The Chena Hot Springs 400 kW Geothermal Power Plant

A Geothermal Case Study for Alaska

Presented by: **Gwen Holdmann**
Renewable Energy and Energy Efficiency for Tribal Community and Project Development for Alaska Natives

Chena Hot Springs

Chena Hot Springs

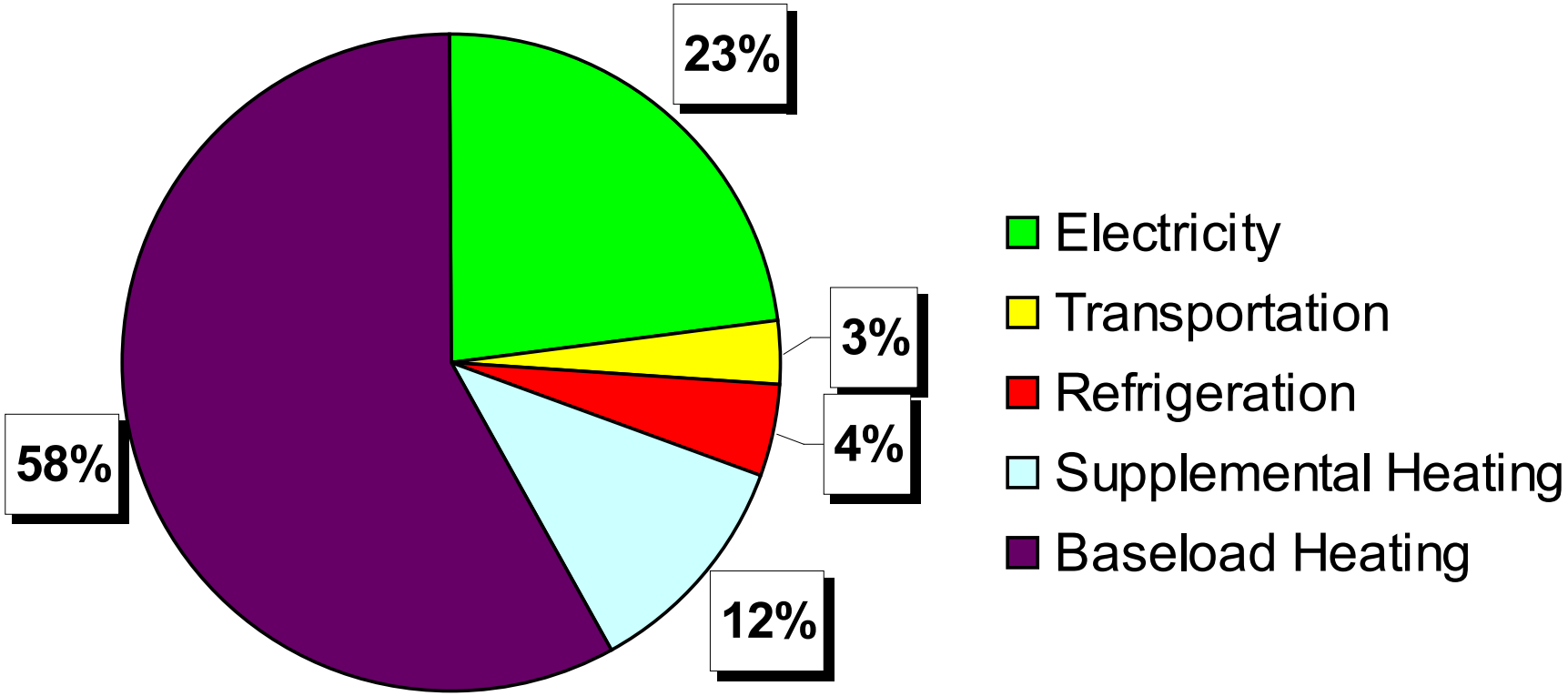
- Semi remote site
- Electric Power 30¢/kWhr
- Load 180kW-380kW

Chena Hot Springs

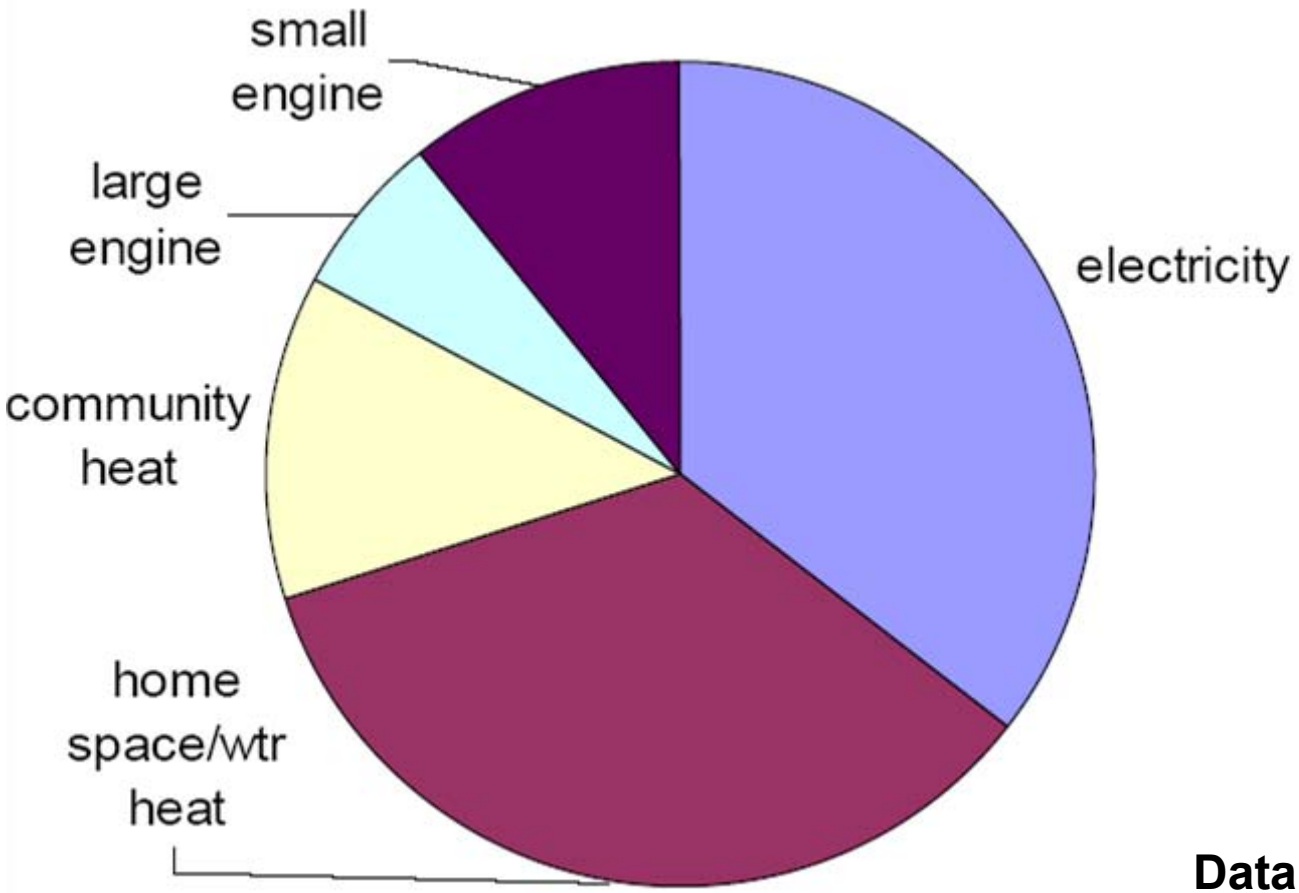
- Semi remote site
- Electric Power 30¢/kWhr
- Load 180kW-380kW

- Average $1000/day spent on diesel fuel in 2004
- $550,000 per year in fuel costs at today's price

Energy Input at Chena



Energy Input in PCE Community



Data from ISER/UA

Chena Hot Springs VISION:

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

Energy Sources at Chena

ENERGY NEEDS	AVAILABLE RESOURCES
• Electricity	• Geothermal
• Base Load Heating	• Hydropower
• Supplemental Heating	• Diesel
• Water Pumping	• Propane
• Refrigeration	• Wind & Solar
• Transportation	• Biomass
• Cooking	
• Remote Power	

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 $383,000 in heating fuel coats

Moose Lodge, 20,000ft^2 heated solely with geothermal district heating system

Greenhouse & Gardens

Geothermally Heated Greenhouse #2 at Chena Hot Springs Resort

Chena Greenhouse

- Completed in 2006
- Cooperative project between UAF and Chena
- Approximately 5000ft^2 plus 1600ft^2 addition
- Requires 60kW for lighting
- Crops include Tomatoes, herbs, lettuce, green beans, bedding plants, cucumbers
- 150-300 lbs tomatoes harvested per week
- 40 heads lettuce/day

Economics

- Kit purchased for $18,355
- Additional fixed costs ~$30,000
- 500,000 btu/hr heating → $40,000/yr saved
- 60kW lighting → $60,000/yr saved
- $100,000 in annual expenses
- Tomato production cost average $1.50/lb
- Lettuce Production average 75¢ per head

Aurora Ice Museum

CHENA HOT SPRINGS ABSORPTION CHILLER

Monument Creek Provides Cooling Water (~40F)

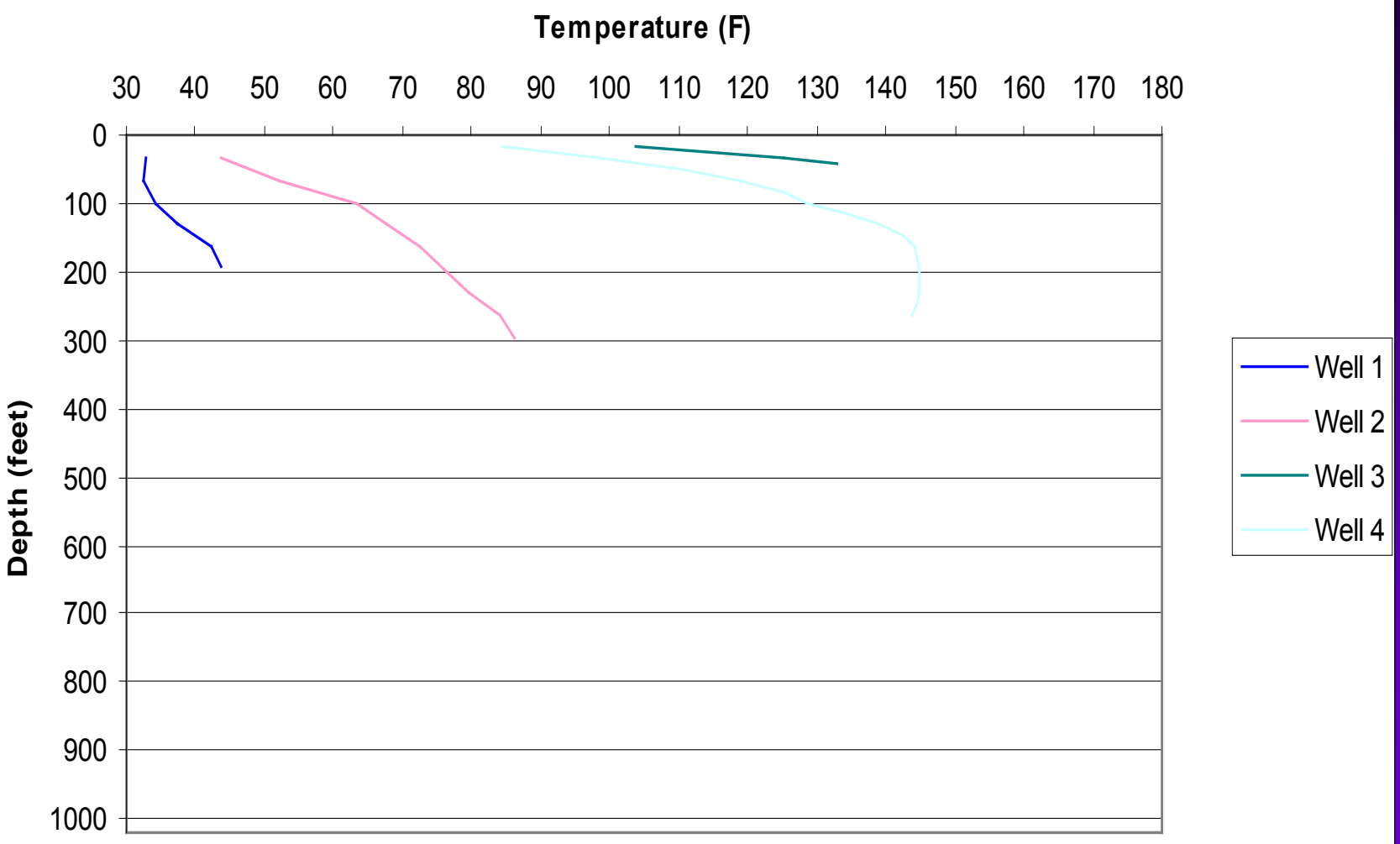
Geothermal Wells Provide Hot Water (~165F)

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

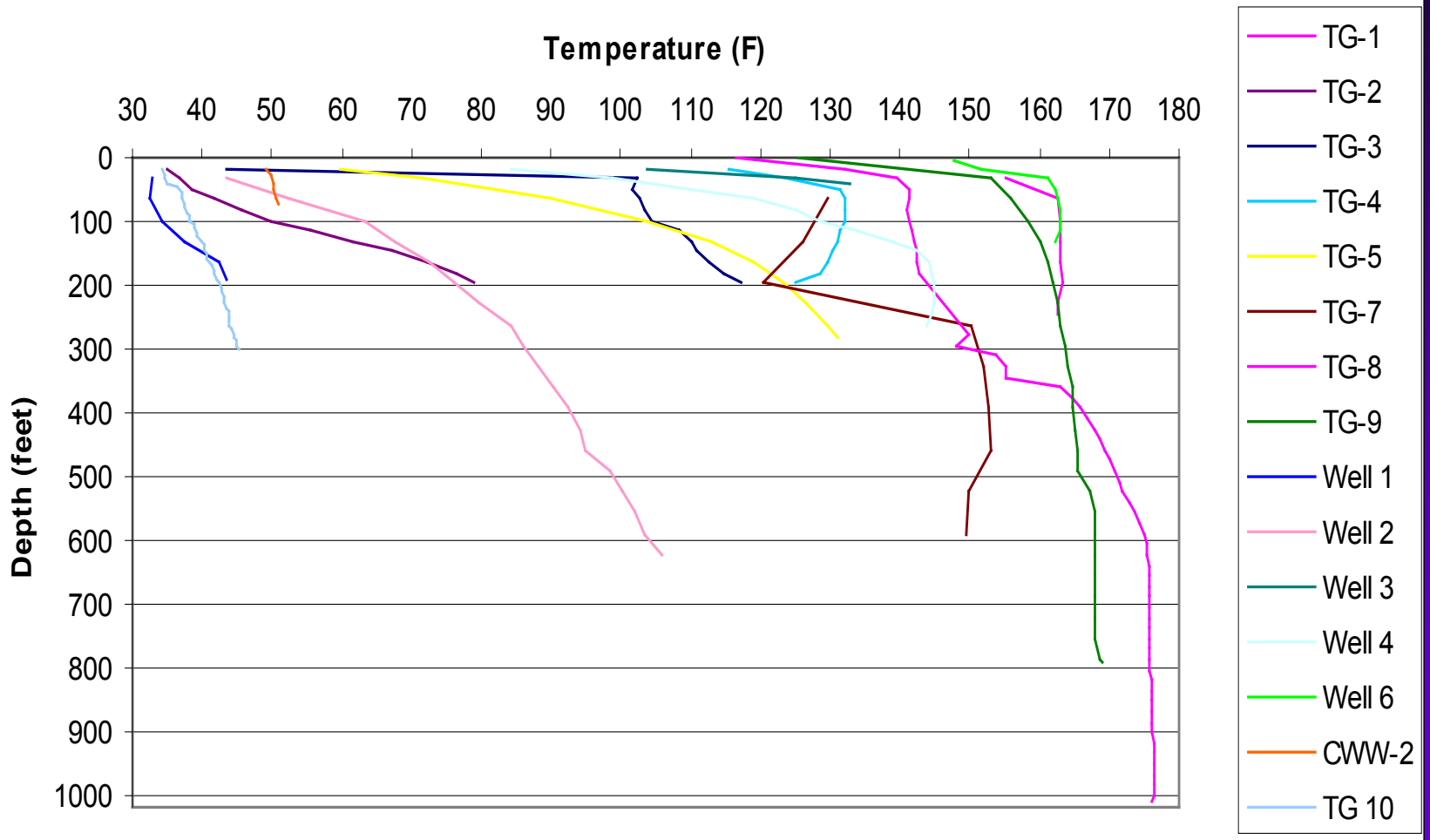
Chena Hot Springs

STEPS TO GEOTHERMAL DEVELOPMENT:

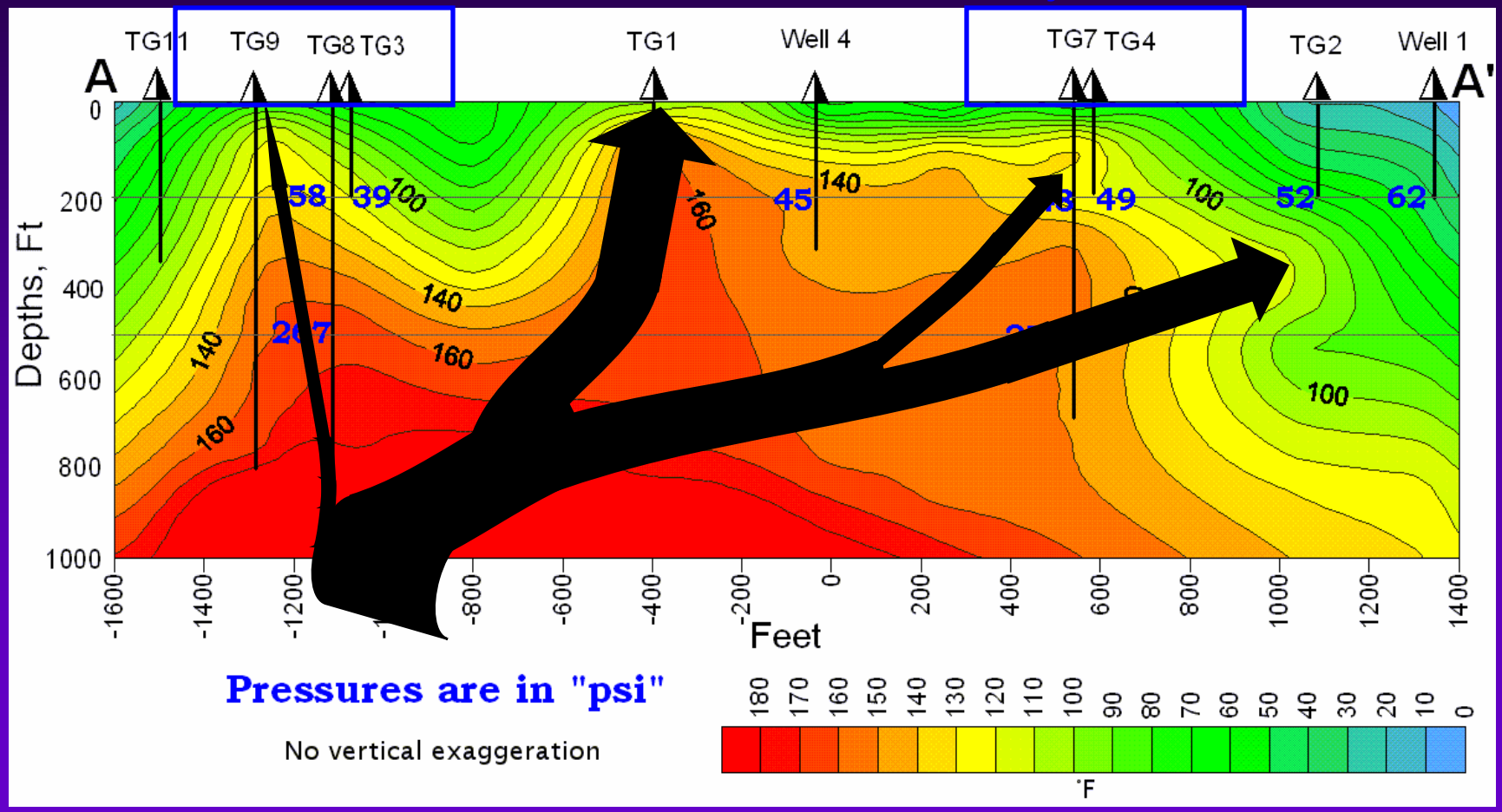
- Resource assessment
- Sustainable development plan adopted
- Manufacturer Selection
- Development of Resource
- Installation of Power Plant
- Ongoing resource monitoring


Chena Hot Springs Static Temperature Logs 2004
Temperature (F)
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
Depth (feet)
0
100
200
300
400
500
600
700
800
900
1000
Well 1
Well 2
Well 3
Well 4

Chena Hot Springs Static Temperature Logs June 2006

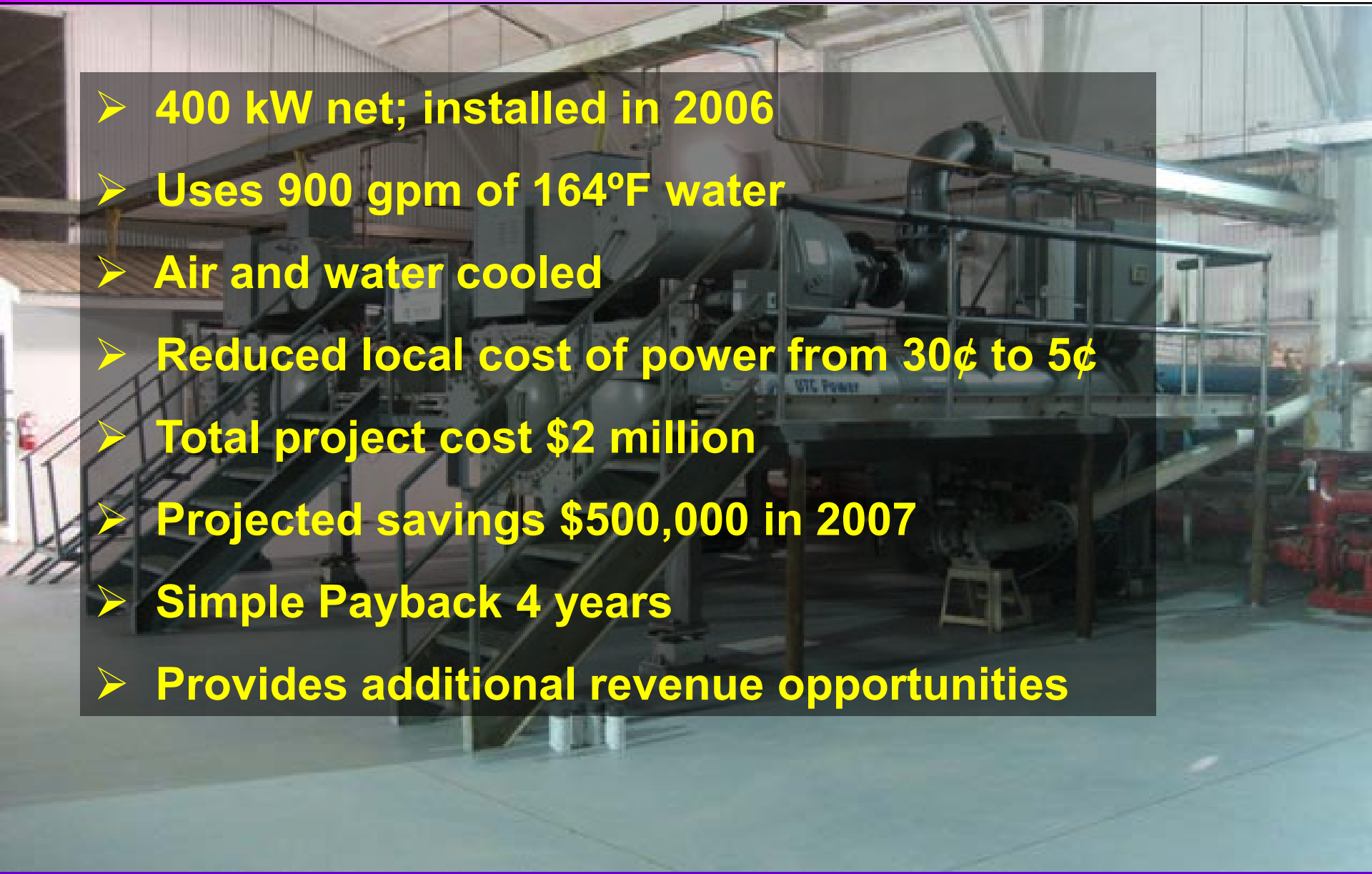


Chena GRED III Project



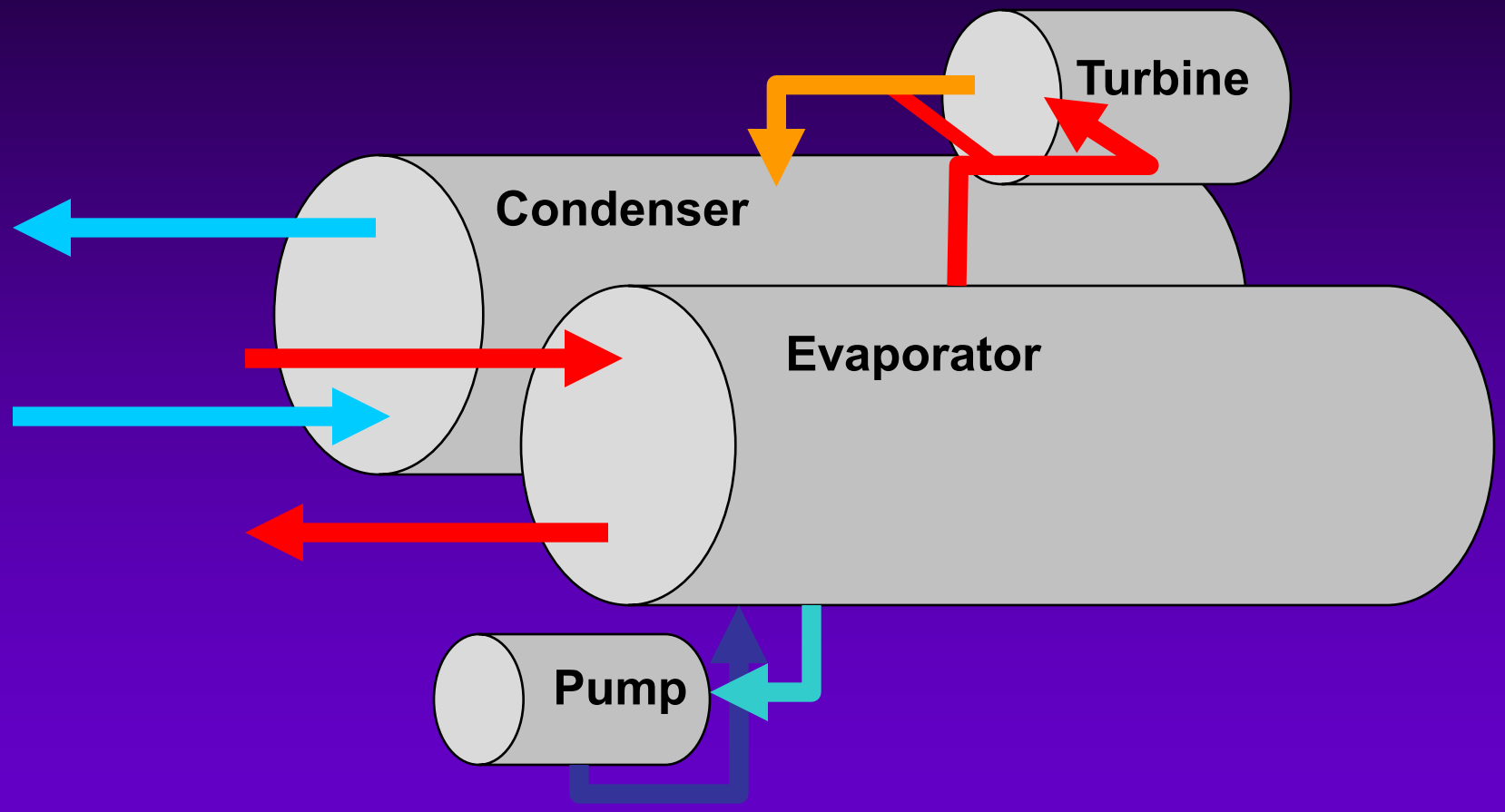
Chena Power Plant

Chena Power Plant

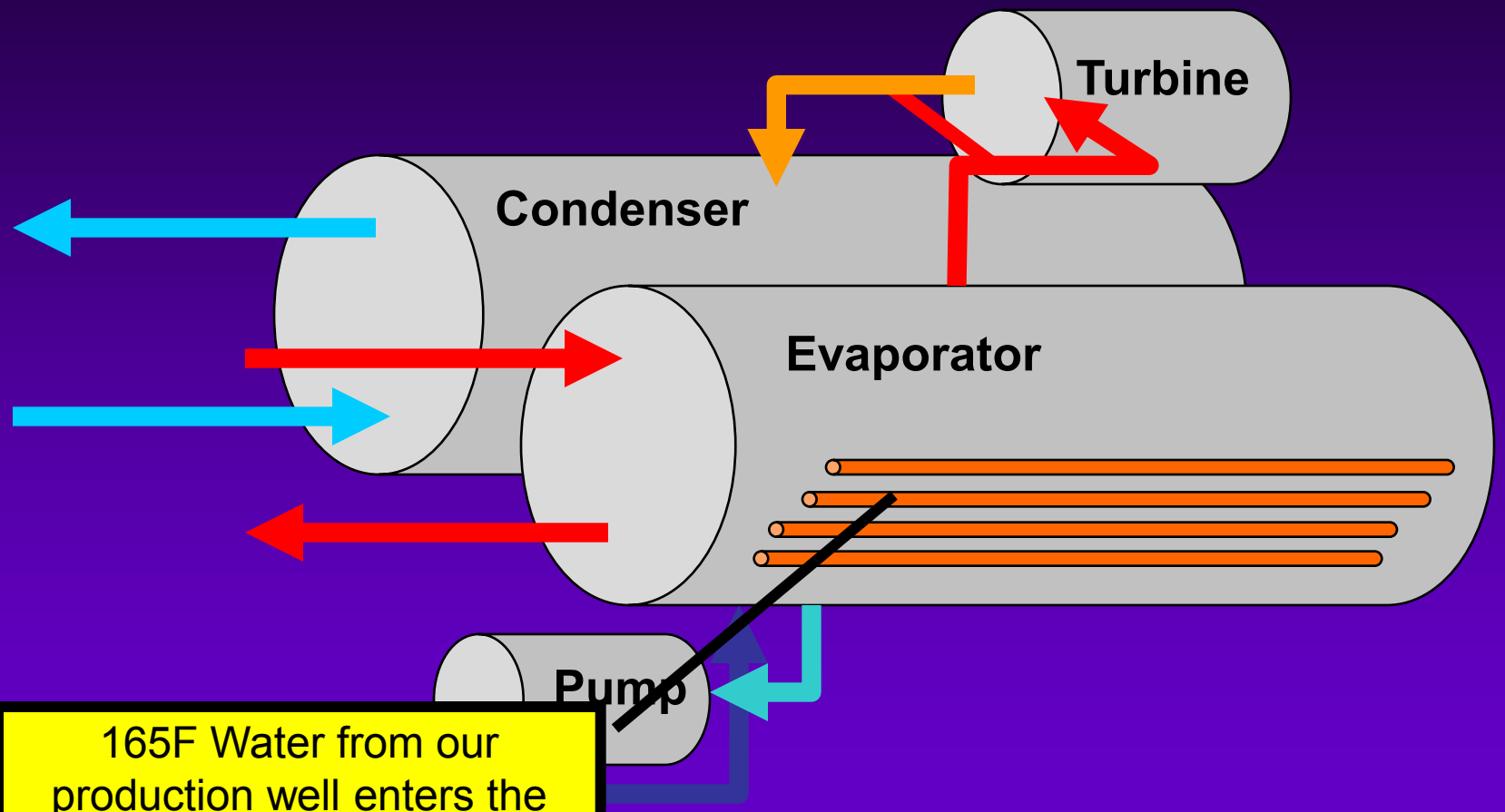


- 400 kW net; installed in 2006
- Uses 900 gpm of 164ºF water
- Air and water cooled
- Reduced local cost of power from 30¢ to 5¢
- Total project cost $2 million
- Projected savings $500,000 in 2007
- Simple Payback 4 years
- Provides additional revenue opportunities

Chena Power Plant

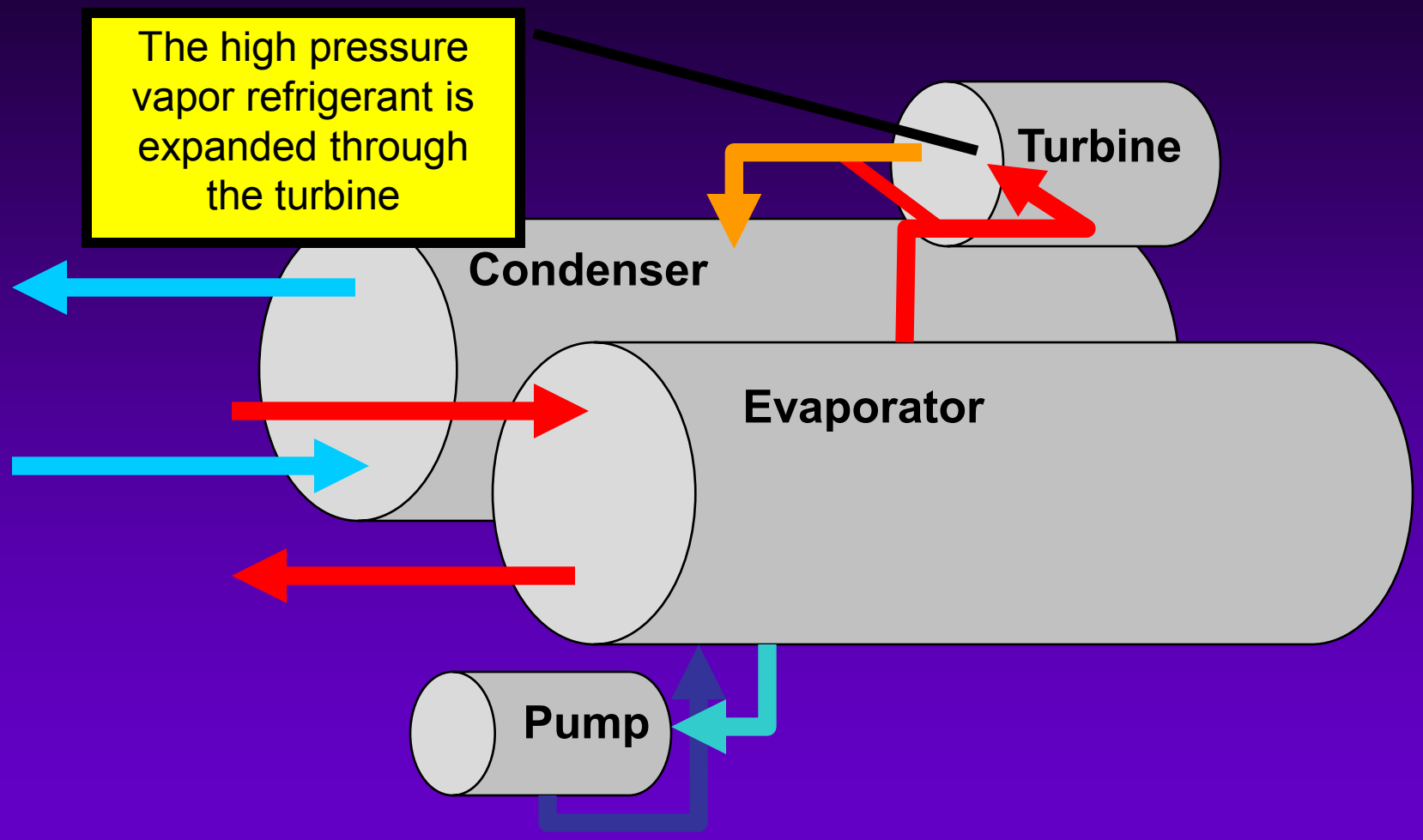


Chena Power Plant

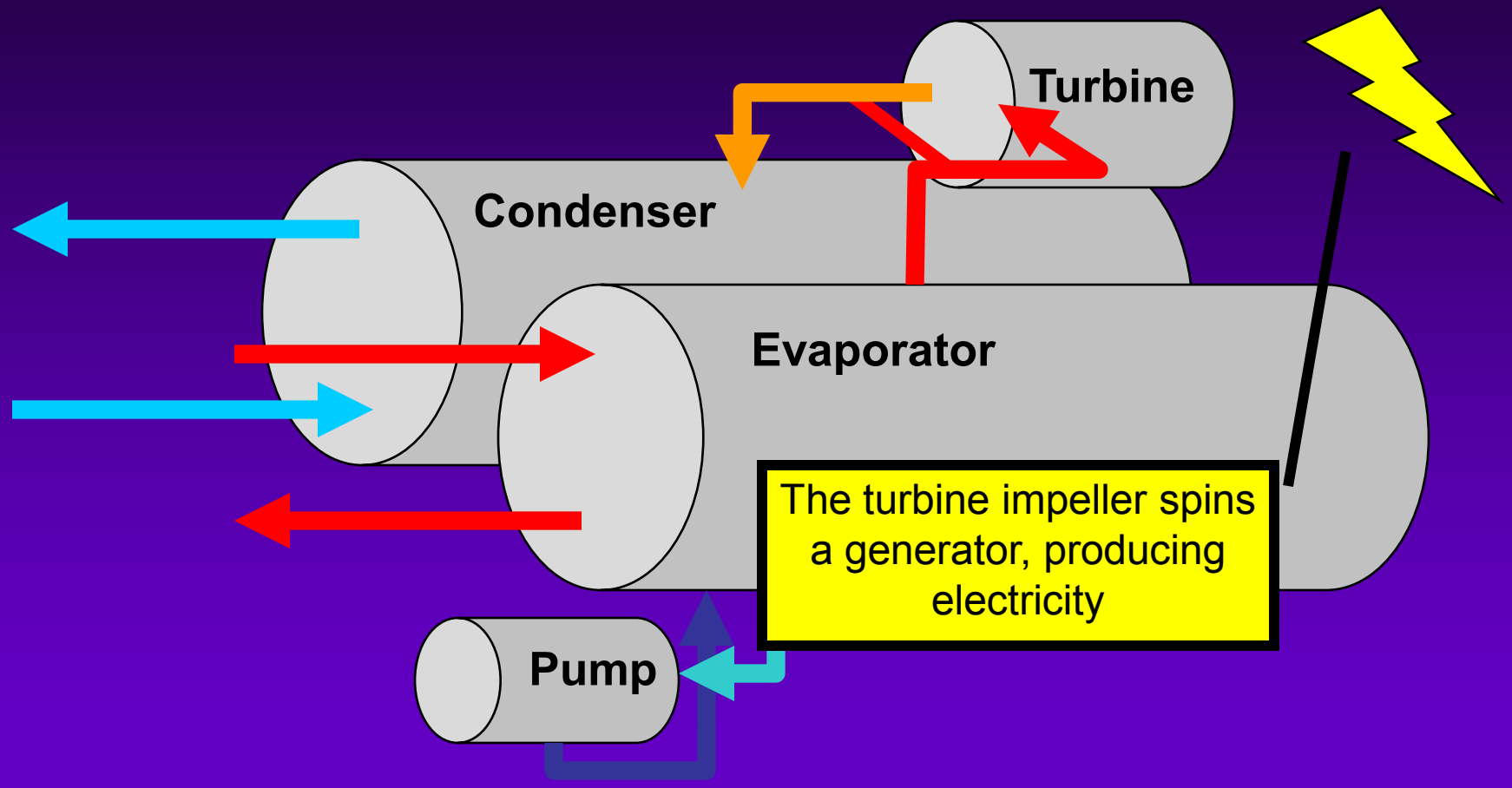


165F Water from our production well enters the evaporator and boils the refrigerant

Chena Power Plant

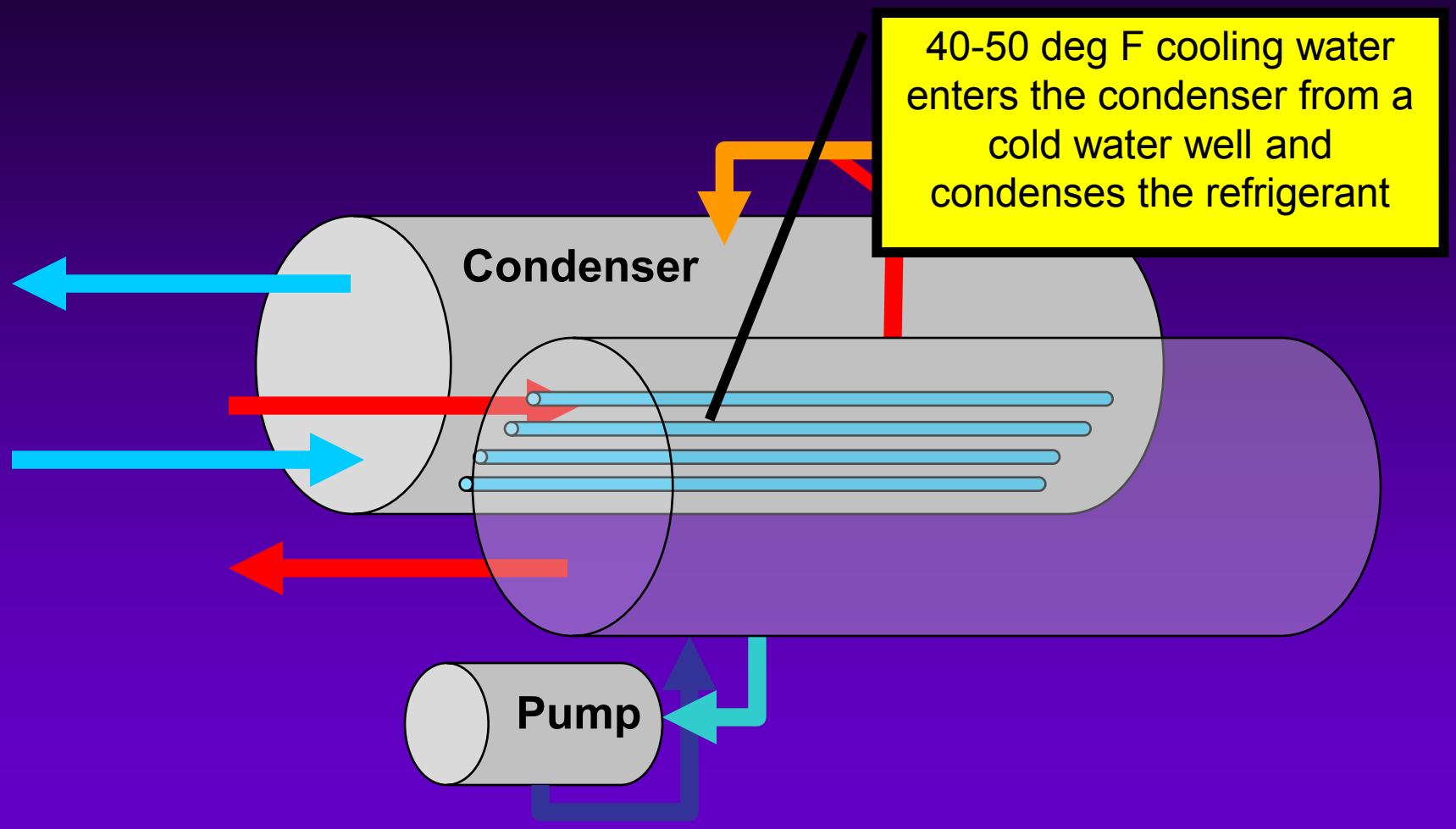


Chena Power Plant

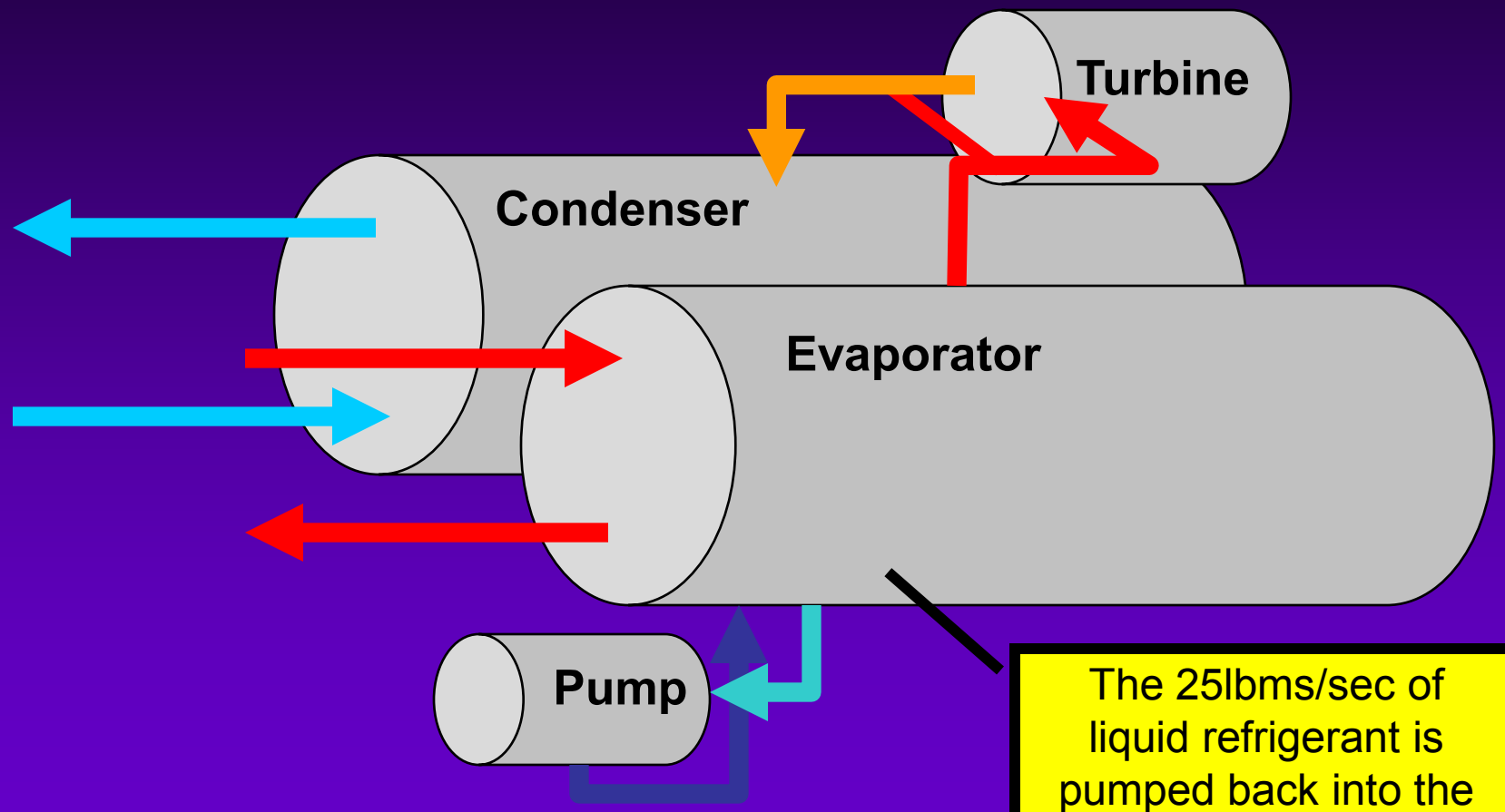


The turbine impeller spins a generator, producing electricity

Chena Power Plant



Chena Power Plant



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

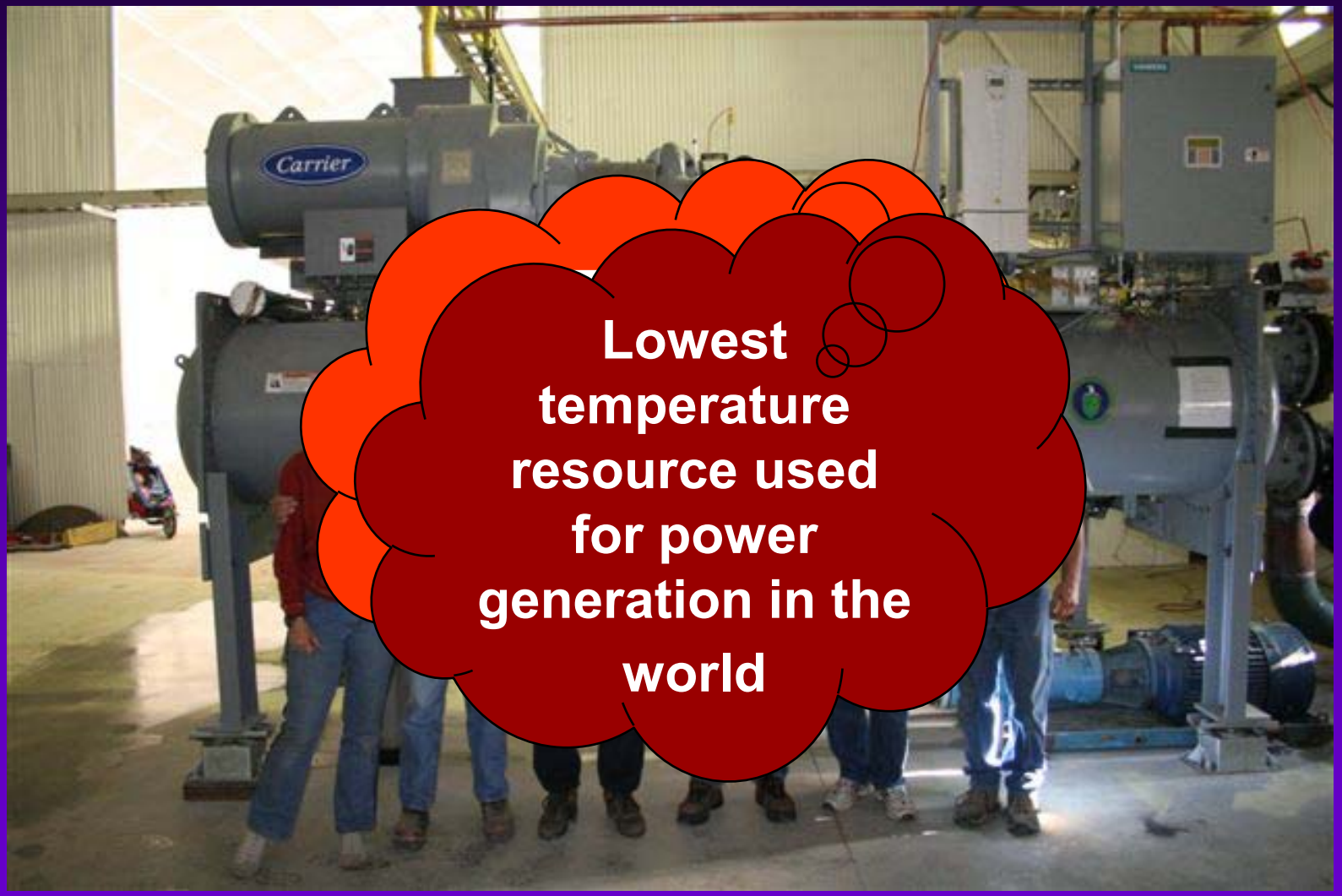
Chena Power Plant

Chena Power Plant

Chena Power Plant

Chena Power Plant

Chena Power Plant



Cold Water Supply

Air Cooled Condenser

Battery and UPS System

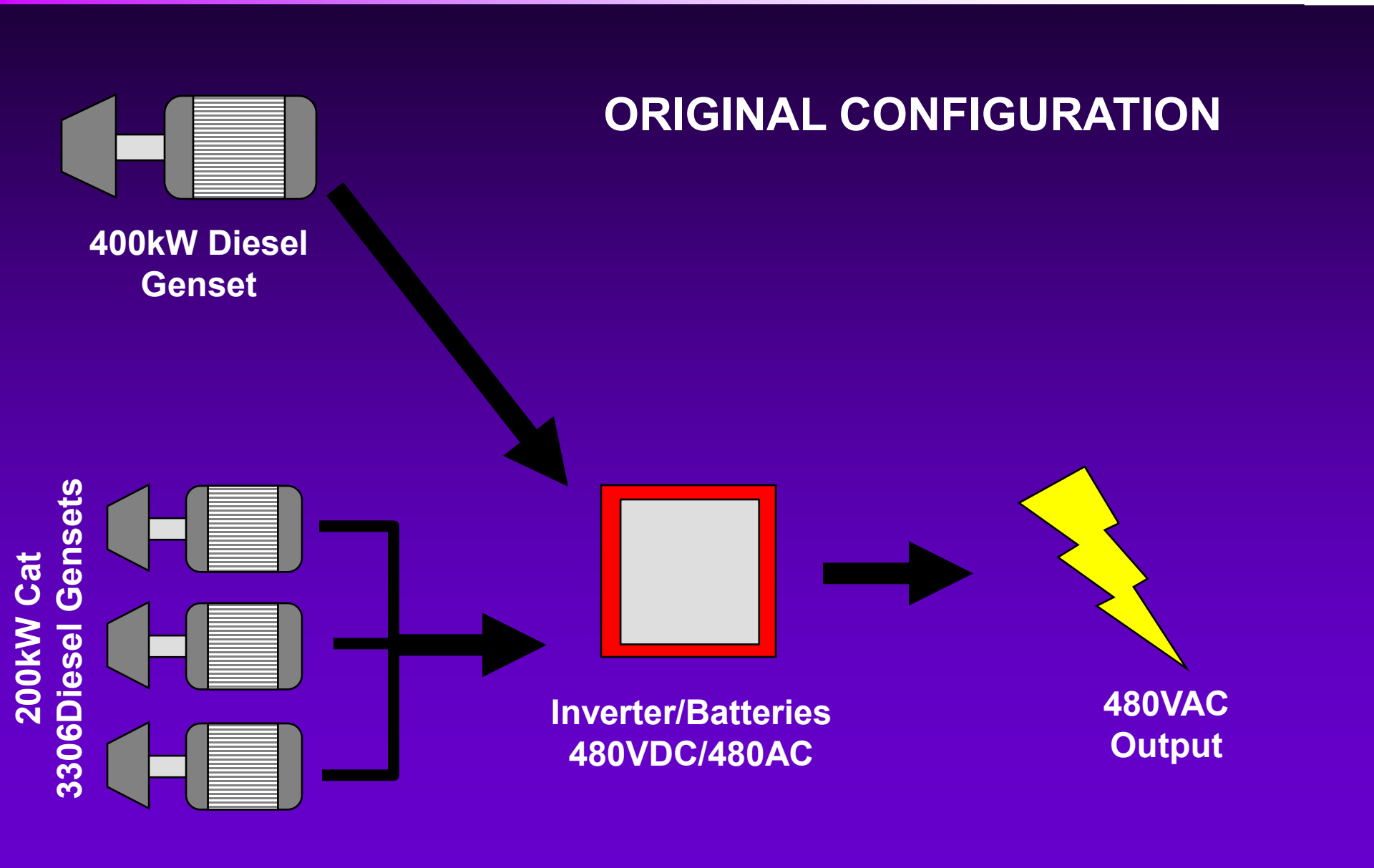
UPS System (MGE)

Batteries 3MW Total

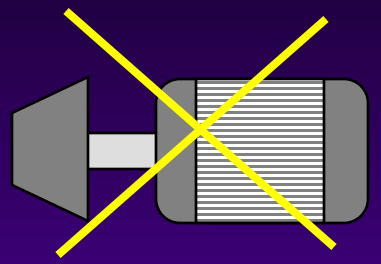
Geothermal Energy is an ideal base load – doesn't depend on sun, wind, rainfall. 99% Availability is common.

Cannot respond quickly to load fluctuations

Battery and UPS System

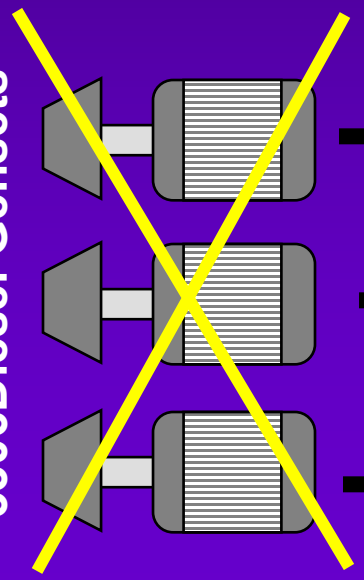


Battery and UPS System

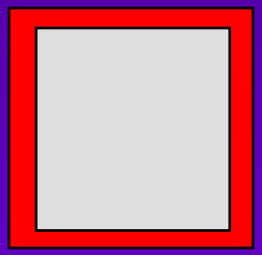


400kW Diesel Genset

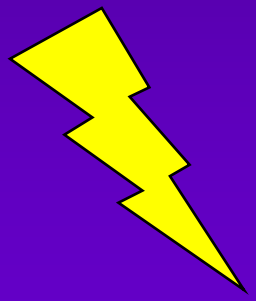
Excess Power to Charge Batteries



200kW Cat 3306Diesel Gensets



Inverter/Batteries 480VDC/480AC



480VAC Output

The bottom line

August 20th 2006 – December 31st 2007	
Hours of Operation	
Availability	
Capacity	
Gallons Diesel Offset	
$ Saved	
Tons CO_2 Avoided	

The bottom line

August 20th 2006 – December 31st 2007	
Hours of Operation	10,850
Availability	
Capacity	
Gallons Diesel Offset	
$ Saved	
Tons CO_2 Avoided	

The bottom line

August 20th 2006 – December 31st 2007	
Hours of Operation	10,850
Availability	95%
Capacity	
Gallons Diesel Offset	
$ Saved	
Tons CO_2 Avoided	

The bottom line

August 20th 2006 – December 31st 2007	
Hours of Operation	10,850
Availability	95%
Capacity (Ave output 175kW)	87.5%
Gallons Diesel Offset	
$ Saved	
Tons CO_2 Avoided	

The bottom line

August 20th 2006 – December 31st 2007	
Hours of Operation	10,850
Availability	95%
Capacity (Ave output 175kW)	87.5%
Gallons Diesel Offset	148,785
$ Saved	
Tons CO_2 Avoided	

The bottom line

August 20th 2006 – December 31st 2007	
Hours of Operation	10,850
Availability	95%
Capacity (Ave output 175kW)	87.5%
Gallons Diesel Offset	148,785
$ Saved	
Tons CO_2 Avoided	

The bottom line

August 20th 2006 – December 31st 2007	
Hours of Operation	10,850
Availability	95%
Capacity (Ave output 175kW)	87.5%
Gallons Diesel Offset	148,785
$ Saved	$365,555
Tons CO_2 Avoided	

The bottom line

August 20th 2006 – December 31st 2007	
Hours of Operation	10,850
Availability	95%
Capacity (Ave output 175kW)	87.5%
Gallons Diesel Offset	148,785
$ Saved	$365,555
Tons CO_2 Avoided	~ 1500

Special thanks to the Alaska Energy Authority and the Denali Commission for their continued involvement and assistance.

Project Awards and Recognition

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

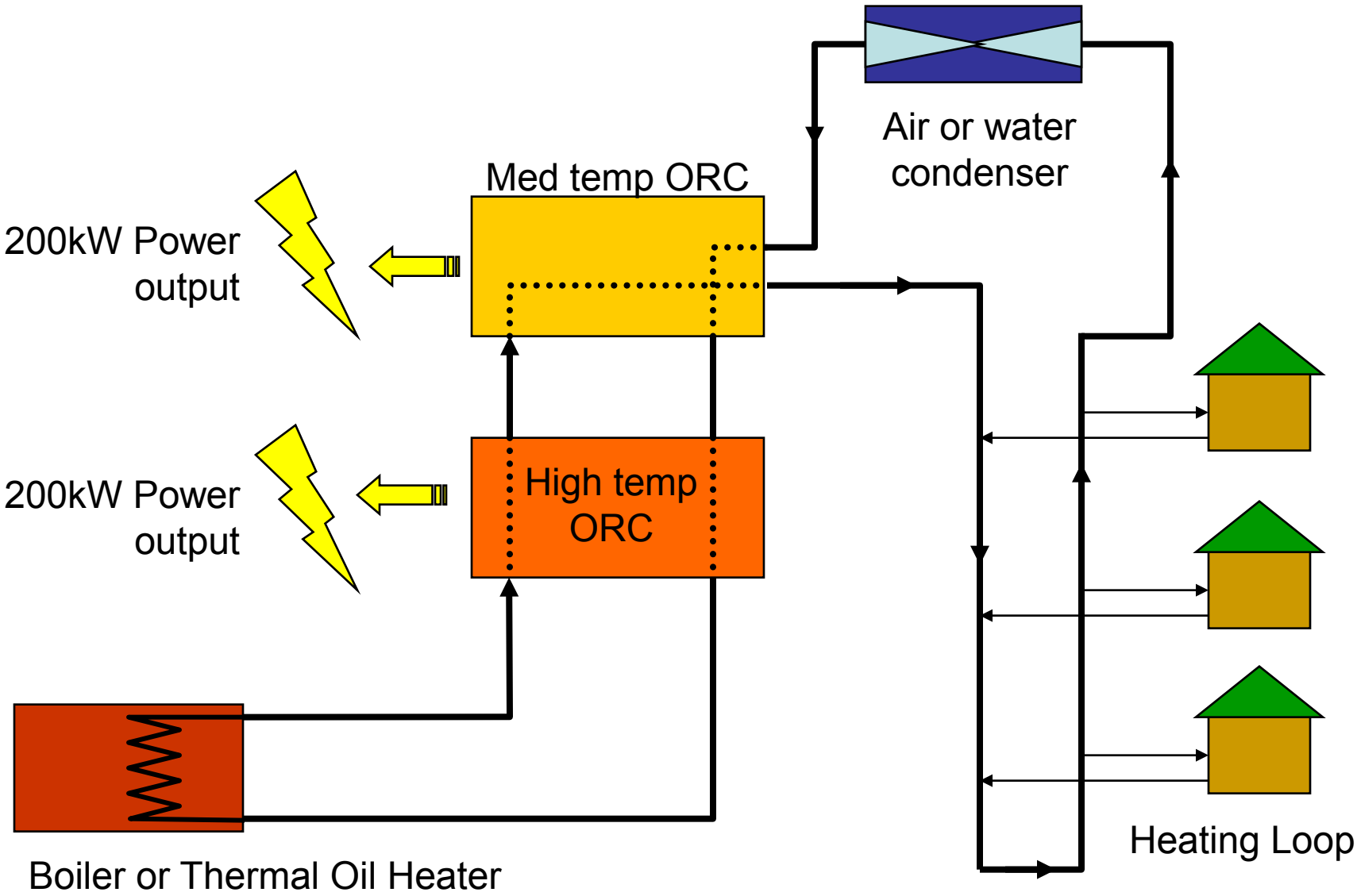
2007 R&D 100 Award

Biomass Power

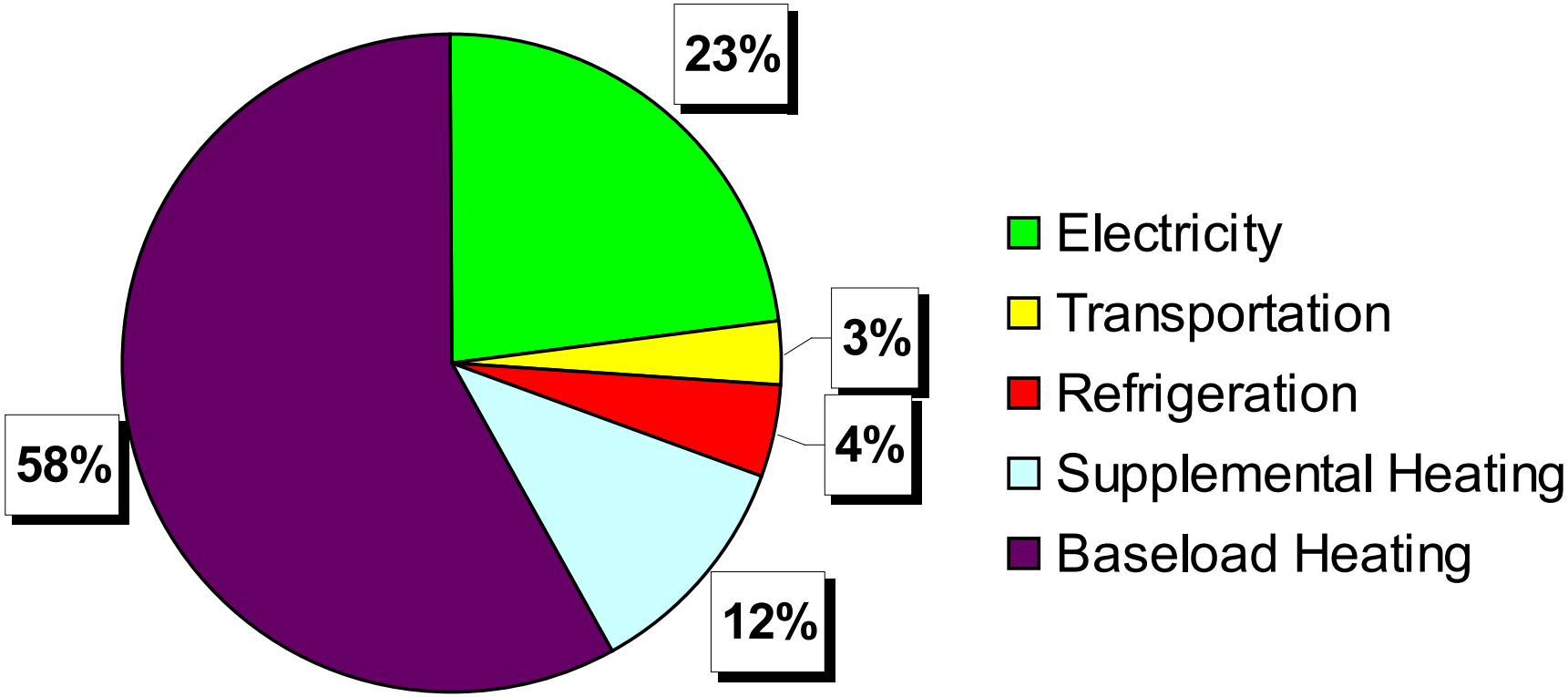
Biomass Power

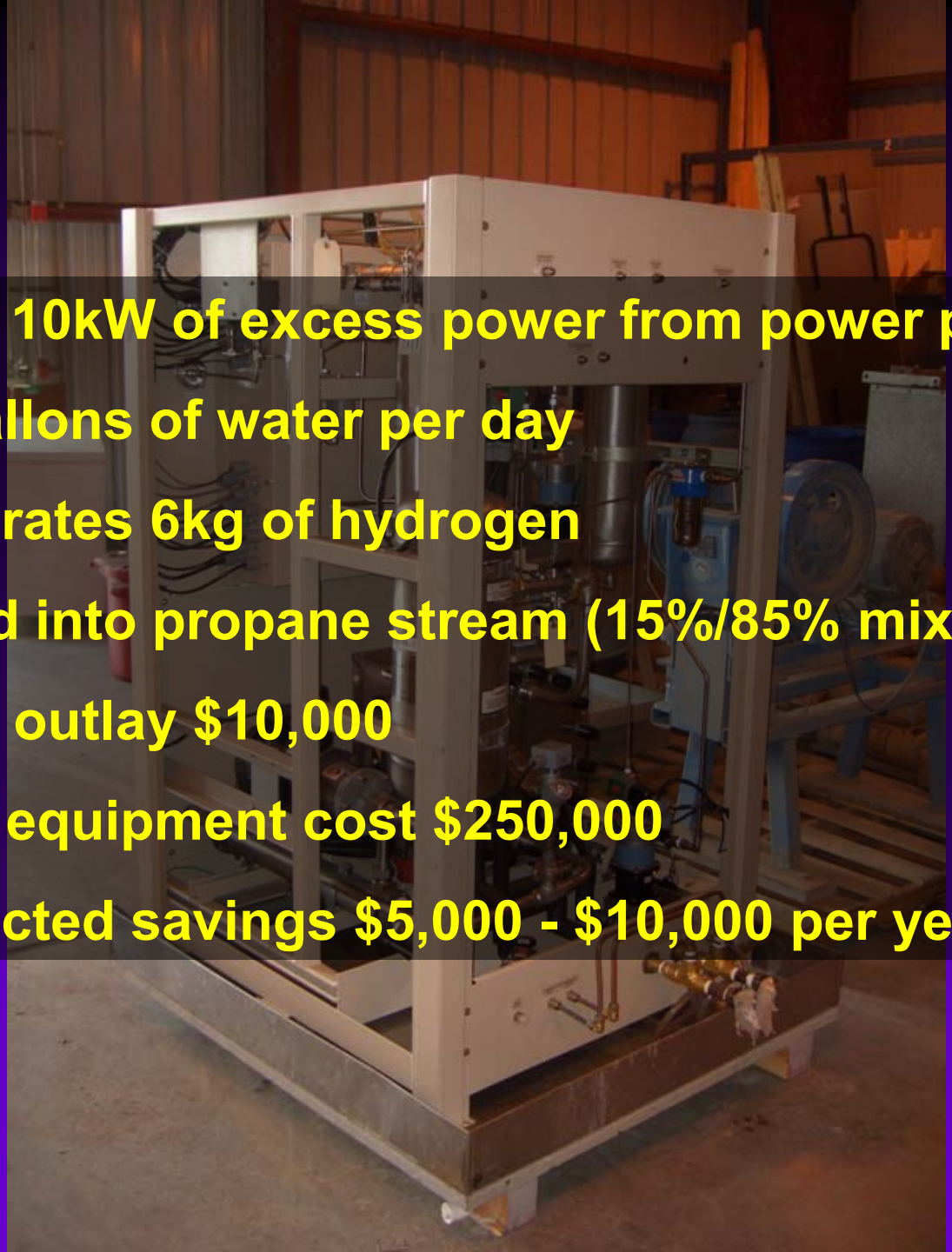
- Proposed demonstration for Fairbanks
- 400kW gross, 300kW net output
- Fuel is 5000 tons of paper, cardboard and brush potentially supplemented with farmed willow
- Designed for rural village application – thermal oil boiler, load following
- Increased efficiency over geothermal installation through addition of a topping cycle
- Co-located with heat load (space heating, greenhouses)

The Goal: Combined Heat and Power (CHP)



Energy Use at Chena Hot Springs (total 850 kW_{eq})





- Uses 10kW of excess power from power plant
- 50 gallons of water per day
- Generates 6kg of hydrogen
- Mixed into propane stream (15%/85% mix)
- Cash outlay $10,000
- Total equipment cost $250,000
- Projected savings $5,000 - $10,000 per year

CHENA HYDROGEN
PRODUCTION FACILITY

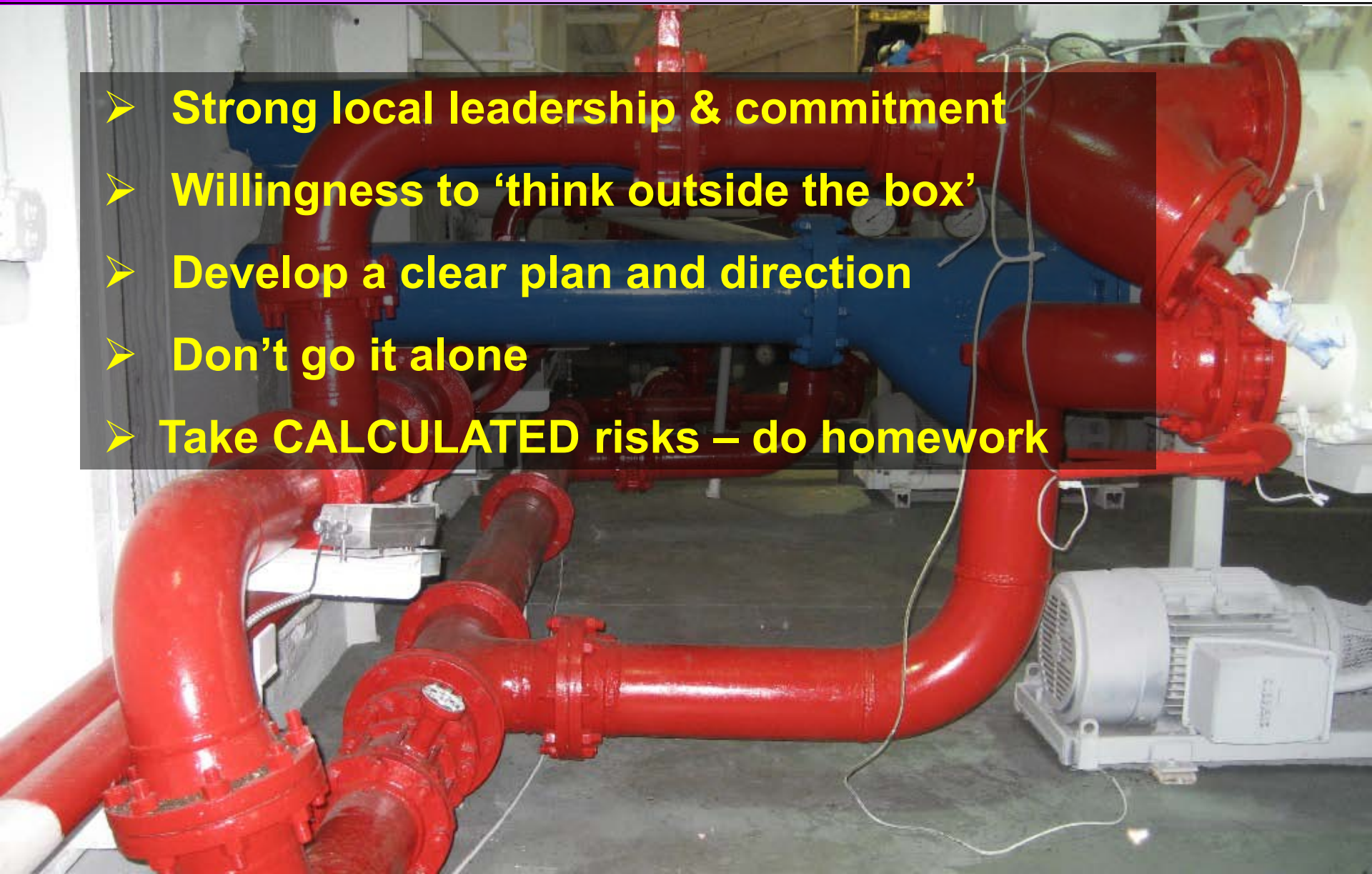
Chena Hot Springs MISSION:

To encourage renewable energy and sustainable community development throughout Alaska

To make Alaska a leader in renewable energy development

What can we learn from Chena?

What can we learn from Chena?



- Strong local leadership & commitment
- Willingness to 'think outside the box'
- Develop a clear plan and direction
- Don't go it alone
- Take CALCULATED risks – do homework

Forming Partnerships with:

- *Alaska Center for Energy & Power (UA)*
- *Department of Energy*
- *Alaska Energy Authority*
- *Denali Commission*
- *United Technologies Corporation*
- *Golden Valley Electric Association*
- *REAP (Renewable Energy Alaska Project)*

CHENA HOT SPRINGS RESORT

www.chenahotsprings.com

Mile 56 Chena Hot Springs Rd, Fairbanks, AK

(907) 451-8104

Gwen Holdmann

VP, New Development

gwen@yourownpower.com

www.yourownpower.com

(907) 451-8104