RECOVER / REUSE / RETHINK

Sustainable Energy and Resource Saving Concepts for HVAC/Process/Water/Wastewater

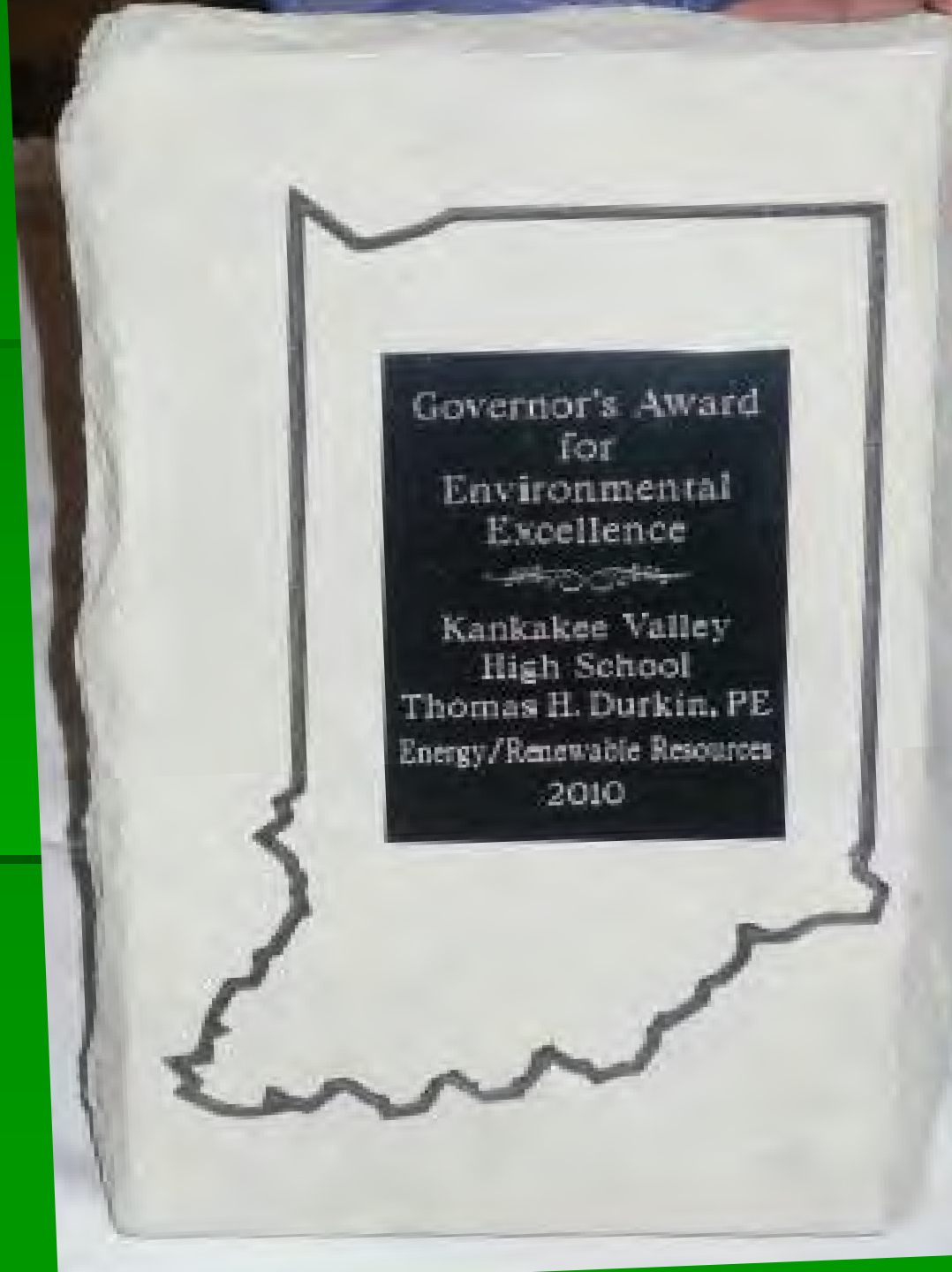
Thomas H. (Tom) Durkin, PE
Dr. Glenn Krueger, EdD
Bob Jacobi

Kankakee Valley High School

25% energy reduction
$112,462/Yr
(2 teachers)

1.8 Million Lbs/ Yr Green House Gas Reduction

8 Yr Payback



Infinitely Renewable Energy

Most of the year, KVHS and KVMS will be heated with energy recovered from the kids, computers and the lights.

The Geo does most of the rest of the heating and cooling.

“You have to get up early to see the boilers run.”

Jim Bachman, Director of Maintenance

Kankakee Valley HS

A synthesis of three ideas invented in Indiana

- Low temperature heat
- Heat recovery chillers
- Geothermal central systems

HPAC Engineering

April 2008

Hybrid Geothermal:

Triple-Tiered HVAC Savings

Dedicated-heat-recovery-chiller and geothermal-heater/chiller technologies reduce heating, cooling, geothermal costs

Editor's note: The 40-year-old HVAC system at Kankakee Valley High School (KVHS) in Wheatfield, Ind., was in need of an upgrade. Teachers complained of being hot or cold daily; the boilers were in desperate need of repair or replacement; the chiller was old, inefficient, and undersized; the cooling tower was rusting through; and the pumping and piping system was said to look as if famed cartoonist Rube Goldberg had designed it. Following is the story of the system's overhaul told from the perspectives of key participants.

Getting Started

By GLENN KRUEGER, PHD
Superintendent
Kankakee Valley School Corp.
Wheatfield, Ind.

School-corporation philosophy. We began talking about renovating the system during the fall of 2005, shortly after Hurricane Katrina ravaged gas-drilling platforms in the Gulf of Mexico and the price of natural gas rose to $1.40 a therm. Kankakee Valley's operating budget was stretched beyond revenues. Energy efficiency was seen as a means of controlling the huge gas-price increase. The school board insisted that energy efficiency be considered in the selection of a design firm and, as much as possible, wanted a plan to protect against future gas-price volatility.

Kankakee Valley High School measures 200,000 sq ft.

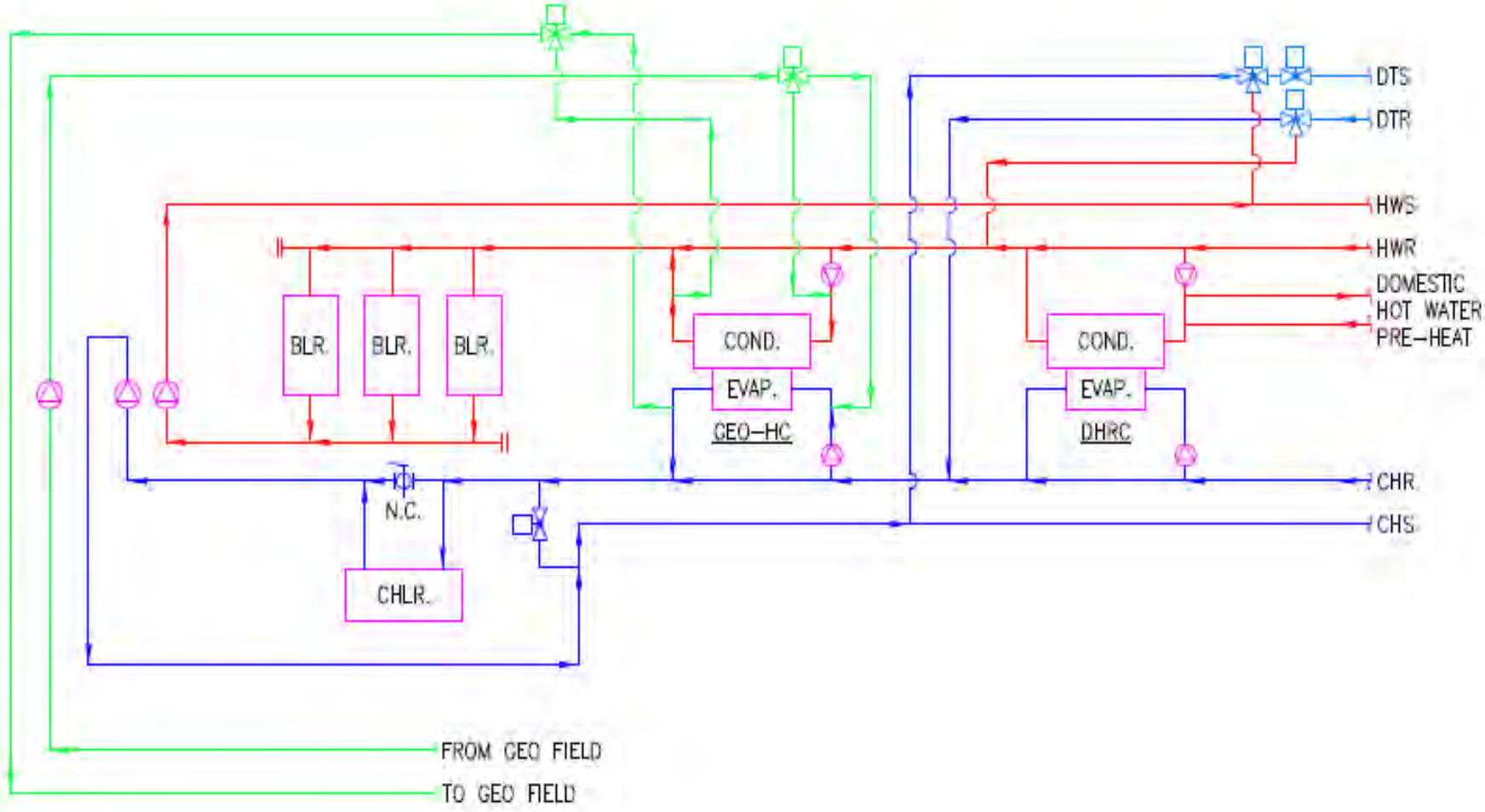
Instrumental to our plans was the involvement of our energy suppliers, including Northern Indiana Public Service Co., which encouraged us to look at geothermal and other high-efficiency electric options, and Jasper County Rural Electric Membership Corp., which encouraged a high-efficiency electric solution for schools and provided a small grant to aid the construction of energy-efficient systems.

Choosing a consultant. A steering committee consisting of myself, the director of business, a local consulting engineer, and the head of maintenance was appointed. The committee wanted a reasonable initial cost, ease of maintenance, reliability, and economy of operation. Following a pre-screening of all credentialed design firms in Northern Indiana, a request for qualifications was issued. Ten firms were invited to participate in an information-gathering day at the schools and given a month to prepare recommendations for KVHS. Each firm then was given an hour-and-a-half to present its ideas. The consensus recommendation was to replace the HVAC system at KVHS. Estimates ranged from $20 to $30 per square foot.

The steering committee chose Durkin & Villalta Partners Engineering (DVPE) of Indianapolis. DVPE presented the most comprehensive solution with the greatest operating-cost savings. Even though the KVHS HVAC system was not a poor performer from an energy standpoint, with a slightly below-average Energy Star score of 41, DVPE saw potential for significant energy savings.

Kankakee Valley High School

Hybrid Geo 4x2 with DHRC



KVHS Mechanical Room

We want Geothermal because…

- It will lower operating costs
- It is a good long term investment…geo field has a 50+ year life expectancy
- It will reduce air pollution and green house gasses
- There may be incentives from the government or local utility
- It would be an excellent addition to the science curriculum

ASHRAE Journal

July 2006

Boiler System Efficiency

By Thomas H. Durkin, P.E., Member ASHRAE

When natural gas cost $0.40 per therm* (1999), even a poorly designed boiler system would have positive payback. Hurricane Katrina changed that.

According to the Energy Information Administration (www.iea.doe.gov), the cost of natural gas has increased 50% in the U.S. since last fall (due to Hurricane Katrina) and 200% in the last seven years. Electricity has increased only 20% in the same time frame (central Indiana). Winter 2006 natural gas cost as much as $1.40 per therm (100,000 Btu) and electricity costs around $0.07/kWh (3,413 Btu). The electric cost equates to $2.05 per therm.

In the simplest terms, when comparing condensing boiler/low-temperature heat and conventional boilers, if the boiler cannot deliver heat to the space at an efficiency of at least 68%, then the boiler has zero payback vs. straight resistance electric heat, which is (theoretically) 100% efficient. This represents a large shift in engineers' approach to heating systems.

Some would argue, probably correctly, that the entire national energy picture is in flux, and that the cost of electricity is artificially low compared to natural gas. Conversely, the cost of natural gas may be artificially high because of the hurricane damage to the gas drilling rigs in the Gulf of Mexico. In Indiana, most of the new electric power generation is gas-fired peaking plants, which likely will create a ripple effect on electric costs.

This snapshot makes it seem that gas-fired boilers are a marginal investment, and that boilers burning fuel oil at $2.80 per gallon (139,000 Btu/$2.01 per therm) or propane at $2 per gallon (91,600 Btu/$2.18 per therm) will cost significantly more than straight resis-

About the Author

Thomas H. Durkin, P.E., is director of engineering at Veazey Parrott Durkin & Shoulders in Indianapolis.

*therm = 105.5 MJ

ASHRAE Journal

October 2003

Dedicated Heat Recovery

By **Thomas H. Durkin, P.E.**, Member ASHRAE, and **James B. (Burt) Rishel, P.E.**, Fellow/Life Member ASHRAE

The advent of the small scroll or screw chiller, capable of producing condenser water as high as 140°F (60°C), created an opportunity for recovering heat from a dedicated heat recovery chiller's condenser water circuit for heating or domestic water systems while providing beneficial cooling for the chilled water system. These systems are called "dedicated" heat recovery because 100% of the heat generated by the dedicated heat recovery chiller (DHRC) can be used for hot water heating applications. Also, the DHRC can be piped and controlled to produce the desired evaporator or condenser temperature. Transfer of the recovered heat in this article is limited to clean water applications, such as preheating, heating, reheating, domestic, pool water heating, or snow melting.

ASHRAE Journal

August 2007

Geothermal Central System

By **Thomas H. Durkin, P.E.,** Member ASHRAE; and **Keith E. Cecil, P.E.,** Member ASHRAE

The next generation of geothermal systems for school buildings is a recent synthesis of three technologies that separately have proven to be effective: geothermal (earth-coupled) heating and cooling; dedicated heat recovery chillers; and the modern two-pipe HVAC system.

From two-pipe HVAC, comes economy and simplicity for school designs, and the proven ability to heat large buildings with low-temperature water (see sidebar on *Modern Two-Pipe System*). From dedicated heat recovery chillers comes a proven machine that can be programmed to simultaneously produce 44°F (7°C) cooling water and 130°F (54°C) heating water. And, from geothermal, comes an efficient heating and cooling source. The geothermal systems discussed in this article are closed systems, circulating an engineered heat transfer solution.

Another Heat Pump Article?

Rather than multiple distributed compressorized units throughout a building (conventional geothermal heat pumps), this concept has a single unit located in a central mechanical room. The heart of the system is a heat recovery chiller/heater, or Geo-H/C. It is a single unit (multiple refrigeration circuits provide redundancy) that will heat the building in the winter, cool it in the summer, do both in the spring and fall, and preheat the domestic hot water if demand is high enough.[1]

Geo-H/C can be connected to either a two-pipe or a four-pipe building system. All of the air-side equipment would be standard air handlers, unit ventilators or fan coils. This configuration can operate air-side economizers, and it can use the well water to cool the building directly when the ground temperature and indoor humidity allow, thus giving two sources of free cooling. When outside temperatures are cool, air-side economizers on AHUs and unit ventilators provide cooling without any compressors running; and when the well return temperature is cool enough, the sensible cooling mode provides air conditioning, again without compressors operating. Economizer availability in this scheme is seen as a significant efficiency benefit (see sidebar on *Economizers in Schools*).

About the Authors

Thomas H. Durkin, P.E.; and **Keith E. Cecil, P.E.,** are partners at Durkin & Villalta Partners Engineering in Indianapolis.

What is a Heat Recovery Chiller?

- Water cooled chiller
- Elevated condensing temperatures = 130F
- Condenser connection to building heating system
- An old concept, at least 1971
- Applicable any time there are concurrent heating and cooling loads
- Dedicated only to the heating load

Heat Source	Efficiency AFUE	Cost per Therm
Electric	100%	$2.49
Steam Boiler	50%	$2.00
Conventional Boiler	66%	$1.52
Condensing Boiler, Low Temp Operation	90%	$1.11
Geothermal	360%	$0.69
Recovered Heat from DHRC	**435%**	**$0.57****

** This does not take credit for the chilled water “by-product of making heat with the DHRC. There are both “naturally occurring” and “artificial” concurrent loads.

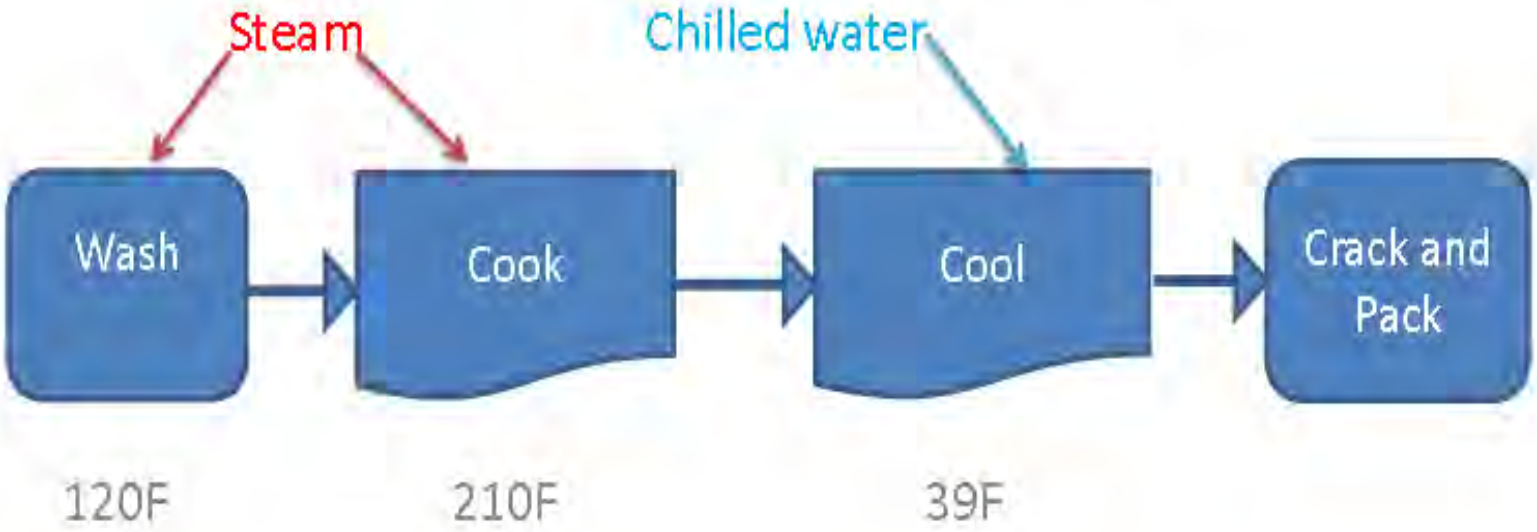
Naturally Occurring Concurrent Loads

- Water heating any time the chiller is on
- The natatorium all the time
- Reheating required for humidity control
- Internal spaces that don’t have economizers
- Data centers in winter
- Kitchen walk-ins in winter

Displacing Chiller Load

Base Chiller Type	COP	$/Therm Cooling	Net $/Therm Heat
Air cooled	2.81	$0.88	<$0.31>
Water cooled	5.02	$0.49	$0.08
Geo H/C	6.17	$0.40	$0.12

A Traditional Process

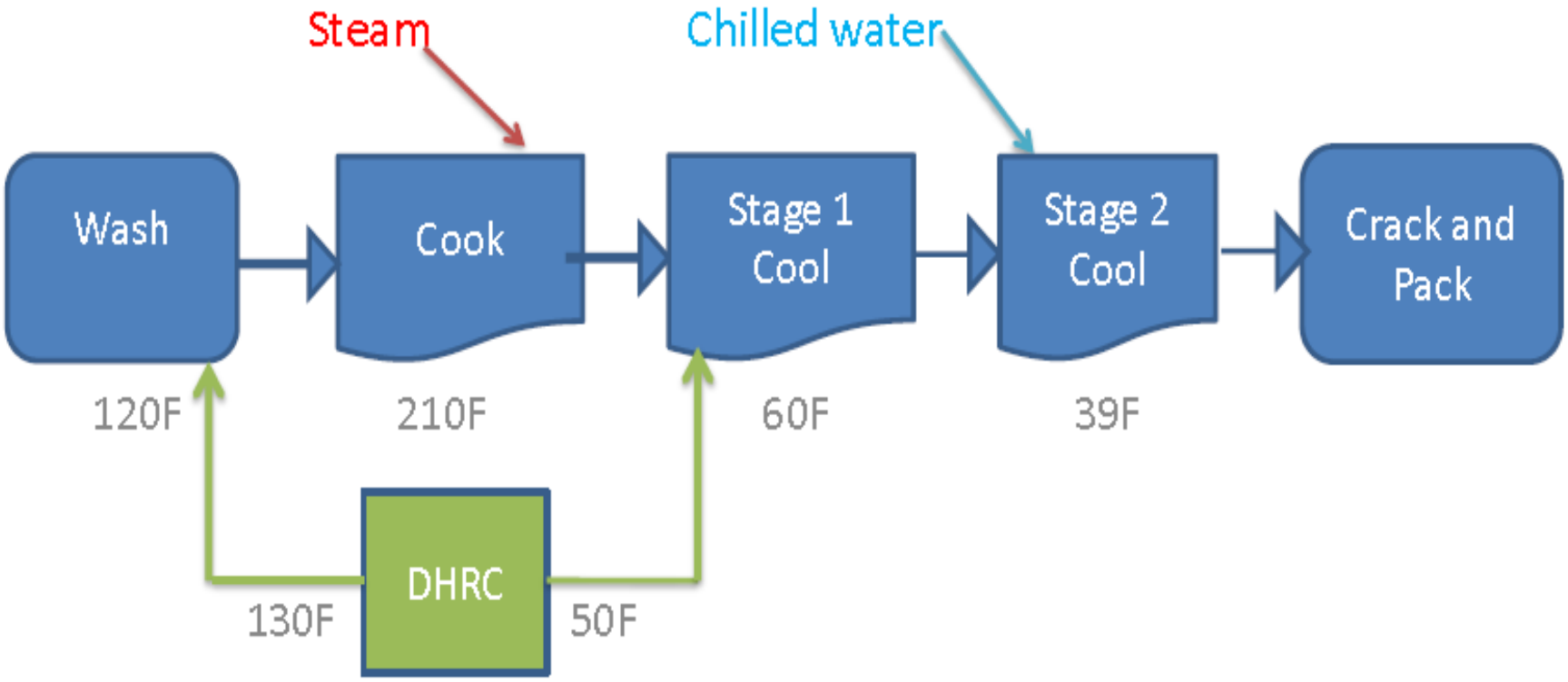


Cost per Therm of Heat = $1.25

Cost per therm of Cooling = $1.19

Total = $2.44

A Rethought Process

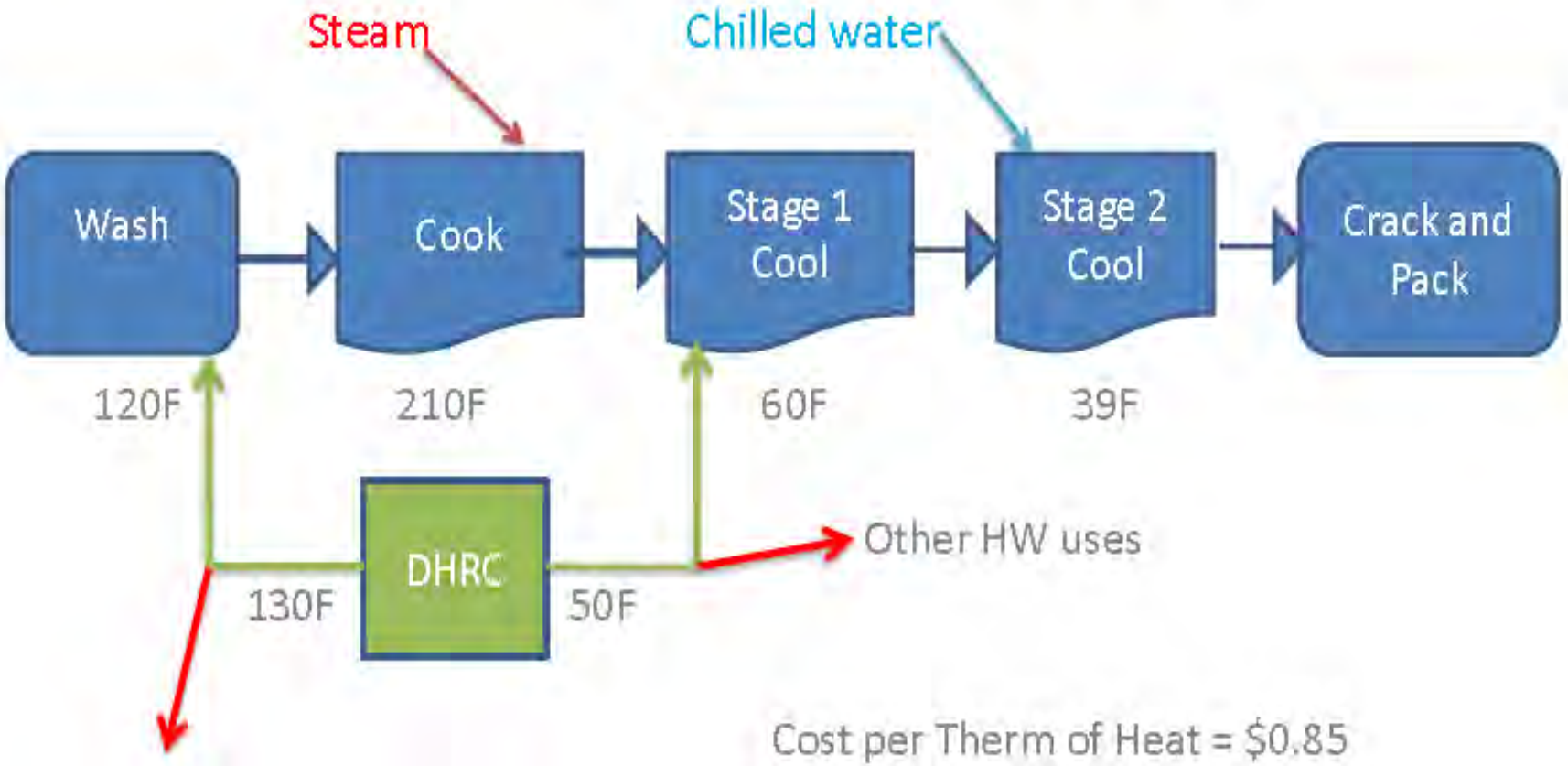


Cost per Therm of Heat = $0.80

Cost per therm of Cooling = $0.00 (free)

Total = $0.80

A Rethought Process



Cost per Therm of Heat = $0.85

Cost per therm of Cooling = $0.00 (free)

Total = $0.85

BTUs = BTUs

Turn **Gray** BTUs into **Green** BTUs

Or

Heating your buildings with BTUs that were going up the cooling tower or out the relief.

RECOVER / REUSE / RETHINK

Thomas H. (Tom) Durkin
PE, LEED AP

Durkin & Villalta Partners Engineering

8425 Woodfield Crossing Blvd. Ste 155E
Indianapolis, IN 46240

(317) 472-3883
tdurkin@dvpe.net

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Sustainable Energy and Resource Saving Concepts for HVAC/Process/Water/Wastewater

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VERDETHERM SYSTEMS HEATER/CHILLER

Verdetherm Systems recovers the waste heat currently rejected by the chillers in HVAC or process cooling systems and recycles this heat for use with simultaneous process or HVAC heating and/or domestic hot water requirements.

Where natural gas is used for boiler operation, **Verdetherm Systems** will greatly reduce or eliminate onsite carbon usage from April-October for heating and domestic hot water production.

Verdetherm Systems provides equipment system and installation and reduced operation costs can pay for the project.

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Since 2000 we have supplied over 60 operational water-to-water heat recovery heater/chillers and geothermal heater/chiller systems we call a Verdetherm System. Verdetherm Systems include all compressor driven equipment, pumps, heat exchangers, ancillary equipment and operational control systems for proper operation and highest efficiency operation.

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VERDETHERM SYSTEMS HEATER/CHILLER

You learned everything you need to know about Verdetherm Systems in high school physics!

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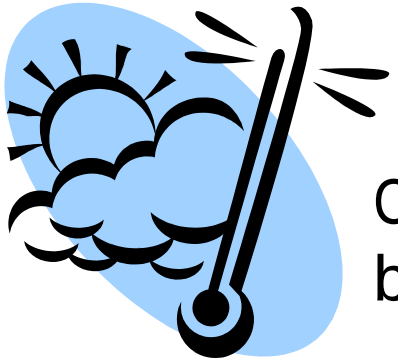
The way to mechanically make cold is to remove heat. In other words, "cold" is the byproduct of removing heat.



Conversely, "hot" is the byproduct of adding heat.

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A mechanical compression system (compressor driven) has four parts:

1. A compressor, which raises the pressure of a refrigerant and corresponding raises the temperatures.

2. Next is a condenser that rejects heat from the system. Note: the condenser adds heat to its surrounding liquid or air.

3. Next is an expansion device that changes the system refrigerant pressure and separates the high pressure heat rejection side from the…

4. Lastly, the evaporator which absorbs heat from the space or process and transfers the heat into the refrigerant which is returned to the compressor where the cycle is continued.

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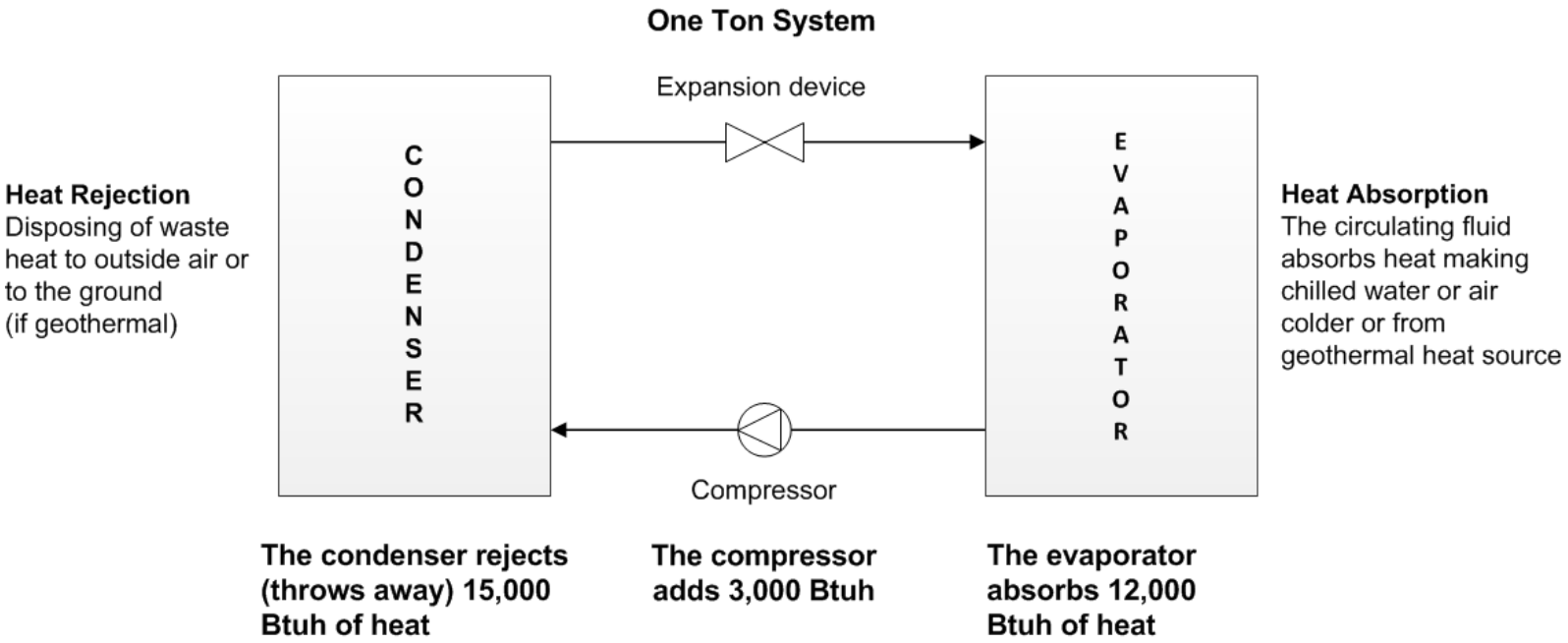
How Air Conditioning Works



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VERDETHERM SYSTEMS HEATER/CHILLER

Most HVAC systems "throw away" up to 55% of their heating/cooling energy dollars

- With a typical chilled water system, for each 1 ton of air conditioning capacity (12,000 Btu's), an additional 15,000 Btu's of potential heating capacity is wasted; being "thrown away" through heat rejection equipment into the outside air either through geothermal, evaporative or air coolers.
- Verdetherm Systems heat recycling recaptures this wasted heat to give you 55% more Btu's for every energy dollar. Verdetherm Systems utilizes 100% of your energy investment providing both 12,000 Btuh of cooling plus 15,000 Btuh of heating – or – 27,000 Btuh of combined cooling and heating capacity for the same cost as your existing 12,000 Btuh cooling only system.
- Verdetherm Systems has documented customers saving 50-70% off the cost of operation compared to their preexisting chiller and boiler systems.
- Verdetherm Systems heat recycling adds additional heating capacity and additional cooling capacity without cooling towers or heat rejection fans.

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Verdetherm Systems uses a hybrid heater/chiller to recycle the heat energy produced by process, people, lights and equipment to simultaneously produce chilled water and heat for process HVAC heating, dehumidification, pool and spa heating and/or domestic hot water heating.

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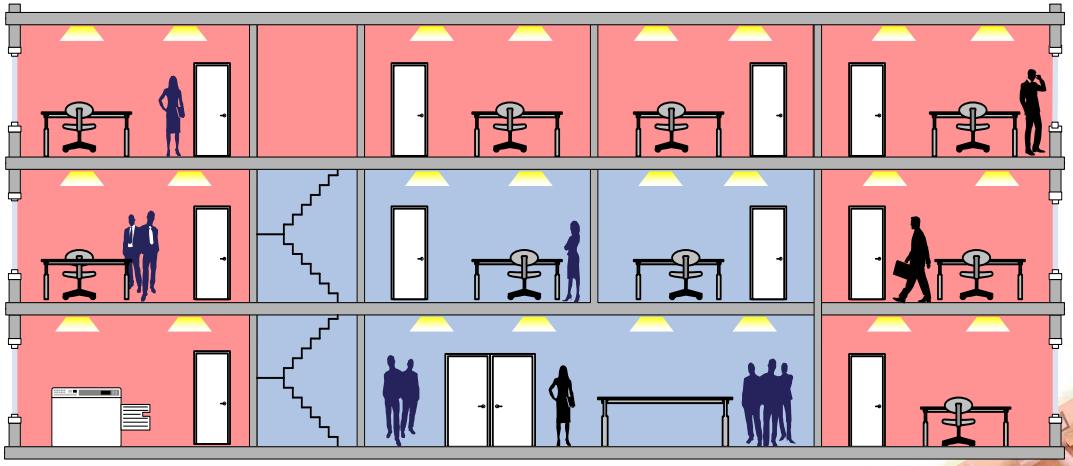
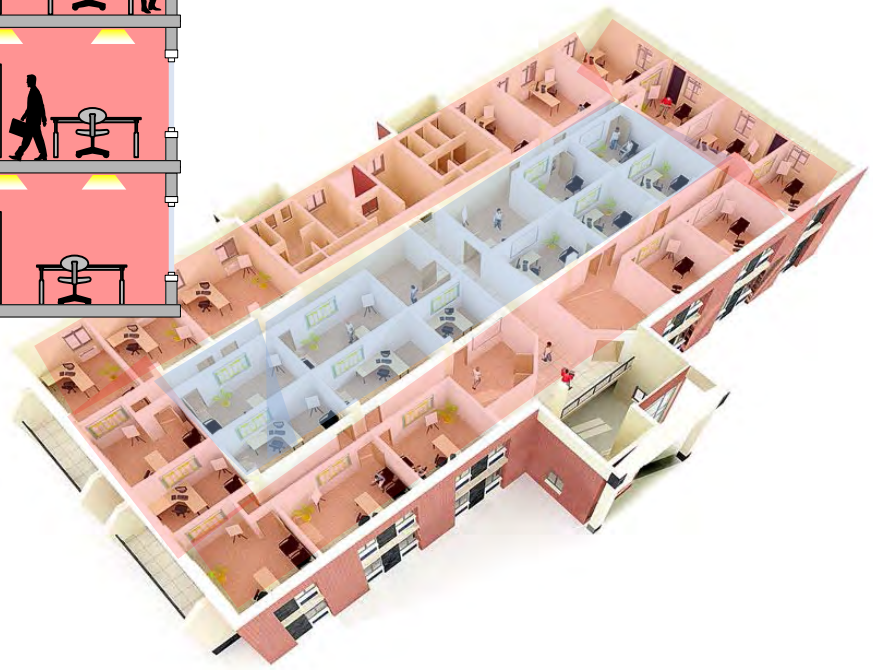
VERDETHERM SYSTEMS HEATER/CHILLER





In HVAC systems **Verdetherm Systems** recycles internal heat by simultaneously cooling the core of the building while providing heat for the buildings perimeter heating load and/or domestic hot water.

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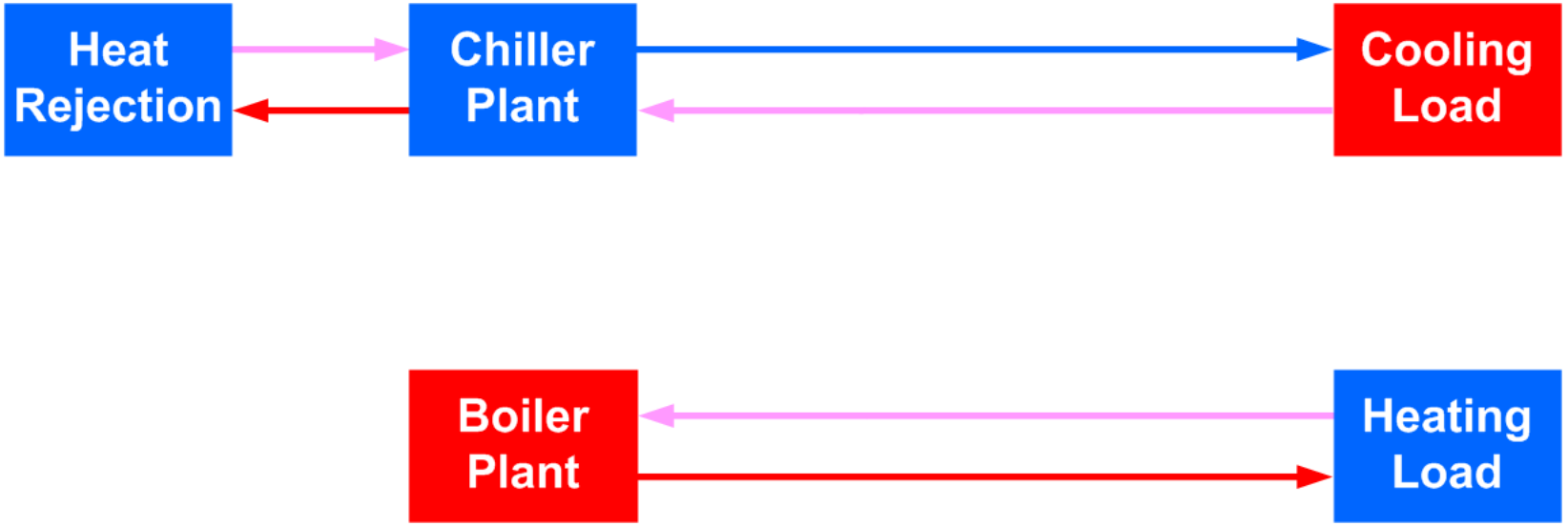
VERDETHERM SYSTEMS HEATER/CHILLER



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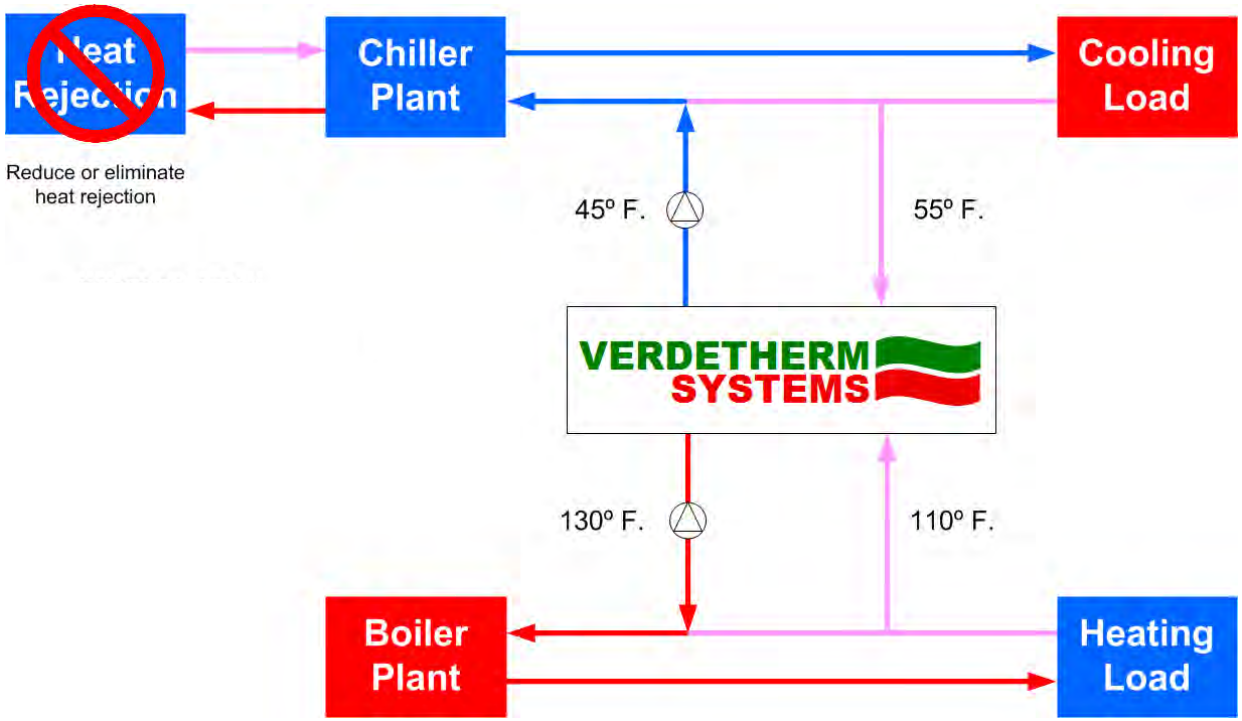
VERDETHERM SYSTEMS HEATER/CHILLER



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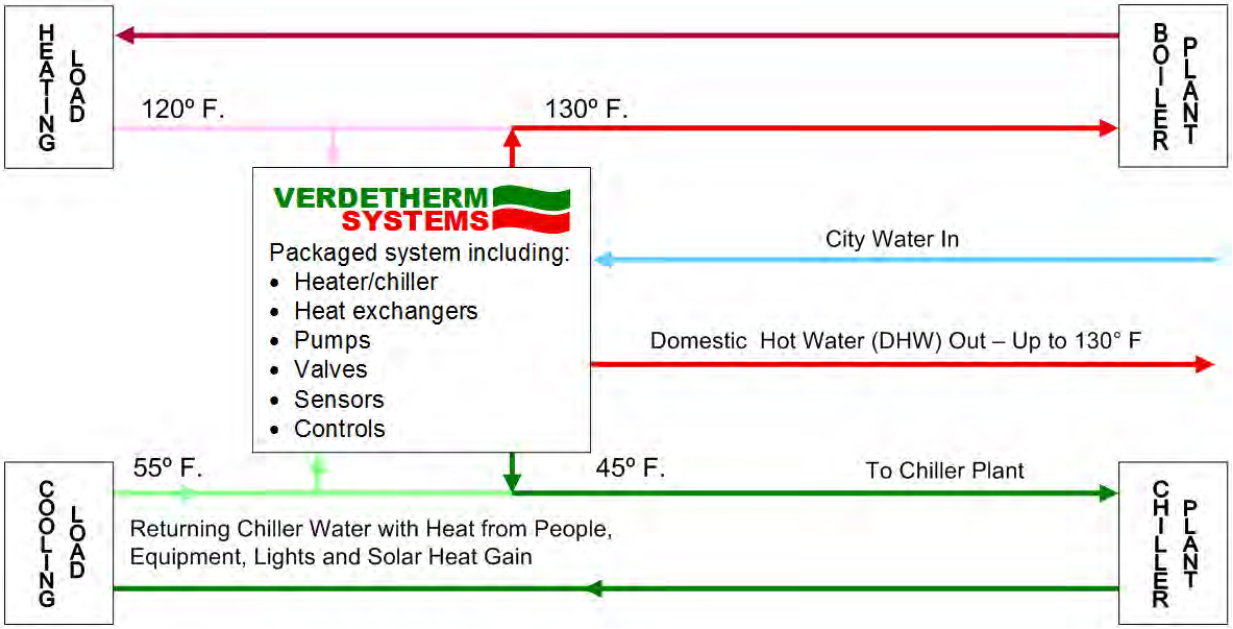
VERDETHERM SYSTEMS HEATER/CHILLER

Recycling heat from returning warm chilled water for simultaneous HVAC heating, cooling and domestic hot water heating



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Verdetherm Systems and LEED

When considering the use of the **Verdetherm Systems** for HVAC upgrades on LEED-NC v2.2 projects, there are several opportunities for credits to consider:

- Water Efficiency Credit 3 – Water Use Reduction
- Energy & Atmosphere Credit 1 – Optimized Energy Performance
- Energy & Atmosphere Credit 3 – Enhanced Commissioning
- Energy & Atmosphere Credit 4 – Enhanced Refrigerant Management
- Energy & Atmosphere Credit 5 – Measurement & Verification
- Indoor Environmental Quality Credit 6.2 – Controllability of Systems
- Innovation & Design Process Credit 1.1 – Innovation in Design

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"Your meter is broken and must be replaced"

Comment from the local gas company in Bloomington, Indiana to the maintenance personnel at both Bloomington North High School and Tri-North Middle School when in the late summer and fall of 2004 a recycling heat system was installed, shutting down boiler operation from March through the summer until the end of November.

Of note, the meters were changed out twice at both schools and were set to be changed out a third time until senior facilities management was informed of the problem and informed the gas company that they are recycling their heat energy, not burning gas (carbon) for their heating requirements.

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VERDETHERM SYSTEMS HEATER/CHILLER

HVAC Retrofit Comparison

Tri-North Middle School

YEAR	ELECTRIC kW/hr	COST	GAS MCF	COST	COST/MCF
2002	971700	$53,436.00	8110	$43,885.00	$5.41
2003	1123200	$62,100.00	6787	$50,421.00	$7.43
Average	1047450	$57,768.00	7449	$47,153.00	$6.42

100-ton Verdetherm Systems Recycled Heat System *

2004	1024800	$58,534.00	4704	$38,130.00	$8.11
2005	1071300	$65,917.00	2636	$28,766.00	$10.91
Average	1048050	$62,225.50	3670	$33,448.00	$9.51

Difference	600	$4,457.50	3779	($13,705.00)	$3.09
			Gas savings at 2005 prices	**$35,938.29**	

* Recycled heat system start-ups were during summer 2004.
Electric rates were level, while gas rates increased by approximately 30%.

66% reduction in consumption in 2004 and 2005 versus average of 2002-03

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VERDETHERM SYSTEMS HEATER/CHILLER

Water Conservation

- *Six month operation saves $ 679 / 350,100 gallons*
- *Twelve month operation saves $ 1,358 / 700,200 gallons*
- *24/7 operation saves $3,800 / 1,960,550 gallons*

100 ton Verdetherm Systems heat recycling versus water cooled chilled water
60 hours per week of operation
Midwest utility rates of $ 0.60 for water + $0.85 for sewer = $1.45 per cubic feet of water
0.005% drift rate and two cycles of concentration for cooling tower

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Operational Cost Analysis – Hourly/Yearly Savings

Verdetherm Systems recycled heat versus traditional boiler and chiller operation

Costs to product 1,200,000 Btuh of cooling and 1,500,000 Btuh of heating per hour (100 tons)

Traditional Central Energy Plant		
70% efficiency boiler @ $0.80 per therm	=	$17.20 per 1,500,000 Btu
.66 kW/ton cooling system @ $0.85 per kW	=	$5.60 per 1,200,000 Btu
Total		$22.80 per hour

Verdetherm Systems with Recycled "Free Heat"		
Verdetherm Systems "free heating"	=	$FREE per 1,500,000 Btu
Verdetherm Systems 1.2 kW/ton cooling	=	$10.20 per 1,200,000 Btu
Total		$10.20 per hour

Verdetherm Systems provides an average savings of $12.60 per hour

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Operational Cost Analysis – Hourly/Yearly Savings

Recycled heat versus traditional boiler and chiller operation

Costs to product 1,200,000 Btuh of cooling and 1,500,000 Btuh of heating per hour (100 tons)

Typical boiler and chiller plant	=	$22.80
Verdetherm Systems recycling heater/chiller	=	$10.20

Verdetherm Systems provides an average savings of $12.60 per hour

With year round operation Verdetherm Systems savings 14 hour day/7 days per week (5,110 hours)	=	$64,386
Verdetherm Systems 1.2 kW/ton cooling 24 hour day/7 days per week (8,760 hours)	=	$110,376

Typical chiller at .66 kW/ton with 70% average efficiency boiler
Verdetherm Systems at 1.2 kW per ton electricity at $0.085 per kW
Gas at $0.80 per therm

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RECOVER / REUSE / RETHINK

Operational Cost Analysis – Hourly/Yearly Savings

Recycled heat versus traditional boiler and chiller operation

Costs to product 1,200,000 Btuh of cooling and 1,500,000 Btuh of heating per hour (100 tons)

Verdetherm Systems recycled “free heat”	=	$10.20
High efficiency boilers with “free cooling”	=	$17.20

Verdetherm Systems saves 40% more compared to “free cooling”

Verdetherm Systems recycled “free heat”	=	$10.20
High efficiency boilers and water cooled chillers	=	$22.80

Verdetherm Systems saves 55% over water cooled central energy plants

Verdetherm Systems saves 65% over air cooled central energy plants

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What is a Verdetherm system?

It's a new type of compression heater/chiller for:

- Simultaneous heating and cooling requirements
- Domestic hot water preheat
- Reheat water for HVAC humidity control
- Preheat water for outside air applications
- HVAC heating water for up to 130º in/110º out designs
- Swimming pool, spa and natatorium heating and cooling
- Snow and ice melt system heating for walkways and drives
- Low H_2O heating/cooling radiators
- Geothermal heater/chiller
  - Sensible only cooling
- RO water heating
- Process heating and cooling

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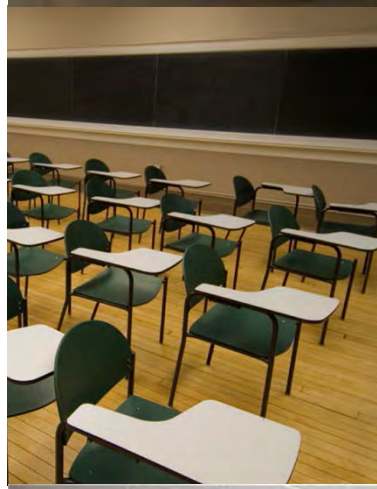

Who are typical customers for Verdetherm Systems?

- Healthcare facilities and hospitals
- Dormitories and barracks
- Hotels/resorts
- Recreational centers
- Campus and district heating and cooling systems
- Natatorium and spa facilities
- Swimming pools, food service and sports facilities
- Laundry facilities
- Museums
- Facilities with critical humidity control requirements
- Office space and buildings requiring reheat
- Process heating/cooling
- Data centers – heat generation
- Additional cooling capacity without adding cooling towers

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Why are Verdetherm Systems applications successful?

- **Project selection logic** – We work with facility managers and/or consulting engineers to correctly size the HVAC equipment.
  In the future additional modules can be added to increase capacity.
- **System design** – Verdetherm Systems provides application engineering and design assistance. We can provide a stand-alone "add on" system or integrate Verdetherm Systems with a new central energy plant. We normally apply the heater/chiller in series and before the existing heater/boiler and cooling/chiller loads.
- **System control** - Verdetherm Systems includes a fully integrated control system for heating and cooling system control and integration with a new or existing building automation systems.
- **Heat recycling equipment** – Properly sized systems with modules sized to handle both minimum and full load conditions.
- **Commissioning/system responsibility** - Verdetherm Systems works from the project's conception, through installation and start-up to assure proper operation
- **Turnkey projects** – Verdetherm Systems provides total system responsibility including financing programs to pay for installation costs using energy savings to pay for new equipment systems.

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VERDETHERM SYSTEMS HEATER/CHILLER

Verdetherm Systems Heater/Chiller Lease-to-Own Program

- Operational savings pay for installation and equipment lease costs
- Complete turnkey equipment and control systems
  - Installation including mechanical, electrical, and temperature control
  - Water quality components may also be required including filtration and/or water treatment
- Increase central energy plant heating and cooling capacity without additional cooling tower or boiler capacity
- Increase cooling capacity while saving water usage versus typical cooling tower systems
- With a customer supplied web connection and address, Verdetherm Systems will provide remote system operational and diagnostic monitoring
- Verdetherm Systems will provide ton/hour cooling and heating Btuh output performance and can calculation energy savings versus lease cost on a monthly basis
- Verdetherm Systems heat recycling can help pay for other Central Energy Plant upgrades

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RECOVER / REUSE / RETHINK

Rethink conventional HVAC systems using ductwork

Deliver cold/cool or warm/hot water directly to in-space cooling + heating emitters eliminating ductwork and greatly increasing efficiency

Eliminating ductwork significantly reduces space requirements between a ceiling and floor above

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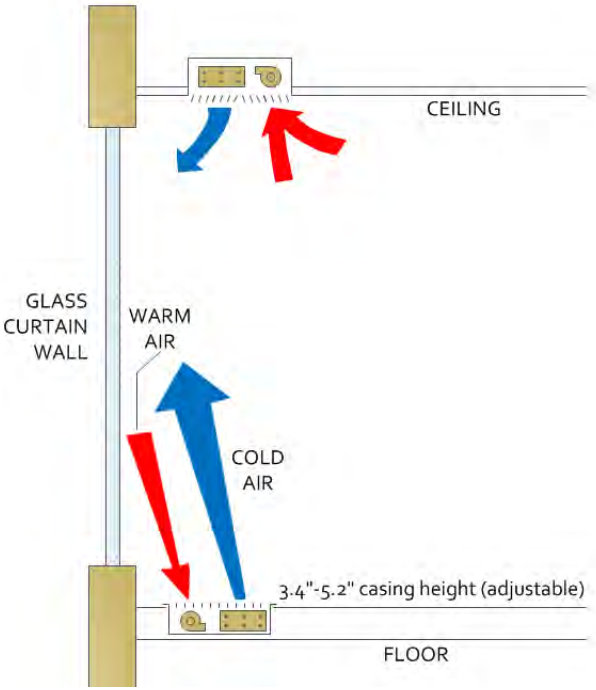
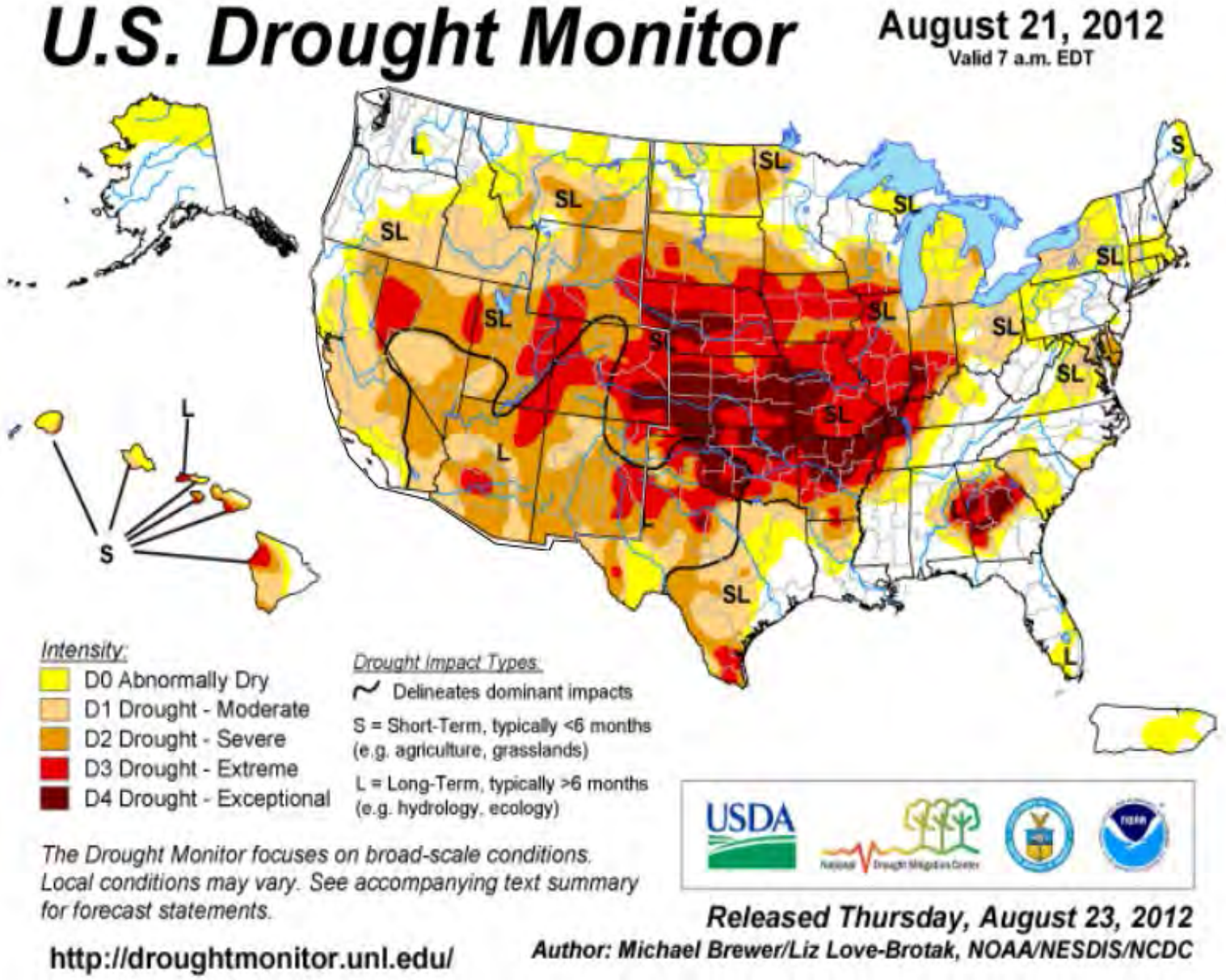
In-space, High Performance, Perimeter Heating and Cooling

SUMMER CONDITIONS



- Perimeter in-floor heating or cooling
- Reduces height of ceiling space
- Chilled water sensible/latent or sensible only cooling
- Best heating performance for compression, solar or condensing boiler heating temperatures
- Low temperature heating
  - Good performance at 110° F entering
  - Full performance at 130° F entering
- Designed for two-pipe or four-pipe systems
- Low H_2O – low water volume, quick temperature control reaction
- Quick changeover from heating to cooling
- EC motor technology saves 70-80% over standard fractional HP AC motors
- 24 VDC motor has low power requirements
  - Variable speed only requires 3-30 watts for power
  - Low voltage wiring eliminates the need for expensive line voltage and conduits
- No ductwork – easy access to clean coil
- Low sound levels of 25-35 dBa



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*The cost of water and wastewater services in the U.S. has risen by **8.1** percent over the last year compared to a **3.6** percent increase in the consumer price index.*

American Water Intelligence

Volume 2/Issue 9/September 2011

- Even at national averages, water rates could double in 10 years!

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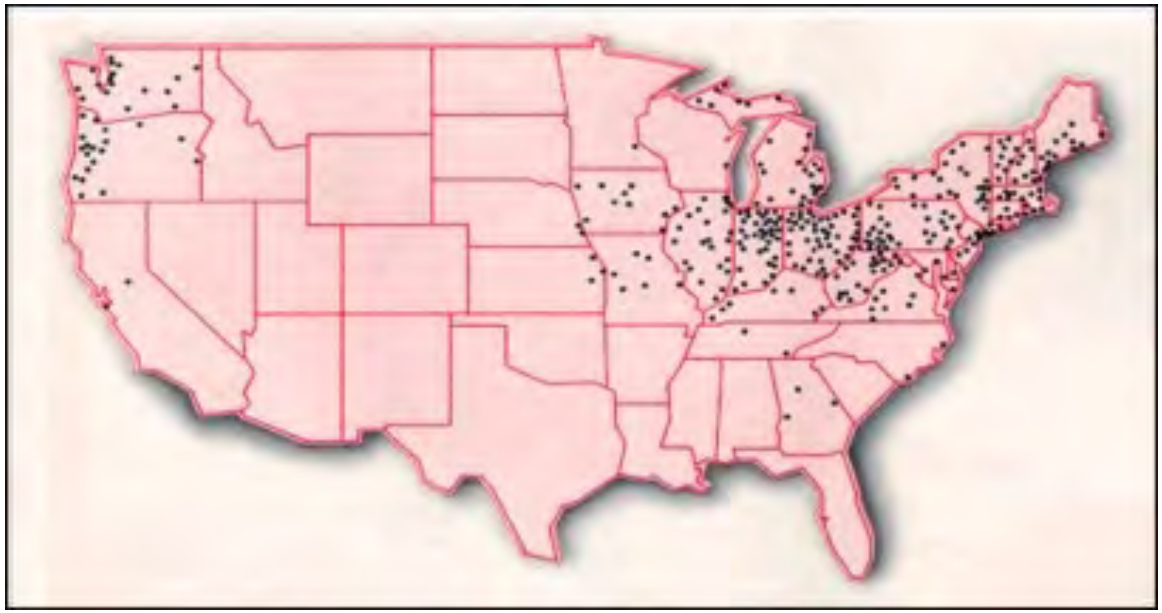
Storm Water Control

Combined sewer systems serve roughly 772 communities containing about 40 million people.
The map below provides a rough illustration of the prevalence of combined sewer systems in the U.S.



http://cfpub.epa.gov/npdes/cso/demo.cfm

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Billions in Improvements

Federal study shows municipalities nationwide need more than $300 billion worth of essential upgrades to long overlooked water and sewer systems over the next 20 years.

- **EPA**: 53,000 community water systems and 21,400 not-for-profit, non-community systems will need to invest an estimated $334.8 billion between 2007 and 2027.
- **National Association of Counties**' 2008 report: Need for water and sewer upgrades between $300 and $450 billion nationwide.

These improvements are 'just a drop in the bucket' compared to the higher cost of continuing to upgrade when emergencies strike.

- excerpted from The Wall Street Journal

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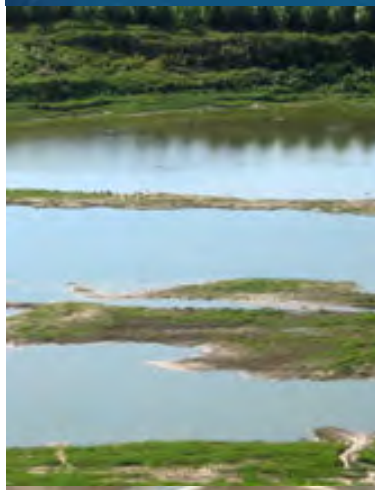

Water sources available:

1. Rainwater harvesting/recovery
2. Groundwater (foundation sump pump system) recycle
3. Reclaimed water (WWTP discharge effluent) reuse
4. Water mining (filtration and reuse of processed return wastewater)
5. Gray water capture and reuse

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Non-potable water uses:

1. Geothermal heating and/or cooling
   First use followed by second use below
2. Cooling tower make-up water
3. Steam boiler feed water
4. Non-potable industrial process
5. Agriculture and landscape irrigation
6. Fire protection
7. Toilet flushing

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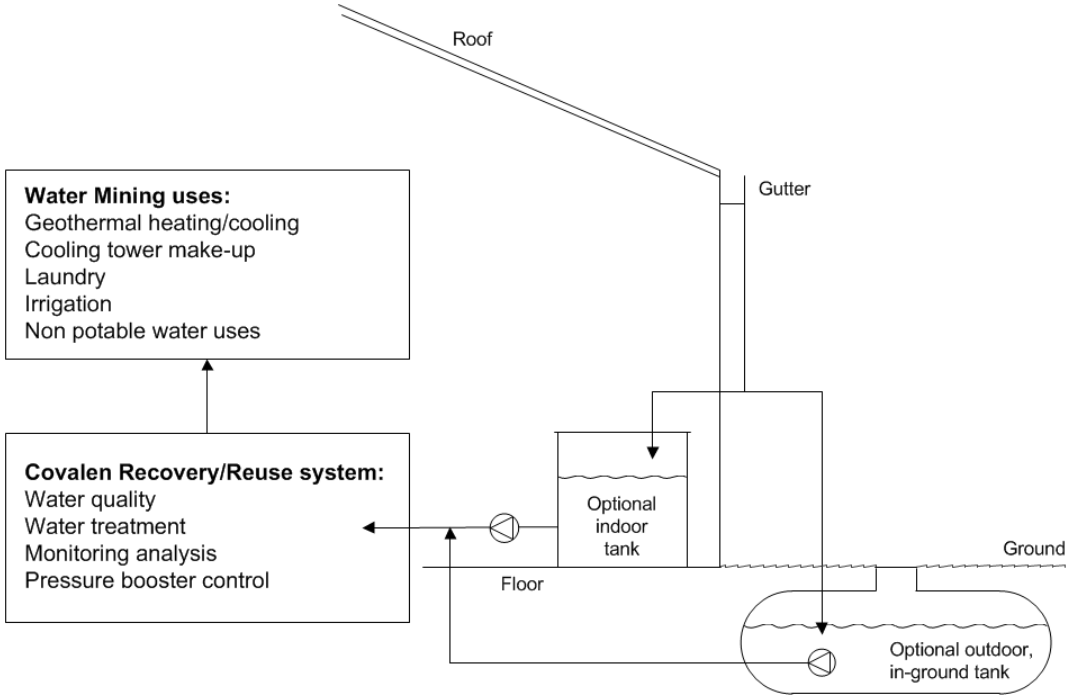
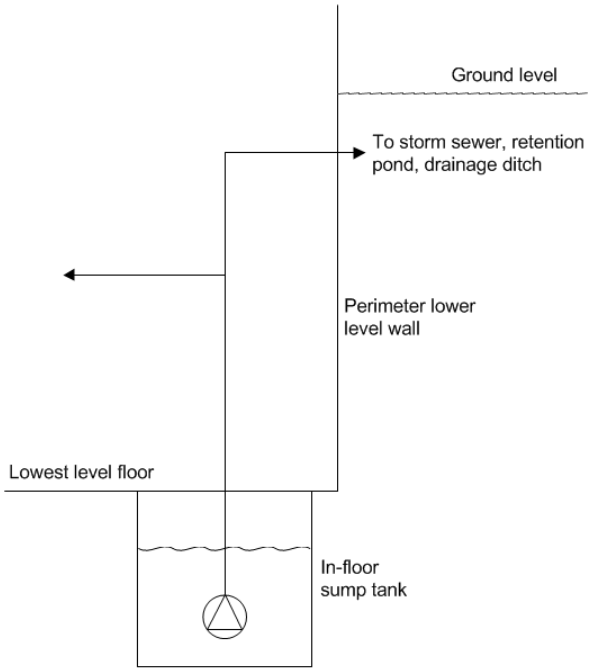
Water Harvesting
Rainwater or Groundwater Recovery/Reuse/Recycle





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Why Capture Rainwater?

- Capturing the rainwater that lands on a roof is the first step in a rainwater reuse
- catchment system.
- Rainwater is similar to RO water (a mineral free natural water source).
- When rainwater lands on a ground surface area it is immediately runoff/storm
- water and must be handled very differently then recovered rainwater.
- Rainwater events are the trigger for combined sewer overflows (CSO).
- If we recover and reuse the rainwater that falls on roof's we can reduce runoff to storm sewers.
- If we repurpose rainwater for reuse in proximity to the area in which we capture rainwater, we significantly reduce the imbedded cost of delivering clean water for a non-potable reuse such as plumbing (toilet flush), HVAC (cooling tower make-up water), irrigation, or process use.
- 80% of the cost to deliver city water to customers is in the pumping and piping system.
- 80% of city water used in buildings is for non-potable uses (I.E. cooling tower make-up, non-potable RO water, toilet flush, laundry, pool/spa, irrigation, etc.).
- Direct use of rainwater reduces the requirement for new and expanded city water production facilities and increased city water delivery capacity.
- Site rainwater capture/reuse systems can reduce storm water flow, cost and storm water infrastructure.

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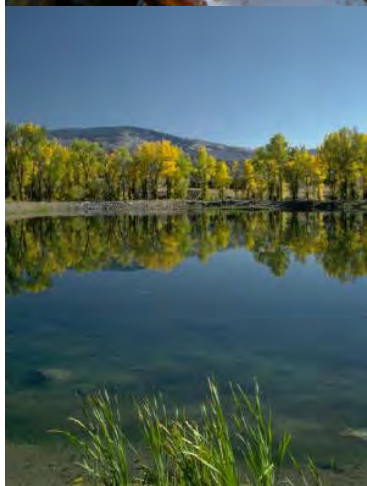
Municipal – Industrial Wastewater Treatment

Clean Water and Air

Air Quality = Odor Control
- Hydrogen Sulfide (H2S)
  - Save Energy
  - Conserve Water
  - Eliminate Chemical/Carbon Use

Natural Solution – Working with Nature



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Utility Systems Integrator

Fluid & Thermal Systems is the source for integrated utility systems including:

- HVAC central plant chilled water for cooling water, hot water for heating, dehumidification and control system
- Potable water production, distribution and control system
  - Geothermal thermal resource recovery
- Domestic hot water production, distribution and control system
- Wastewater collection, transfer, treatment and control system
- Site dewater, rainwater and ground water flow management
  - Ground water geothermal resource recovery
- Integrated control system
  - SCADA facility wide supervisory control system
  - Local and remote (via internet) monitoring

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Assessment - Feasibility

Data gathering	=	Project budget $
Identify opportunities	=	Projected energy saving $
Project scope	=	Initial commitment

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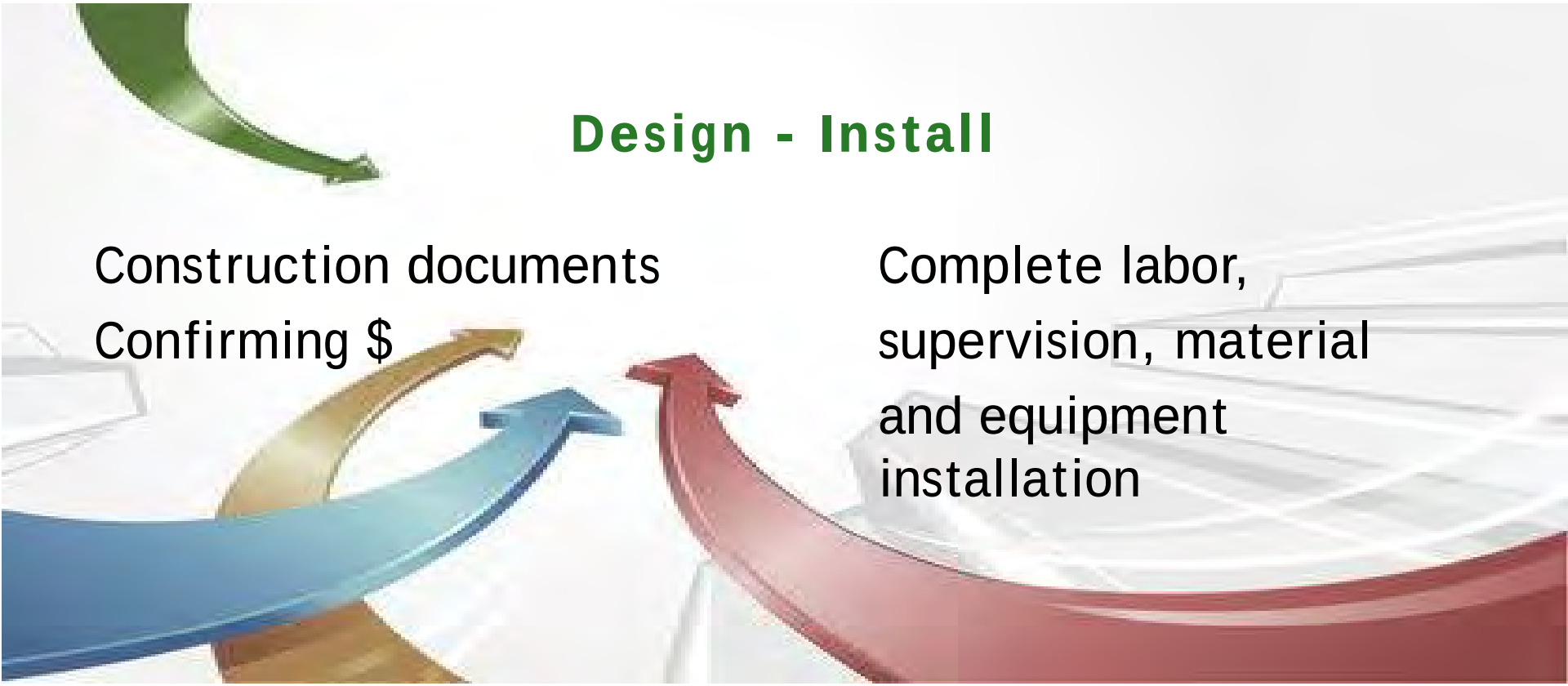

Design - Install

Construction documents

Confirming $

Complete labor, supervision, material and equipment installation

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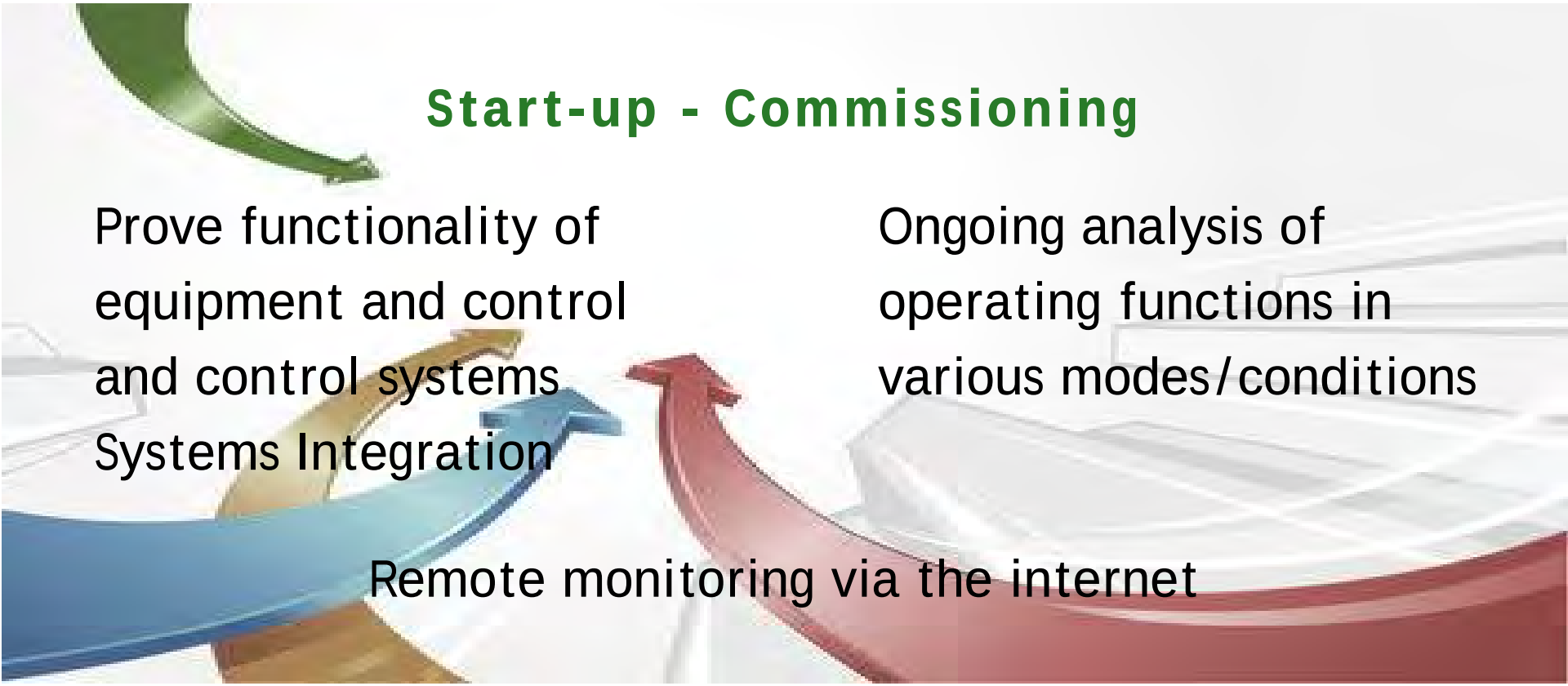

Start-up - Commissioning

Prove functionality of equipment and control and control systems
Systems Integration

Ongoing analysis of operating functions in various modes/conditions

Remote monitoring via the internet

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