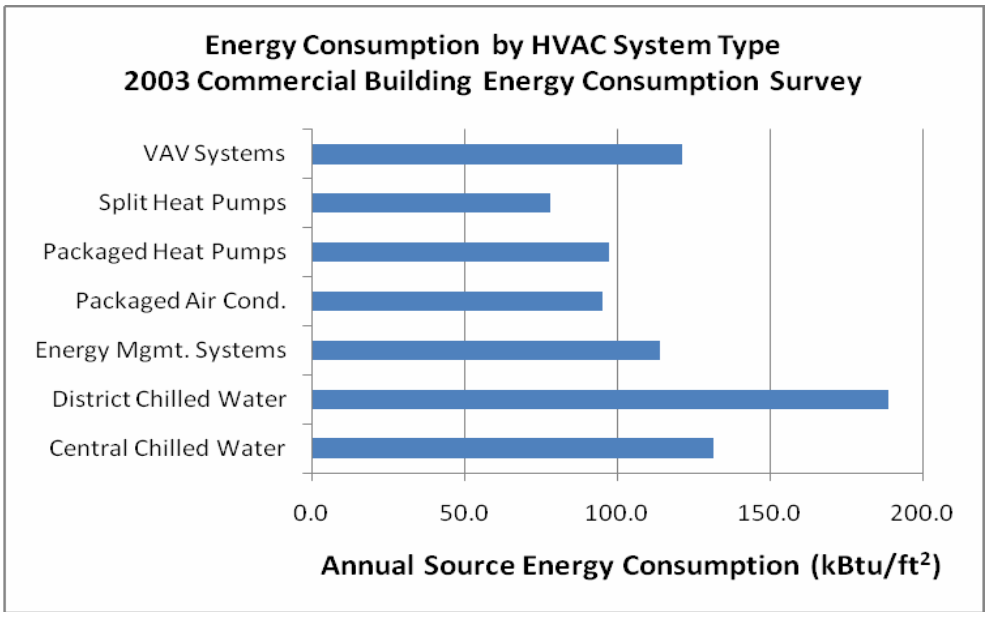
Why Do Engineers Think Chilled Water VAV Systems are So Efficient?

The engineers in my area say chillers are the way to go for high efficiency. Is this true? Keith Swilley, Gulf Power

Engineers think that chillers are the answer to lower energy cost because they are not aware that the efficiencies (or kW/Ton) are only for the chiller itself. They fail to include the impact of the auxiliary components (Supply air handlers, return fans, chilled water pumps, condenser water pumps, fan powered VAV terminal boxes, and cooling tower or condenser fans). Not only do these items draw power but many of them add a significant amount of heat into the HVAC system, thus serving as a double penalty to efficiency.

When measured energy is considered chilled water systems use far more energy in commercial buildings than simple split systems, packaged air conditioners, and packaged heat pumps. Data from the Energy Information Administration (DOE) backs this up as shown below. These simple systems typically have small auxiliary power requirements (low static pressure fans and one condenser fan). Unitary ground source heat pumps when correctly applied can be even better because the compressors operate near the efficiency of a chiller but the systems only have a small pump and low static fan.



The following page demonstrates why central chilled water VAV systems are so inefficient even with a 0.5 kW/Ton chiller. The example system is typical (air handler with 4.0" total static pressure, return fan with 2.0" total static pressure, chilled water pump with 80 ft of head, condenser water pump with 70 ft. of head, axial cooling tower fan, fan-powered VAV terminals). Add them all up and you get an EER of 7.1 which is about 30% lower than a window unit you can get a Walmart for around $300/ton.

Steve Kavanaugh

Water Cooled Chilled Water System
Variable Air Volume
Fan Powered Terminal

Override Default Values (d) in Input Column

		Input		kW	Ton	hp/ton	Std 90.1 Fan HP 1000 cfm
1	KWperTonWCC	0.5	0.5	0.50	1.00	0.6	
2	TSPSupply	d	4	0.32	-0.09	0.39	0.97
	MotorEffSup	d	90				
	FanEffSup	d	65				
	CFMperTonSup	d	400				
3	TSPReturn	d	2	0.16	-0.04	0.19	0.48
	MotorEffRet	d	90				
	FanEffRet	d	65				
	Exhaust%	d	20				
4	ChillWtrHead	80	80	0.06	-0.02	0.07	
	MotorEffChW	d	90				
	PumpEffChW	d	65				
	GPMperTonChW	d	2.4				
5	CondWtrHead	d	70	0.07		0.08	
	MotorEffCW	d	90				
	PumpEffCW	d	65				
	GPMperTonCW	d	3				
6	KWperTonCTower	d	0.065	0.07		0.08	
7	KWperTonTermFan	d	0.18	0.18	-0.05	0.16	0.39
			Σ=	1.35	0.80		1.85

kW/Ton =	1.69
EER =	7.1
COP =	2.09

Chiller kW/ton based on 44 F Chilled Water & 85 F, 3.0 gpm/ton Condenser Water

Override Temperature Default Values (d) below (Condenser flow adjusted above)

	Input		CorFac
LWTempCHW	d	44	1.00
EWTempCW	d	85	1.00