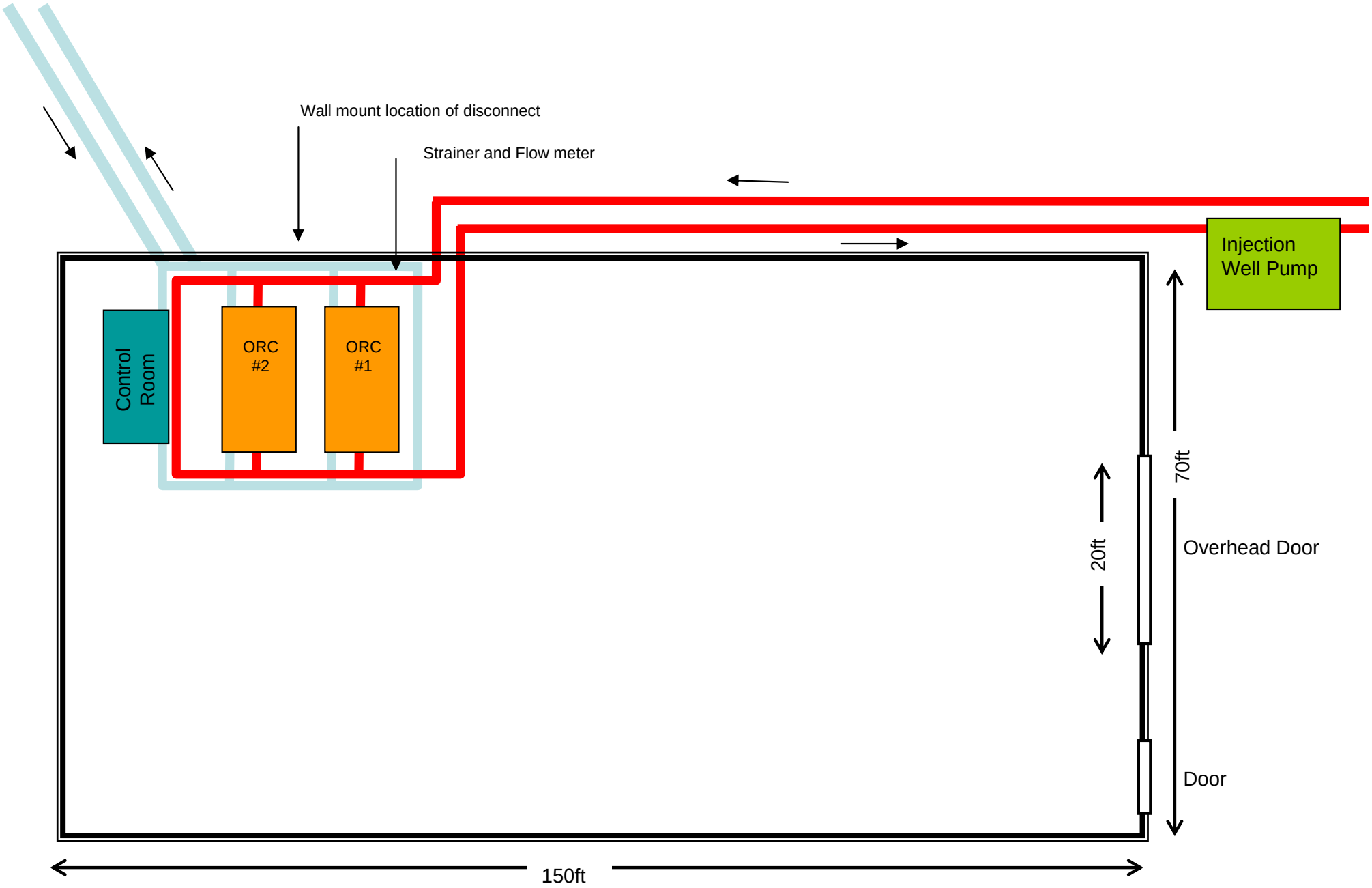
Umnak

Makushin

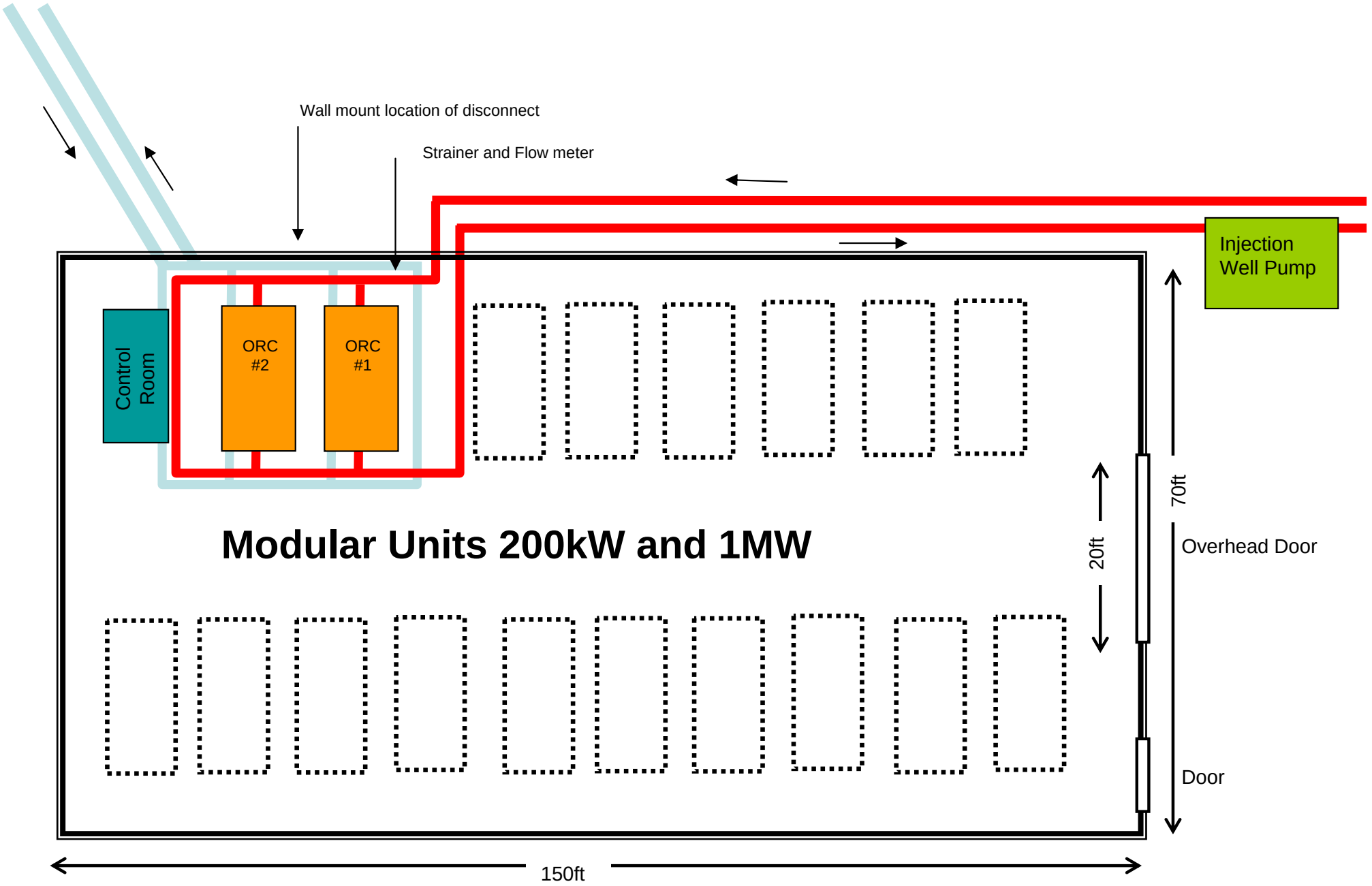
Akutan

Mt. Spur

Chena Power Plant - Current



Chena Power Plant - Future



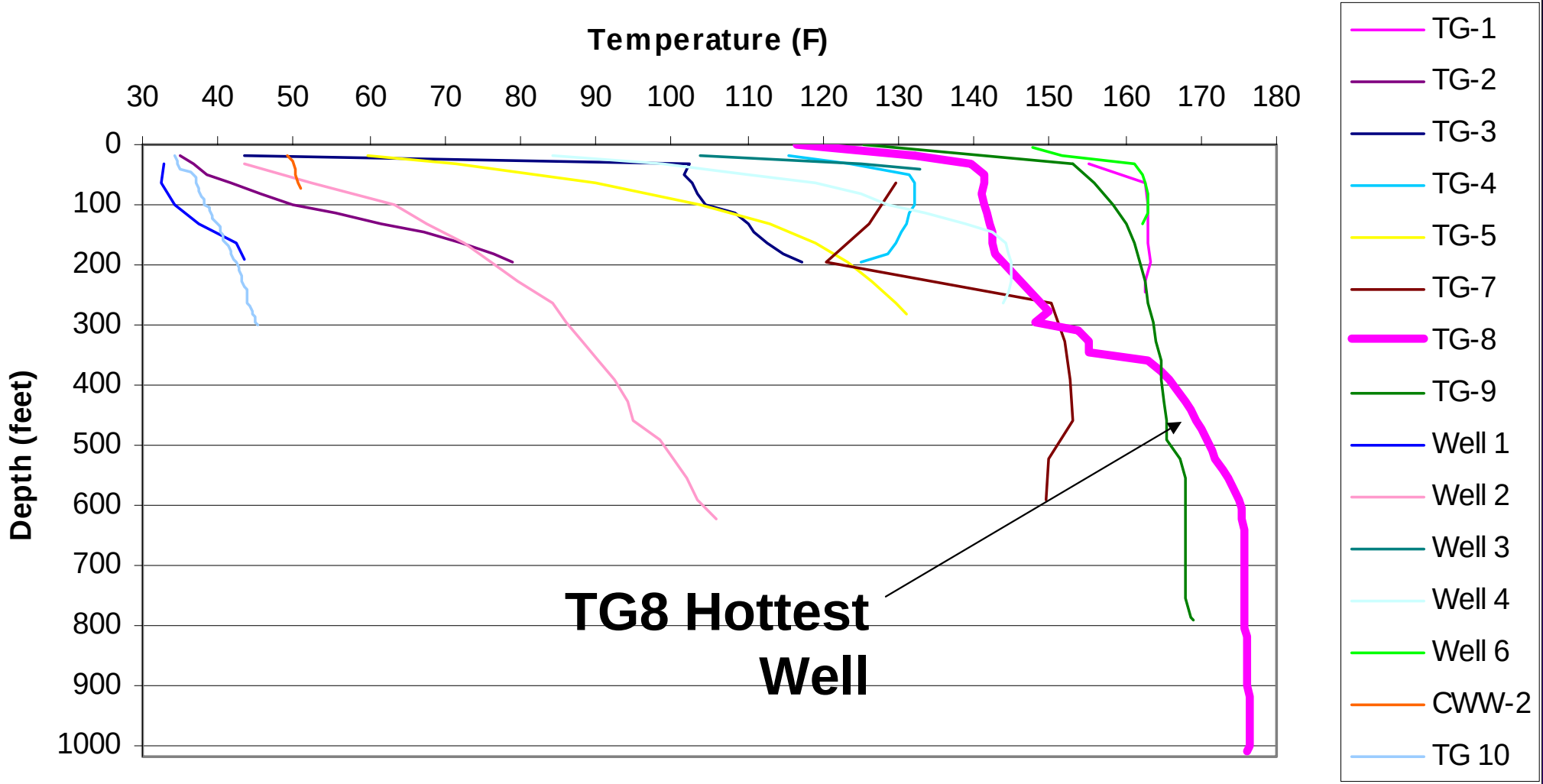
Chena GRED III Project

(Geothermal Resource Exploration and Definition)
Funded by the DOE Geothermal Technologies Program

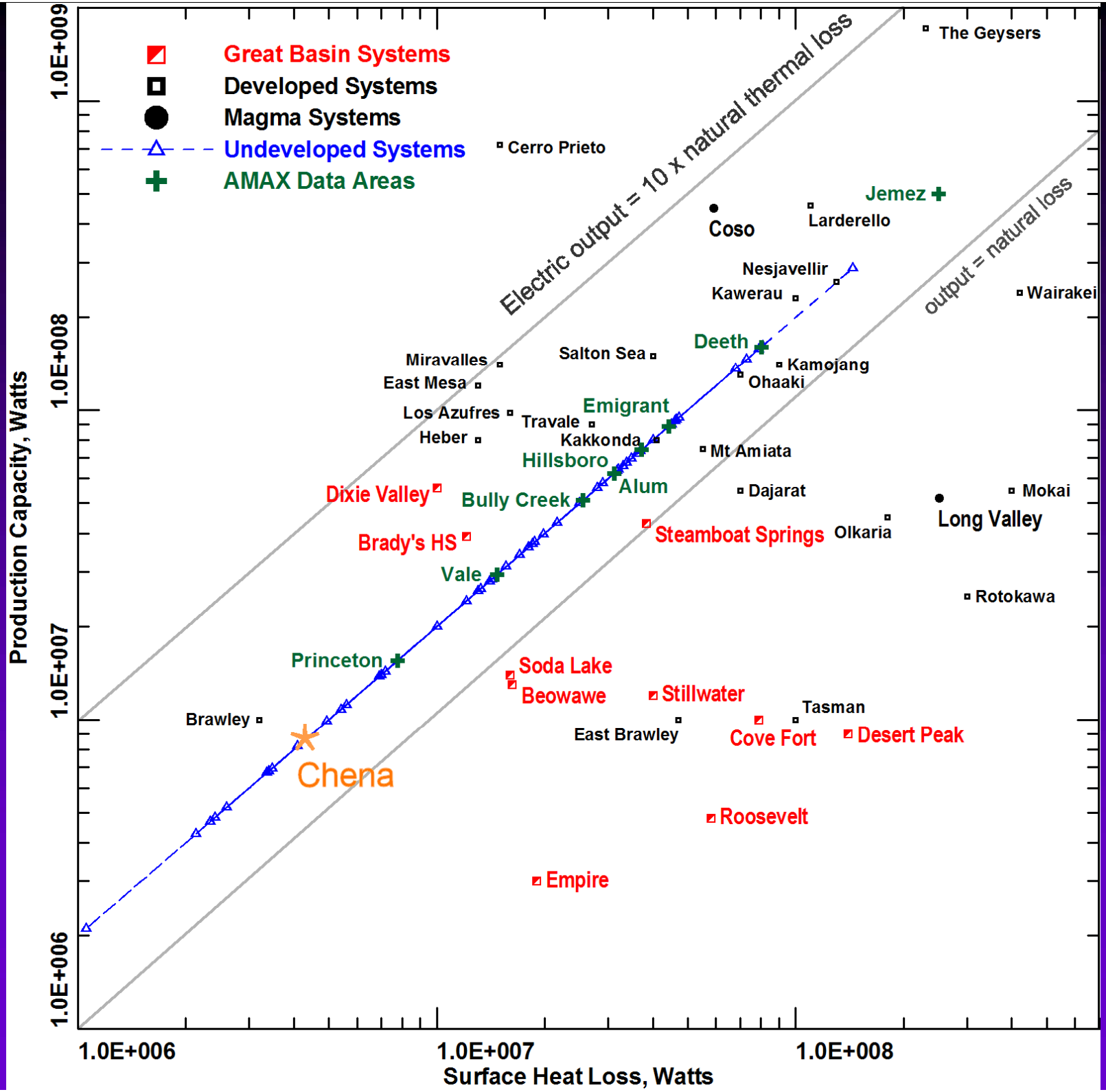
Geothermal Exploration Project to Determine the Power Generating Capacity of the Deep Geothermal Resource at Chena Hot Springs

Need to Drill a Deep Hole (two 2500-4000ft) planned for GRED III Phase II to verify geothermal reservoir model at Chena

Chena Hot Springs Static Temperature Logs June 2006



CHENA HOT SPRINGS RESORT
Alaska


Great Basin Systems
Developed Systems
Magma Systems
Undeveloped Systems
AMAX Data Areas
Electric output = 10 x natural thermal loss
output = natural loss
Production Capacity, Watts
1.0E+009
1.0E+008
1.0E+007
1.0E+006
Surface Heat Loss, Watts
1.0E+006
1.0E+007
1.0E+008
The Geysers
Cerro Prieto
Jemez
Coso
Larderello
Nesjavellir
Kawerau
Wairakei
Deeth
Miravalles
Salton Sea
Kamojang
East Mesa
Ohaaki
Emigrant
Los Azufres
Travale
Heber
Kakkonda
Mt Amiata
Hillsboro
Alum
Dixie Valley
Bully Creek
Dajarat
Mokai
Long Valley
Steamboat Springs
Olkaria
Brady's HS
Vale
Rotokawa
Princeton
Soda Lake
Beowawe
Stillwater
Tasman
Brawley
East Brawley
Cove Fort
Desert Peak
Chena
Roosevelt
Empire

Renewable Energy Center

CHENA HOT SPRINGS RESORT
Alaska

Renewable Energy Center

Chena Hot Springs Resort Alaska

Renewable Energy Center

Chena Hot Springs Resort Alaska

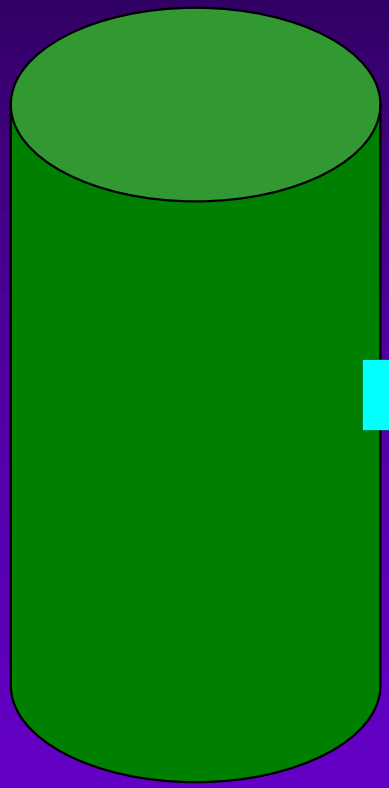
Class Field Trips

CHENA HOT SPRINGS RESORT Alaska

Internship Opportunities

- Part-time and full-time opportunities
- Summer or Winter
- Natural resources, engineering, education program opportunities

Water Ram Pump



Water Ram pumps water from nearby creek (~1200gpd)

4200 gallon storage tank delivers water at 10psi to gardens

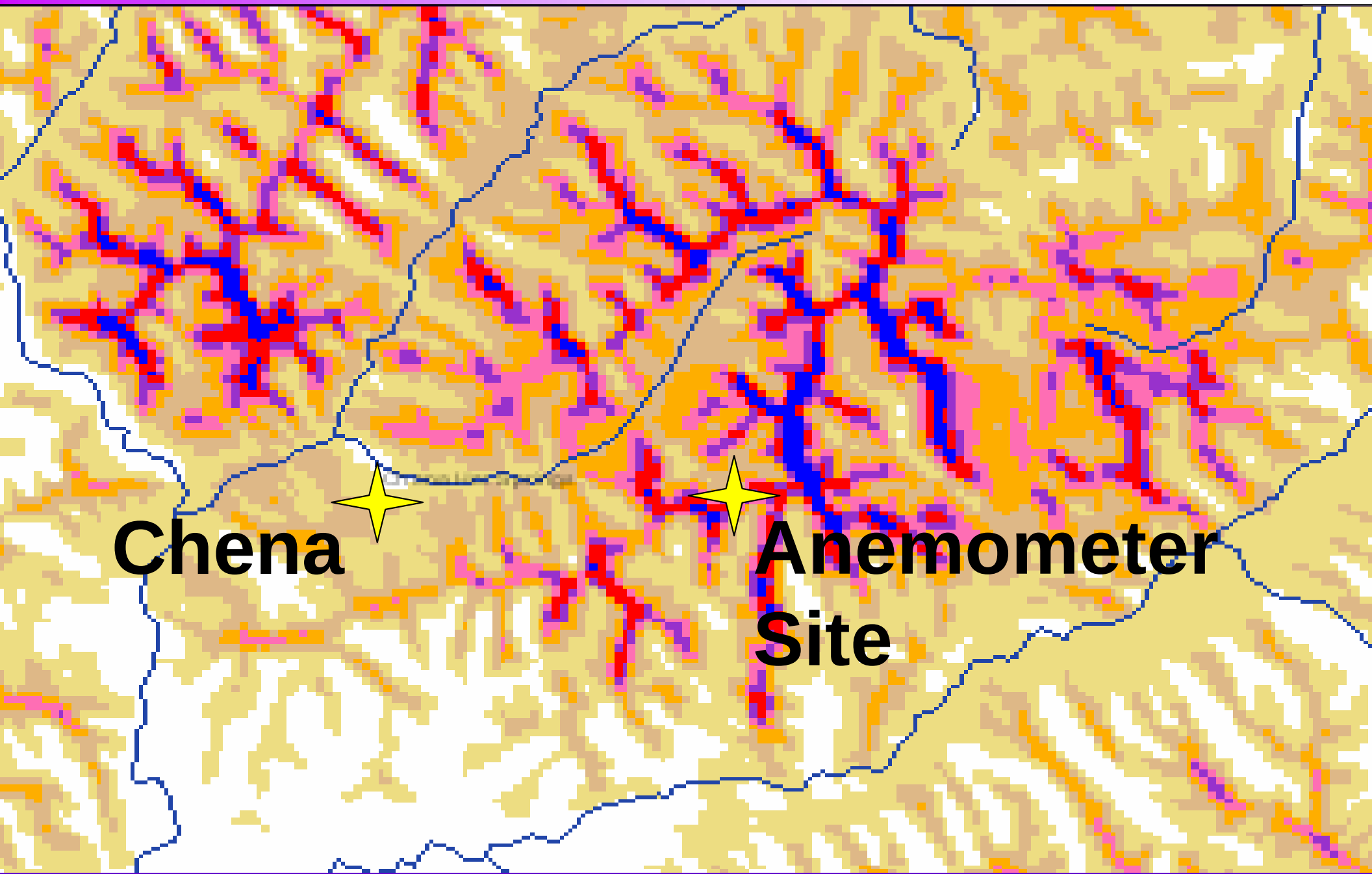
Drip Irrigation used to supply water to all production areas

Water Ram Pump

Water Ram Pump

CHENA HOT SPRINGS RESORT
Alaska

Wind Power



Wind Power

Chena Production Greenhouse

A collaborative project between Chena Hot Springs and the University of Alaska School of Natural Resources Forestry and Agriculture Experiment Station

Greenhouse & Gardens

- First greenhouse established in 2004 as a joint project between Chena Hot Springs and UAF
- Producing crops for onsite use on a year-round basis

Greenhouse & Gardens

- First greenhouse established in 2004 as a joint project between Chena Hot Springs and UAF
- Producing crops for onsite use on a year-round basis
- New 5000ft greenhouse recently completed for 2006 season
- Heated from geothermal wells but could operate off any waste heat source

Greenhouse & Gardens

Geothermally Heated Greenhouse #2 at Chena Hot Springs Resort

Alternative Fuels

Alternative Fuels – Used Vegetable Oil

Chena Hydrogen Project

Using electrolysis & excess power from geothermal power plant


Hindenberg
May, 1937
Lakehurst, NJ

Reykjavik in 1932

All buildings heated using fossil fuels

Reykjavik today

One of the cleanest cities in the world

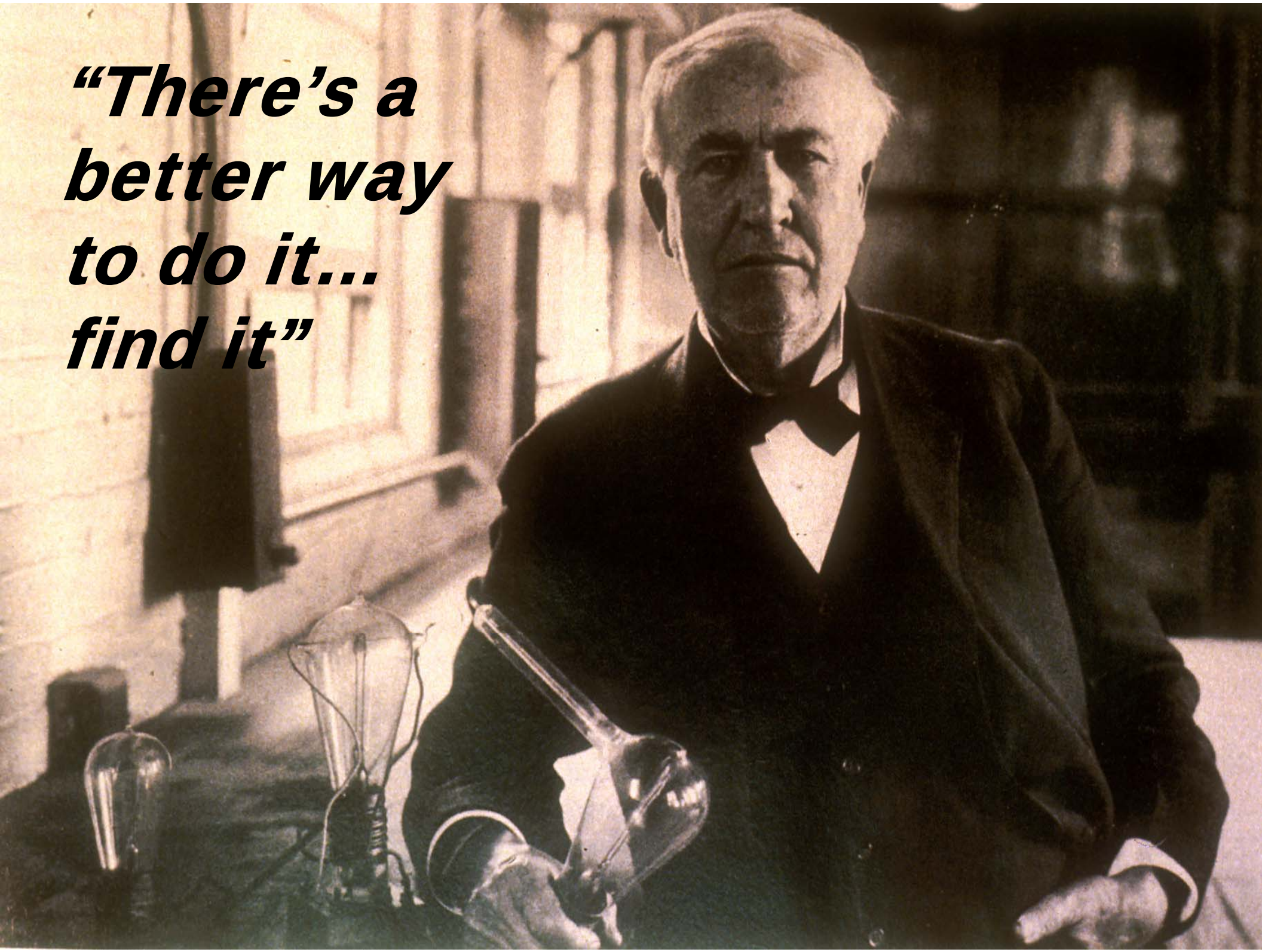
Geothermal Power:

Nesjavellir Power Plant, Iceland; 90 MW

Sustainability

Sustainability: " Meeting our needs without compromising the ability of future generations to meet their own needs "

United Nations Commission on Environment and Development (UNCED)
"Our Common Future", 1987


“There’s a
better way
to do it...
find it”

Project Awards and Recognition

2006 Green Power Leadership Award (EPA and DOE)

Project of the Year
Renewable Energy Category
Power Engineering Magazine
PowerGen Conference 2006

CHENA HOT SPRINGS RESORT

www.chenahotsprings.com

www.yourownpower.com **(projects website)**

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Bernie Karl

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