

Solving Low Delta T Syndrome for Better Energy Efficiency

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Strategy and Brand Management


LOW DELTA T SYNDROME



The dark side of HVAC systems




**The Paris Agreement forces us to
limit global warming and lower
greenhouse gases**



Buildings are an integral and elementary part of the global energy system

Buildings use about:

- 40% of global energy
- 25% of global water
- 40% of global resources they emit 1/3 of GHG



For buildings to be able to realize their potential, they must first and foremost be energy efficient

According to LEED 33- 39% of a building's energy use is HVAC

Greenbuild estimates that 6% of the world's energy is used for cooling



**As discovered in the Helsinki Report,
buildings with central plants are far from
being energy efficient**

*Many suffer from a condition called
Low Delta T Syndrome*

An aerial night view of a city, likely New York City, showing a dense urban landscape with numerous skyscrapers and buildings. The right half of the image is overlaid with a red tint, highlighting a specific area. The text is overlaid on the left side of the image.

Research suggests that more than half of buildings with a central plant are suffering from Low Delta T Syndrome

Today, we can see a high awareness of the Low Delta T syndrome



Low Delta T Syndrome



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Low Delta T-Definition
 A Condition Whereby a Low Chilled Water Return Temperature Causes an Excessive Amount of Chilled Water to Circulate to Meet System Cooling Loads and Chillers Receiving Low Return Temperature CHR Loaded to Their Design Capacity

Table 6: Installation nominal operating conditions

	Chilled water temperature °C	
	Return	Out
A	7.45	6.11
B	8.21	6.64
C	12.45	10.43
D	10.40	10.01



Designing Low Delta T-immune HVAC hydronic systems

Abstract
 The paper focuses on a common phenomenon in HVAC hydronic systems called "Low Delta T Syndrome." Conventional techniques traditionally used to mitigate the issue are examined, along with their inadequacy. A new, permitting type of the control device is examined in greater detail, along with its impact on the hydronic systems design. The paper shows how the new technology provides the long-sought solution to the Low Delta T problem.

Factors affecting performance of HVAC hydronic systems

Low Delta-T Syndrome Diagnosis and Correction for Chilled Water Plants

ASHRAE JOURNAL

Achieving High Chilled-Water Delta Ts

David P. Flavin, PE

The low-delta-T syndrome is a common problem in hydronic systems. It occurs when the chilled-water return temperature is too low, causing the chilled-water supply temperature to rise above the design value. This results in a higher delta-T, which is not what the system was designed for. The article discusses the causes of this problem and provides practical solutions to correct it.

Key points:

- The low return in the secondary chilled-water system causes the chilled-water supply temperature to rise above the design value.
- The present low in the secondary chilled-water system is caused by 10% flow in the 100-ton (35.3 kW) chiller.
- Assuming 80% pump efficiency, pumping energy in the variable flow hydronic cooling system. Once high chilled-water Delta Ts are realized, some 20% to 30% of cooling will be accomplished per gallon (liter) of chilled water distributed (Fig. 2). Because lower and pumping energy will decrease considerably as cooling hydronic systems and radiator pumps and piping may be installed in new hydronic cooling systems. Also, water chiller operation will be longer by increasing evaporator flow rates and chilled-water storage tanks will maintain mass-to-leave (M/L) of cooling. This fundamental approach requires specific, on-site improvement in the performance of variable-flow hydronic cooling systems.
- The greatest of these values will be limited to a maximum velocity of 10 ft/s (3.0 m/s).
- The resultant velocity of the water (chilled-water) will be limited to a maximum of 1.0 ft/s (0.30 m/s), which is a low velocity for a cooling system (1.0 ft/s).
- It is not clear that the low-delta-T syndrome will be solved by the high-delta-T cooling flow being installed in peak cooling and condenser. It will not be solved by the high-delta-T cooling flow being installed in peak cooling and condenser.
- The chilled-water temperature in the low-delta-T syndrome is 100°F (37.8°C). The chilled-water supply temperature is 100°F (37.8°C). The chilled-water return temperature is 100°F (37.8°C). The chilled-water supply temperature is 100°F (37.8°C). The chilled-water return temperature is 100°F (37.8°C).

ASHRAE Journal November 1999

What is...
Low Delta T Syndrome?



Low Delta T Syndrome may occur when...

**coils and
valves are not
sized properly**

**too much
water is
delivered**

**coils foul and
degrade with
age or lack
proper
maintenance**

**water systems
are not
dynamically
balanced**

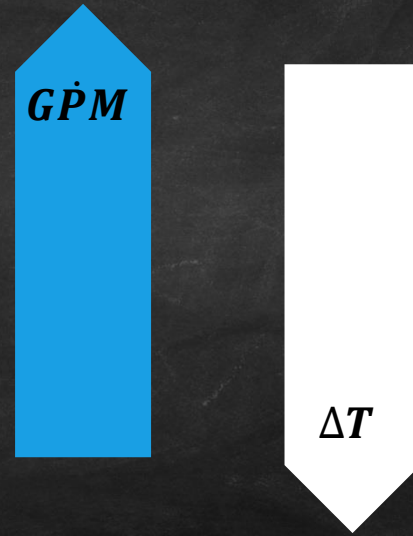
A quick lesson on Power Output

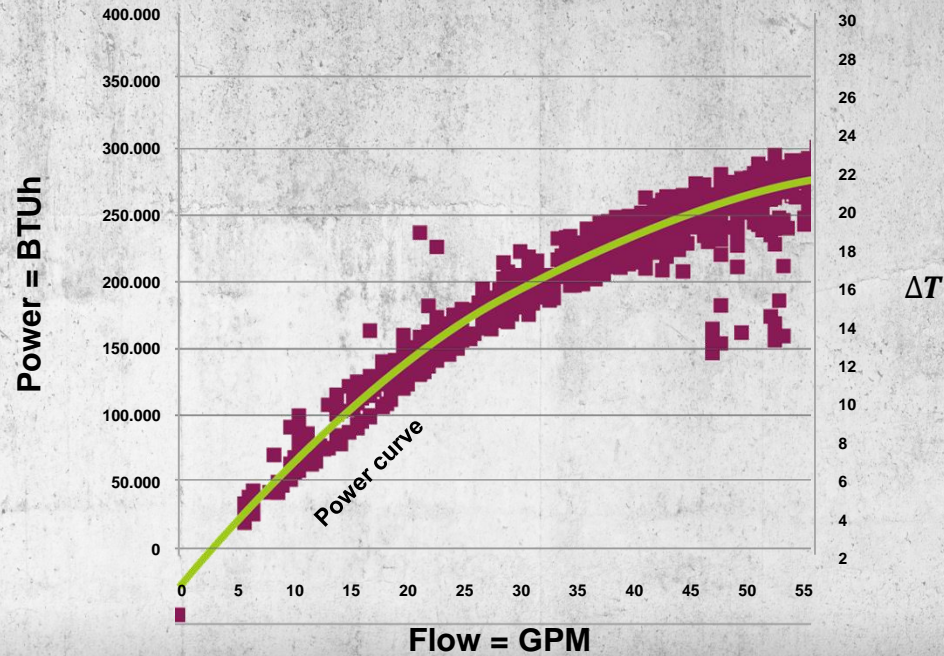
For a given/constant load on the coil, flow and Delta T are inversely proportional

Power Output

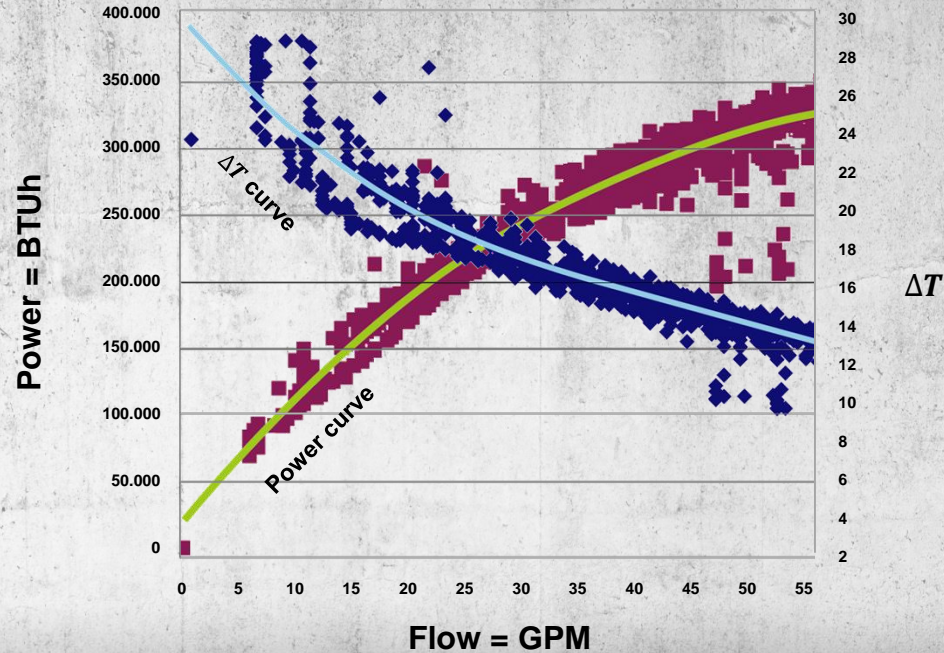
$$Q = 500 \cdot GPM \cdot \Delta T$$

\dot{Q} in BTH/U and is constant

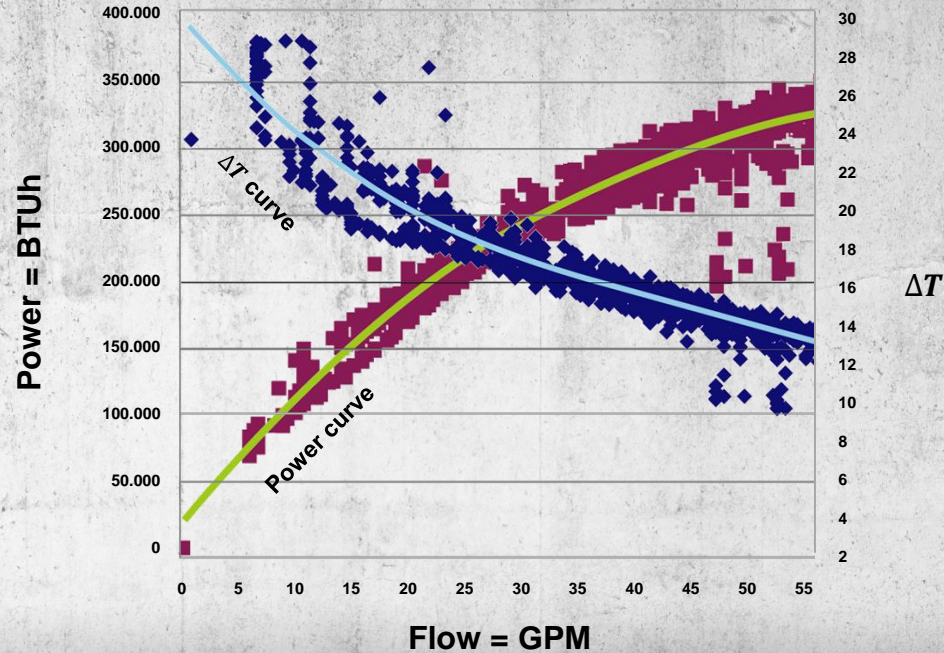




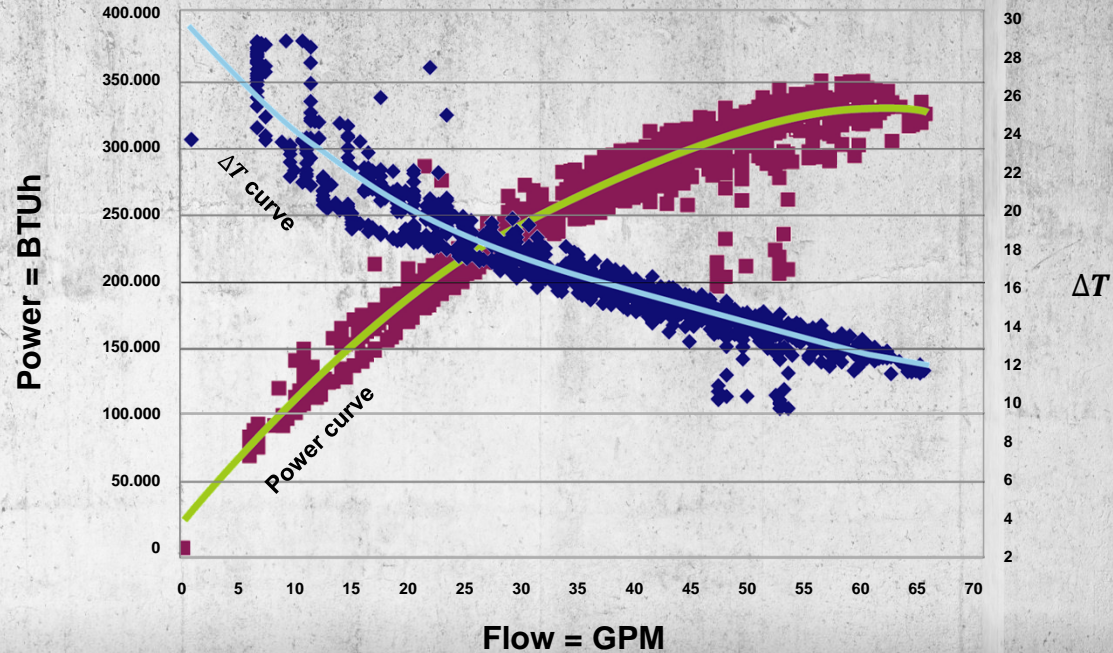
The Power output in BTUh increases with the flow



Delta T decreases as the flow to load ratio decreases

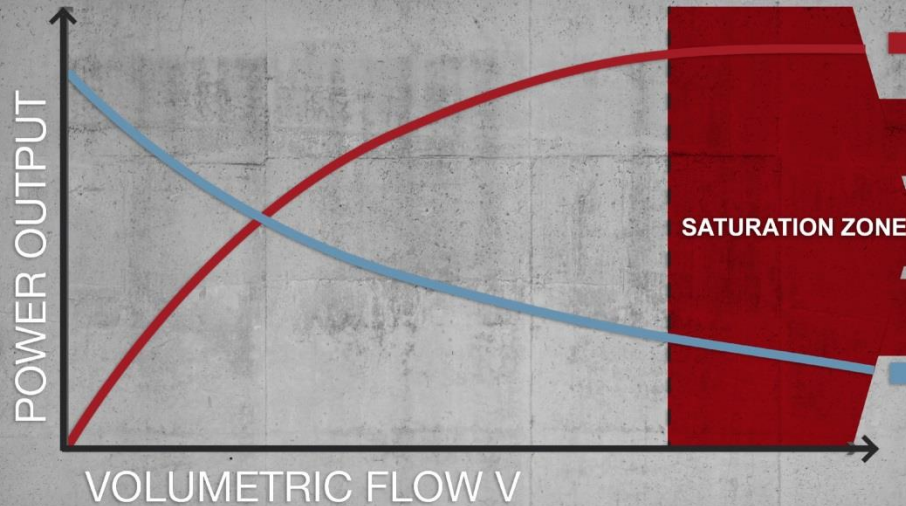


What happens when the coil receives more flow than is needed?



What happens when the coil receives more flow than is needed?

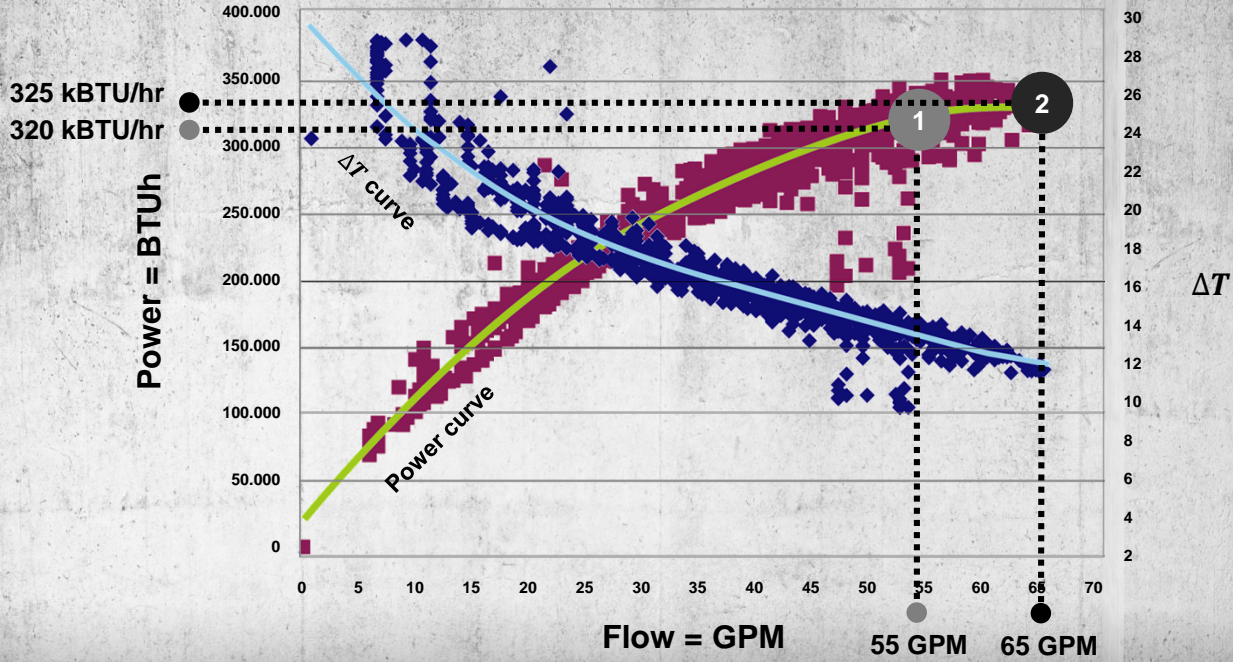
The plant will operate in the saturation zone with a higher flow, but no added kW



Pumping more water

Reduced Delta T

No added kW



Costs of overflowing the coil

The energy required to increase the flow can be calculated using the Pump Affinity Law

$$\frac{HP_2}{HP_1} = \left(\frac{GPM_2}{GPM_1} \right)^3$$

HP₁: power needed for GPM₁

HP₂: power needed for higher GPM₂

GPM₁: flow in gallons per minute

GPM₂: flow in gallons per minute

According to the Pump Affinity Law: power is proportional to the cube of the flow

$$\frac{HP_2}{HP_1} = \left(\frac{GPM_2}{GPM_1} \right)^3$$

	1	2	Δ
BTUh	320,000	325,000	1.6%
GPM	55	65	16%
PUMP HP	HP increase = $(65/55)^3$		65%

**A 1.6% increase in cooling results
in a 65% increase in pumping energy**

Pump Affinity Law

$$\frac{HP_2}{HP_1} = \left(\frac{GPM_2}{GPM_1} \right)^3$$

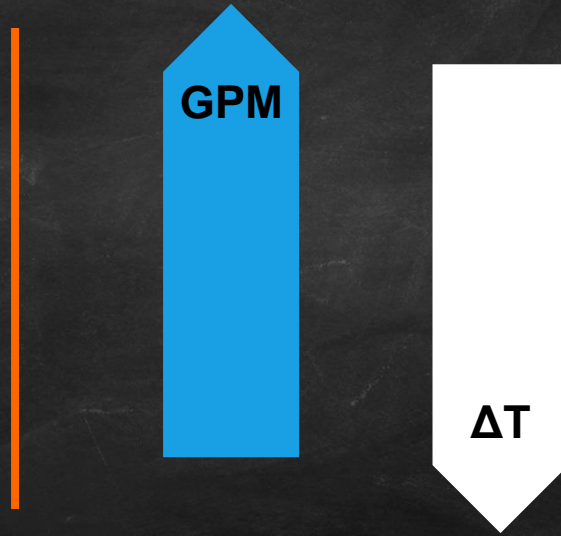
	1	2	Δ
BTUh	320,000	325,000	1.6%
GPM	55	65	16%
PUMP HP	HP increase = $(65/55)^3$		65%

Low Delta T wastes energy at the coil.

**What effect can this have on the
chiller plant?**

At the chiller, flow and Delta T are
inversely proportional

$$GPM = \frac{Tons \cdot 24}{\Delta T}$$



Tons: Load at the chiller

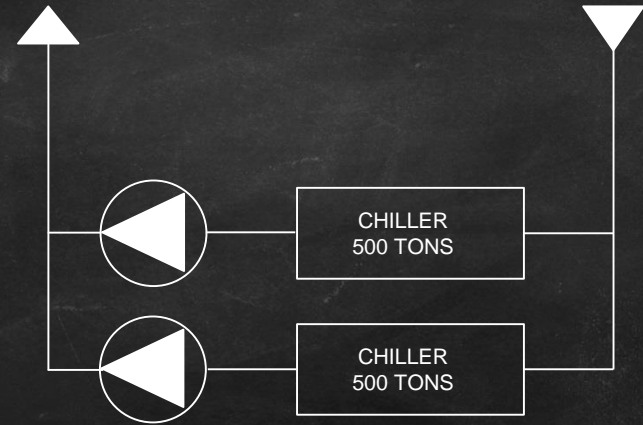
**Example: At a design Delta T of 12 this
500 ton chiller will run at 100% capacity**

$$GPM = \frac{500 \cdot 24}{12} = 1000$$



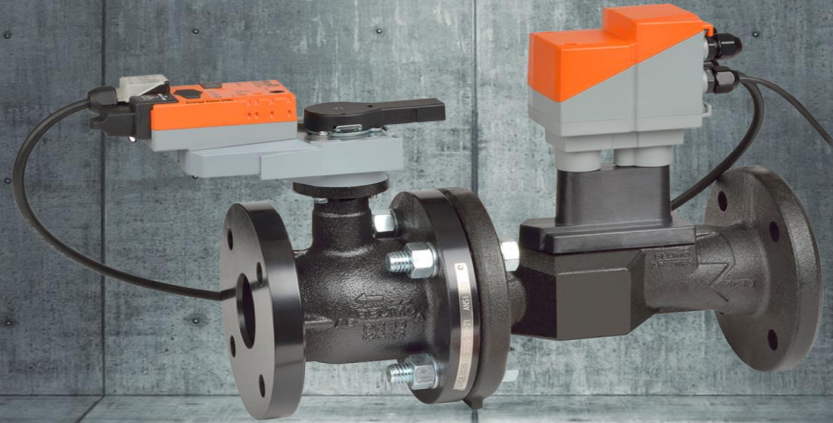
Example: If the Delta T were to drop to 8 with the same 500 ton load, a second chiller will need to be staged on due to the additional flow

$$GPM = \frac{500 \cdot 24}{8} = 1500$$



If the Delta T could be maintained as designed, the central plant would operate much more efficiently

Solving Low Delta T
Syndrome with
Belimo Energy Valve



Success Story Massachusetts Institute of Technology (MIT)

Average Delta T rose from
6 F to 12 F, reducing chilled
water flow by

49%

If implemented campus wide
annual savings were
estimated to be as high as

\$1.5 million



Success Story Nanyang Technical University, Singapore

The peak chilled water flow through the cooling coil was reduced from 25 l/s to 18 l/s

18.4% reduction in average day-time flow

Annual pumping energy reduced
76,700-90,500 kWh

Annual cooling energy reduced
175,000 – 220,000 kWh

SUCCESS STORY

Hillsdale College Mossey - Library & Delp Hall

Delta T was raised on average over 3.5F,
reducing usage of chiller by

300 hrs/year

Electricity consumption reduced
by as much as

16%

The Energy Valve is an innovative solution recognized by the HVAC industry



ACME 2016
Winner of Innovation Award



Acrex 2015
Winner of award of excellence



ControlTrends 2014
Energy Saving Product of the Year



ControlTrends 2012
Best commercial product of the year



2015 Energy Show
Best Energy Efficient Product



2017 AHR Innovation Award
Finalist in the Category of Building Automation



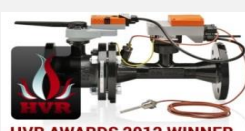
2014 AHR Innovation Award
Winner in the Category of Building Automation



2013 Building Efficiency Award
Best energy efficient automation product



BCIA Awards 2013
Technical Innovation of the Year



HVR Awards 2012
Air-conditioning product of the year



Shanghai Energy IAC 2014
Golden Key Award



Silver Trophy Award 2013
Winner of Energy Smart Automation Award

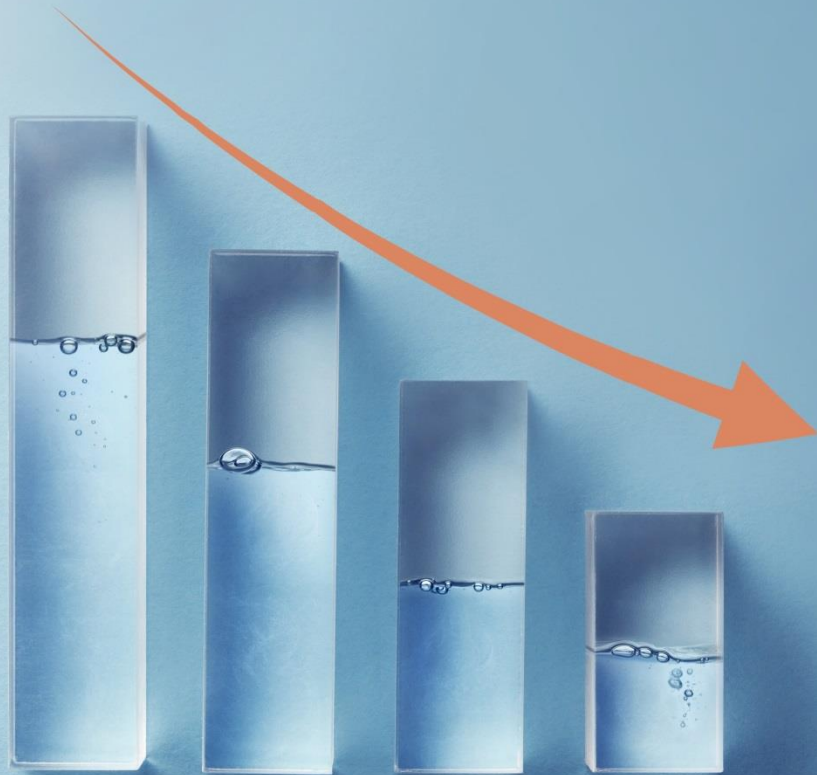
A large, leafy green tree stands on a wooden pier that extends into a turbulent, blue sea. The sky is a deep, dramatic blue with scattered white clouds. The text is overlaid on the left side of the image.

To achieve higher energy efficiency
in buildings a change of mind set is
needed.



A building revolution is needed to meet the requirements from the Paris protocol and the Helsinki report

Closing the performance gap of central plants, will lead to the demanded efficient energy usage



The Introduction of Energy Valve 3.0 will provide:



Advanced efficiency

Automatic optimization

Cloud-based services

For more information contact Belimo or visit energyvalve.com

For more information and access to useful tools and resources, please see

energyvalve.com

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