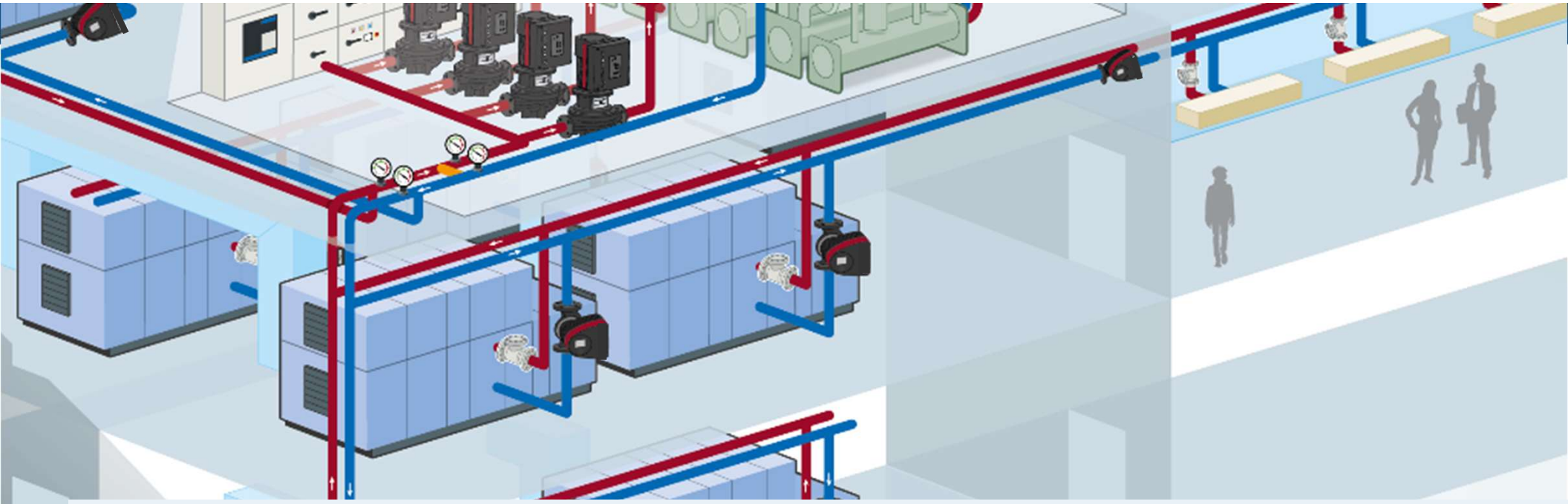
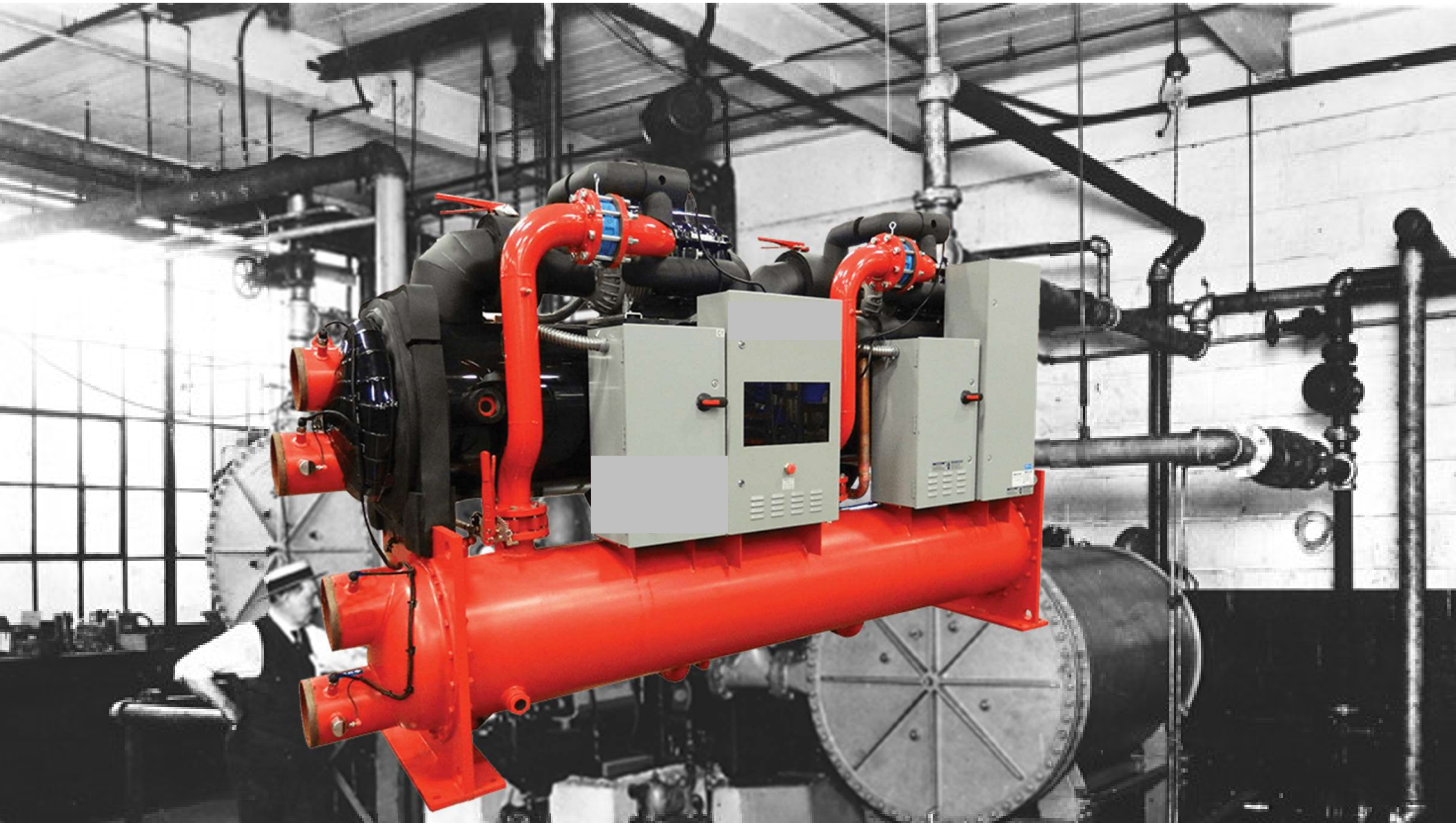


HVAC Distributed Pumping

Distributed pumping - Agenda

1. Today's HVAC systems
2. Distributed pumping concept
3. Controls
4. Reference case

Intelligent Pump Systems & Distributed Pumping

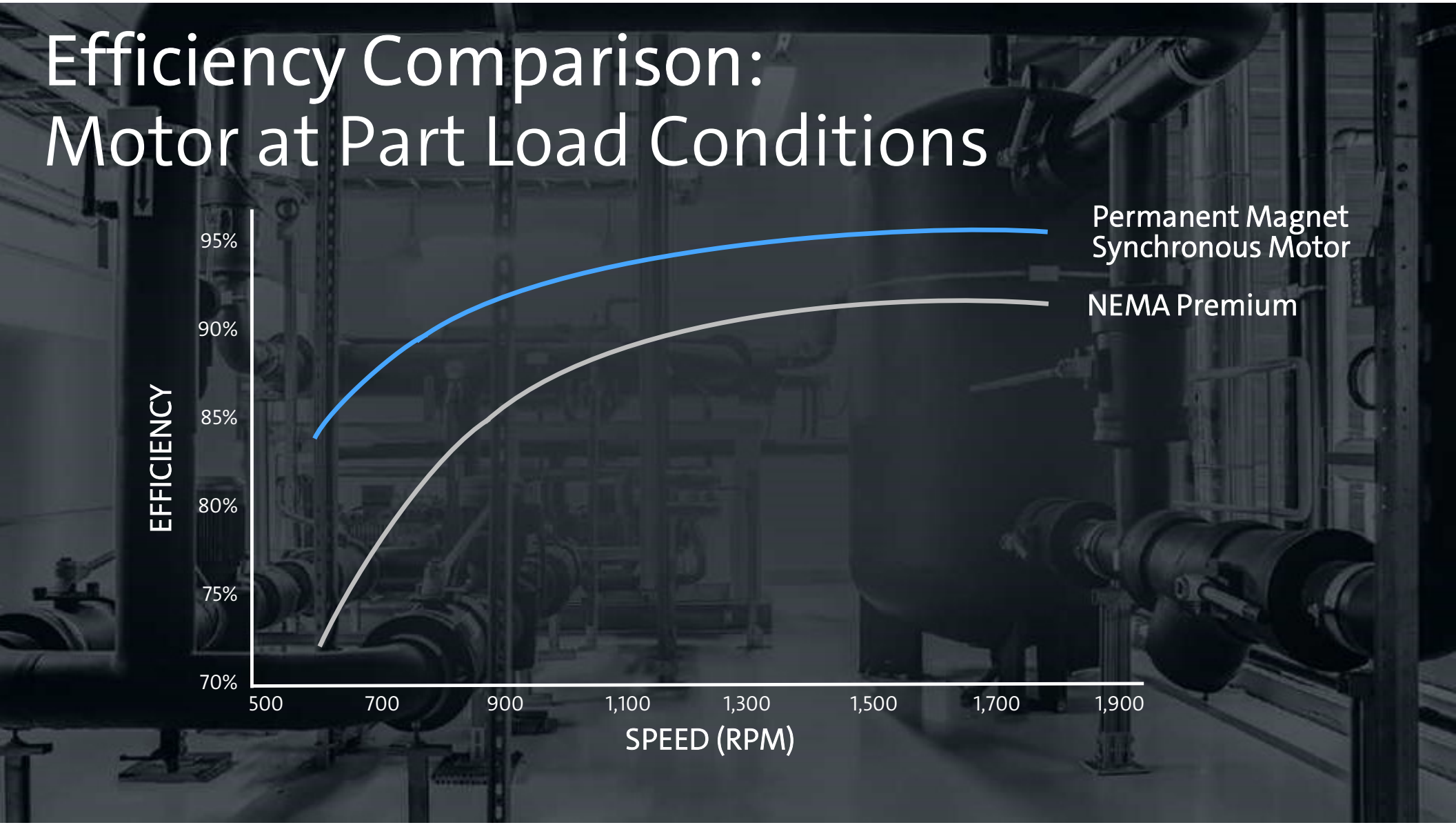


HVAC Packaged Pumping Systems

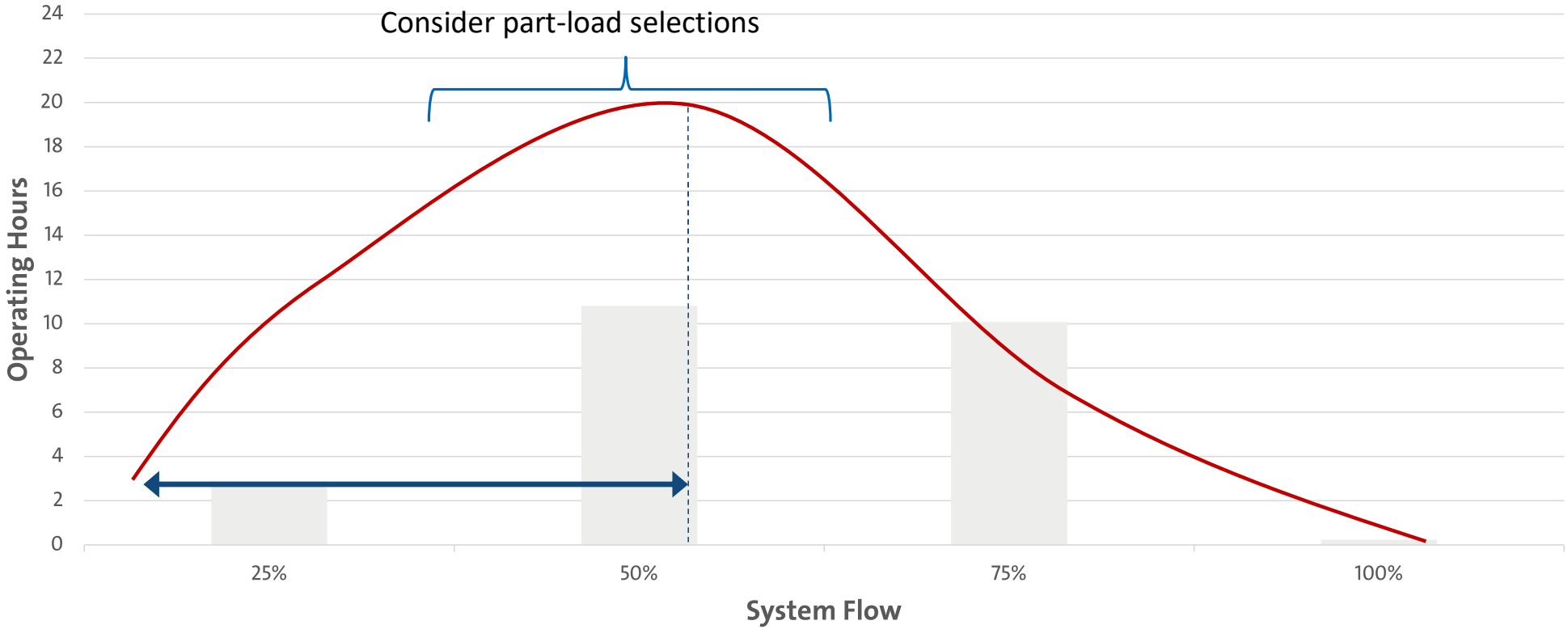
Highly Efficient IE5 Motors: Reduced Energy Consumption

UP TO
10%
ADDITIONAL
ENERGY
SAVINGS

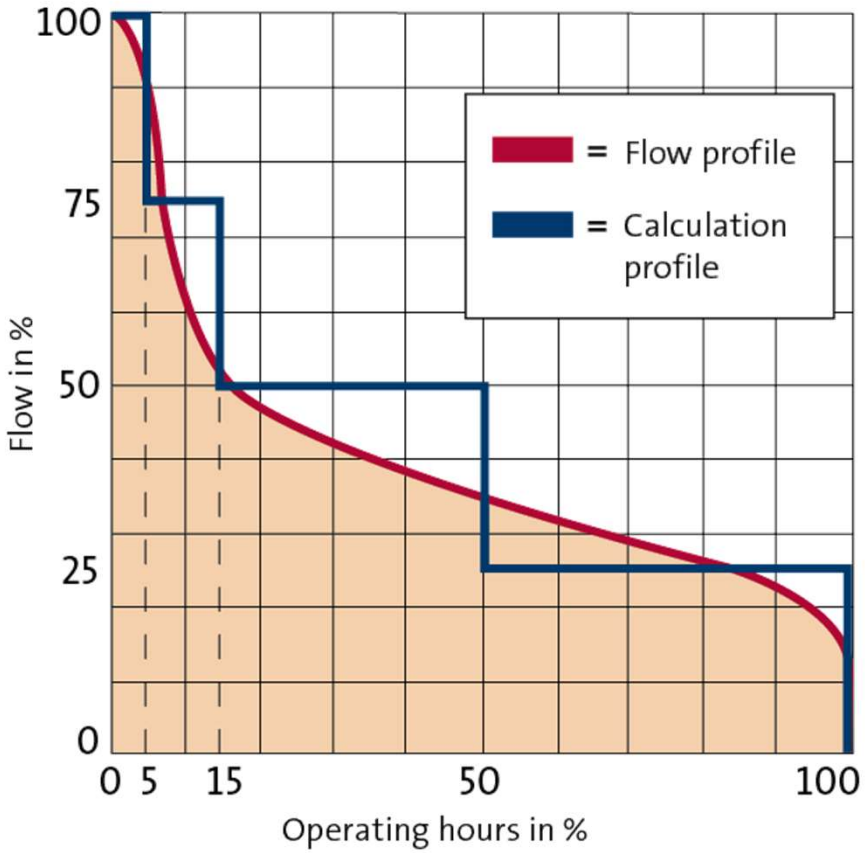
Efficiency Comparison: Motor at Part Load Conditions



Where do our systems operate?
AHRI Integrated Part Load Values (IPLV)



Blue Angel – Heating Load profile

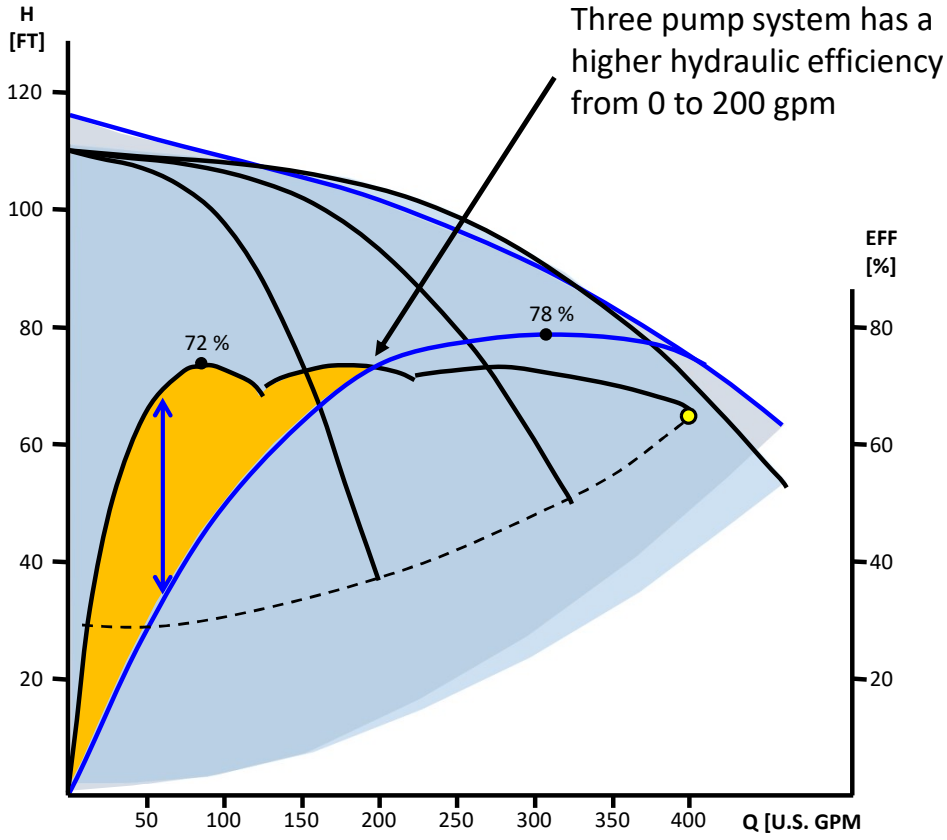


Chiller IPLV	
Flow in %	Hours in %
100	1
75	42
50	45
25	12

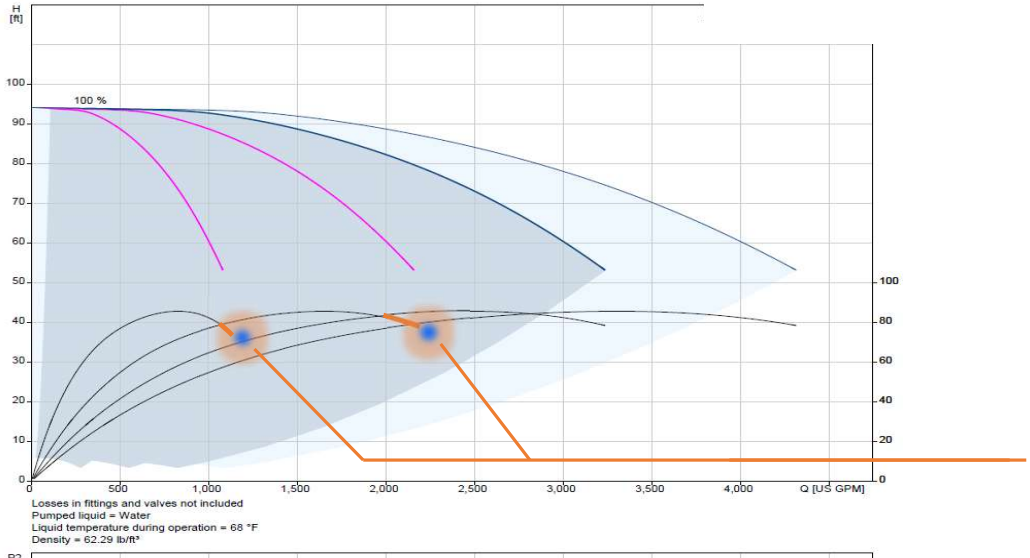
Blue Angel	
Flow in %	Hours in %
100	6
75	15
50	35
25	44

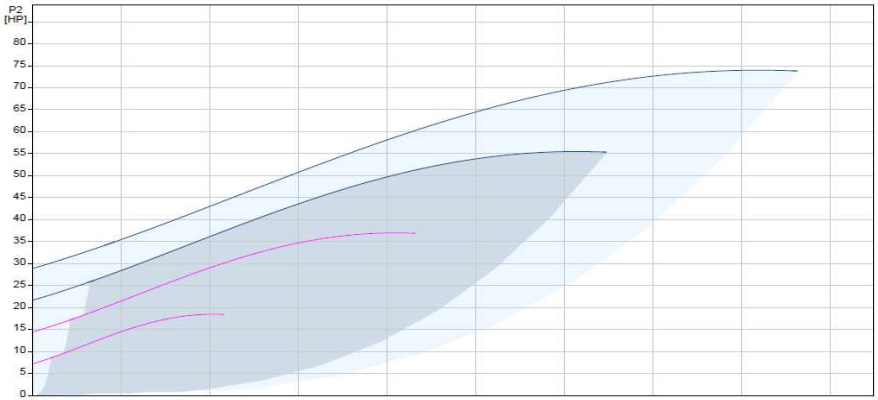
Pump System Control

At 60 gpm the difference in efficiency is **35%** (69% vs. 34%)



Efficiency-Based Pump Sequencing





"Chop" off these areas of low pump efficiency

Efficiency-Based Pump Sequencing

Energy Savings

Optimized Pump Operation

- Reduces energy consumption
- Significant energy savings

Lower Operational Costs

- Reduced energy cost

Improved System Reliability

- Minimize Wear and Tear
- Pumps operate within optimal ranges
- Extends the lifespan

Efficiency-Based Pump Sequencing

Efficiency-Based Sequencing

- Prioritizes pump operation based on efficiency rather than speed
- Uses system demand data to determine the most efficient pump combination
- Selects the most efficient pump or combination of pumps

How

- Use PLC with preloaded pump curves and monitor sensors for real time data
- Use ASHRAE Wire to Water Efficiency Based Sequencing Guide

Comparison with Speed-Based Sequencing

- Speed-Based Sequencing
- Adjusts pump speed to meet demand
- Can lead to suboptimal energy use

LV-17-025

Sequencing Control of Parallel Pumps in Variable-Flow Systems Using Wire-to-Water Efficiency

Gang Wang, PE, PhD
Member ASHRAE

Xuejing Zheng, PhD

Koosha Kiamehr
Student Member ASHRAE

Published in ASHRAE Transactions, Volume 123, Part 1

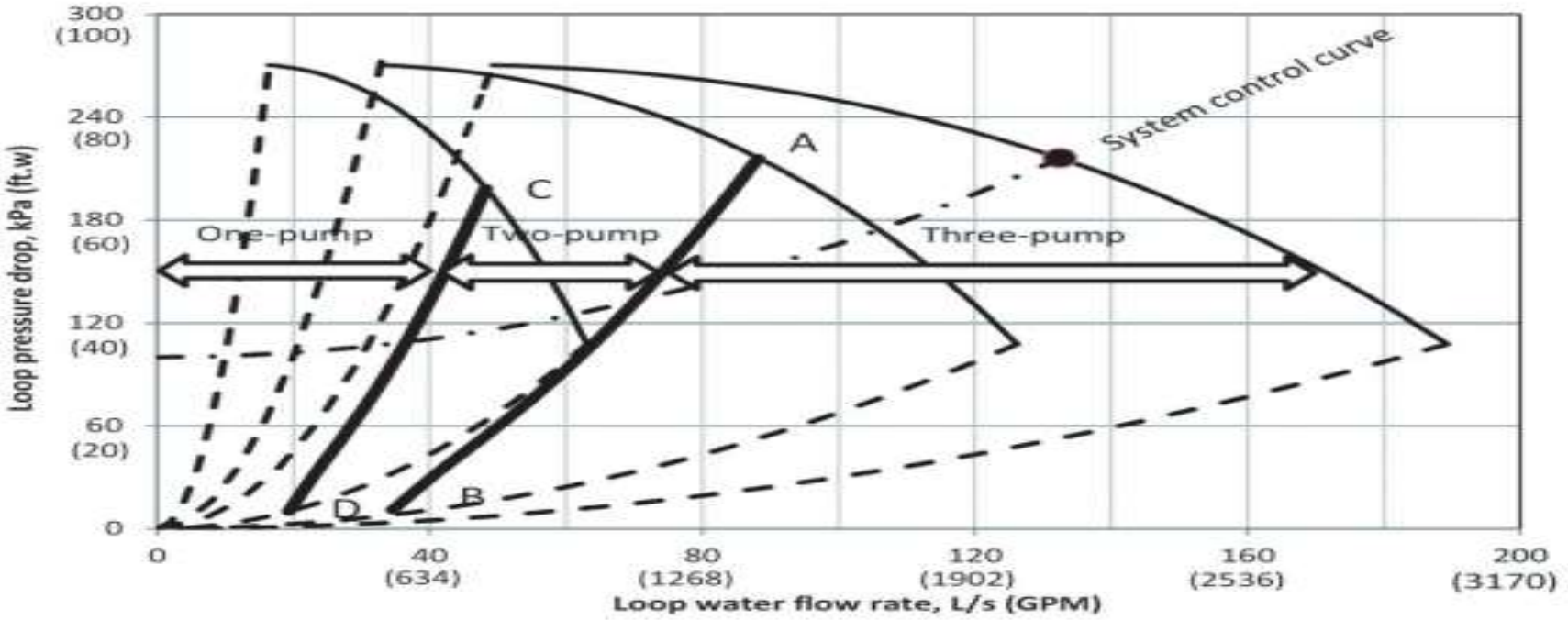
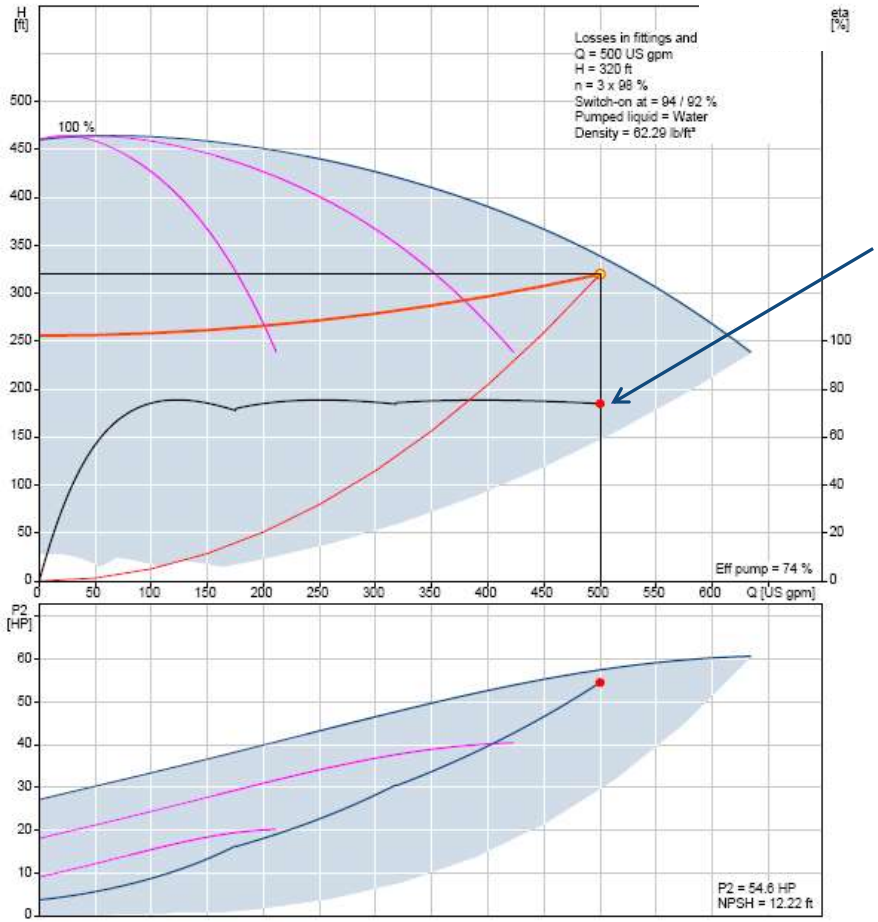


Figure 11 *Optimal parallel pump sequencing.*

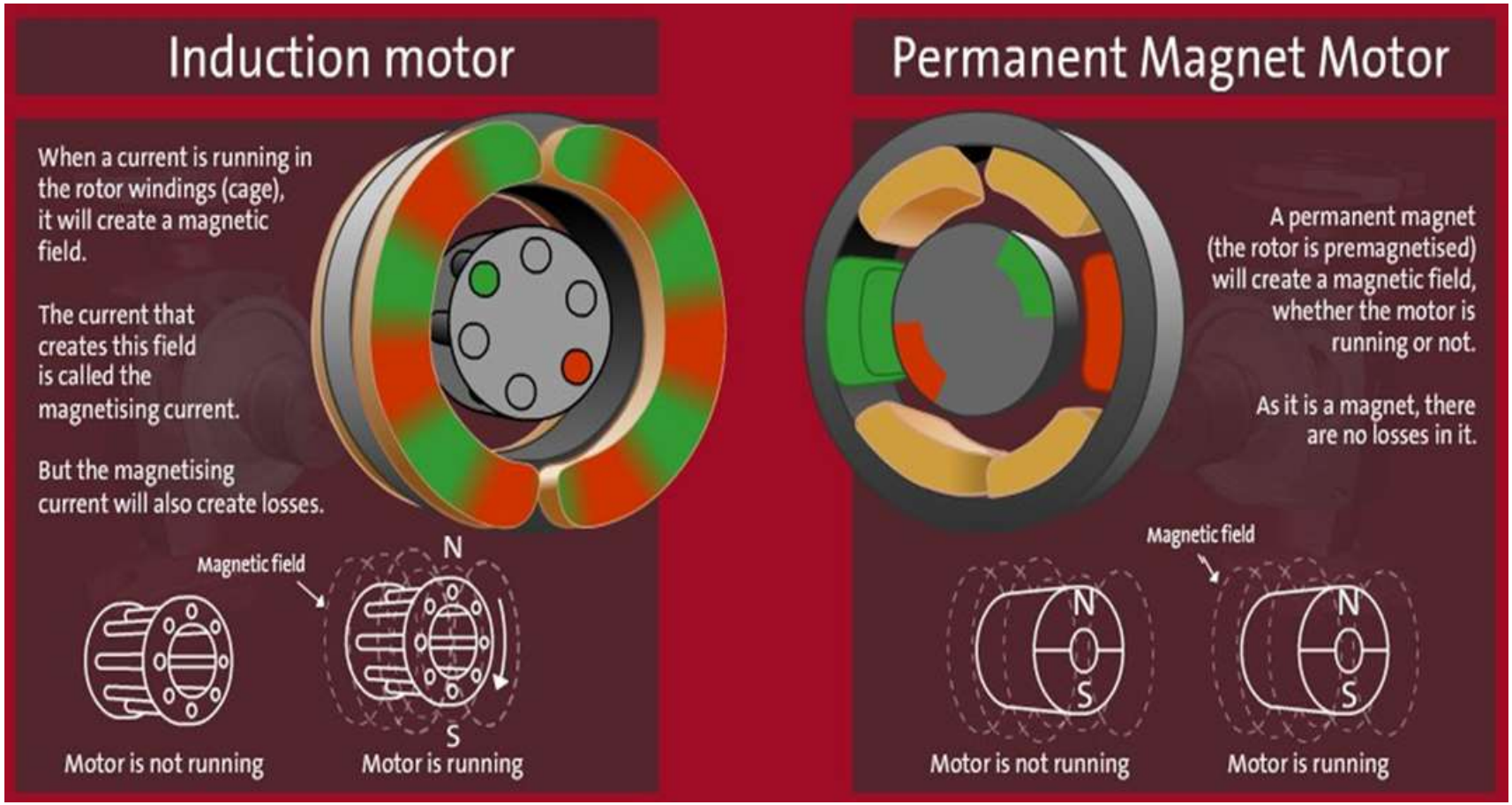
Efficiency Based – Cascade Control



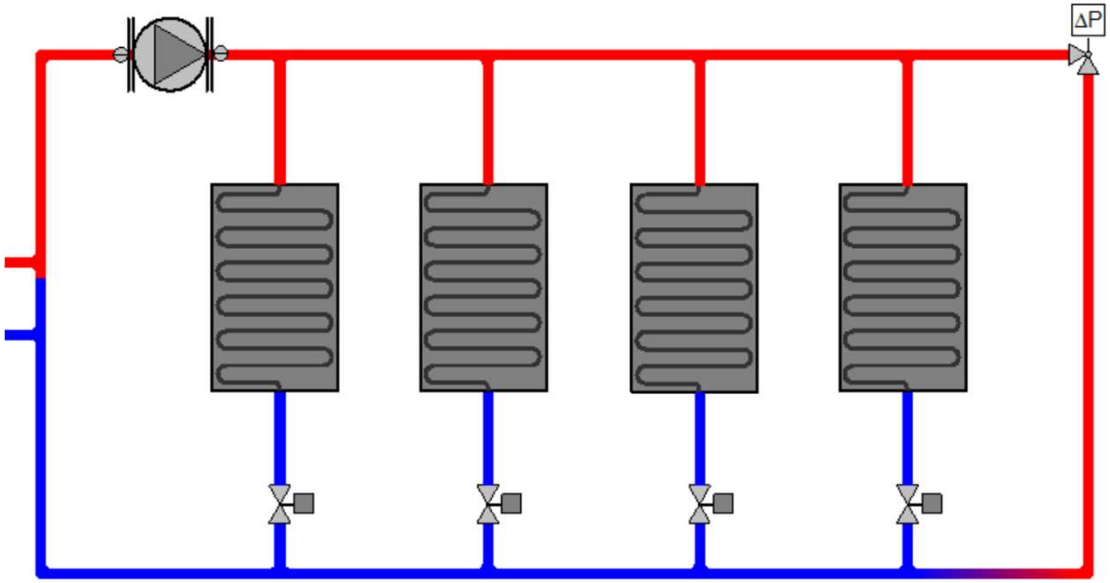
With variable speed motor control, high efficiency is maintained with BOTH speed control AND pump starting based on efficiency

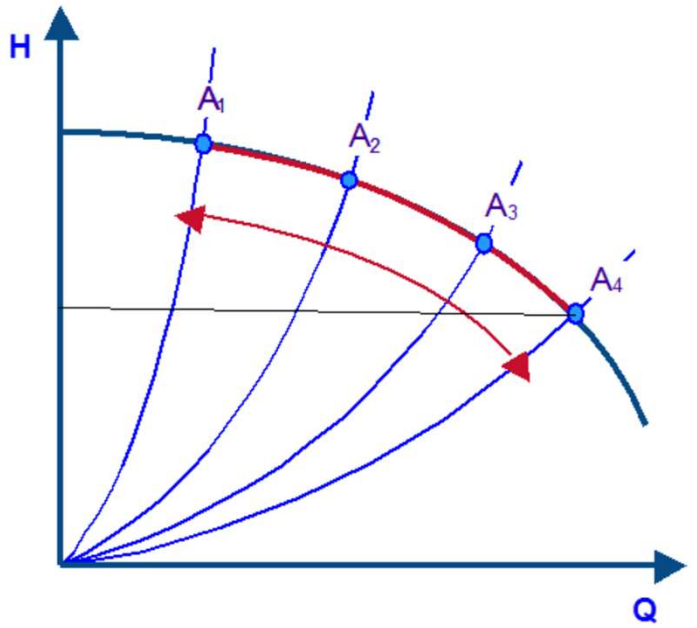
Smart Pumps replace PICV

Induction vs Permanent Magnet Motor

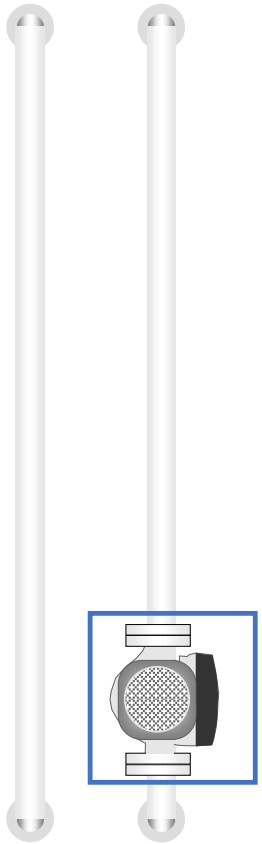


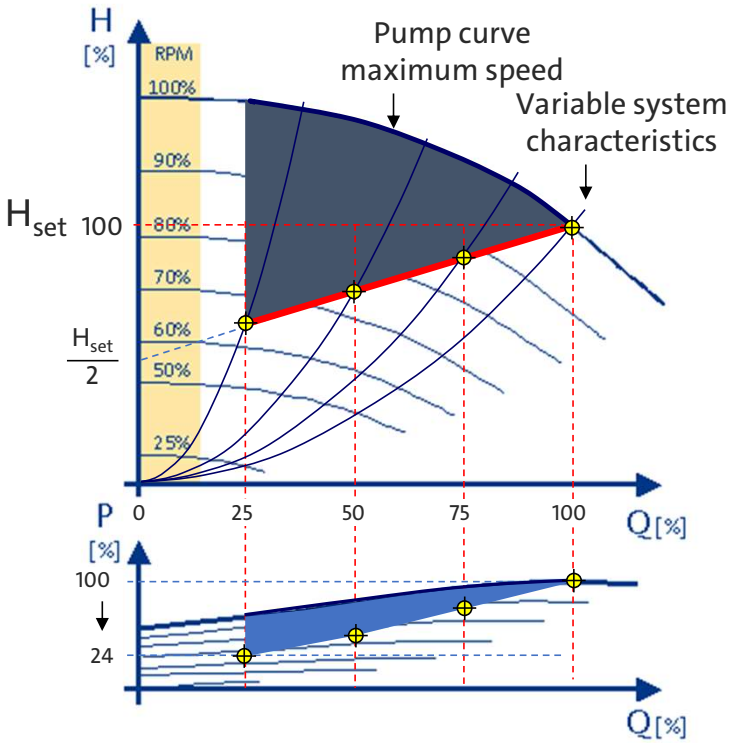
Traditional hydronic system





Proportional pressure control

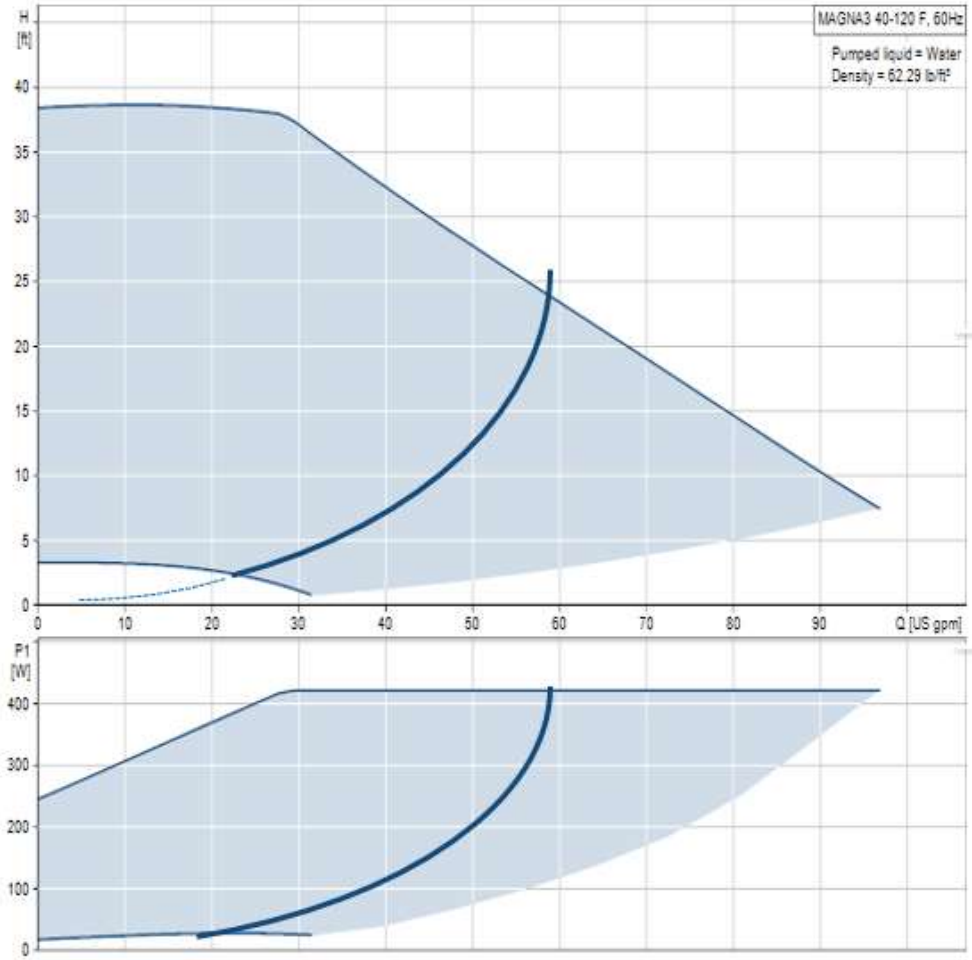




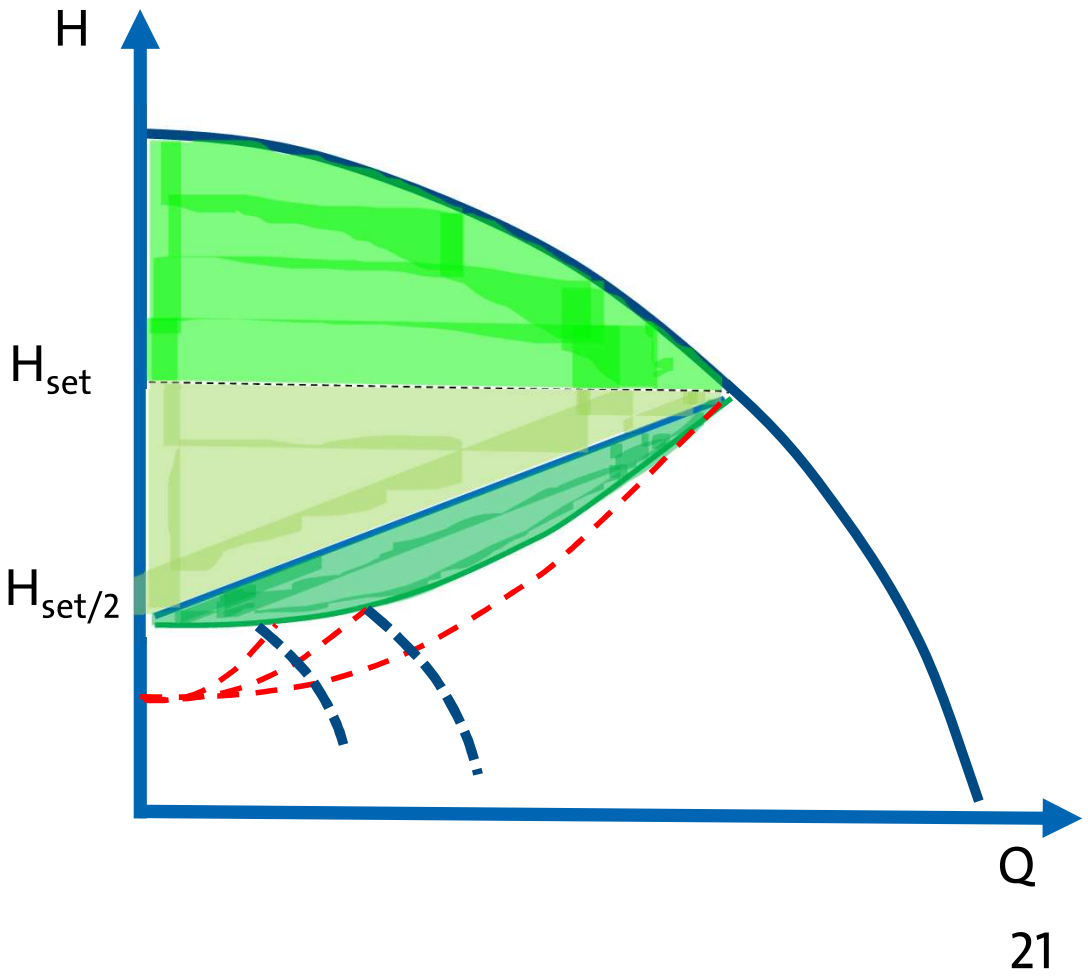
The blue area is showing the decreasing in head compared to an uncontrolled pump.

The red area is showing the decreasing in effect compared to an uncontrolled pump.

Maintain Constant Temperature in flow pipe



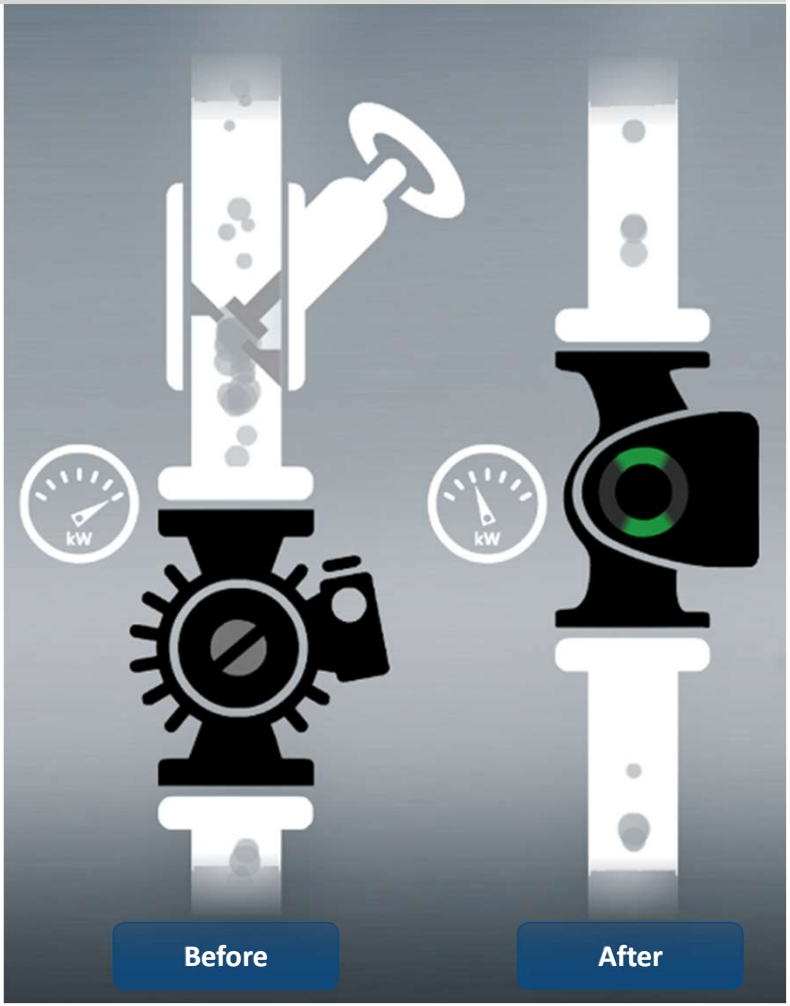
Proportional pressure control - quadratic



Energy Savings - FLOW*LIMIT*

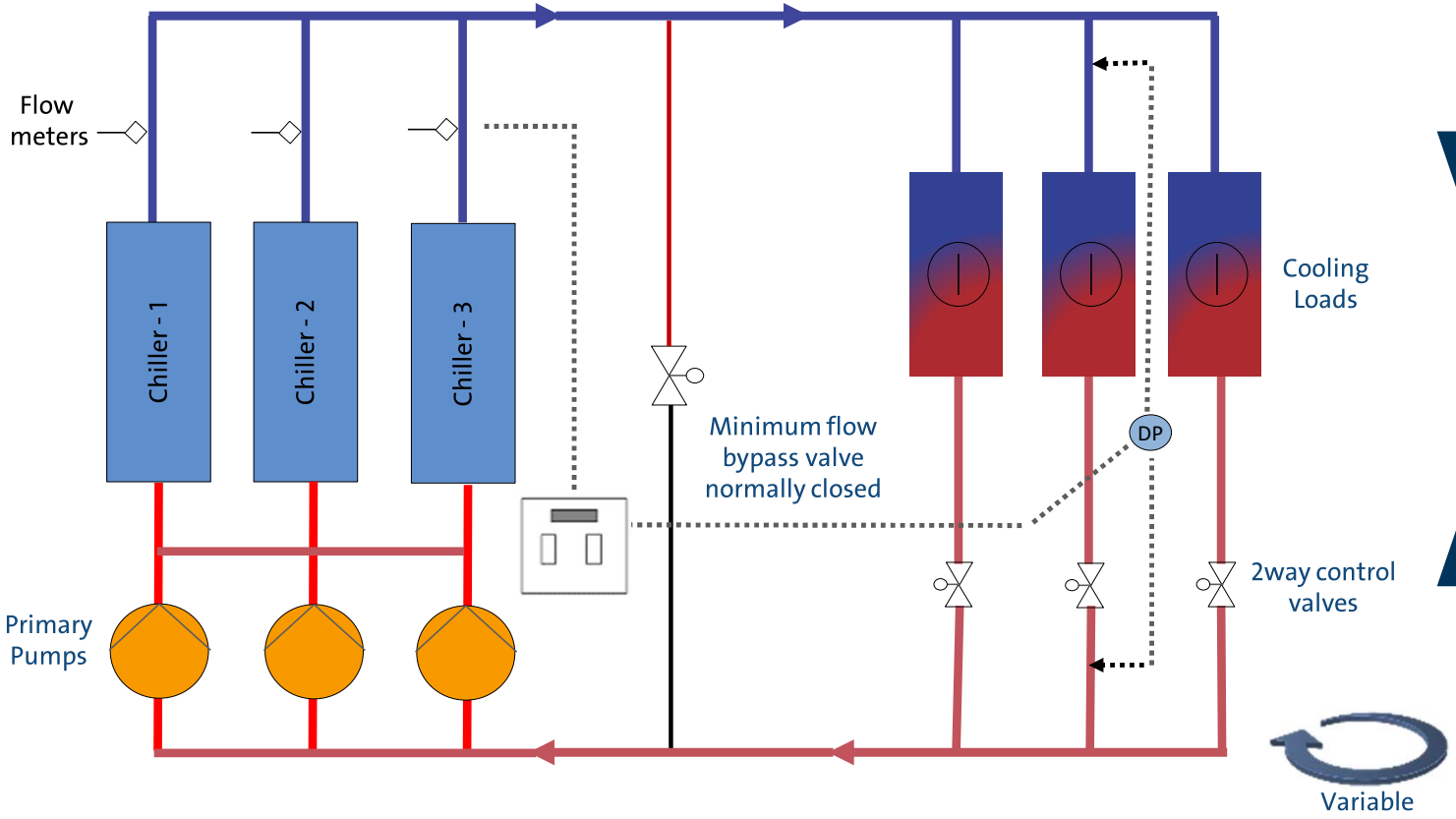
FLOW*LIMIT*

- FLOW*LIMIT* control function makes it possible to set a maximum flow limit for the pump



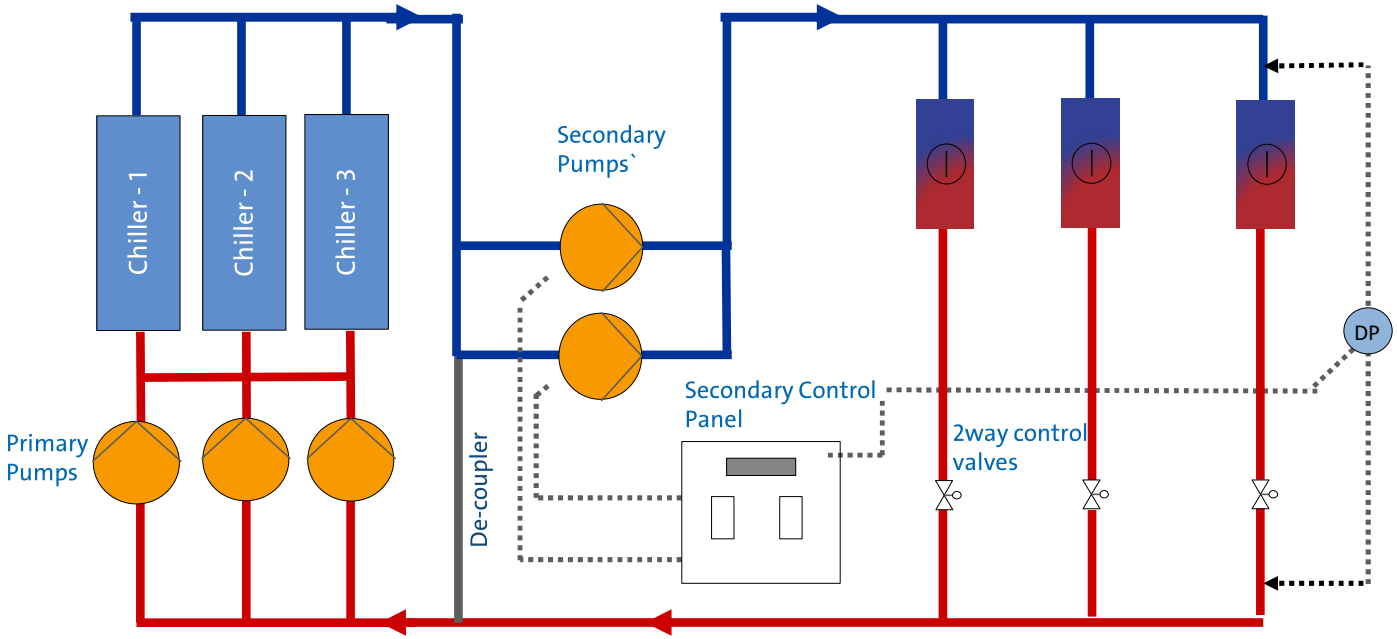
Distributed Pumping
Reducing pressure and improving performance in chilled water systems

Variable Primary Flow (VPF) System



- Variable primary flow
- More energy efficient

Variable Primary / Variable Secondary System

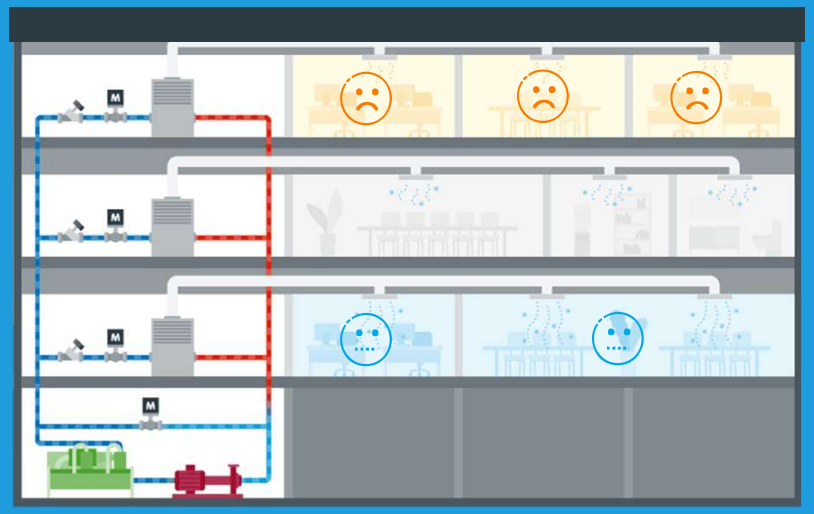


- Variable primary flow
- Variable secondary flow
- More energy efficient

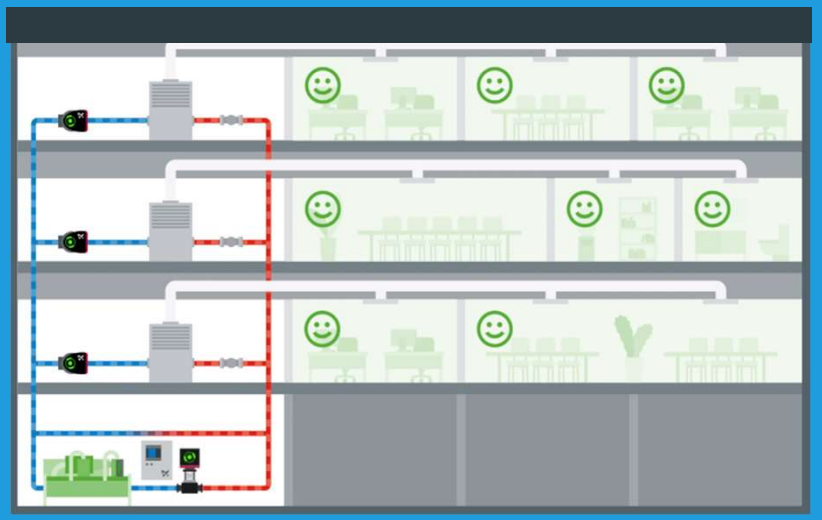
Comparing Variable Primary to Distributed Pumping

Distributed Pumping systems for commercial buildings is a paradigm shift towards decentralised pumping.

Conventional

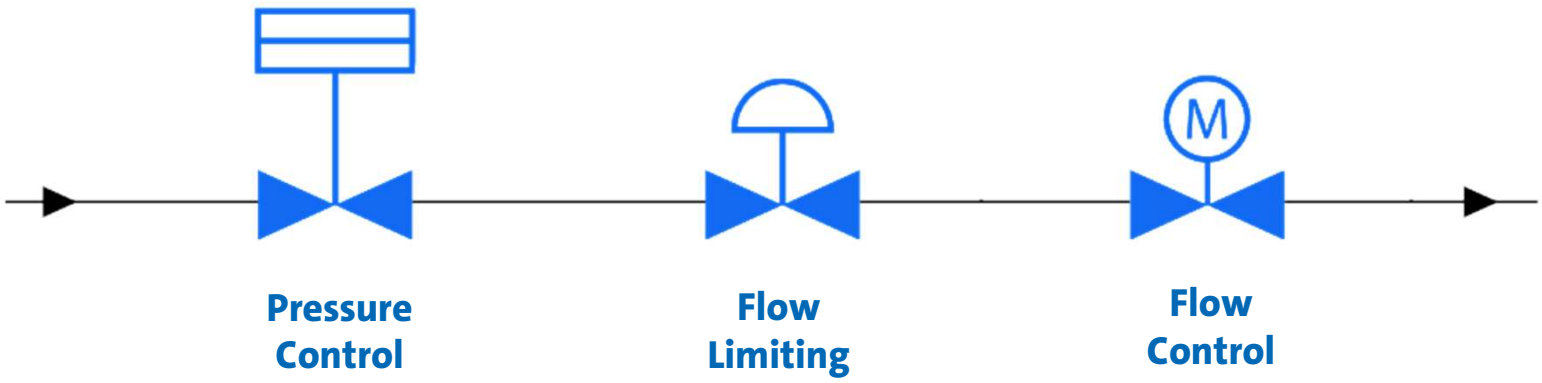


Distributed Pumping

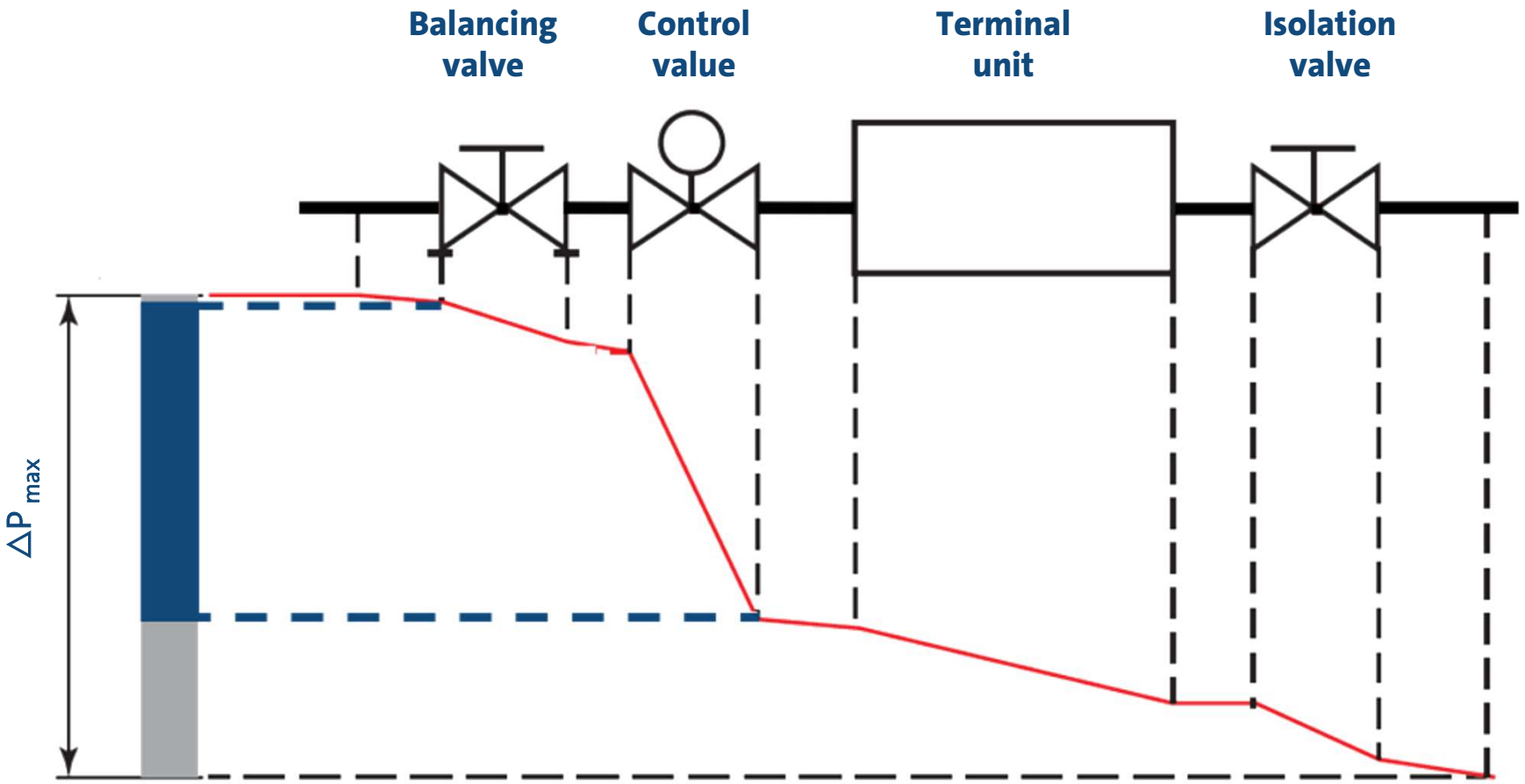


Pressure Independent Control Devices (PIC-D)

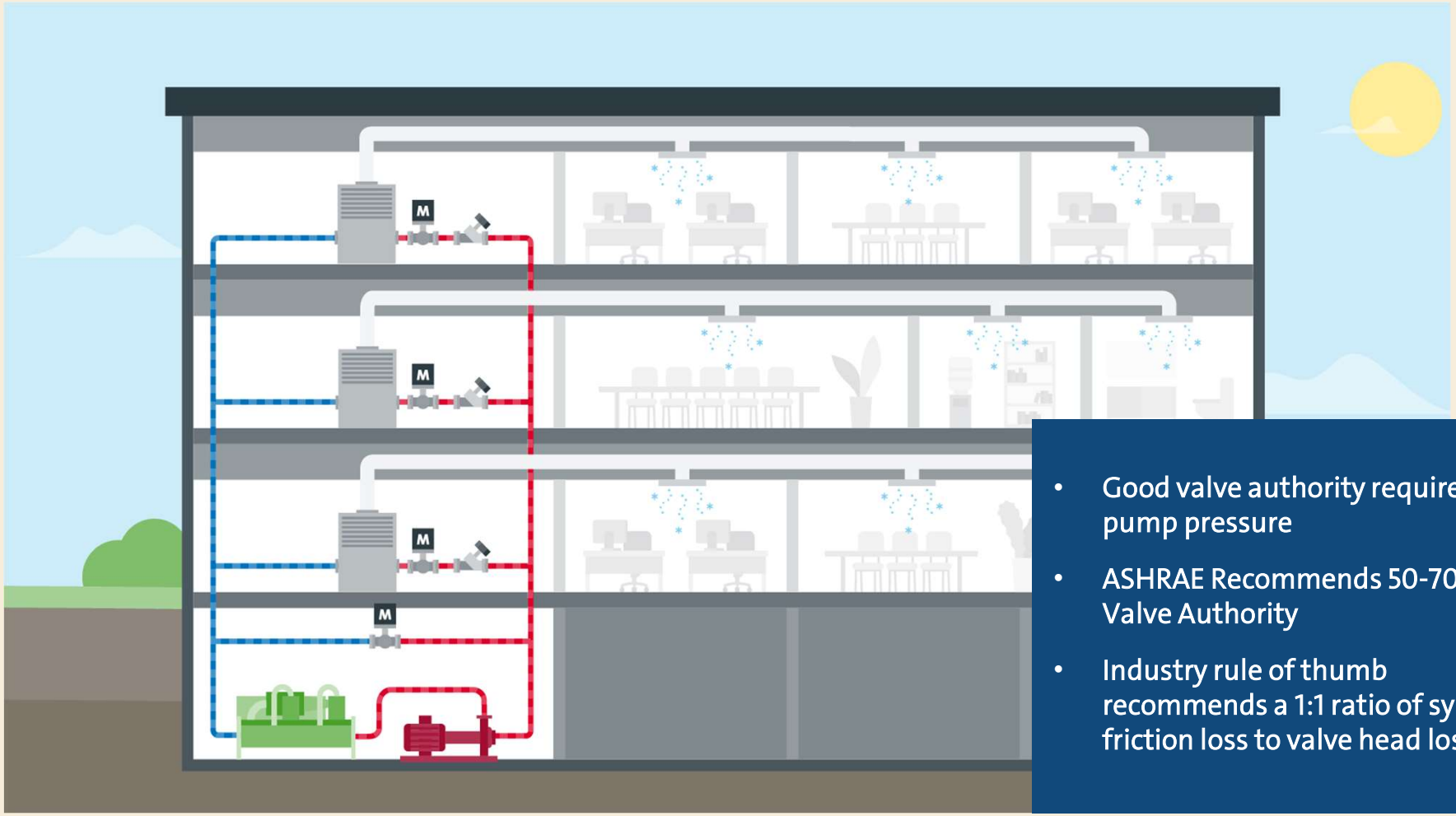
A pressure independent control valve (PIC-V) combines three functions in a hydronic system



Terminal Unit Pressure Profile

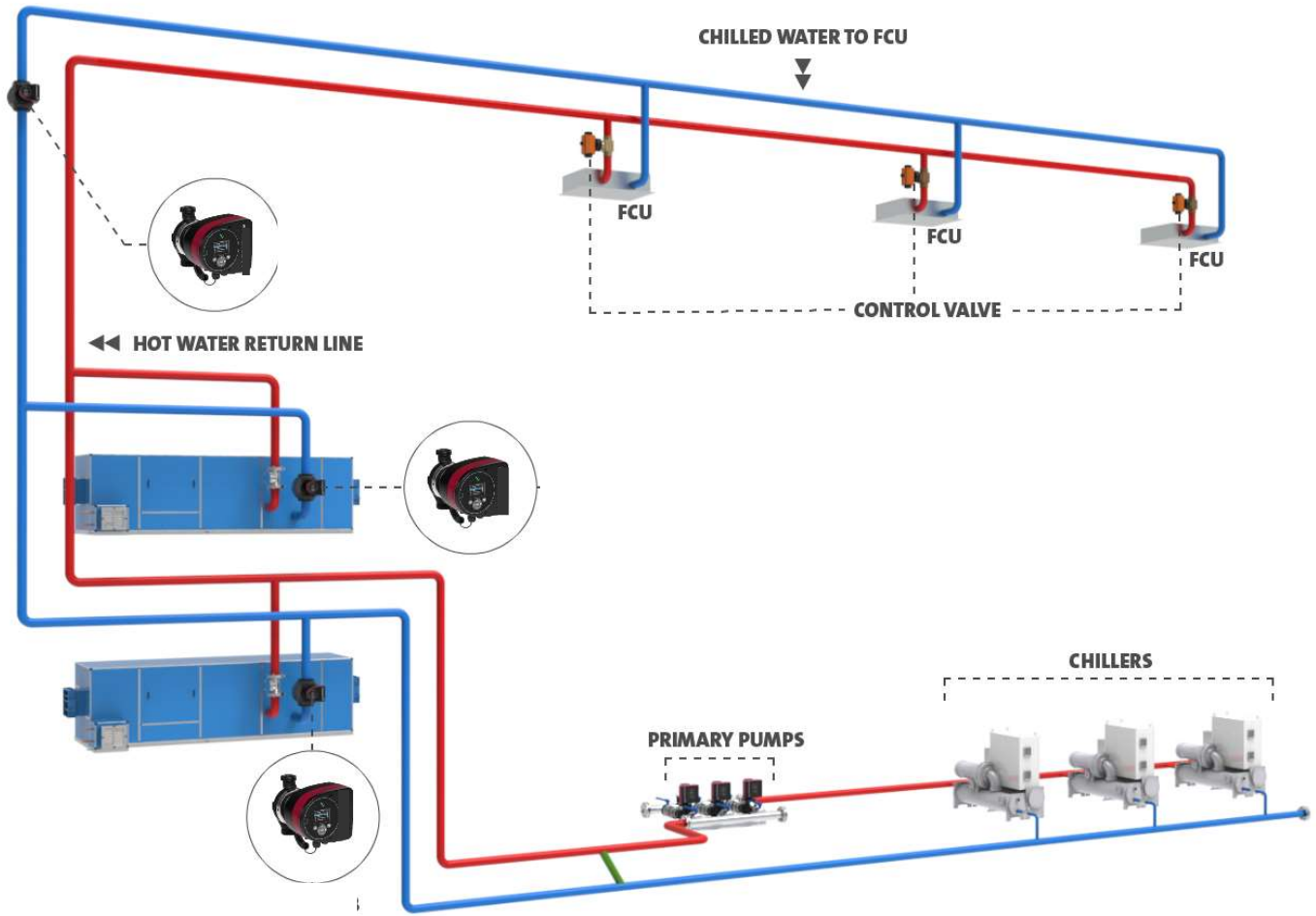


The cost of control



- Good valve authority requires pump pressure
- ASHRAE Recommends 50-70% Valve Authority
- Industry rule of thumb recommends a 1:1 ratio of system friction loss to valve head loss

DISTRIBUTED PUMPING SYSTEM



SAVES UPTO **54%** ENERGY

Valves waste the energy your primary pumps have put into the water. Its like driving your car with your breaks always on.

FREEDOM FROM **LOAD ADJUSTMENT**

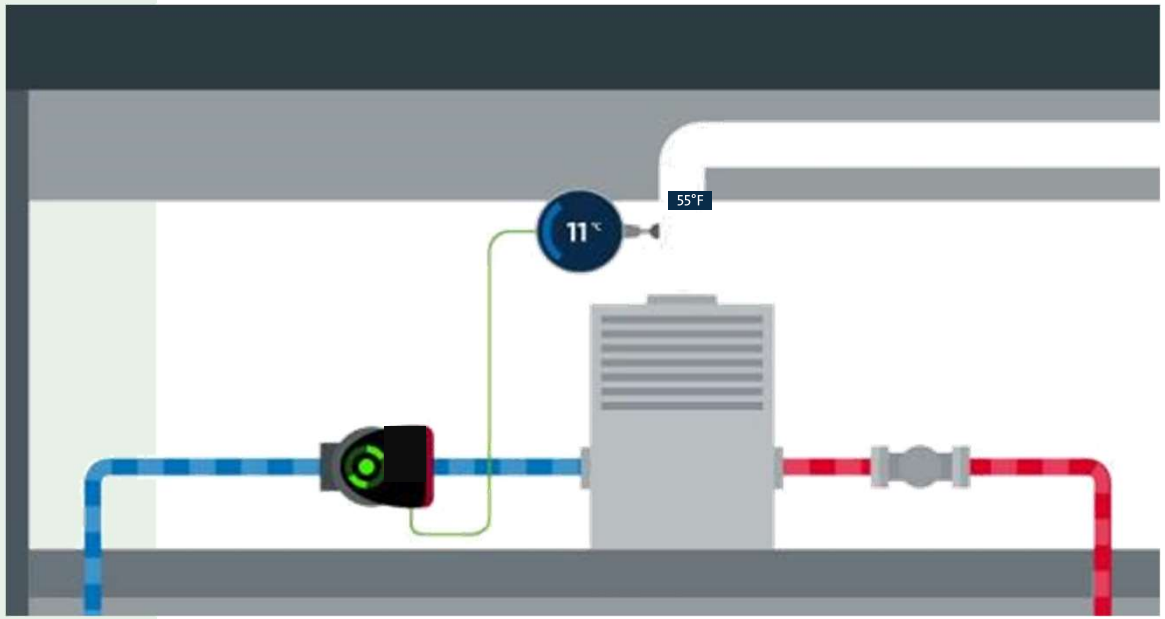
Balancing your system according to load is no more a requirement. With intelligent pumps your load side will always be in tune.

PERFECT TEMPERATURE - **ALWAYS**

Pumps react much faster compared to valves ensuring desired temperatures - perfect indoor climate.

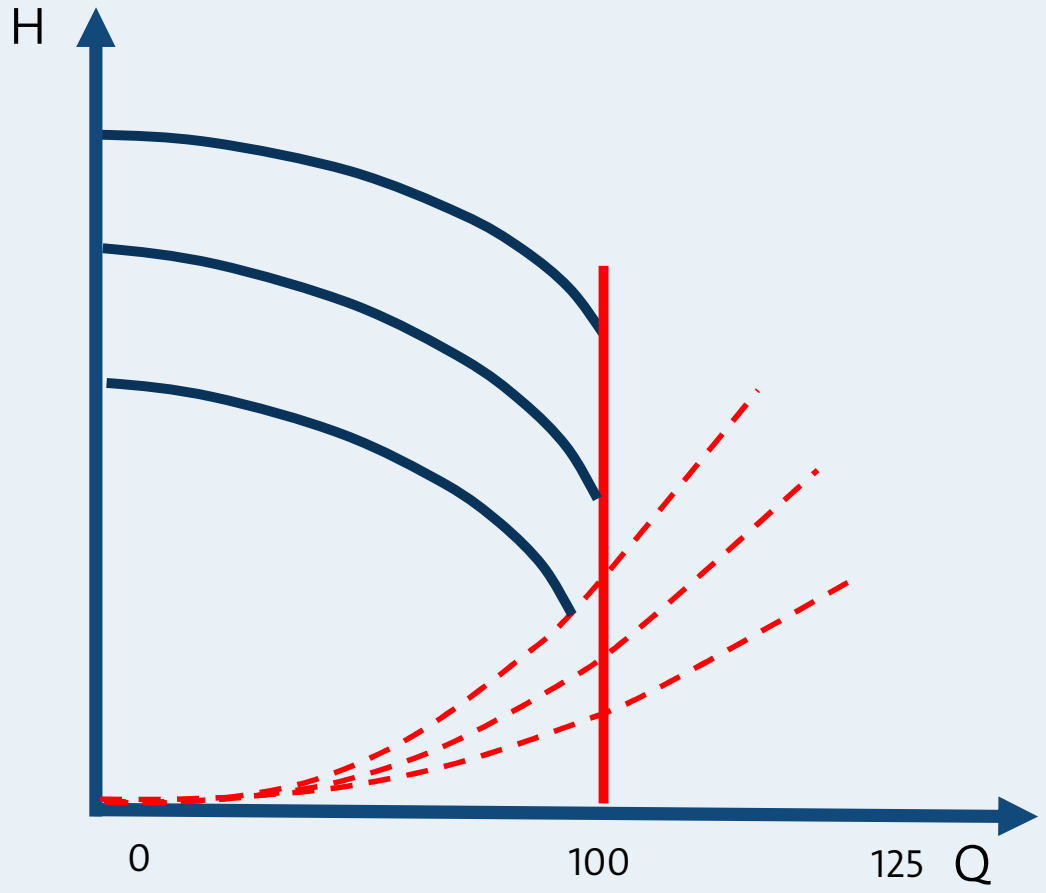
Temperature reference for pump near the air handling units

Automatic balancing
During operation, the distributed pump serving each circuit, continuously measure the air duct temperature and automatically adjust the pump speed to achieve the desired temperature. Each circuit is always being supplied to demand.



FLOW*LIMIT*

Example Flow*LIMIT*
is set at 100 gpm

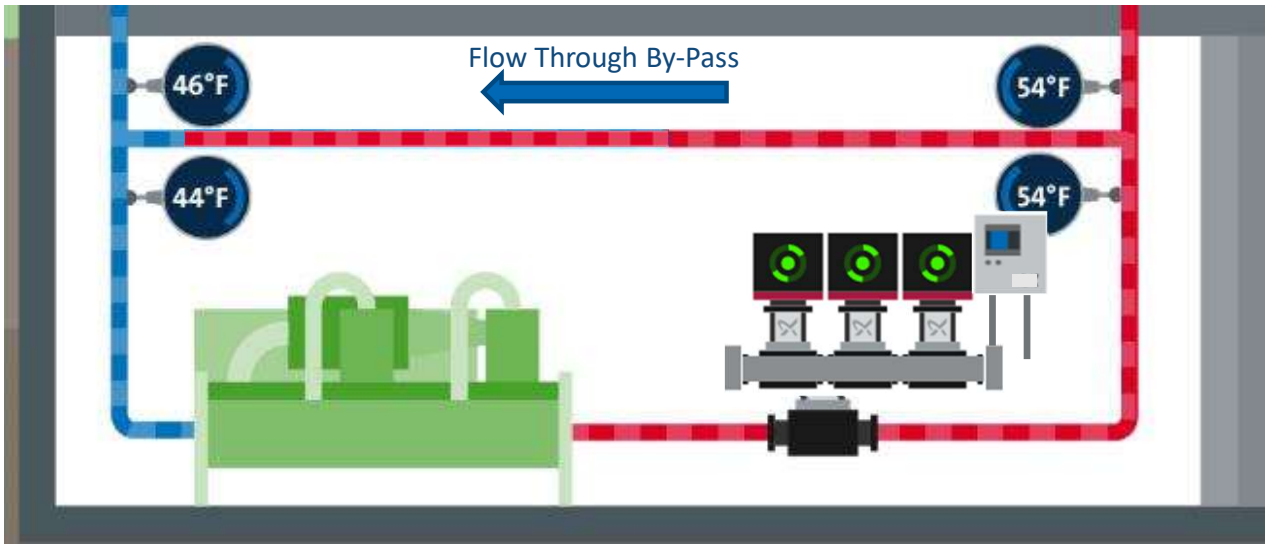


Balancing of Primary/Secondary Side

Balanced Primary Secondary Side
Temperature across by-pass is equal

Decrease Primary Pump Speed
Supply- is mixed with Return water

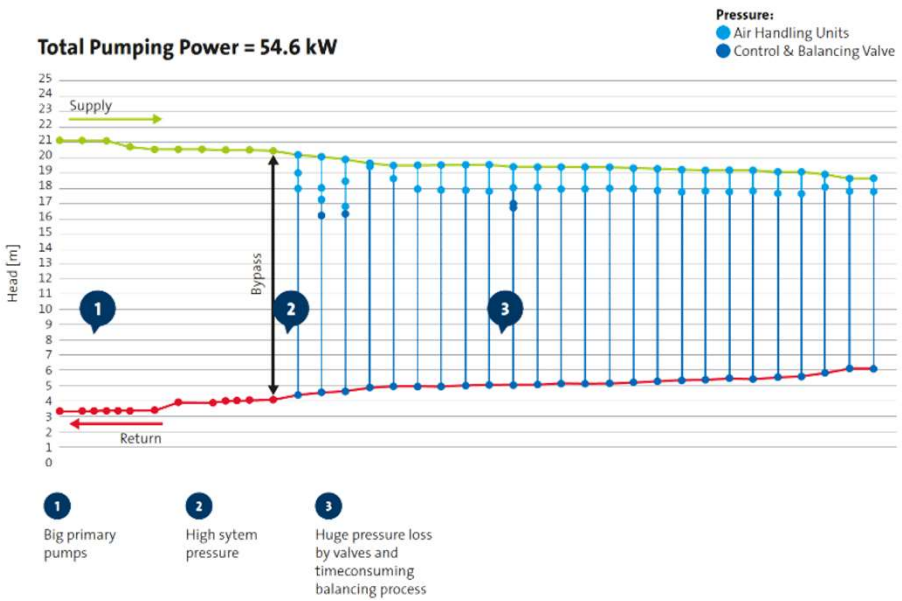
Increase Primary Pump Speed
Return- is mixed with Supply water



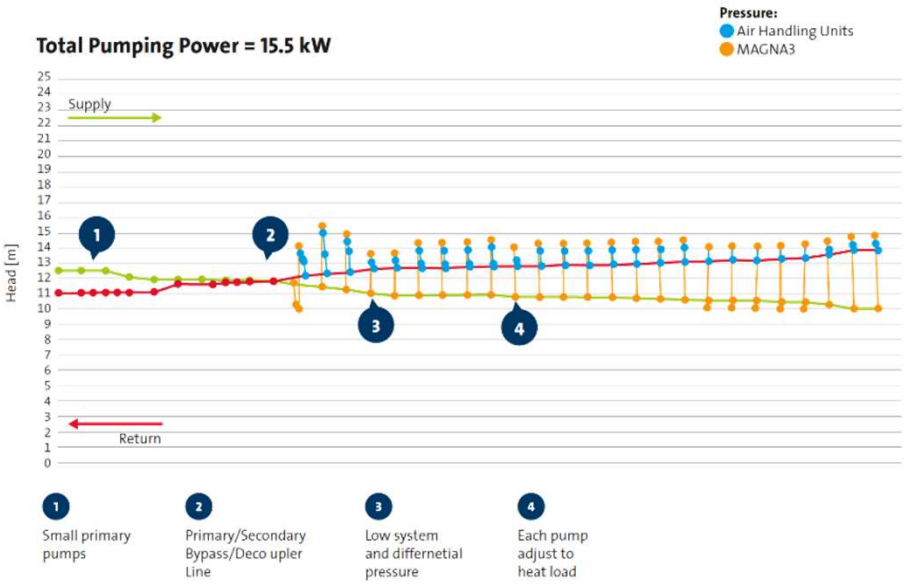
Deep dive into the two systems

Simulation of 25 floor riser at 50% max flow

The valve-based Variable Primary chilled water system

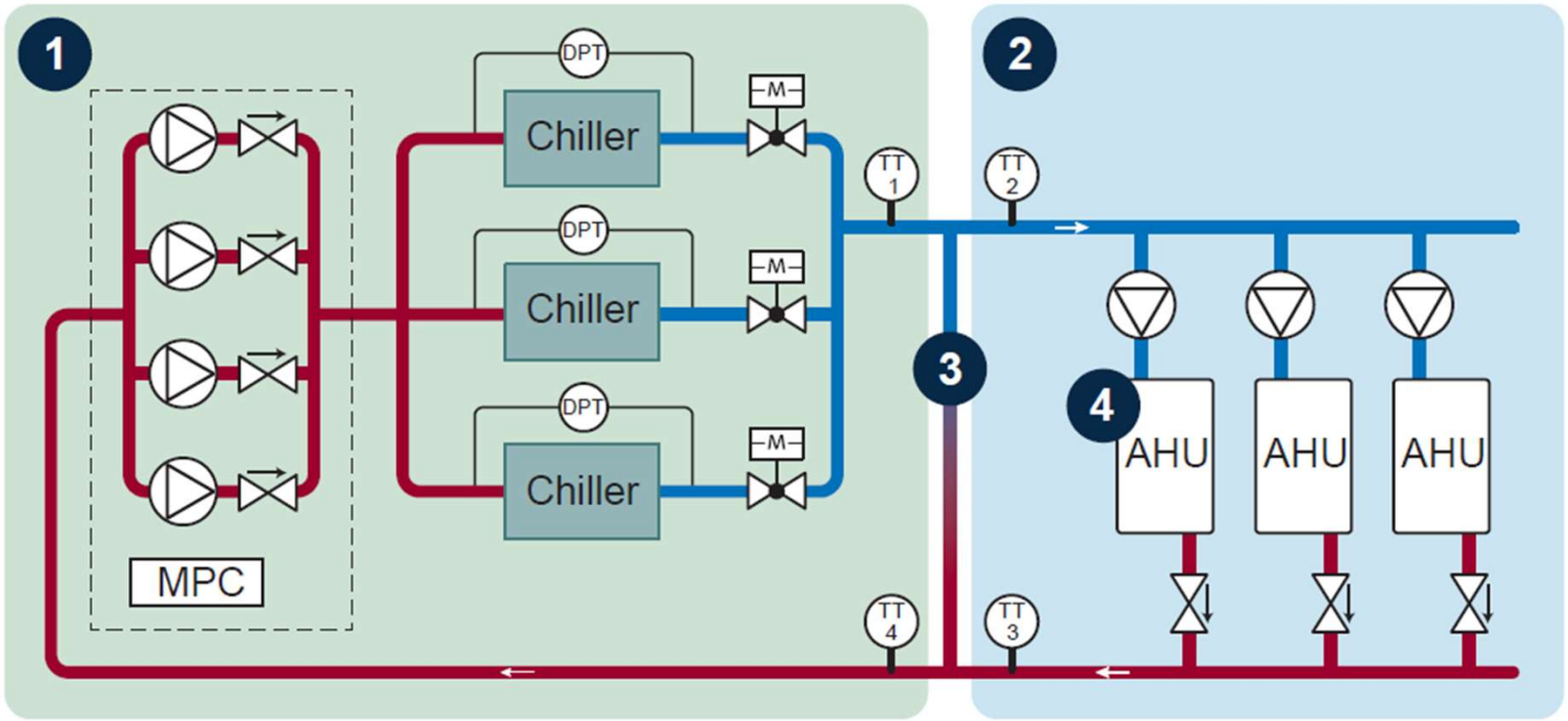


Distributed Pumping system



Variable primary/Variable distributed secondary

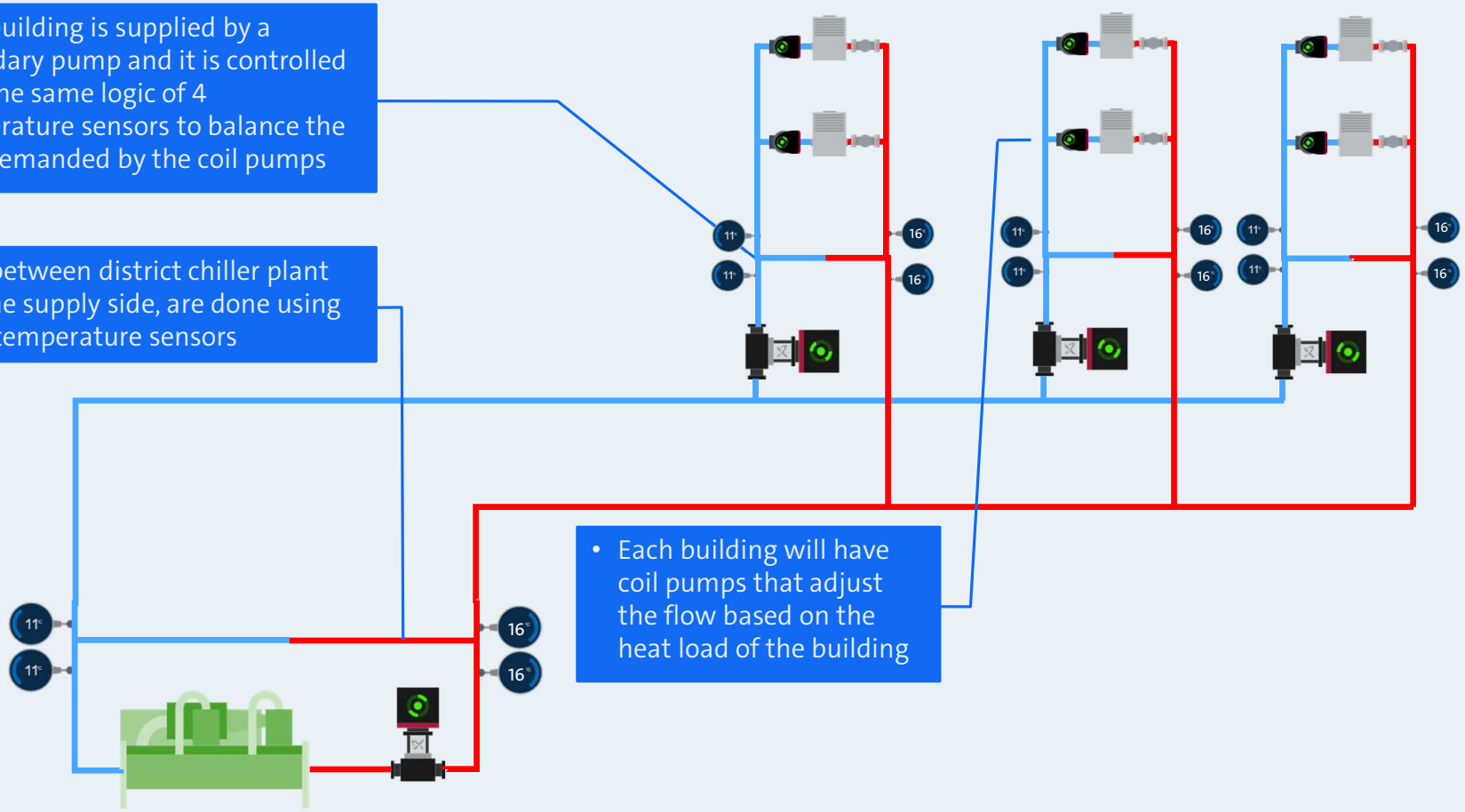
1. Primary side
2. Secondary side
3. Decoupler
4. Terminal Units



Design Example: Central Utility Plant

- Each building is supplied by a secondary pump and it is controlled with the same logic of 4 temperature sensors to balance the flow demanded by the coil pumps

- Flow between district chiller plant and the supply side, are done using the 4 temperature sensors



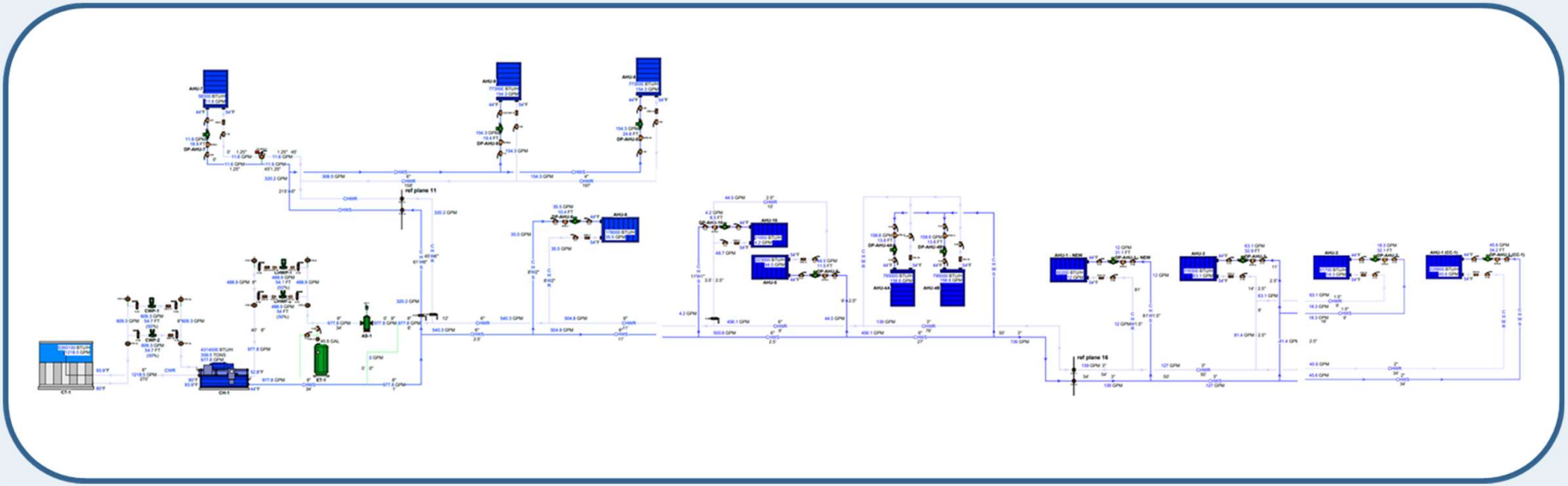
- Each building will have coil pumps that adjust the flow based on the heat load of the building

After distributed pump change over

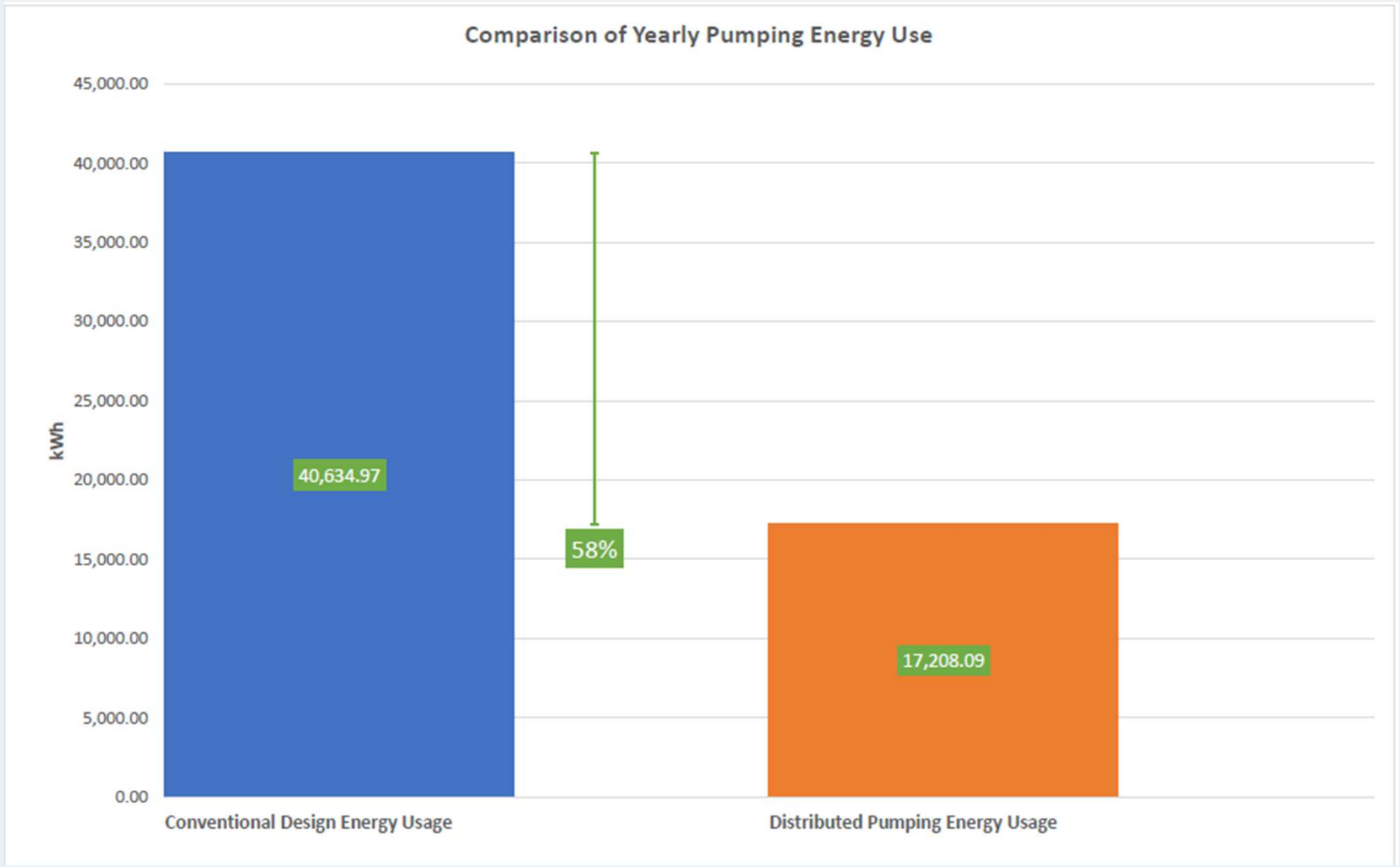
- Medium size building – 200,000 sq ft
- Water cooled chiller – 400 tons
- 11 AHUs
- 12 Distributed Pumps
- 2 Packaged Systems

THE MUSEUM OF FLIGHT

Case Study – Museum of Flight



Schematic of chilled water system (CWS) piping layout


Comparison of Yearly Pumping Energy Use
45,000.00
40,000.00
35,000.00
30,000.00
25,000.00
20,000.00
15,000.00
10,000.00
5,000.00
0.00
kWh
40,634.97
58%
17,208.09
Conventional Design Energy Usage
Distributed Pumping Energy Usage

Presenter Bio

- Mike Madsen – Grundfos Pumps Corporation
  - Technical Sales Manager – Distributed Pumping
  - 40 years experience in Engineering and Commercial Sales roles
  - P.E. State of California
  - LEED AP

What questions do you have?

Michael Madsen
michael.madsen@grundfos.com