



Biomass Power Generation Using UTC PureCycle Technology



Presented by: Gwen Holdmann
2007 Alaska Rural Energy Conference, April 24-26th

UTC

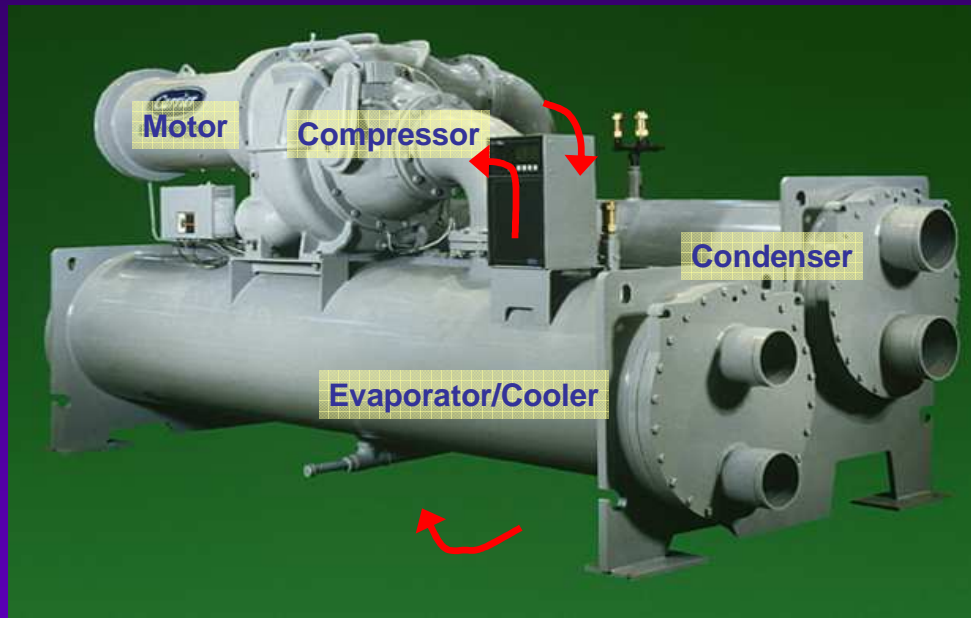


United Technologies

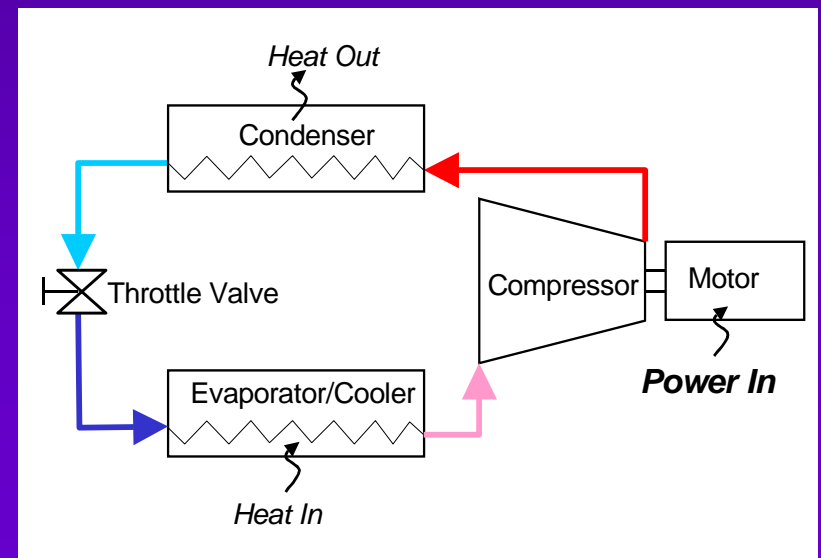


- **Fortune 500 Company**
- **Divisions include: Hamilton Sunstrand, Otis, Pratt & Whitney, Sikorsky, UTC Power, and Carrier**
- **20th largest US Manufacturer**
- **39th largest US Corporation**
- **220,000 employees**
- **42.7 billion in sales in 2005**

Carrier Chiller



Refrigeration Cycle



First working 200kW ORC Unit



The PureCycle© 200

ORC in Austin, Texas operating off landfill flare heat



ORC in Danville, IL using exhaust heat from 3 Jenbacher engines



Chena Geothermal Power Plant



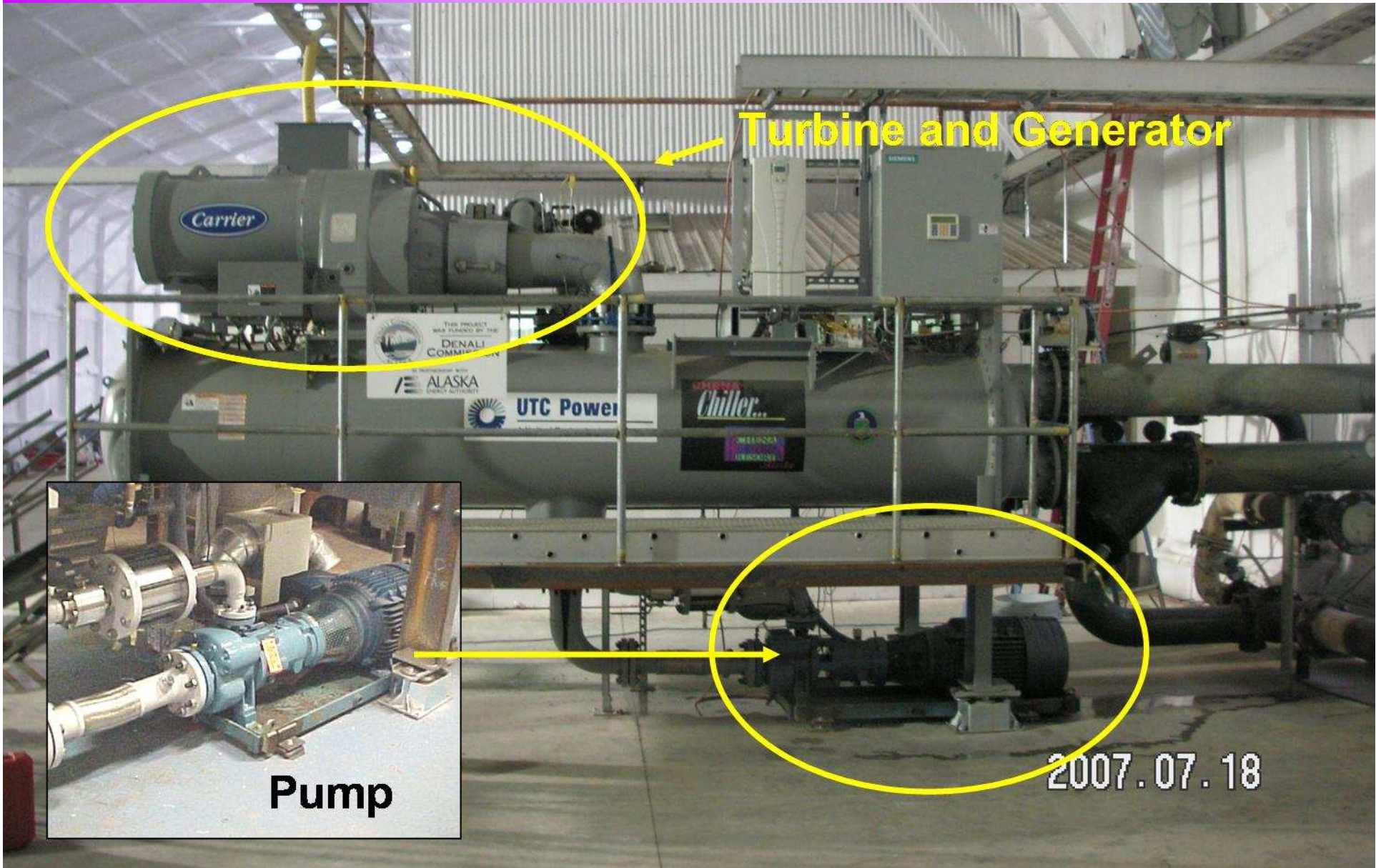
Chena Geothermal Power Plant



- **400kW net; installed in 2006**
- **Uses 500 gpm of 165°F water**
- **Air and water cooled**
- **Reduced local cost of power from 30¢ to 5¢**
- **Total project cost \$2.2 million**
- **Thanks to AEA and Denali Commission**
- **Efficiency <10%**



Chena Power Plant



Pump

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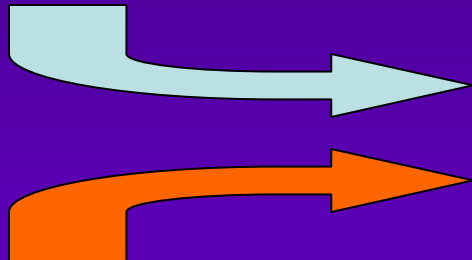
Chena Power Plant



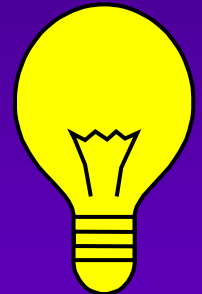
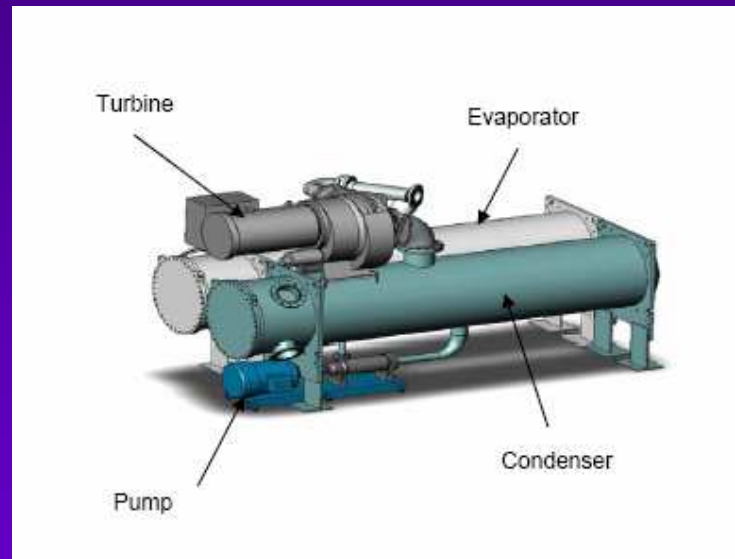
PureCycle w/ Water-Cooled System Configuration for Chena



Monument Creek Provides Cooling Water (~40F)



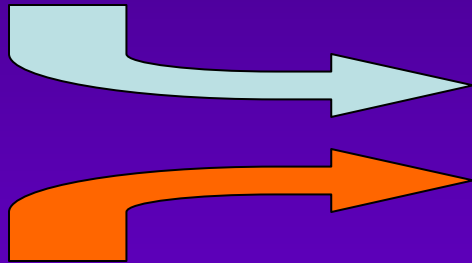
Geothermal Wells Provide Hot Water (~165F)



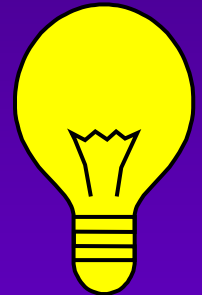
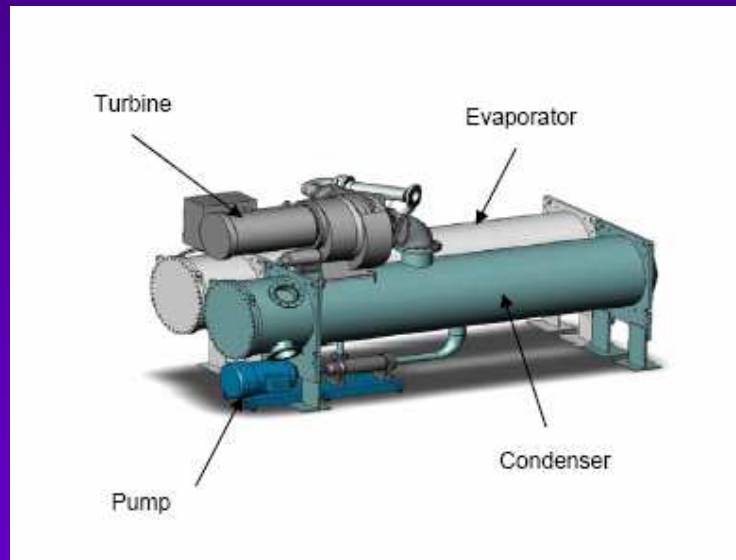
PureCycle using Biomass Heat Source



Air cooled condenser



Biomass (8000btu/lb)



Biomass Power Plant



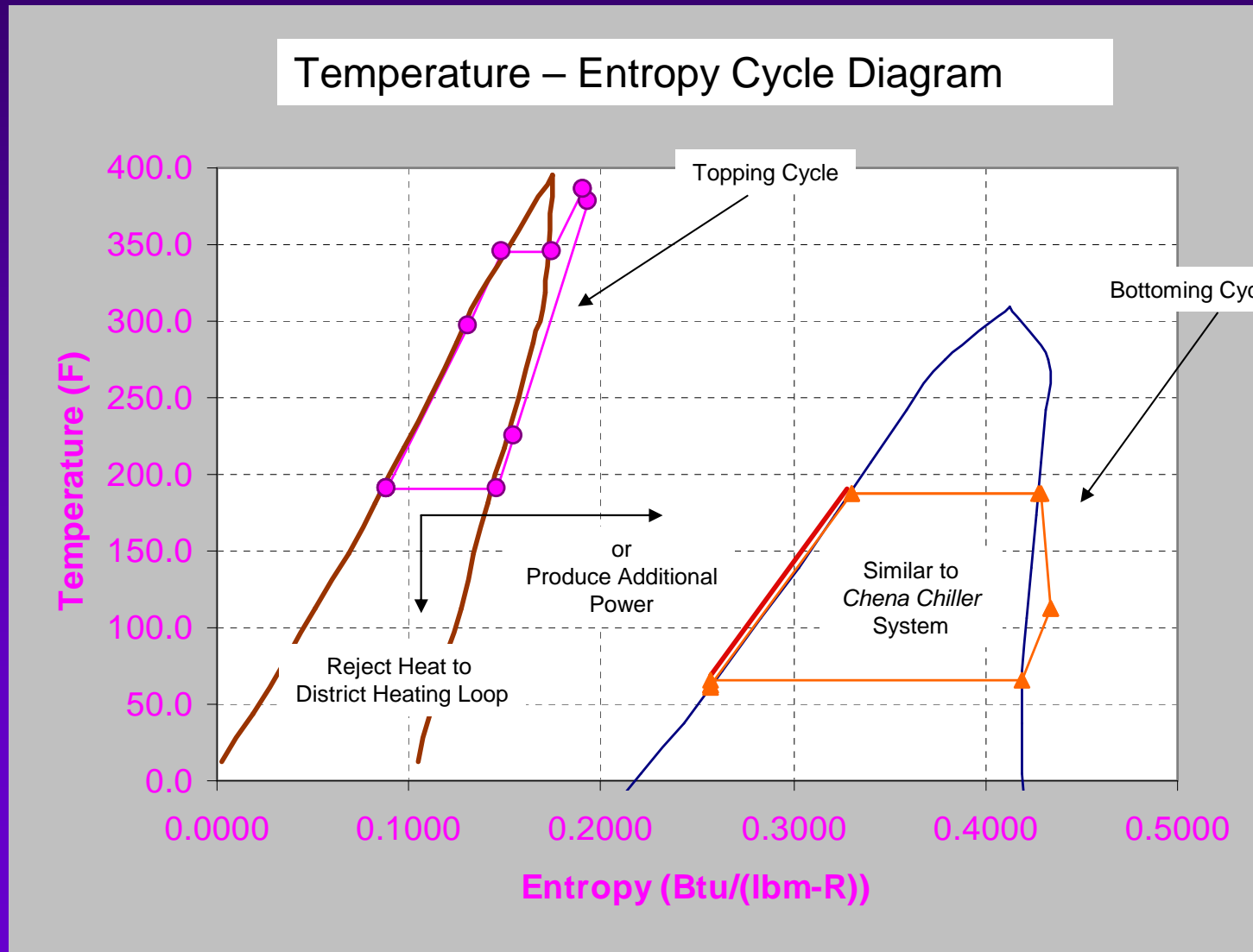
Biomass Power Plant



- **Proposed for Fairbanks North Star Borough Landfill**
- **400kW gross, 300kW net output**
- **Fuel is 5000 tons of paper, cardboard and brush**
- **Designed for rural village application – thermal oil boiler, load following**
- **Increased efficiency over geothermal installation through addition of a topping cycle**

Proposed Biomass Power Cycles

Ketone topping cycle doubles efficiency to 20% and increases energy utilization to 80%



Municipal Waste: Fairbanks



Paper makes up ~
50% of the waste
stream in U.S.

- Eielson Recycling Program to densify 1500 tons per year of waste paper and cardboard discontinued in 2006
- Fuel pellets co-fired with coal at Eielson
- Potentially 14,000+ tons available based on national averages – current no recycling of paper
- The FNSB is committed to implementing a more comprehensive recycling plan

Shred-Tech System



Photo of Shred-Tech STQ100 (photo of model at a different project location)

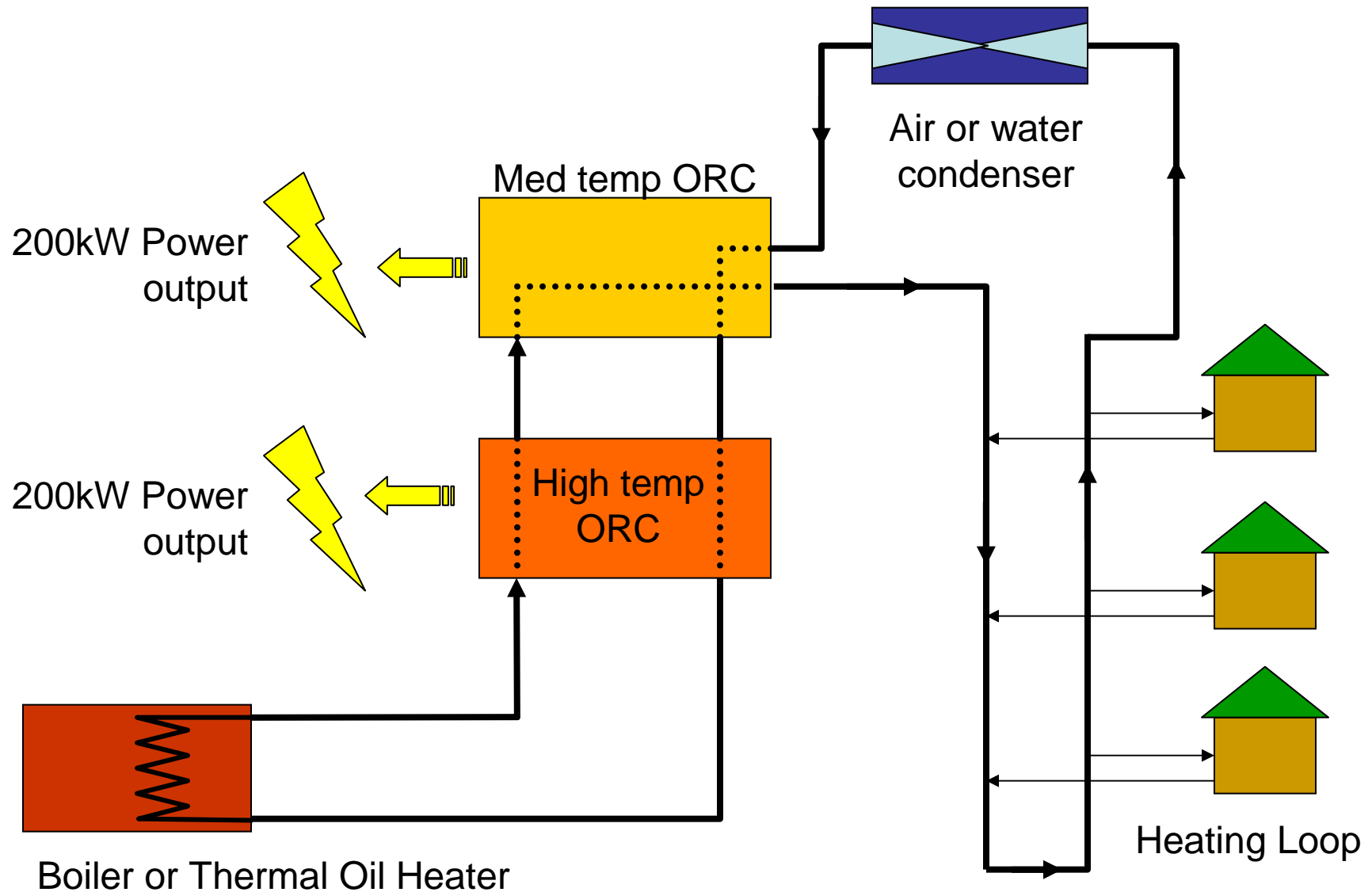
Live Floor to Feed Thermal Oil Heater



Right: Auger system automatically feeds boiler as heat is needed.



The Goal: Combined Heat and Power (CHP)



Wood for Space Heating (Dot Lake)



Short Rotation Woody Biomass Crops



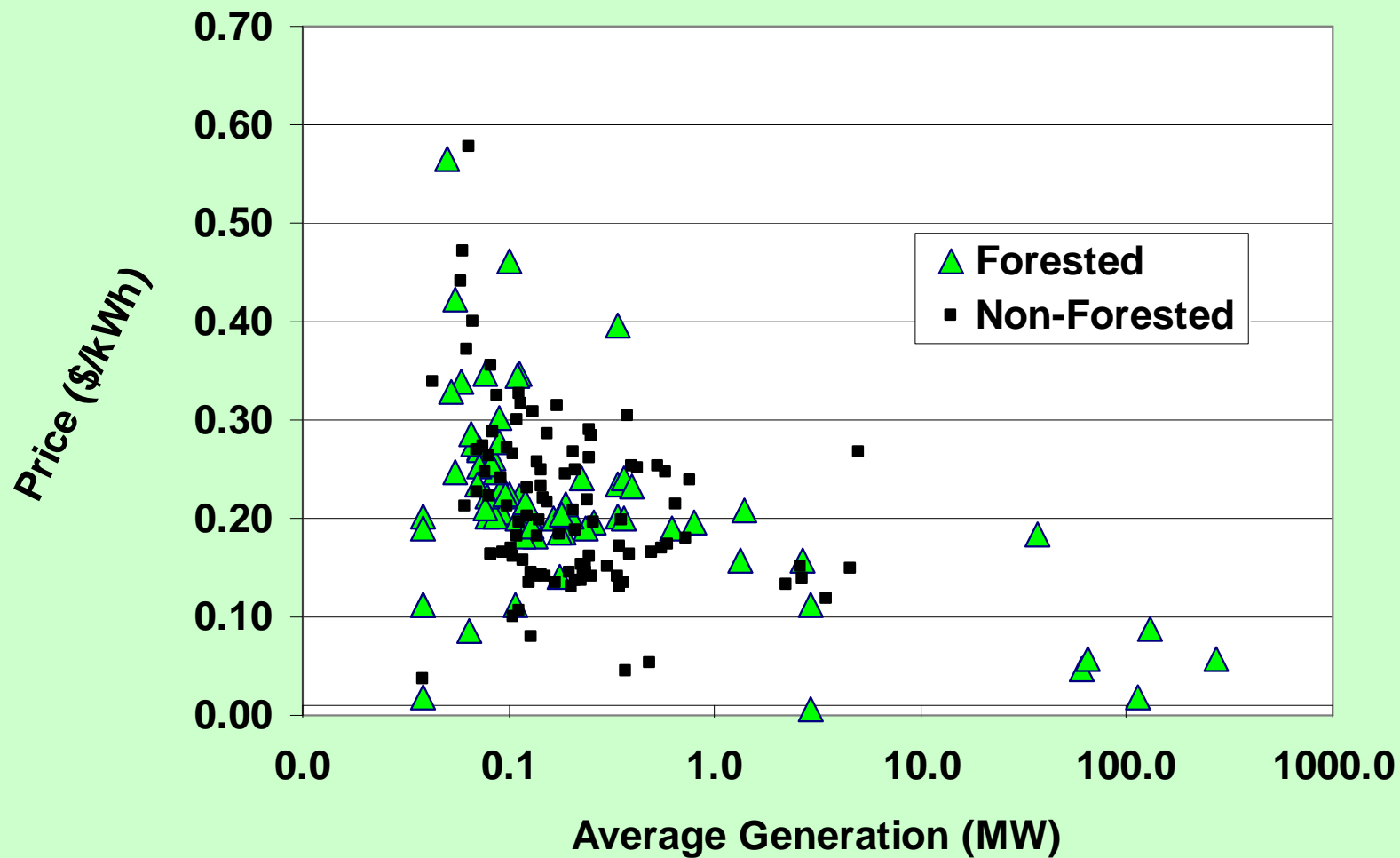
- Successful biomass crop in Europe and in test plot at New York University
- Could be used in rural Alaska for heating and power generation
- Provides excellent moose and caribou habitat
- Already grows successfully in Alaska!!

Short Rotation Woody Biomass Crops



New York University 500 acre willow biomass test plot

Average Power Generation vs. Non-Firm Price





Project Objectives



- Design stand-alone biomass fueled power plant for Alaskan village applications
 - 200kW Modular size
 - Thermal oil substitutes for water (steam) to eliminate freezing problems with unplanned shutdown, eliminate need for makeup water and water treatment
 - Couple with short-rotation woody biomass crop (willow)
 - Unmanned grid independent operation with safe shutdown and remote monitoring
- Increase cycle efficiency to 20%