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Capstone Microturbine CCHP at Vineyard 29, St. Helena, CA

The Good, the Bad and the Ugly

Chuck McMinn, Owner
Vineyard 29

Ray Cole, PE
Axiom Engineers

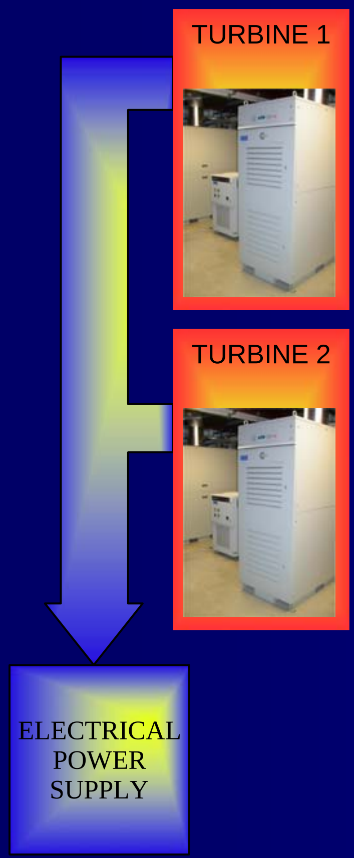
System Overview

- 2 Capstone C60 microturbines – 120 kW
- 2 Copland 29 SCFM gas compressors with piping cross over
- Stand alone Unifin2 880K BTU/hr. heat recovery unit
- ABB Alpha Plus load following meter
- Capstone automatic transfer switching on grid failure
- Nishiyoda 20 ton adsorption chiller
- RTI 20 ton Electric chiller to supplement cooling at harvest
- Parker 900K BTU/hr. backup boiler
- Evapco 2.2M BTU/hr. cooling tower
- Dolphin pulsed power tower water treatment system

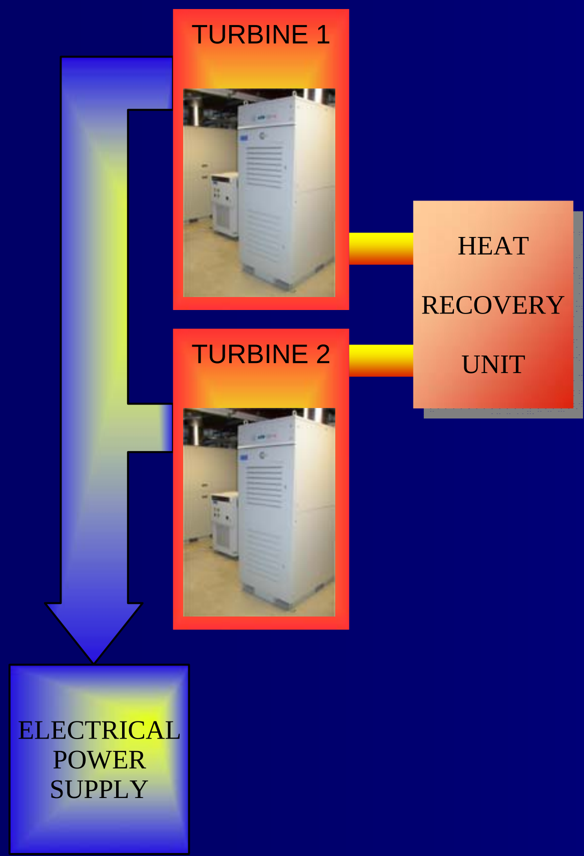
Project Team

Owner	Chuck & Anne McMinn
Project Manager	Batt and Associates
Funding	Owner, CA CEC/PUC
System Engineer	Axiom Engineers, Inc.
General Contractor	Ryan Associates
Electrical Sub Contractor	William Bradley Electric
Mechanical Sub Contractor	Peterson Inc
Equipment Supplier	CoGen Equipment Solutions

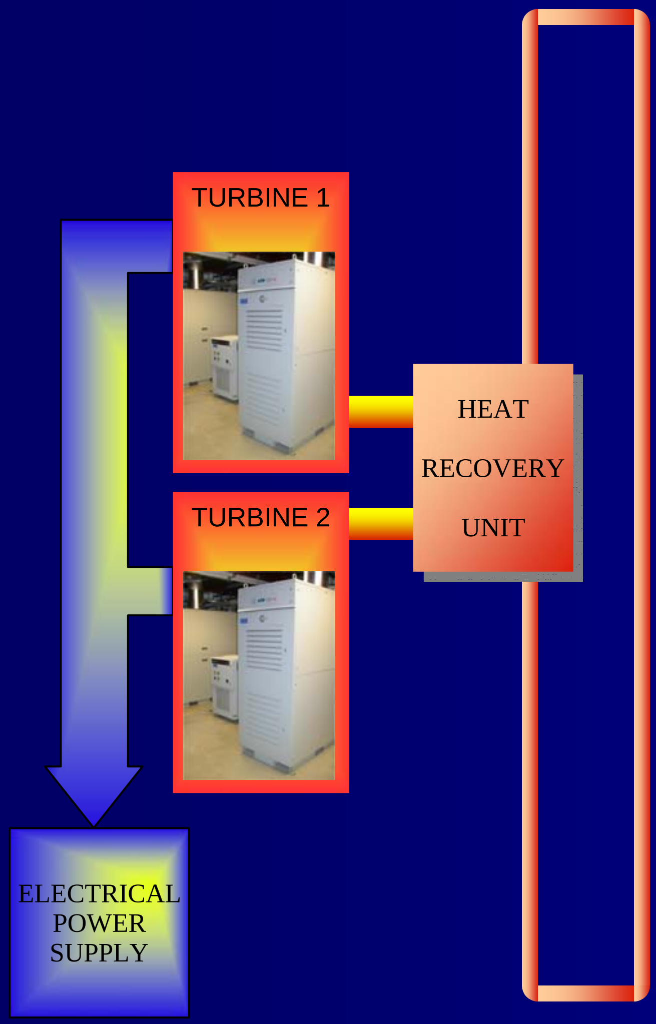
Dual Capstone 60KW Microturbines are the Power Plant at Vineyard 29



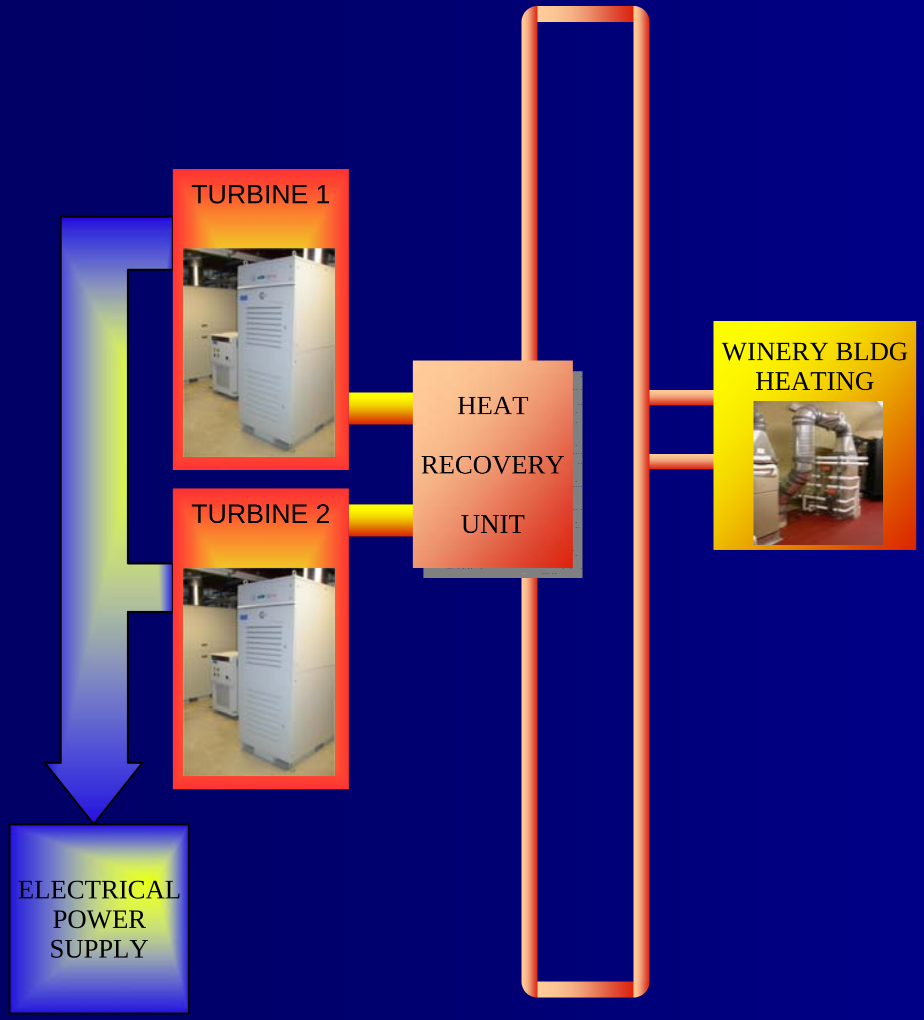
Microturbine Exhaust Heat Is Recovered to Heat Water in a Heat Exchanger



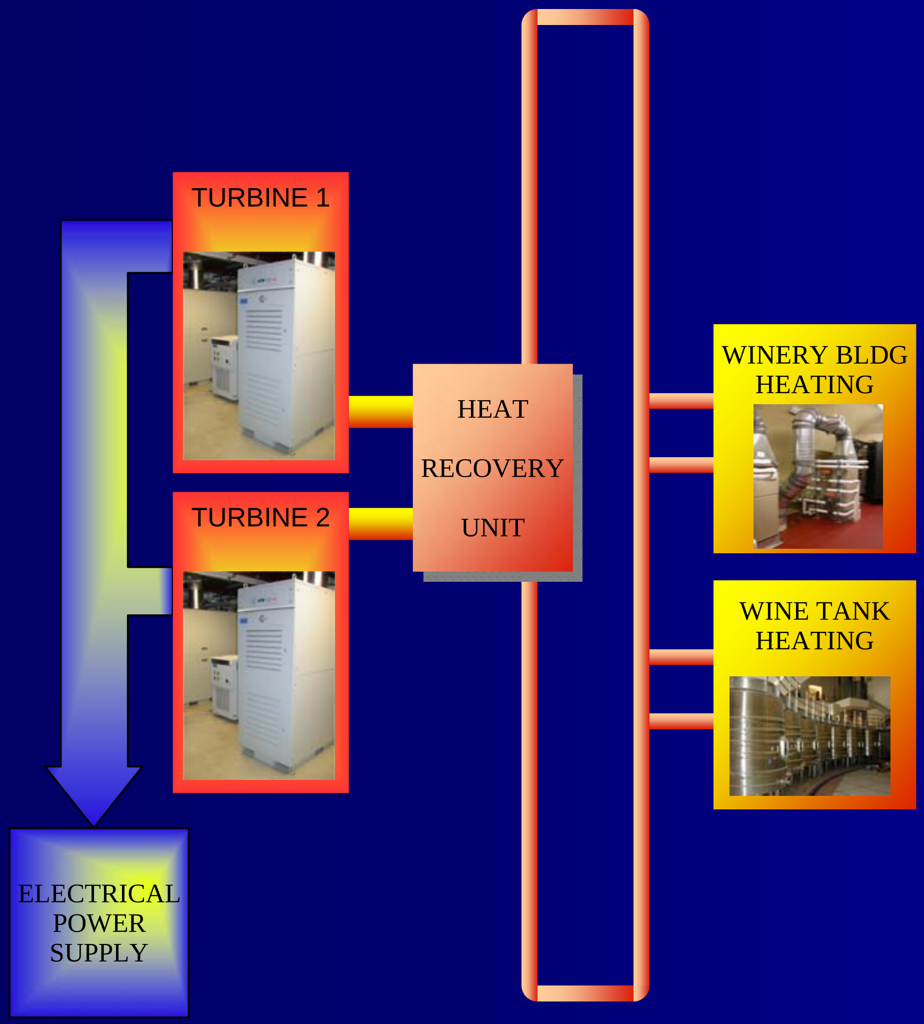
Which is Circulated in a Hot Water Loop



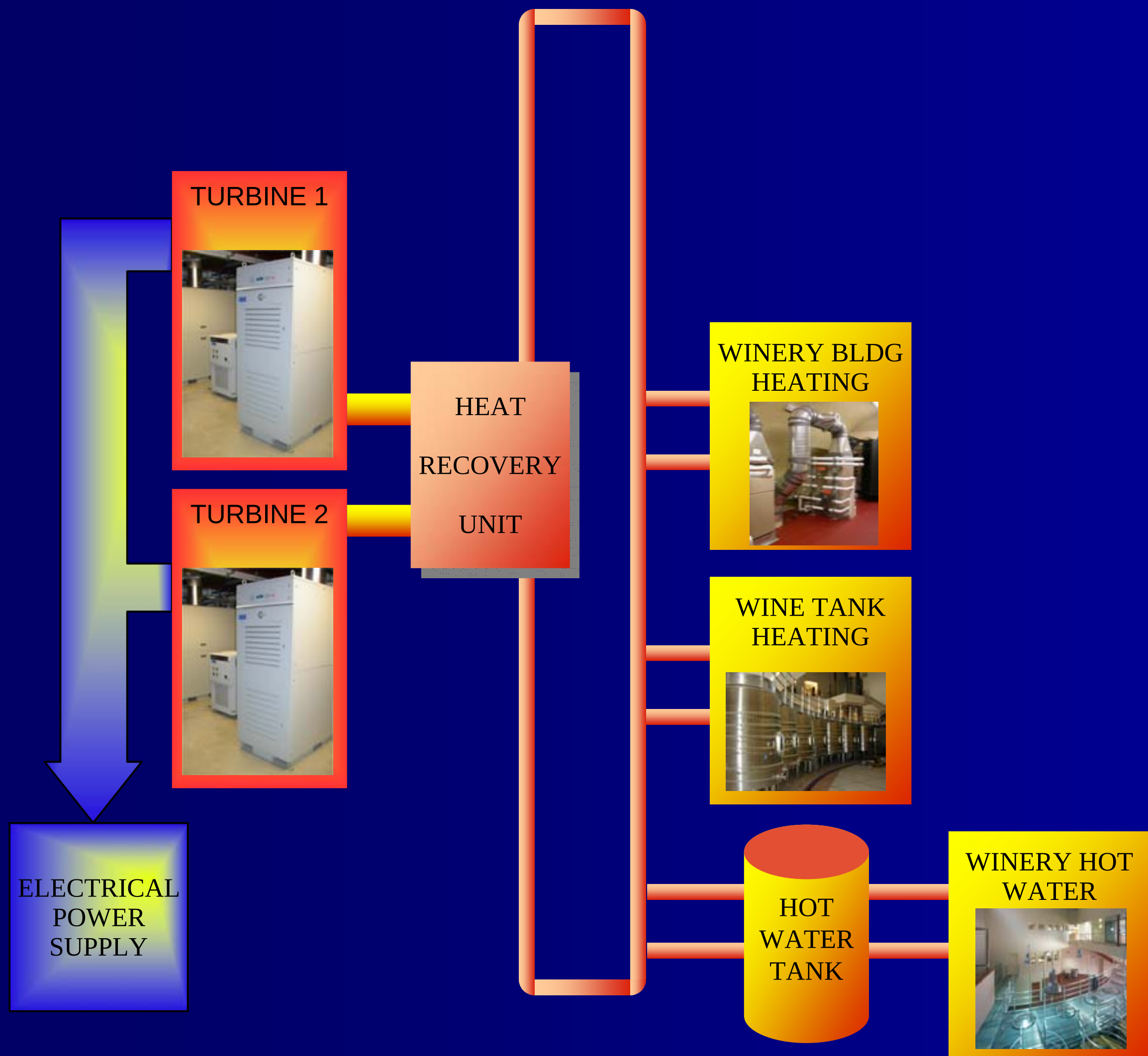
This Hot Water is used for Winery Building Heating...



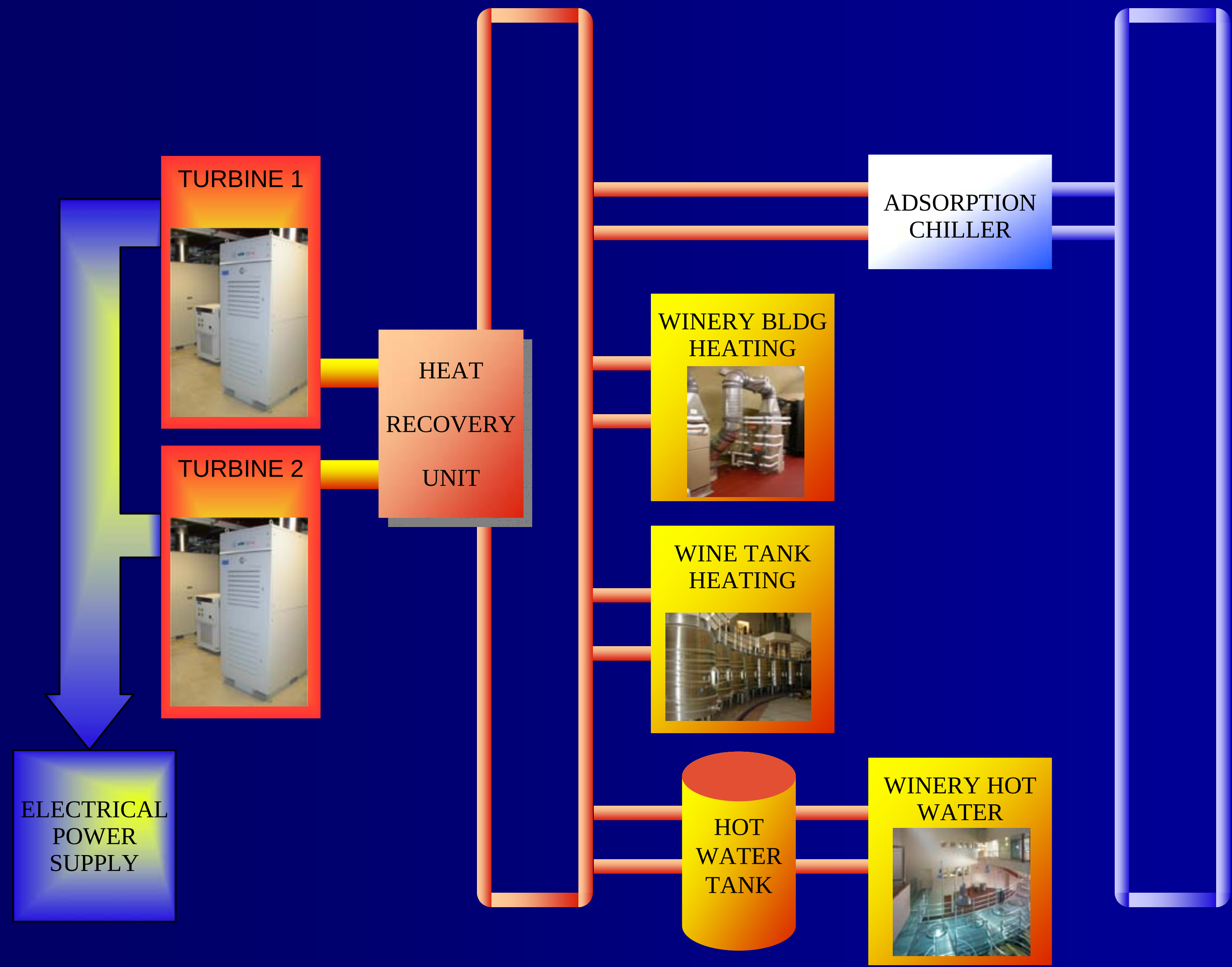
For Wine Tank Heating...



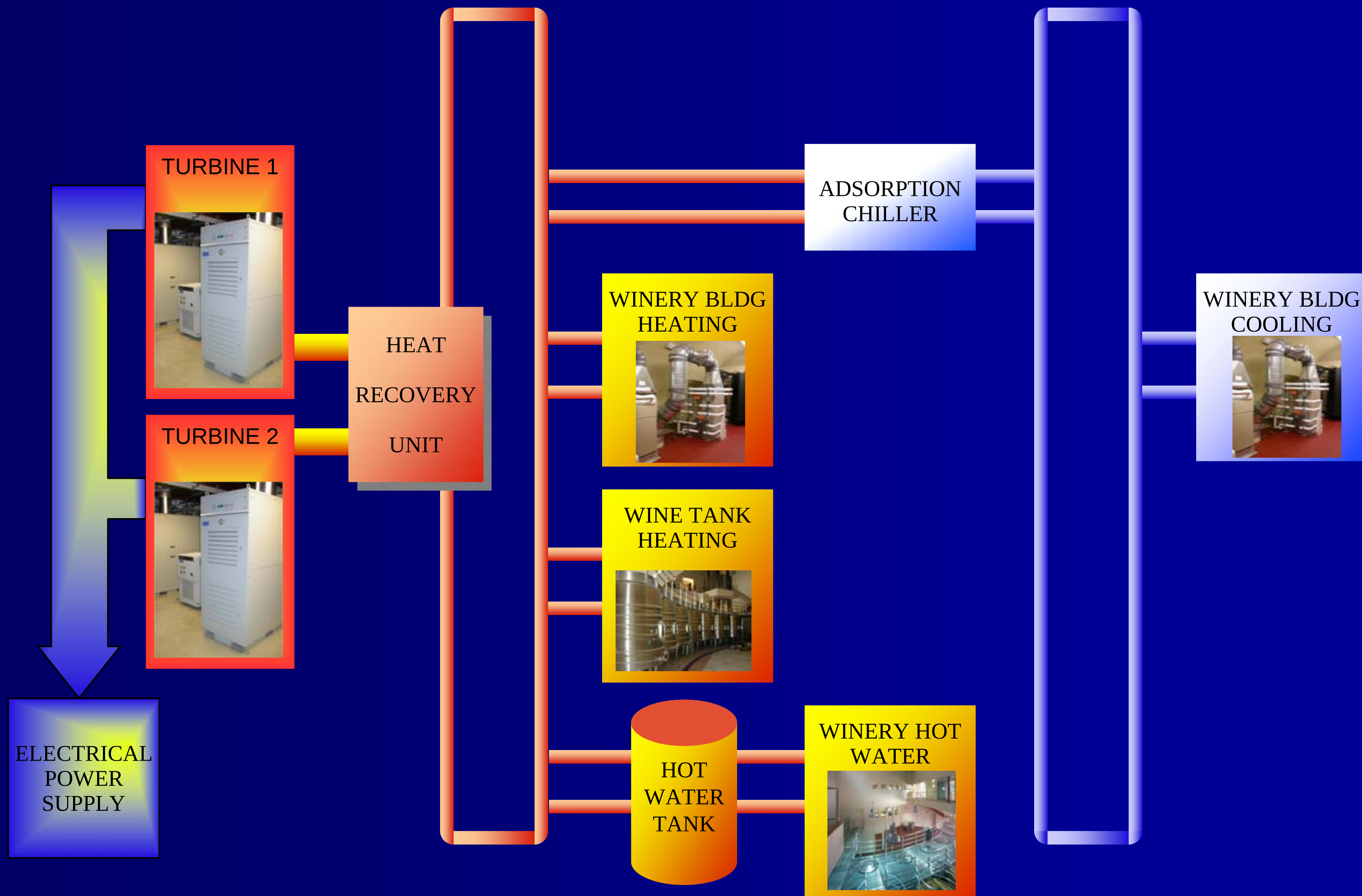
And for Winery Process Water Heating



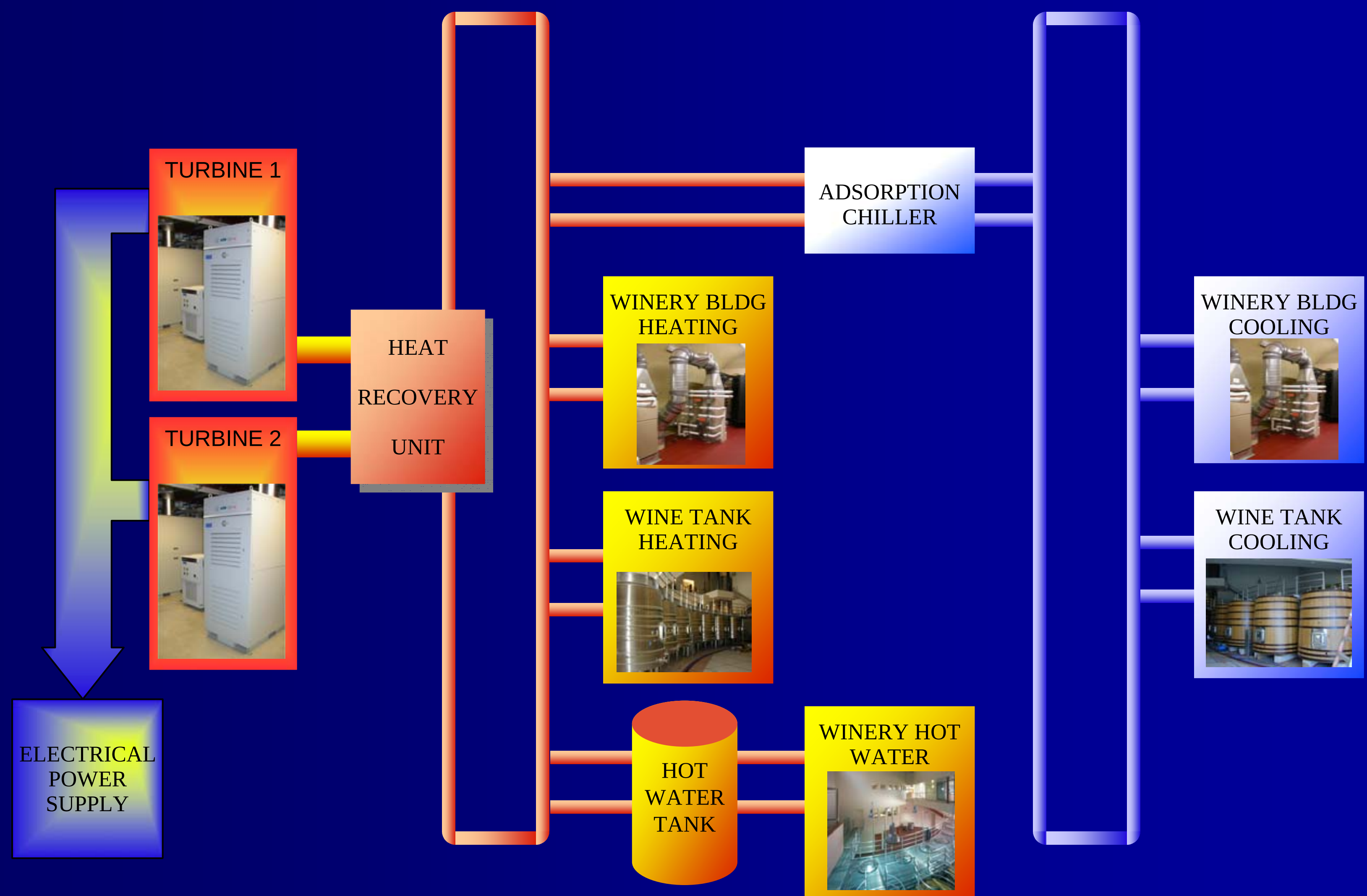
Hot Water also Powers an Adsorption Chiller



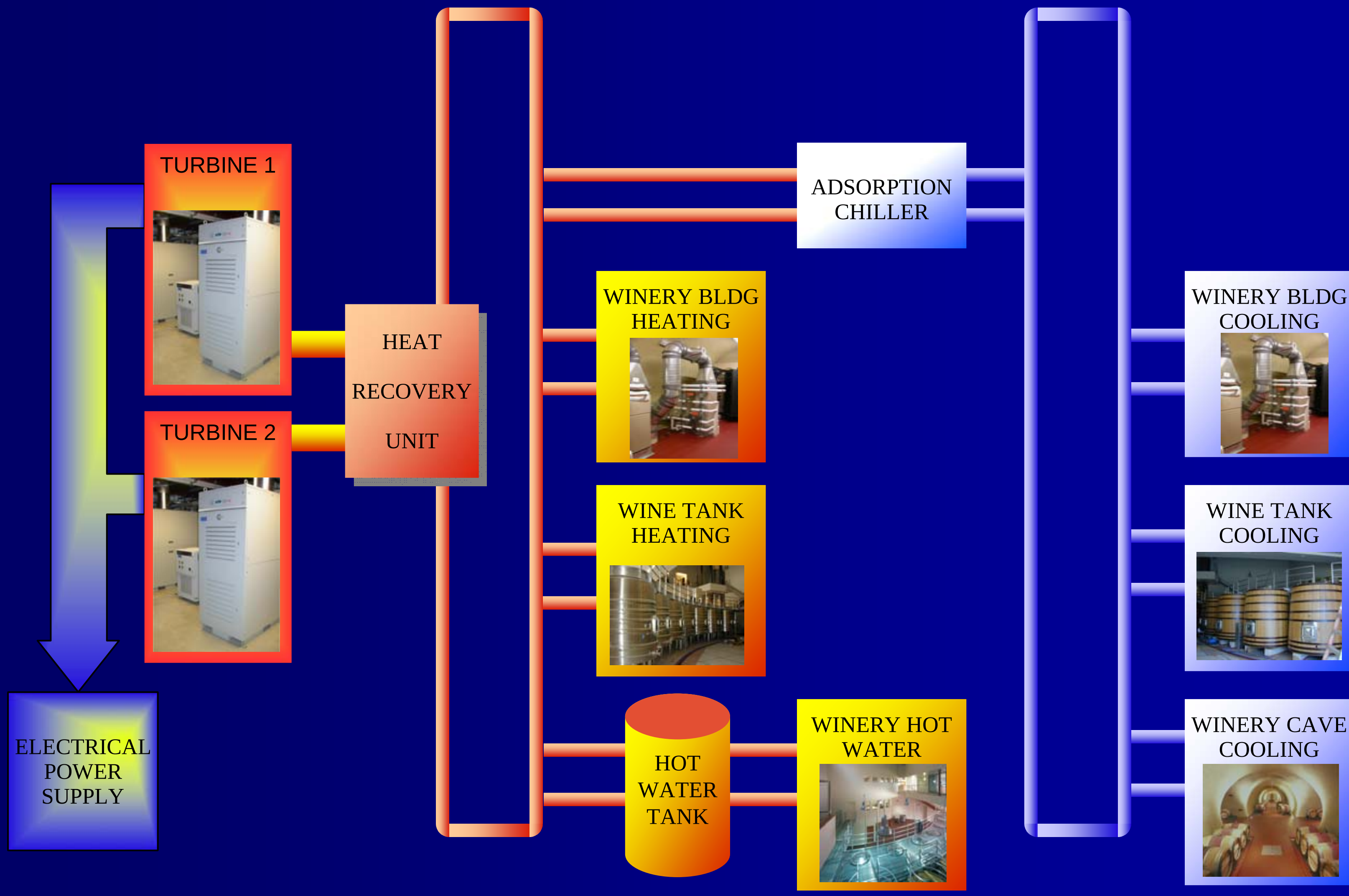
Which in Turn Provides Winery Building Air Conditioning...



Provides Cooling to Vineyard 29's Wine Tanks...



And Cools Vineyard 29's Caves



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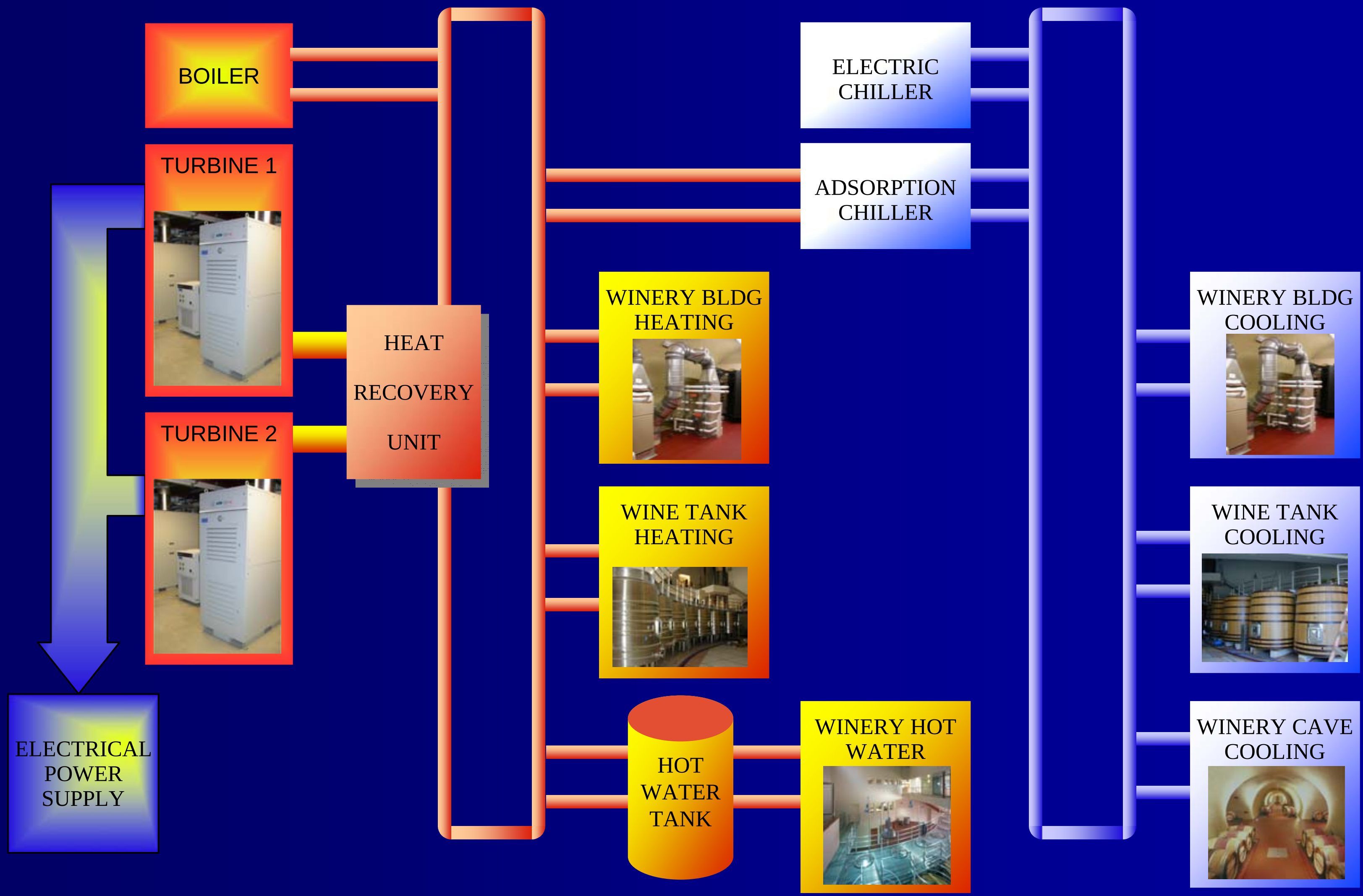
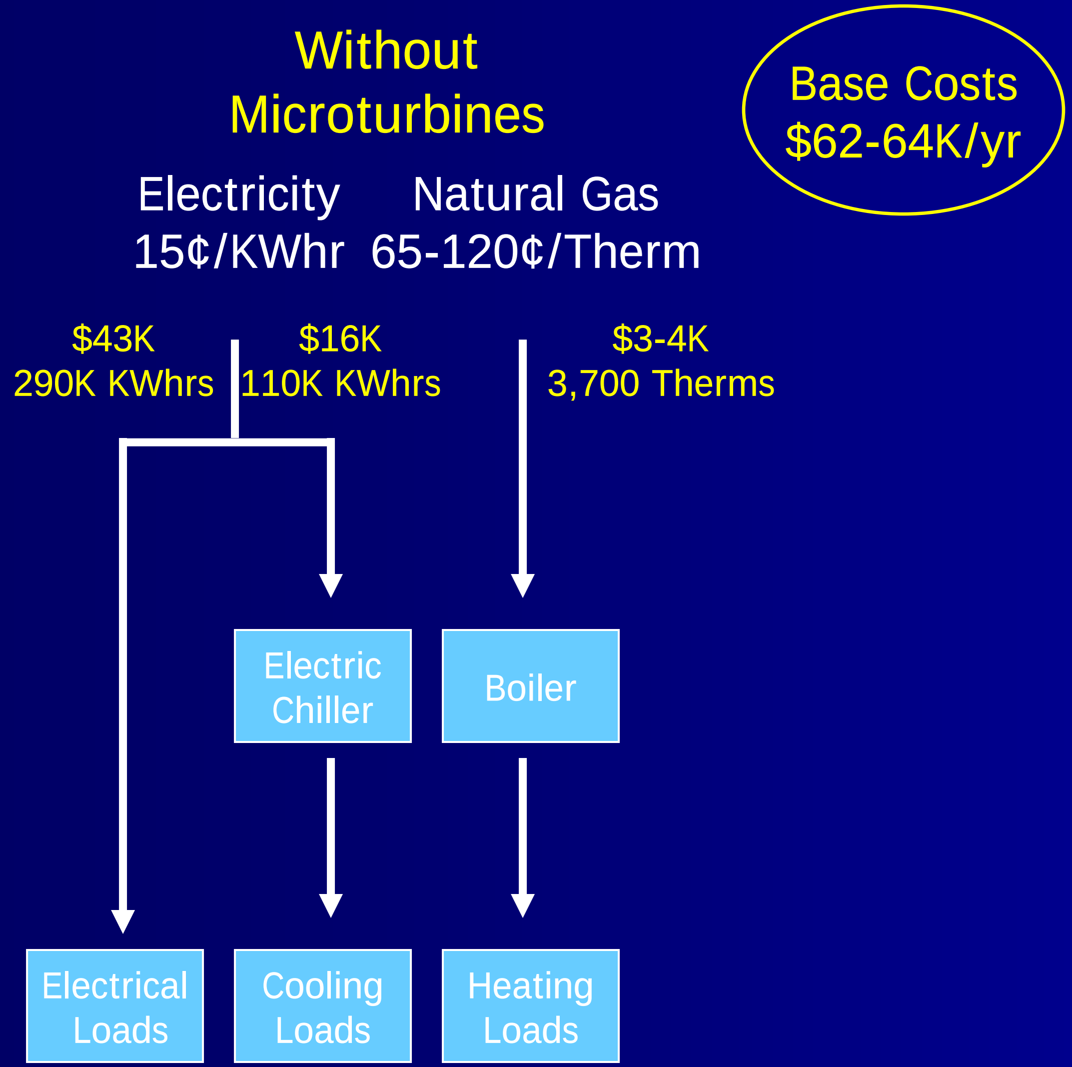
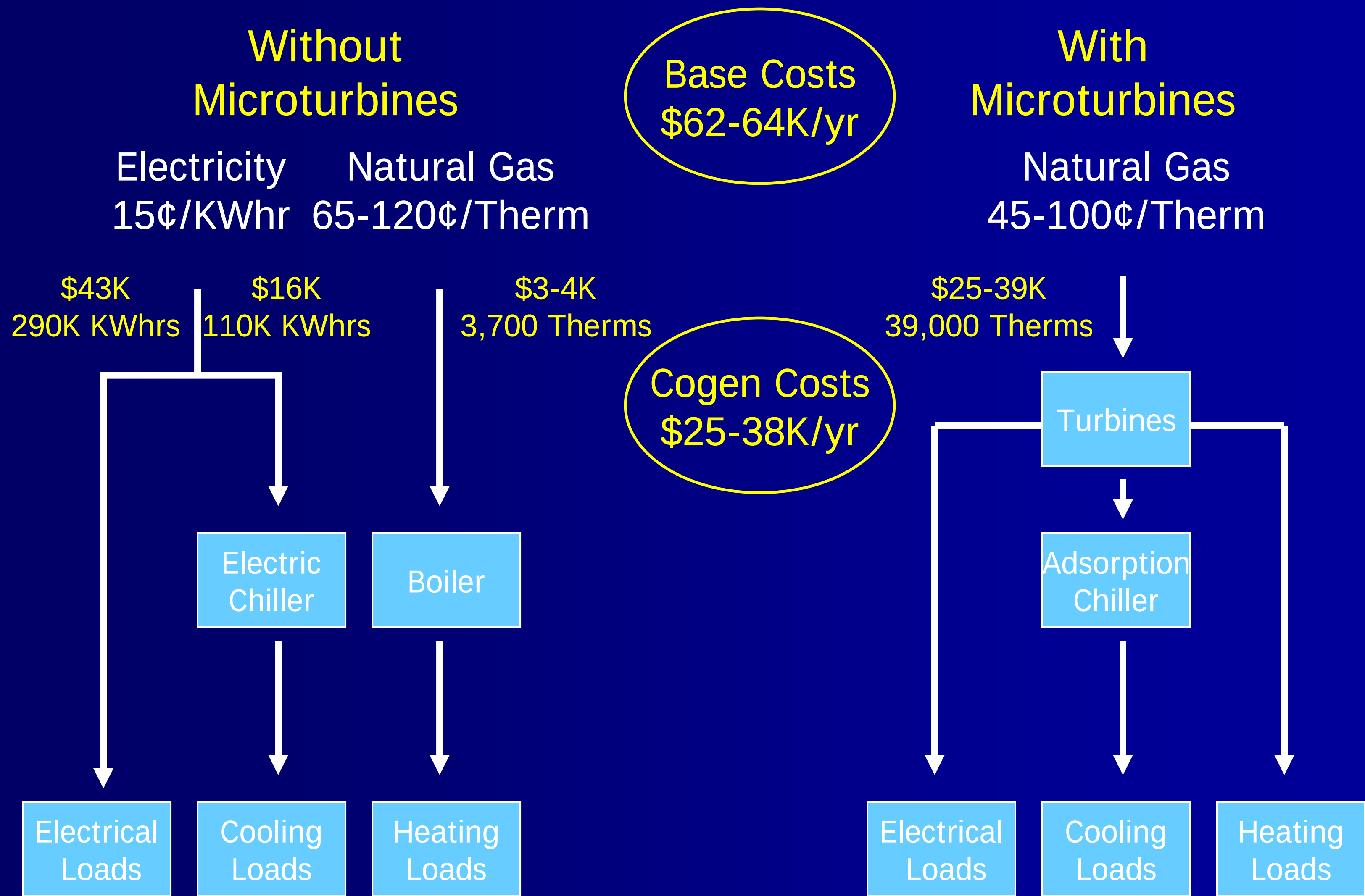
Backup Boiler for Water Heating when Turbines Offline
Backup Electric Chiller for Harvest Peak Cooling



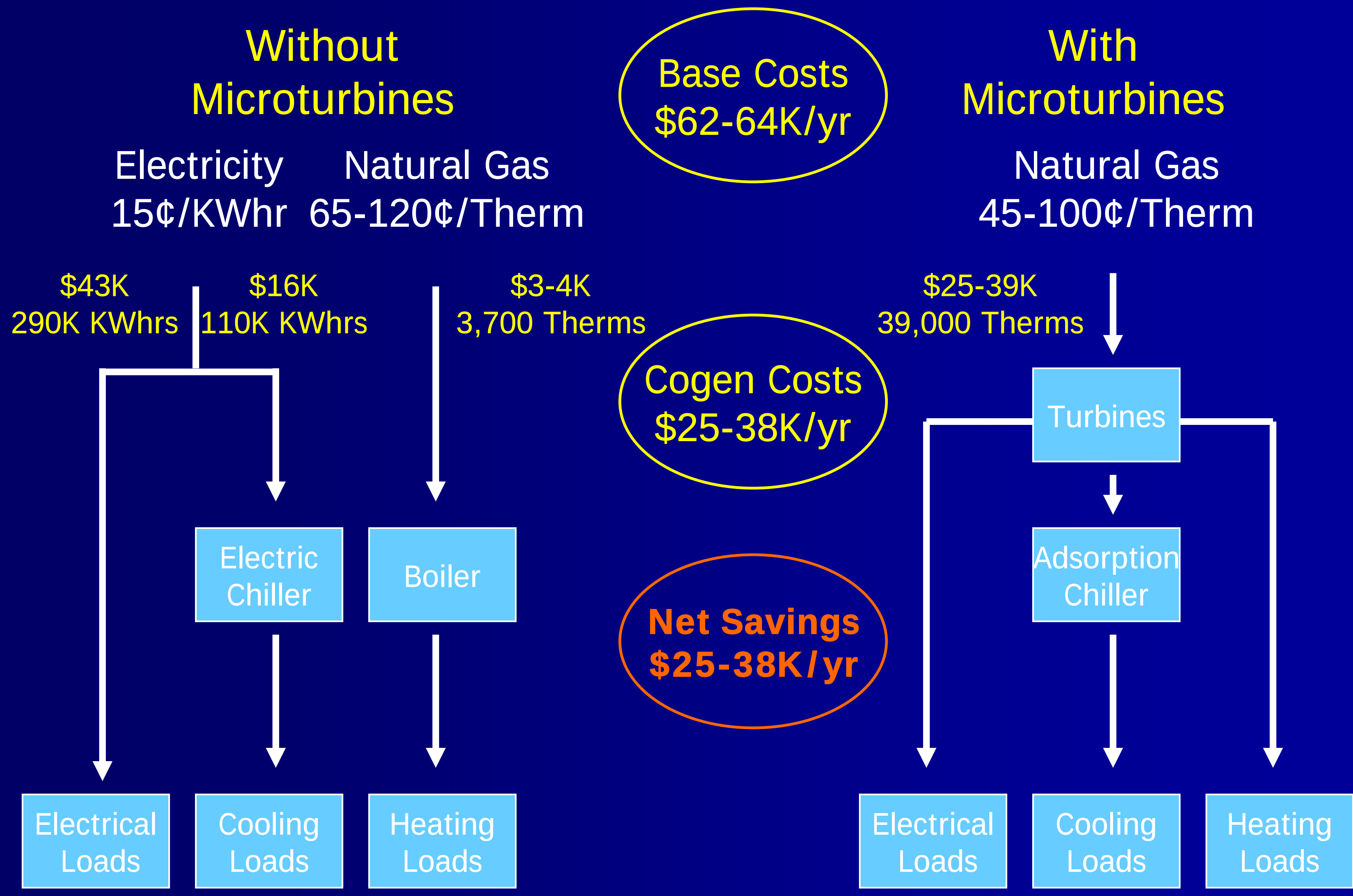
Starting From a Base Annual Operating Cost



Cogeneration Reduces Energy Consumption



And Yields a Net Annual Energy Cost Savings



Resulting in Overall Cost Savings and an Acceptable Payback

System Cost		$ 470,000
Less PGE Incentive ($1K/KW)		120,000
Less Avoided Costs	Backup Generator	120,000
	Larger Chiller	20,000
Net Cogen Capital Cost		210,000
Annual Energy Savings		25,000-38,000
Payback (years)		5.6-8.4 years*
*high end now due to gas cost spike		

System Installation, Operation and Performance

Program Dates

	Planned	Actual
Equipment Delivery	04/2003	11/2002
System Commissioned	07/2003	09/2003
Monitored Operation	09/2003	09/2003

- Early delivery of turbines at request of manufacturer
- Delay in system final commissioning due to electrical contractor not ordering load following meter

Performance

System Hours	Total: 19,000 T1: 14,150 T2: 13,686
Electrical Efficiency (LHV)	Utility: 21.5% Internal: 28.5%
Parasitic Loads	Full Load: 5KW Average: 2KW
Recovered Energy	8.4 Billion BTU to 12/31/2005 .44 Million BTU/hr.
Heat Exchanger	74 GPM 12° Delta T
CCHP Efficiency (HHV)	Utility: 64% Internal: 83%
Chiller COP	.65 BTU out/in

Installation Experience

- Paperwork drill: BAAQMD permit to operate
- Educate the Fire Department: fire pump control
- Educate PGE local: no protection relays required
- Work around the General: equipment owner supplied
- Design the system: vendors supply boxes, not solution
- Fix DOA parts: Controller, Compressor, Power Server
- Install and bring up: no/wrong documentation
- Get Building Permit signoff: demonstrate fire pump
- More paperwork: getting the PUC rebate

Operational Experience

- 97% System availability since commissioning
- System operated 24 x 7 versus 8 x 5 expectation
  - Chiller used to cool cave temperature
  - Not practical without cogeneration
- 3x one of the turbines offline for 1-3 weeks
  - System performance not impacted due to redundancy
- O&M costs higher than planned
  - $10,000 per year going forward (2.5¢ per KWhr)
  - More equipment than needed (45KW average demand)
  - Higher cost manufacturer supplied service contract
- Environmental performance not measured, but significantly better than grid

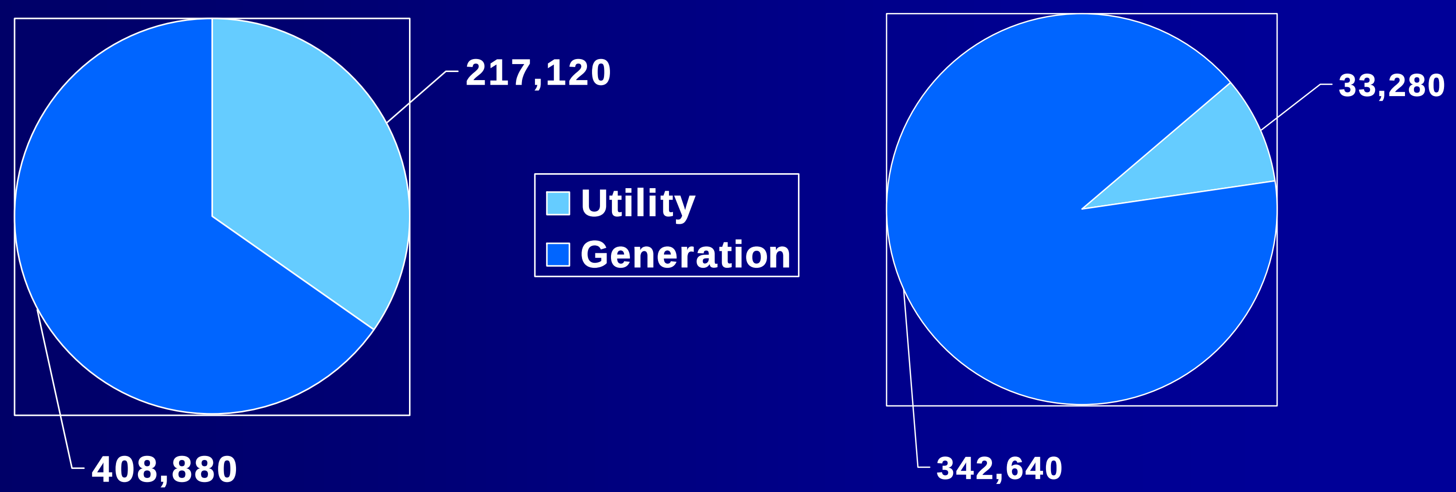
The Big Operational Issues

- Backdraft Damper Design Flaw
  - Did not allow ping-pong operation
  - required replacement with redesigned dampers
- Power Server Functionality
  - Did not allow close load following
  - Erratic response to transient loads (elevator operation would trigger second turbine start)
  - Replaced with custom designed PLC

Performance Comparison

Original Dampers
Original Power Server

Redesigned Dampers
New PLC



17 Months of Operation
65% self generation

10 Months of Operation
91% self generation

Other Operational Issues

- Gas Compressor Failure
  - 1 at startup, 1 at 12,000 hours
- HRU sensor failure at 4,000 hours
- Turbine battery failure at 4,000 hours
- Early turbine igniter and electronics replacements
- 3 trips of pump inverter on chiller
- Cooling tower fan failure
- Chiller circulation pump bearing/seal failure
- Turbine max power output has deteriorated
  - Manufacture indicated problem may be recuperator
  - One unit max output now less than 50 kW
  - Turbine cores are scheduled for replacement

Axiom Engineers

Cost Projections

Item	Actual#	100% Hindsight	50th Installation
Turbines	$150,000	$150,000	$100,000
HRU & Comp	$35,000	$35,000	$15,000
Chiller	$55,000	$55,000	$35,000
Mechanical#†	$105,000	$75,000	$35,000
Electrical*#	$135,000	$85,000	$50,000
Engineering	$30,000	$15,000	$10,000
Project Mgmt#†	$50,000	$25,000	$15,000
Commissioning#†	$50,000	$15,000	$5,000
Total	**$610,000**	**$455,000**	**$265,000**

Approximate because lumped into general Contract
* Includes Control and monitoring system
† Only partially billed to Vineyard 29

Action Items

- Resolve thermal and electrical efficiency discrepancy between internal data and utility data
  - Spot checks and calculations tend to support internal data
  - Manufacturers published data supports internal data
- Resolve Turbine maximum power output decay
  - Seek resolution from manufacturer before extended warranty expires
- Continue ongoing performance monitoring

While the installation at Vineyard 29 has not been perfect, it has delivered on the design goals of:

Lower power costs
Increased power reliability
Better environmental operation