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Siemens Demand Flow®

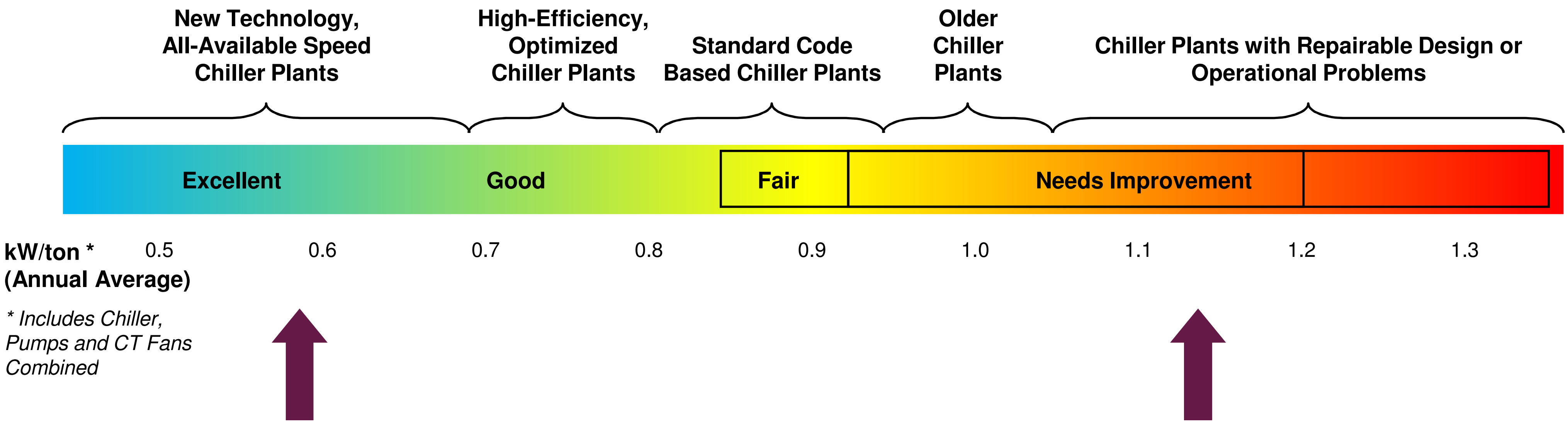
A unique and proven energy and operational cost saving application for water-cooled, central chilled water systems

Answers for industry.

Agenda

- **Demand Flow Chilled Water**
  - Holistic Solution
  - Large installed critical plants across country
  - Customized Solution driven by CoE dedicated team
  - Case Studies

Overview: Why Chiller Plant Optimization?



Post-Optimization
(Annual Average can range from 0.5 – 0.75 kW/Ton)

Pre-Optimization
(Annual Average typically $\geq$ 0.8 kW/Ton)

Source: "All Variable Speed Chiller Plants", ASHRAE Journal, September 2001

Traditional Chilled Water Plant Optimization

There are many traditional chiller plant optimization offerings. Typically, these offerings consist of:

- Operating each component of the central chiller plant on its own efficiency curve instead of focusing on the interrelationships between each component
- Increases total chiller run hours.
- Limited functionality for complex chiller plants.
- Resets chilled water temperature up. Tends to increase humidity.
- Increases annual AHU fan energy.
- Extreme difficulty handling site system pressure and flow control.
- Chiller sequencing program. Tries to run chillers in sweet spot.

Overview: Common CHW System Characteristics

Typical Characteristics	Inherent Shortcomings
Chillers not operating at design temperature splits	Plagued with "Low Delta-T Syndrome"
Excessive bypass of chilled water flow	Excessive pumping / chiller energy and shaft-miles
Constant volume pumping (both CHW and CW)	Excessive pumping / chiller energy and shaft-miles
Comfort is often sacrificed to obtain efficiency	Uncomfortable occupants = reduced productivity
Total plant energy performance not fully measured	Difficult to manage (increased risk)
Operate at design intent conditions only 5% of the time (per ARI standards)	Inefficient and costly plant operations 95% of the time (per ARI standards)
Continuous full speed operation of some plant equipment	Decreased equipment life

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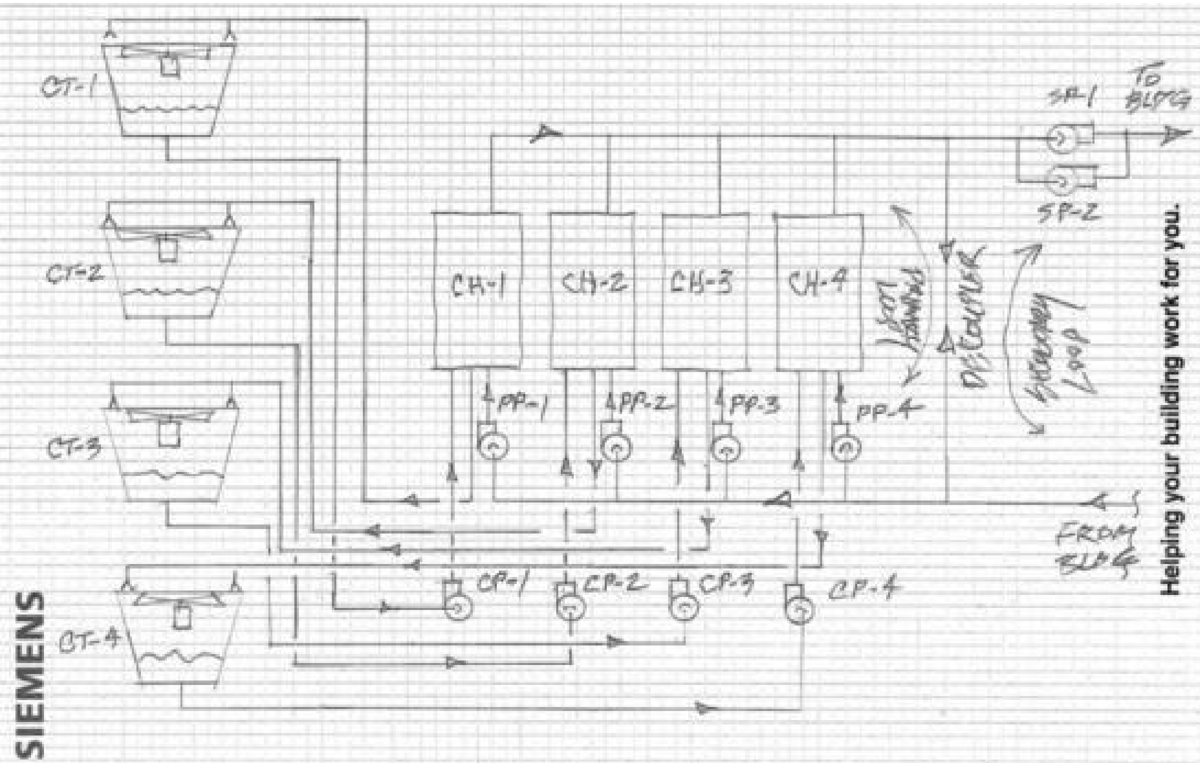
Overview:
What is Chilled Water System Optimization?



Fundamental energy consuming sub-systems that influence deliverable capacity:

1. Chillers
2. Chilled Water Pumping
3. Condenser Water Pumping
4. Cooling Tower Fans
5. Air Side

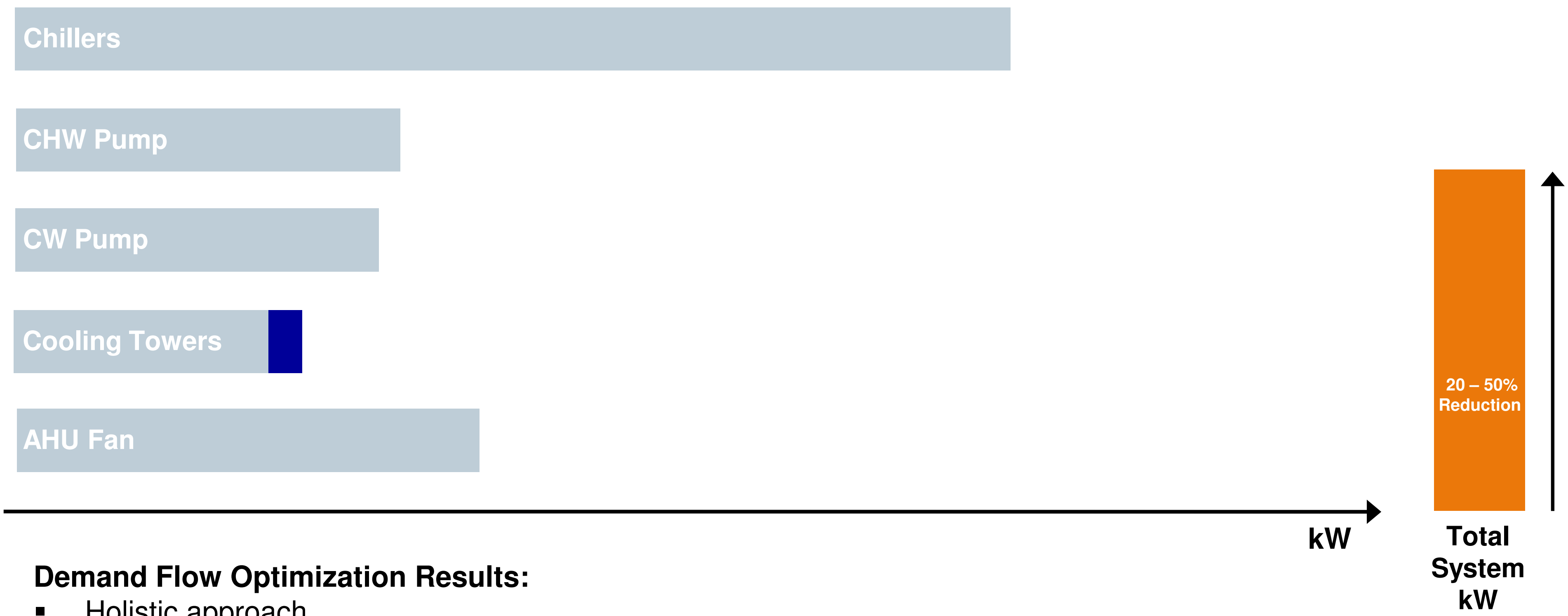
These 5 subsystems are interdependent

- Energy and deliverable capacity are interdependent
- Often "conservation methods" reduce deliverable capacity
- Often energy conservation methods result in a "transfer of energy" among the 5 subsystems

Siemens understands these technical relationships, delivering a "holistic" approach to CPO

Net Energy Effect of Demand Flow

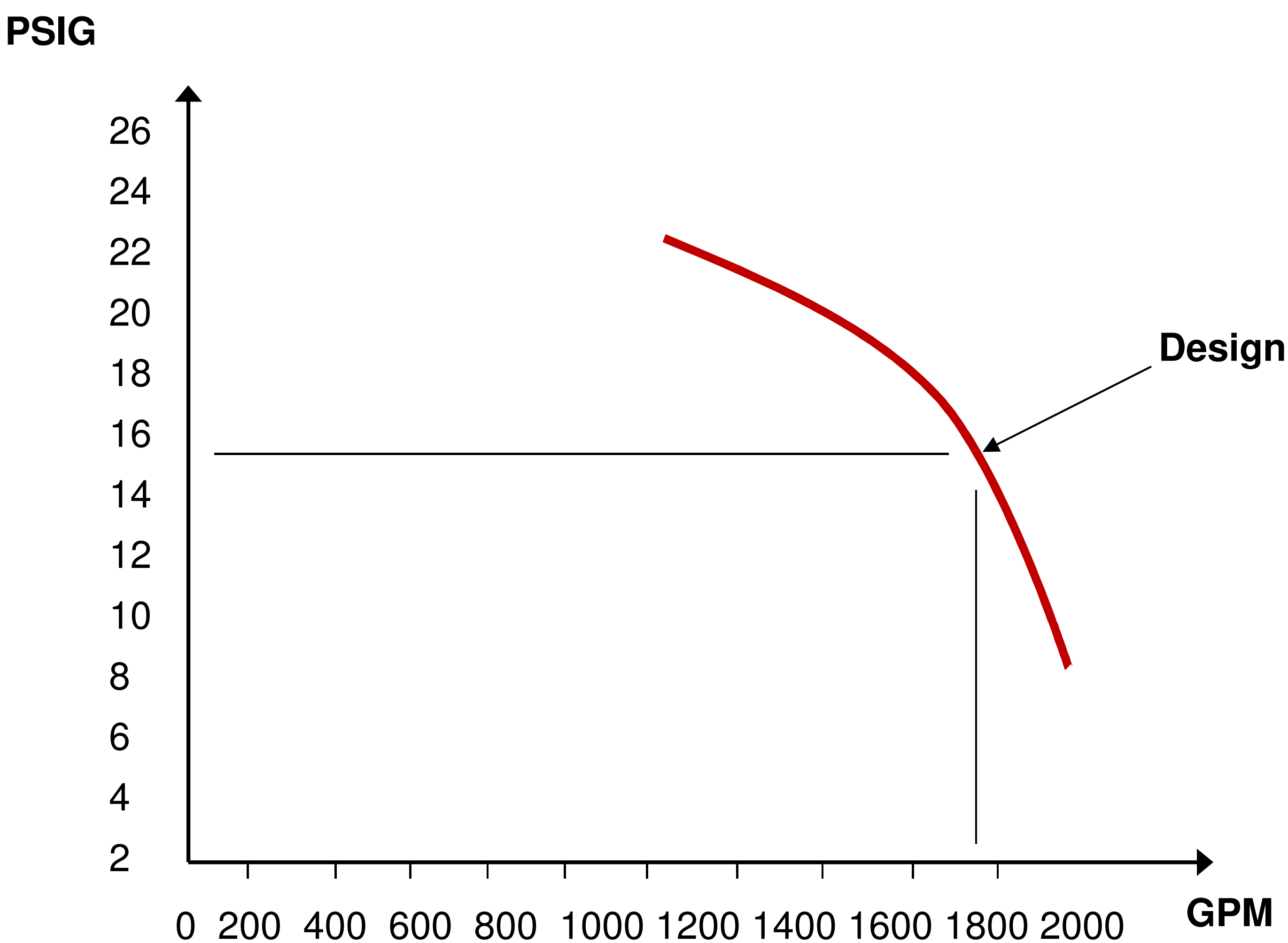
Demand Flow Optimization Project



Demand Flow Optimization Results:

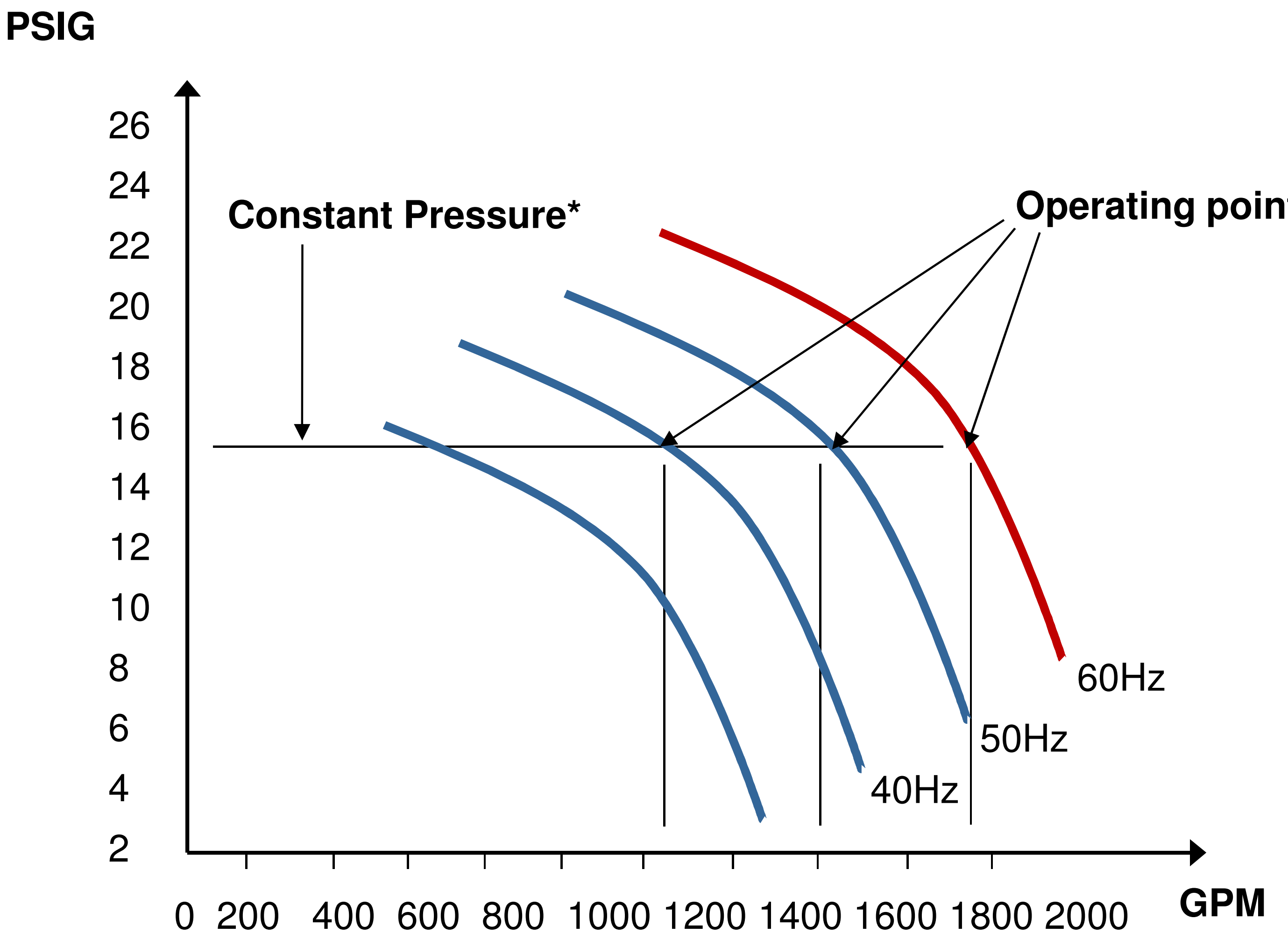
- Holistic approach
  - 15–50% reduction of total kW
  - Improved occupant comfort
  - Improved humidity control

Constant Speed Pumping



Selection of a pump curve that intersects the Design Point

Variable Speed Pumping



A typical control strategy is to control to a constant differential pressure in the loop

With the application of a variable speed drive, the pump curve shifts as motor speed decreases

Demand Flow Control Strategy:
Variable Pressure Curve Logic (VPCL)

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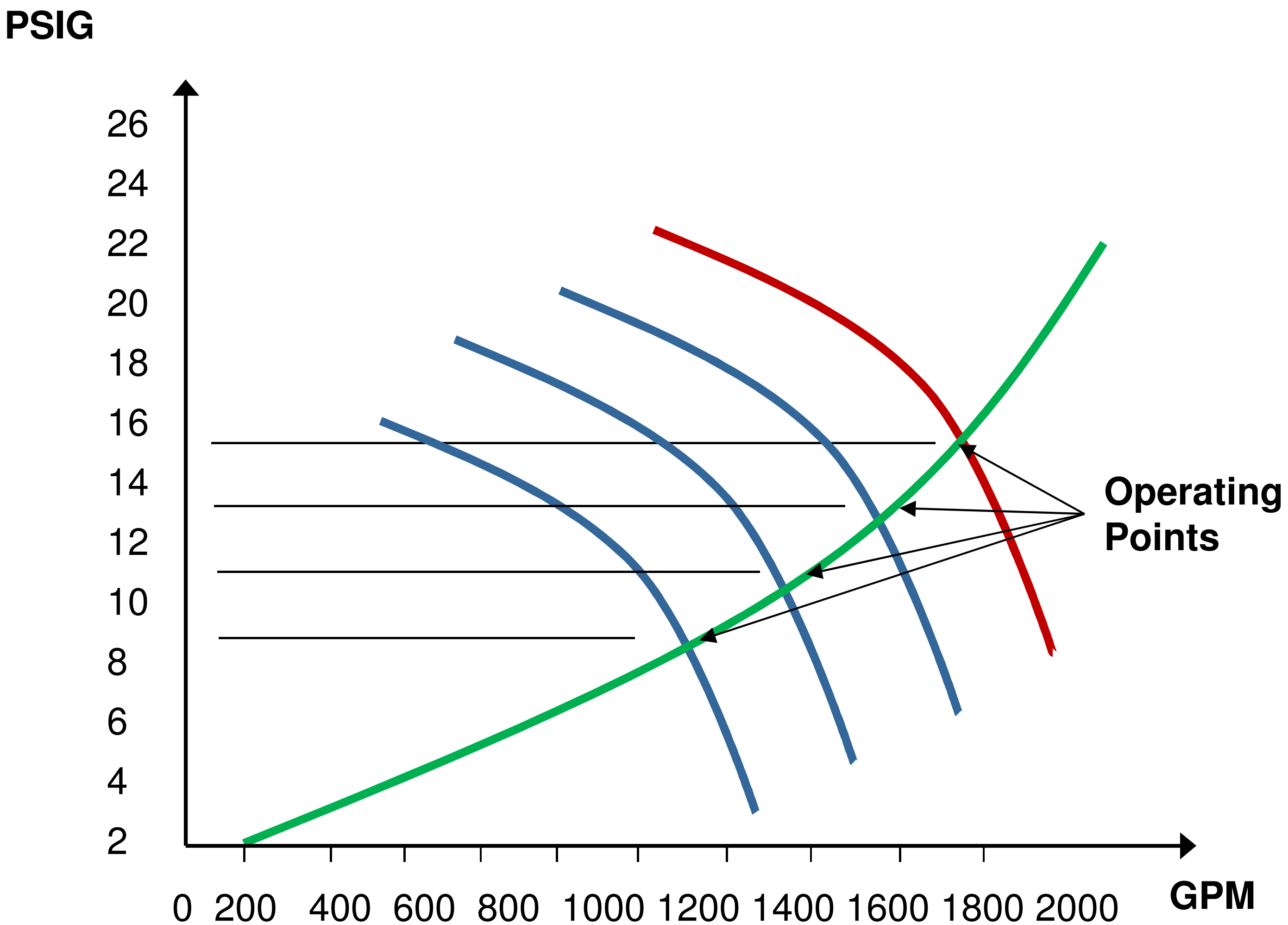
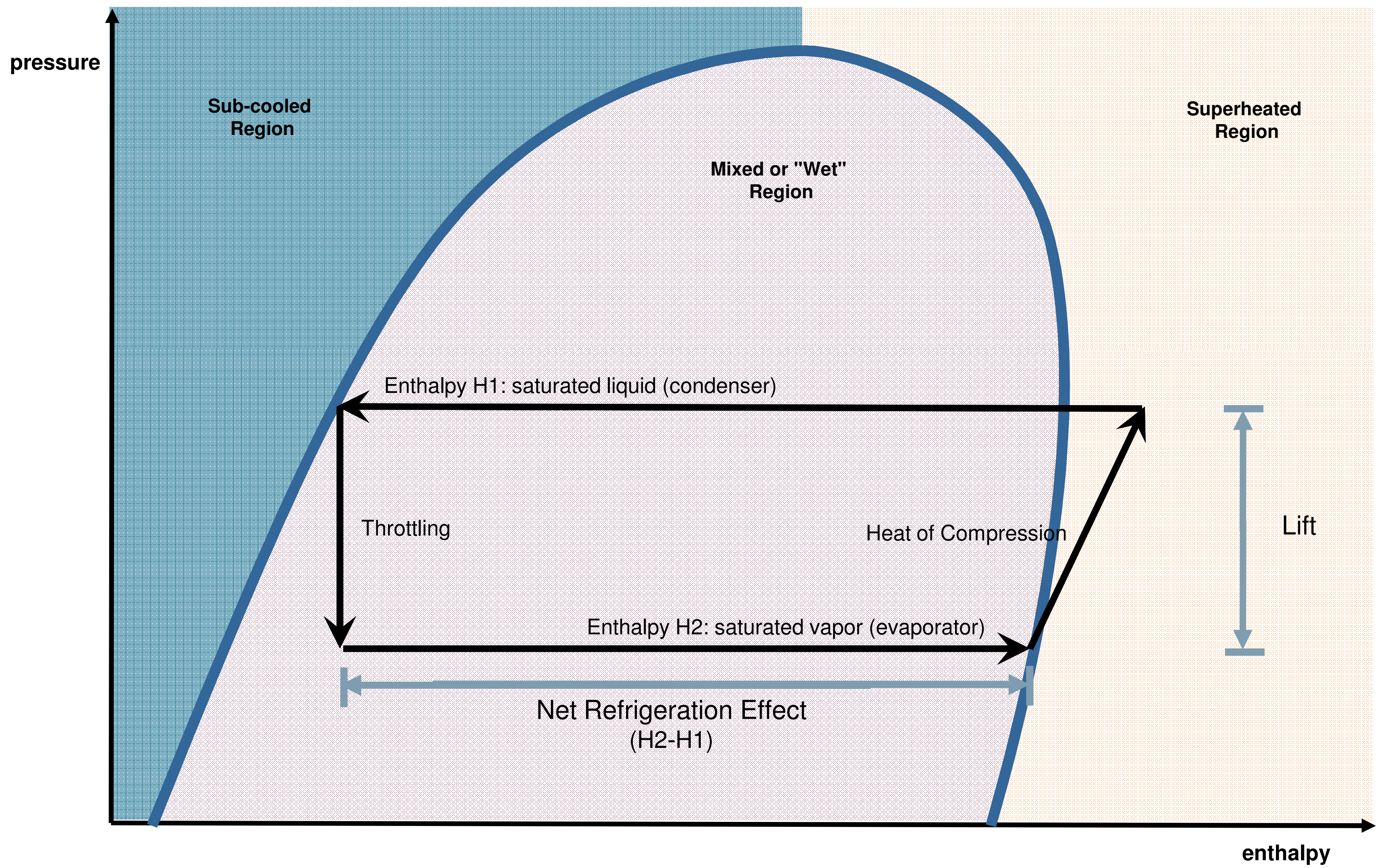
Calculated Dynamic Variable System Pressure Curve



Demand Flow continuously resets system differential pressure along calculated curve

Demand Flow Patent-Pending Variable Pressure Curve Logic (VPCL)

Refrigeration Cycle and Mollier Curve



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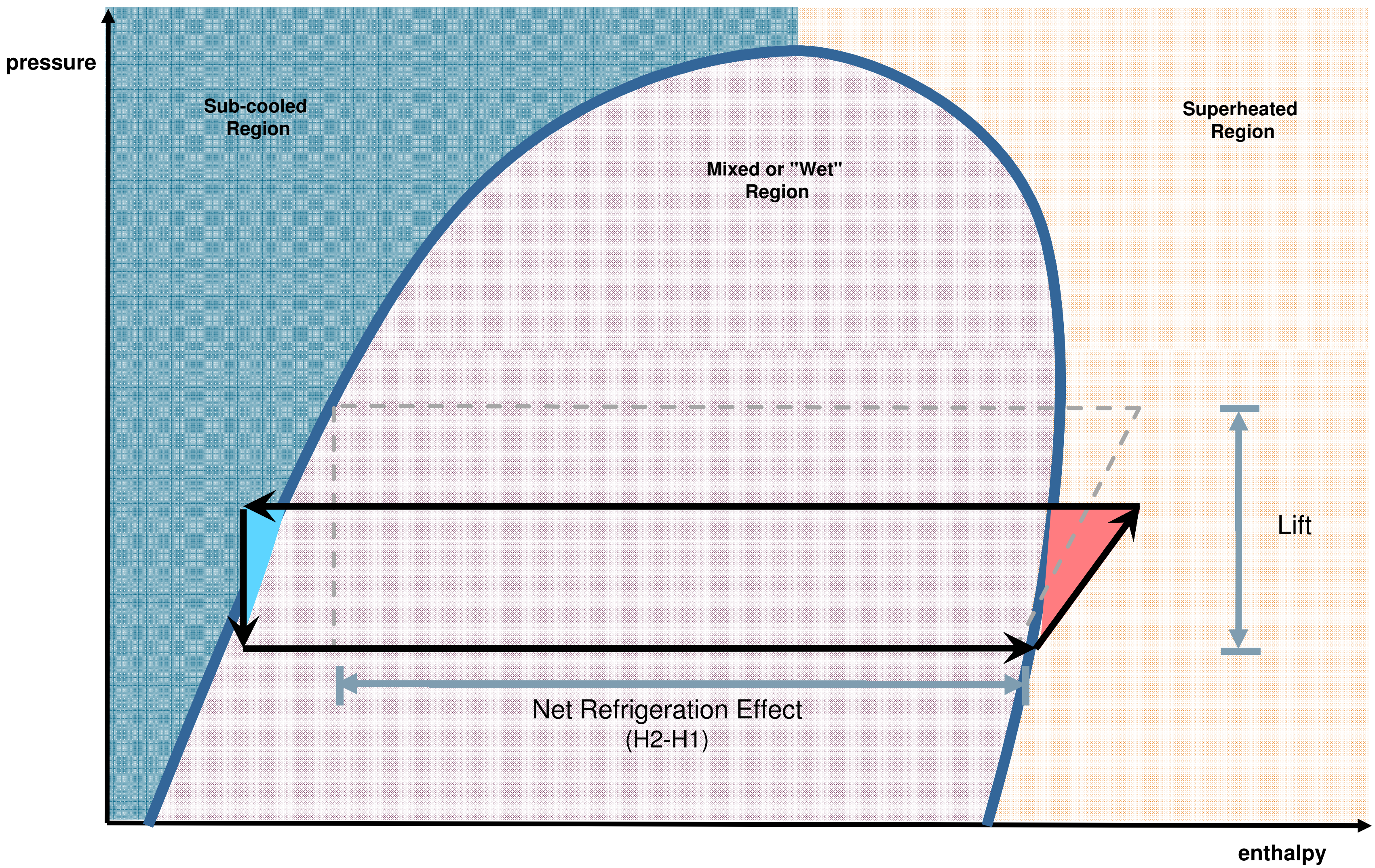
Impact on Lift and Refrigeration Effect



Compressor Energy:

Compressor Energy = Mass Flow of Refrig. x Differential Pressure or ‘Lift’

Mass Flow of Refrigerant = 200 / Refrigerant Effect x Effective Tonnage

$$\text{Compressor Energy} = \frac{200}{RE} \times \text{Effective Tonnage} \times \text{‘Lift’}$$

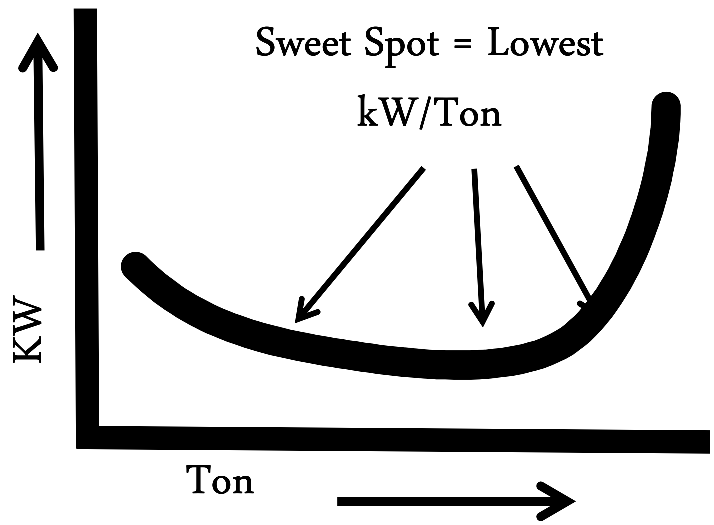
Simplified Chiller Sequencing

Traditional methods of optimization

- Reset chilled water temperature up
- Chillers sequenced via a database of load profiles
- They all try to find a "sweet spot"
- Kw/ton based on historical data not necessarily in real-time

Demand Flow Sequencing

- Demand Flow widens "sweet spot"
- Wider "sweet spot" = increased efficiency through the entire tonnage range
- Increased deliverable tonnage
- Less start/stop = less wear and tear
- Chillers sequenced lead / lag based on run-time
- Most efficient system kw/ton in real-time



What's Different

- VFDs installed on all CHW and CW Pumps and CT Fans
- Water Flow Varies thru Chiller Evaporator and Condenser
- Virtually no CHW/CW bypass
- Optimize Pressure and Temperature set-points based on system dynamics
- VFDs are **not** required on the Chillers (Will work with or without VFDs on chillers)
- Turn-key Installation and Commissioning
- Pre and Post Measurement and Verification

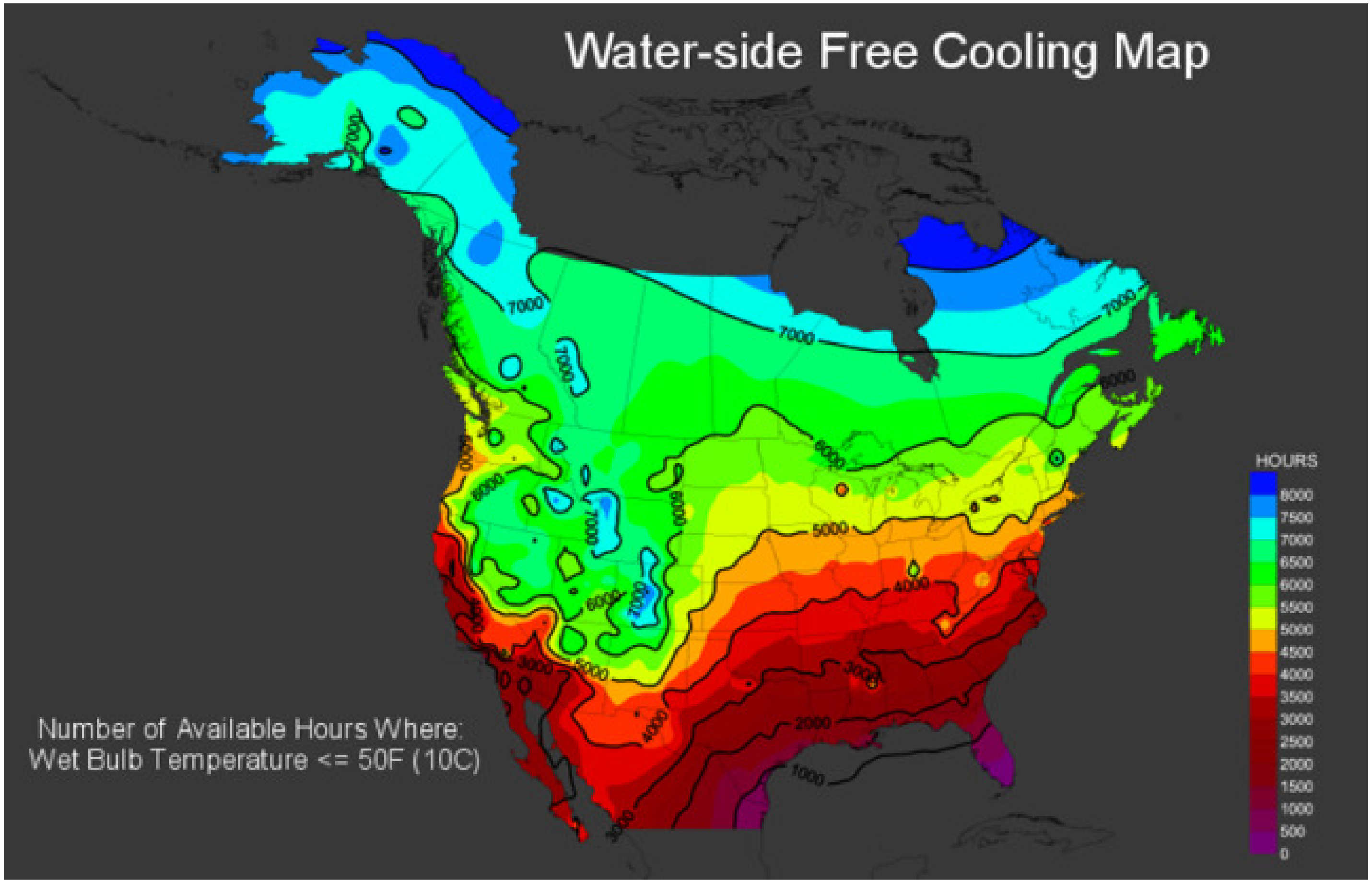
System Effects

- Solves Low Delta T Syndrome
- Increases system deliverable tonnage (where low Delta-T is present)
- Manages chiller "Lift", effectively eliminates refrigerant flow issues at low load conditions
- Stable Chiller Refrigerant loop performance at virtually all tonnage loads

Demand Flow Enables Water-Side Economizer

Demand Flow & Free Cooling

- Reliable switch-over to Water-Side Economizer
- Enables simultaneous operation of plate and frame and chiller in Demand Flow mode w/o the need for a variable speed chiller
- Proven capabilities



(Source: The Green Grid)

Primary Benefits of Demand Flow

- **Reduced energy consumption and greater performance**
  - Typically 15-50% total Chilled Water System energy savings
    - 2-4 year simple payback
  - Requires less energy to deliver potentially colder chilled water temperatures
  - Improves System *Deliverable* Cooling Capacity

- **Extended equipment Life**
  - Increased *Deliverable* tonnage means more redundancy
  - Reduced run-time = less maintenance
  - Less wear and tear on system components

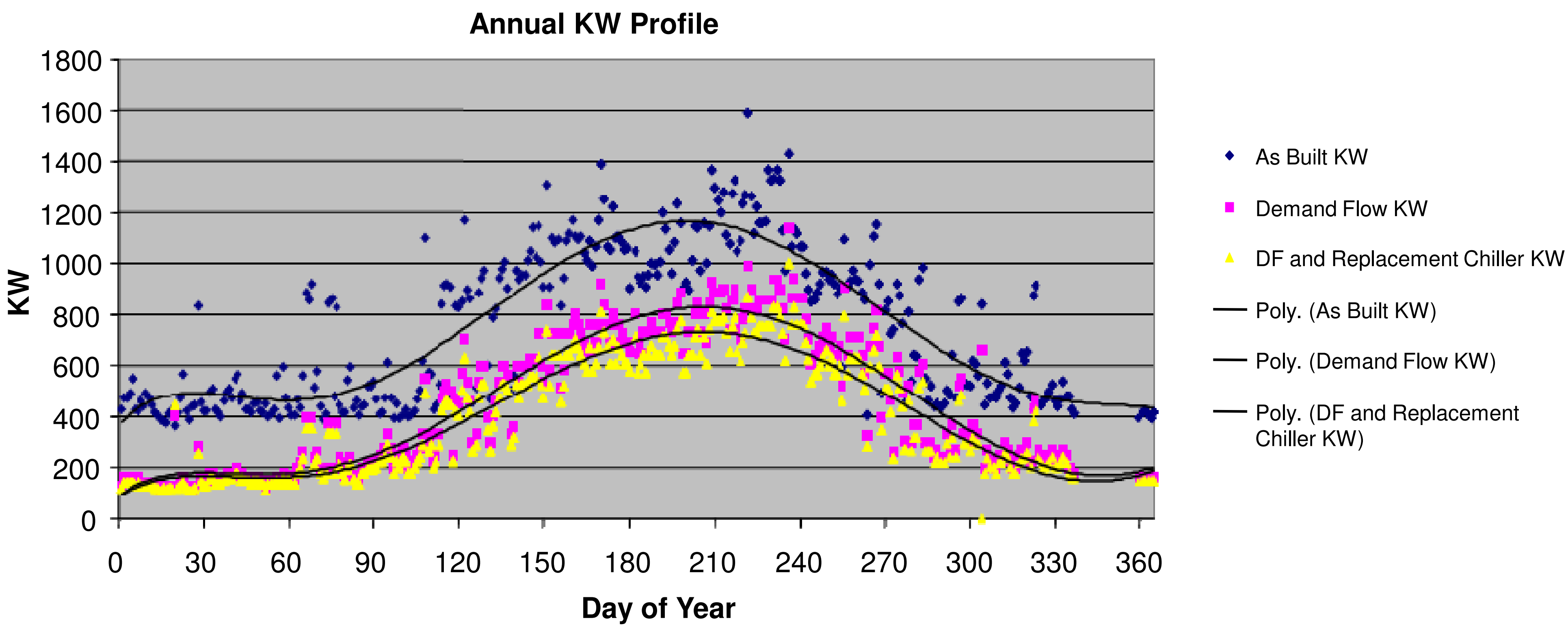
- **Improved indoor environmental quality**
  - Occupant comfort is not sacrifices to provide energy savings
  - More effective humidity control

- **Simplified system operation**
  - Sequencing chillers is typically Lead/Lag based on run-hours (can be customized)
  - More intuitive sequencing of equipment
  - Improved system reliability and control

Demand Flow results in significant energy savings and improved comfort

Statistical Energy Modeling

Siemens utilizes 12 months of customer's historical chiller logs to develop base-line energy consumption vs. optimized energy consumption



Financial Analysis: What Can You Expect

Example: Avg 1,800 Ton Plant

Typical Sell Price: $ 300k	**MBCx & "Service": $ 15k/yr**
Typical Savings: $100k/yr	**CPI: 2% escalation**

Year	DF Savings ($)	Project Cost ($)	Incentives Received ($)	MBCx & Service ($)	Annual Cash Flow ($)	Cumulative Cash Flow ($)
0					**-300,000**	
1	+100,000	-300,000	0	-15,000	**+85,000**	**-215,000**
2	+102,000	-		-15,300	+86,700	**-128,300**
3	+104,040	-		-15,606	+88,434	**-39,866**
4	+106,121	-		-15,918	+90,203	**50,337**
5	108,243	-		16,236	+92,007	**142,343**
6	110,408	-		16,561	+93,847	**236,190**
7	112,616	-		16,892	+95,638	**331,914**
8	114,869	-		17,230	+97,638	**429,552**
9	117,166	-		17,575	+99,591	**529,143**
10	119,509	-		17,926	+101,583	**630,726**

Break-even point (Year 4)

Total Cost: $ 300,000	**Total Benefit: $630,726**
IRR: 27.2%	**ROI: 210.2%**

3.4 Year Payback

Financial Analysis: What Can You Expect

DF sell price: $ 300k	MBCx & "Service": $ 15k/yr
DF savings: 100k/yr	CPI: 2% escalation

Example: Typical 1,800 Ton Chiller Plant

Year	DF Savings ($)	Project Cost ($)	Incentives Received ($)	MBCx & Service ($)	Annual Cash Flow ($)	Cumulative Cash Flow ($)
0					-300,000	
1	+100,000	-300,000	100,000	-15,000	+185,000	-215,000
2	+102,000	-		-15,300	+86,700	-128,300
3	+104,040	-		-15,606	+88,434	-39,866
4	+106,121	-		-15,918	+90,203	150,337
5	108,243	-		16,236	+92,007	242,343
6	110,408	-		16,561	+93,847	336,190
7	112,616	-		16,892	+95,638	431,914
8	114,869	-		17,230	+97,638	529,552
9	117,166	-		17,575	+99,591	629,143
10	119,509	-		17,926	+101,583	730,726

Break-even point

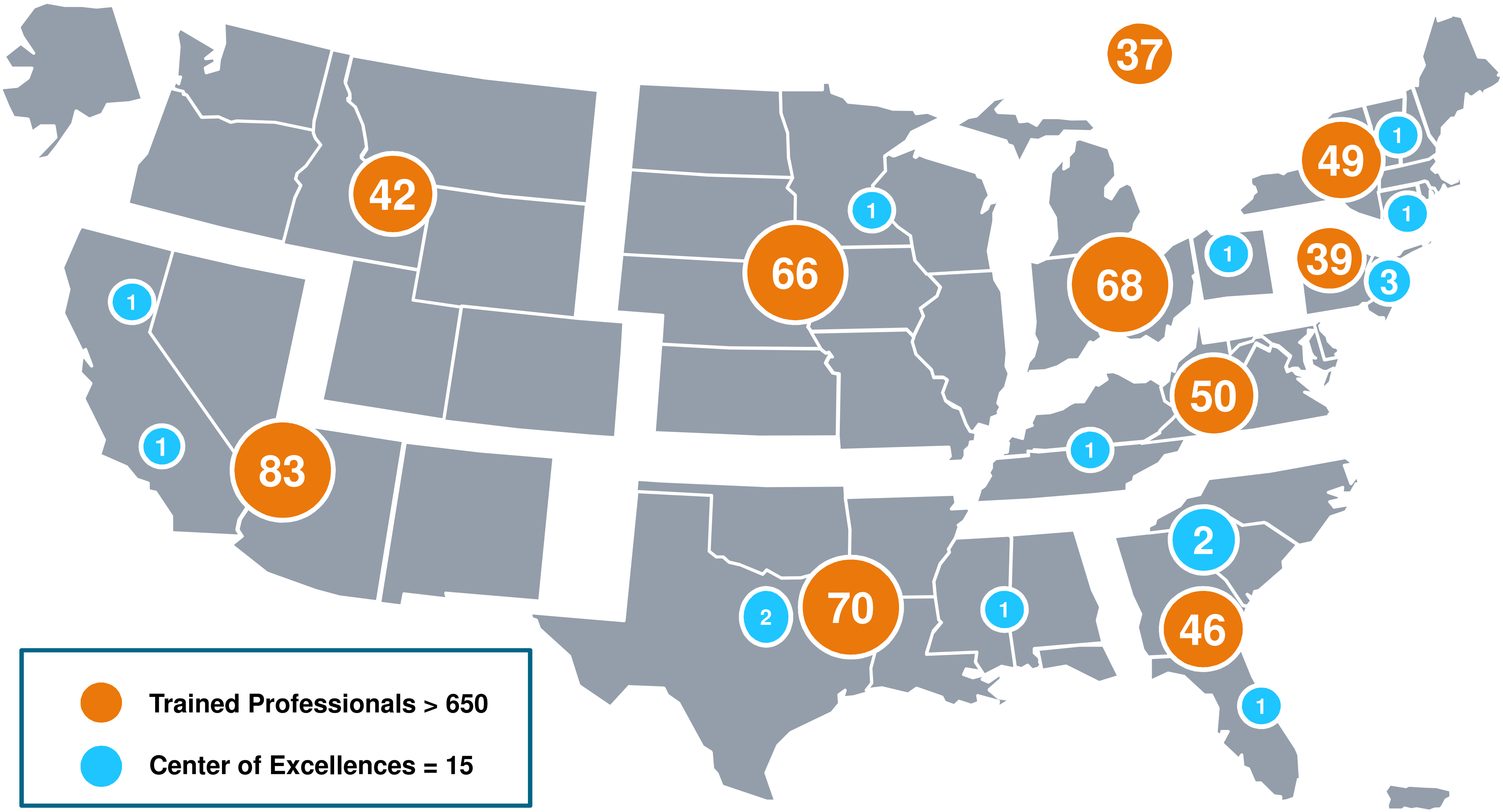
Total Cost: $ 300,000	Total Benefit: $730,726
IRR: 37.5%	ROI: 243.5%

2.3 Year Payback

Utility Rebates to Improve ROI (partial list)

Utility	Service Territory	Project Site
Duke Energy	• Indiana Kentucky • North Carolina • Ohio • South Carolina	• IBM 401 Data Center
NSTAR Electric Gas	• Eastern Massachusetts	• Novartis
nationalgrid	• Massachusetts • New Hampshire • Rhode Island • New York Upstate	• Twin River
ui	• New Haven and Bridgeport, CT	• Bluestone
nyserda Energy. Innovation. Solutions.	• New York State	• IBM Fishkill
conEdison	• New York City • Westchester County	• Financial Customer
Xcel Energy	• Colorado • Kansas • Michigan • Minnesota • New Mexico • North Dakota • Oklahoma • South Dakota, Texas	• USPS Data Center • Ameriprise Financial • Methodist Hospital
PSEG	• New Jersey	• Data Center Customer

EXPERTISE – DF Center of Excellence Team – Branch Office Support



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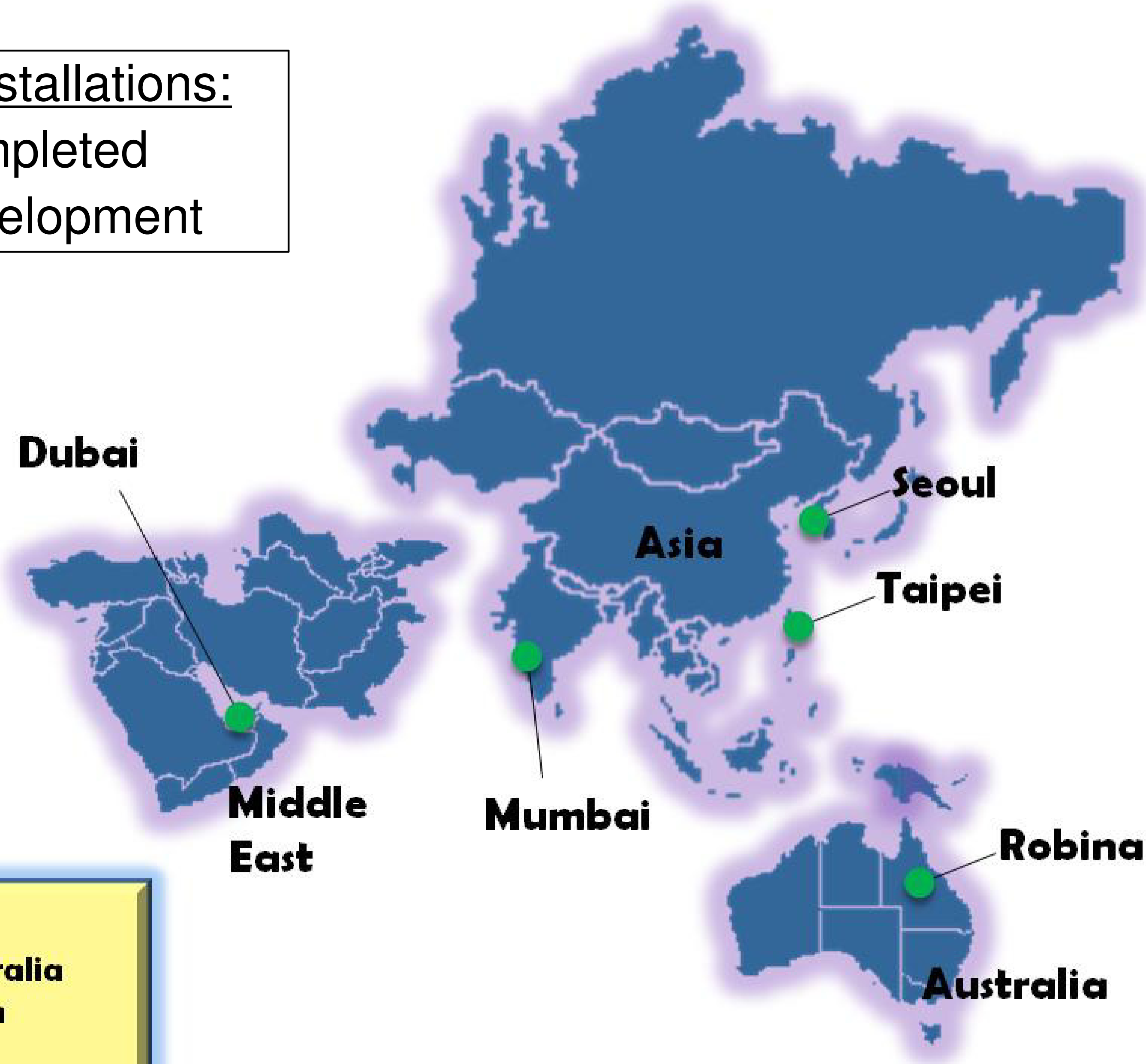
Global Installations:

5 completed

5 in development



Coming soon:

- Melbourne, Australia
- Sydney, Australia
- Singapore,
- Hong Kong, China
- Macau, China

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Kettering Medical Center Kettering, OH

Demand Flow 2014

$500K project
4 chillers – 3750 Tons
$127K savings
$250K rebate
2.3 GWH Energy Reduction

~3.9 Year ROI
(1.9 ROI w/Incentive)

Team Members:
Danny McCloud - KMC
Donald Bloom – KMC
Brian Arbogast – Heapy Engineering
Mark Dancer – DP&L
Scott Johnson – Siemens
Jim Moore – Siemens
Jake Meyers - Siemens

KETTERING Medical Center
KETTERING HEALTH NETWORK

ADD P&G INFO

Questions?