Contributing to Zero Carbon through

# T&C and System Optimization

Ir Cary Chan
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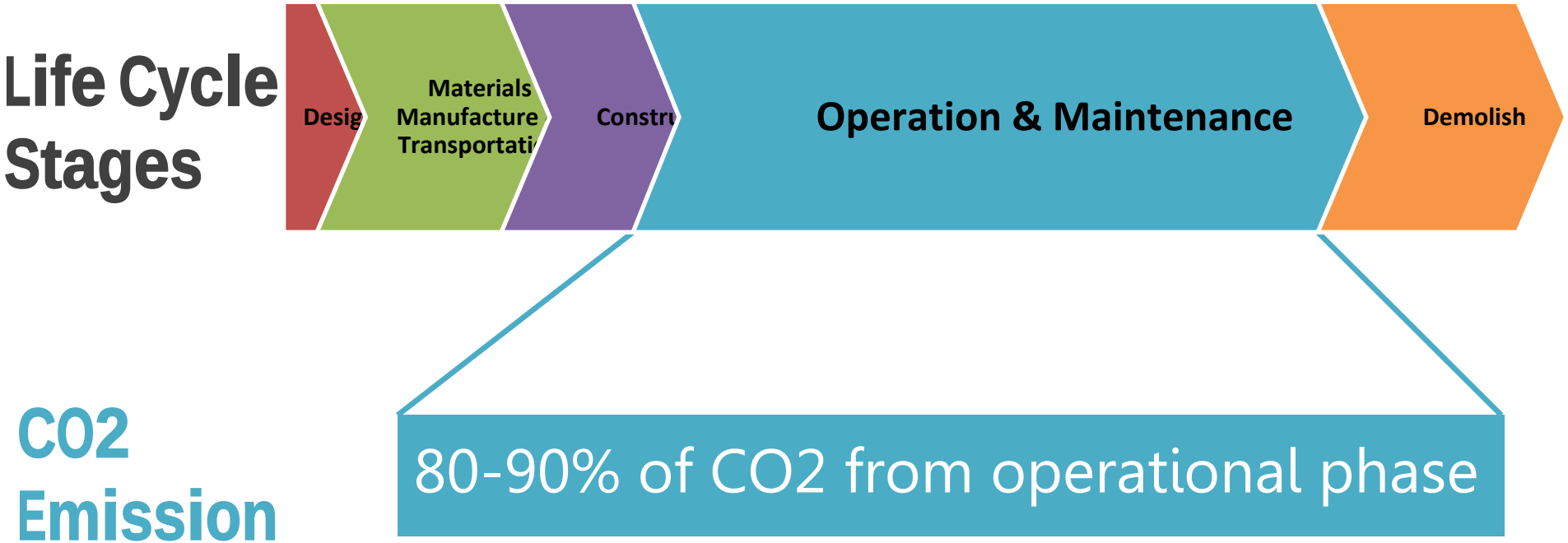
# Key Process for a Zero Carbon Building

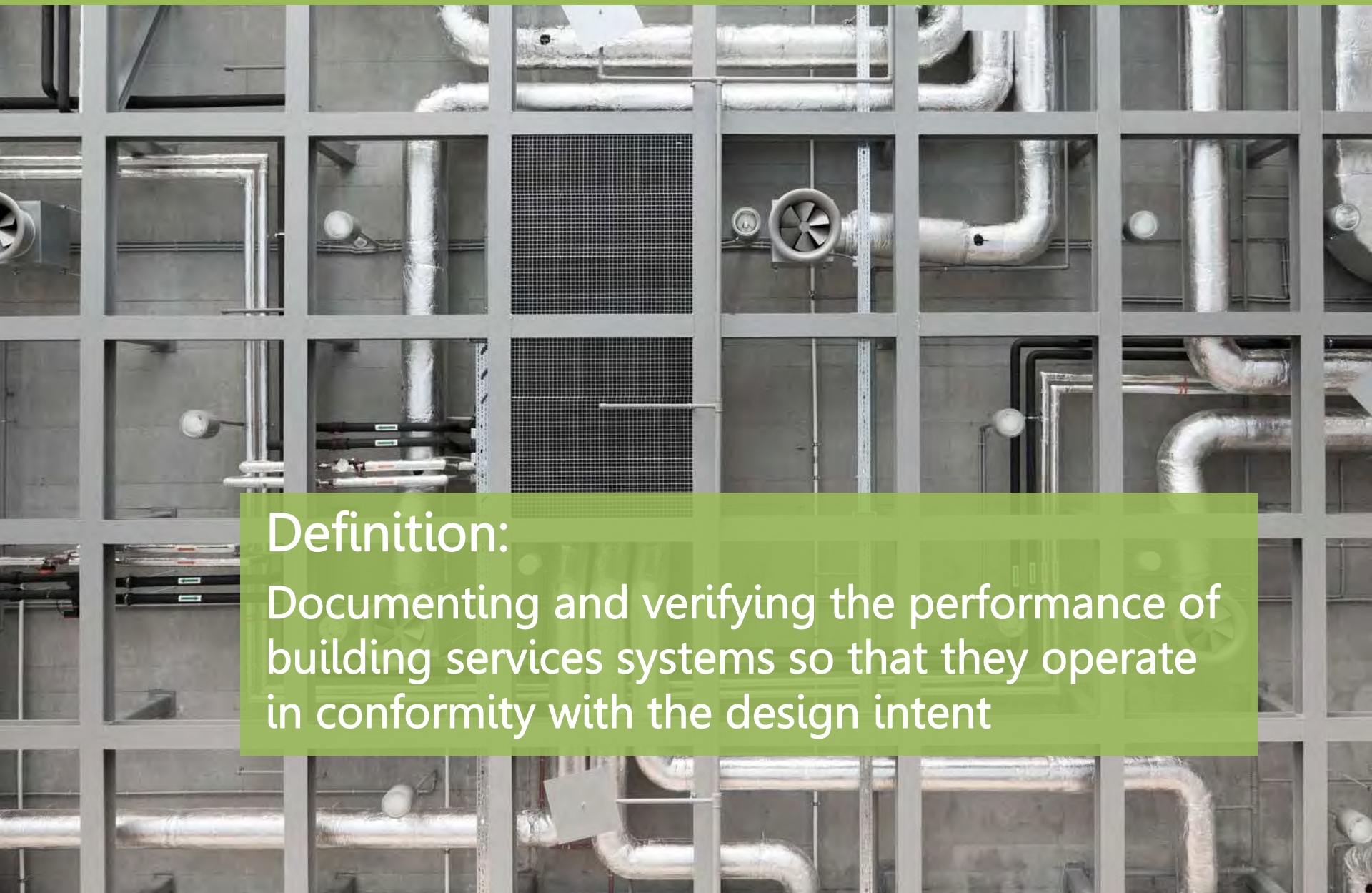
- Define objective, target and scope
- Integrated design
  - Passive design
  - Active design
- Testing and commissioning
- Continuous optimization

# Life Cycle of Buildings




Source: UNEP Sustainable Buildings and Climate Initiative. http://www.unep.org/sbci/Activities/CCM_Pilot.asp

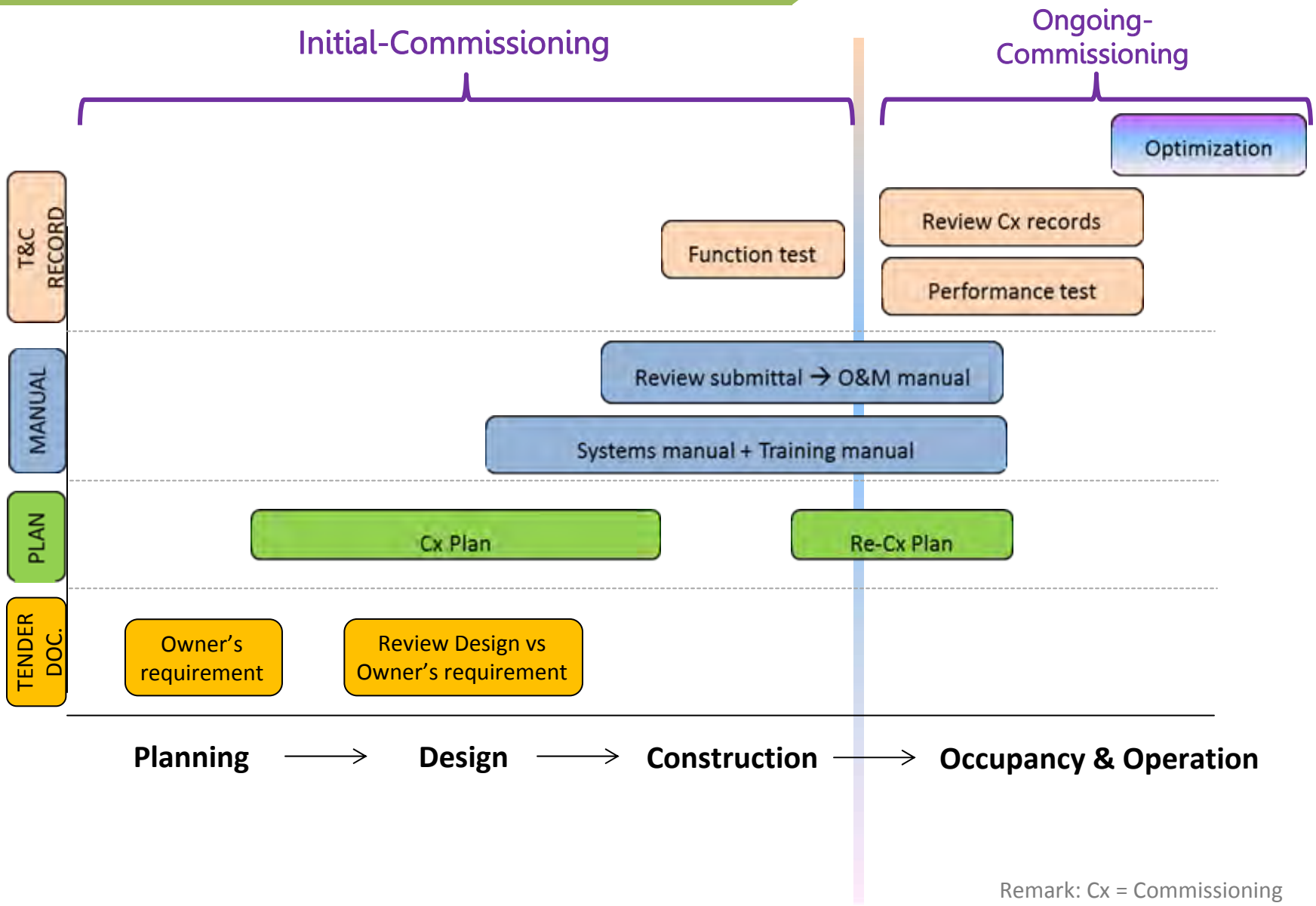
# Testing and Commissioning



## Definition:

Documenting and verifying the performance of building services systems so that they operate in conformity with the design intent

# Commissioning Process




Remark: Cx = Commissioning

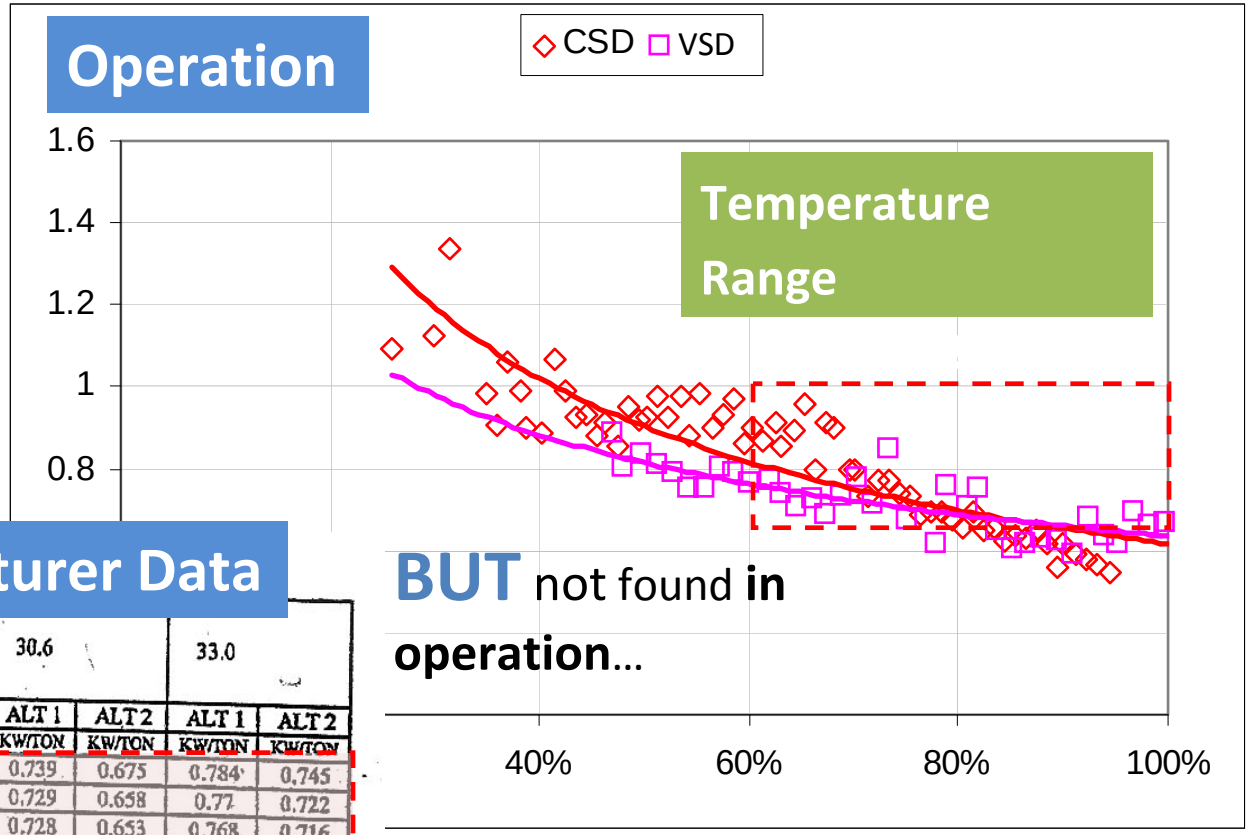
# Benefits

- **Reduce** energy/carbon consumption
- **Better** understanding of design intent & goal
- **Clearer** performance responsibilities
- **Improve** planning and co-ordination
- **Assure** quality & occupant satisfaction
- **Recognize** system capabilities and limitation

# Example 1: Commissioning of a variable speed chiller

**5-10% efficiency improvement** claimed by **Manufacturer**

**Operation**




**Temperature Range**

**BUT** not found **in operation**…

**Manufacturer Data**

| ENTERING CONDENSING WATER TEMP. (DEG. C) | 18.3 | | 28.1 | | 30.6 | | 33.0 | |
|---|---|---|---|---|---|---|---|---|
| TONNAGE | ALT 1 KW/TON | ALT 2 KW/TON | ALT 1 KW/TON | ALT 2 KW/TON | ALT 1 KW/TON | ALT 2 KW/TON | ALT 1 KW/TON | ALT 2 KW/TON |
| 600 | 0.562 | 0.415 | 0.697 | 0.614 | 0.739 | 0.675 | 0.784 | 0.745 |
| 540 | 0.562 | 0.395 | 0.691 | 0.6 | 0.729 | 0.658 | 0.77 | 0.722 |
| 480 | 0.566 | 0.379 | 0.693 | 0.595 | 0.728 | 0.653 | 0.768 | 0.716 |
| 420 | 0.573 | 0.366 | 0.702 | 0.593 | 0.737 | 0.655 | 0.775 | 0.721 |
| 360 | 0.587 | 0.365 | 0.72 | 0.601 | 0.755 | 0.666 | 0.794 | 0.737 |
| 300 | 0.613 | 0.364 | 0.751 | 0.662 | 0.787 | 0.692 | 0.826 | 0.771 |
| 240 | 0.663 | 0.378 | 0.802 | 0.662 | 0.839 | 0.739 | 0.879 | 0.827 |
| 180 | 0.761 | 0.406 | 0.892 | 0.736 | 0.929 | 0.822 | 0.97 | 0.921 |
| 120 | 0.976 | 0.48 | 1.072 | 0.88 | 1.103 | 0.983 | 1.14 | 1.106 |

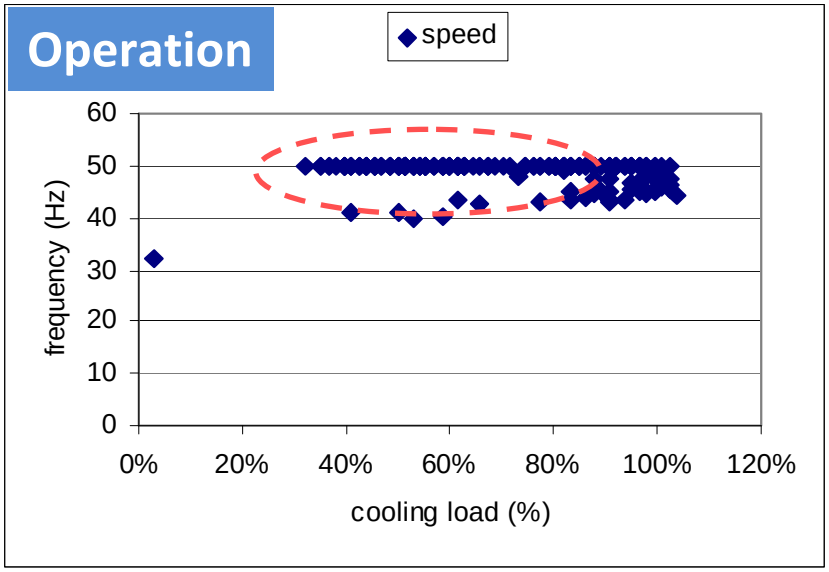
REMARKS:
ALT 1: CONSTANT SPEED
ALT 2: VARIABLE SPEED

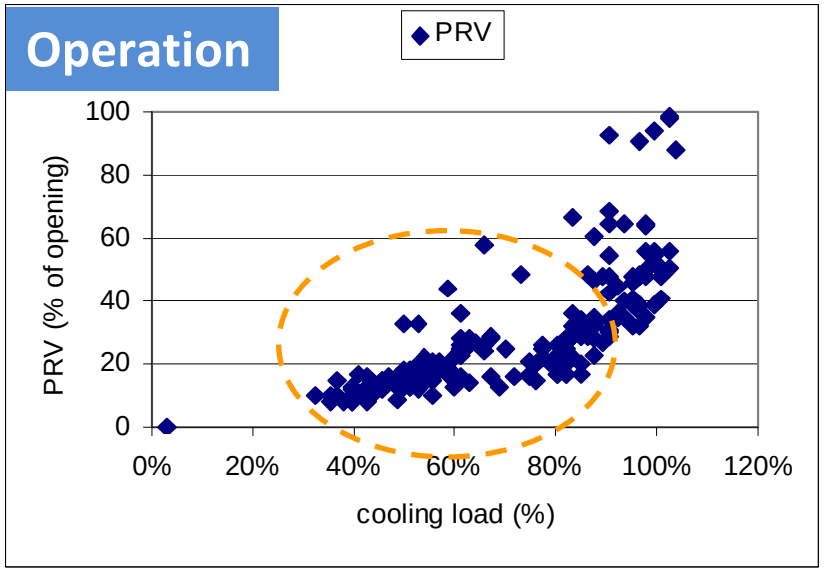
**What's Wrong?**

# Reasons

**Root Causes**

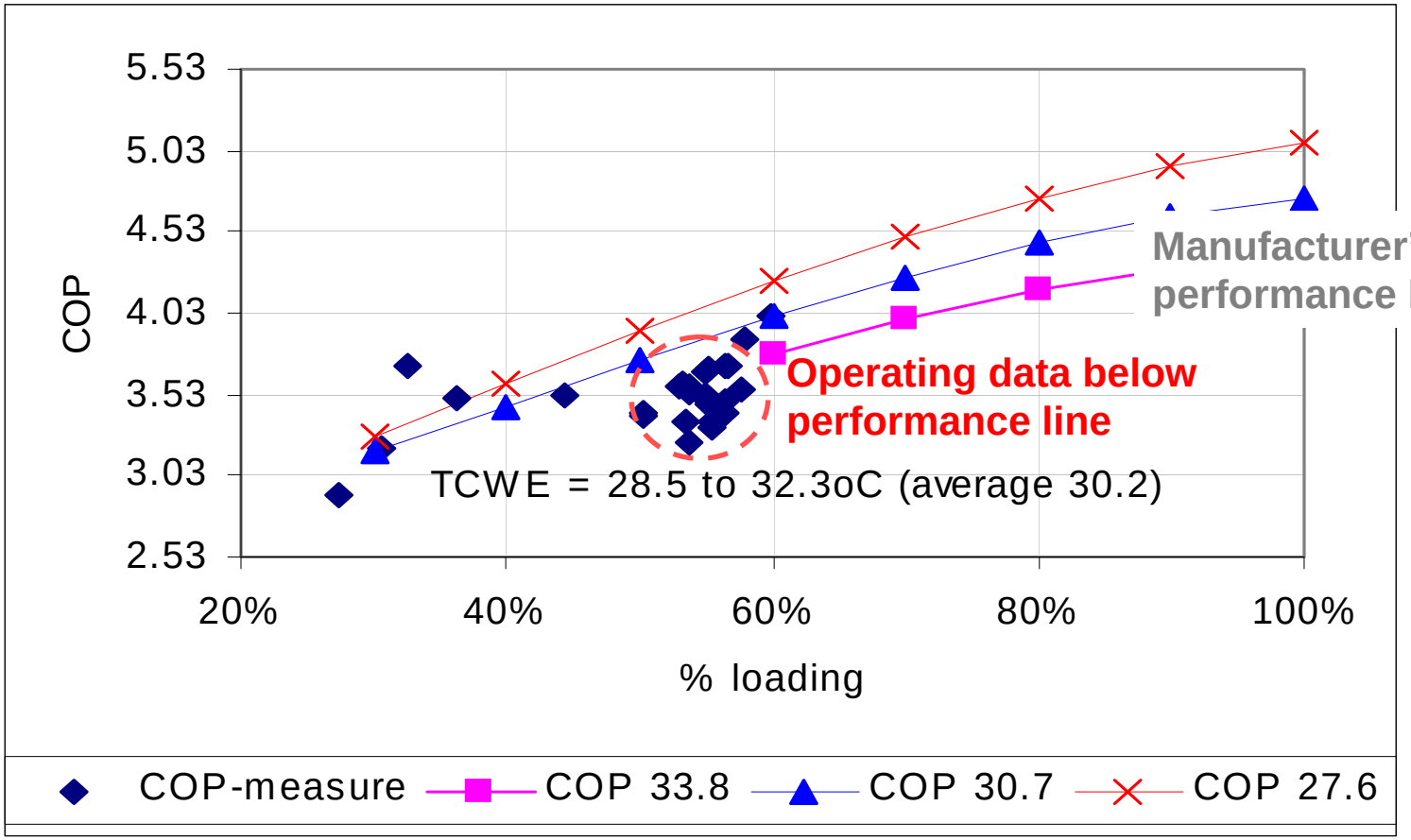
•**Speed** often at 50Hz while pre-rotation vane (**PRV**) closed to minimum (i.e. a CSD performance rather than VSD)




**7% of energy wasted due to VSD control not properly tuned**

# Example 2: Chiller operating efficiency below Manufacturer's Specification



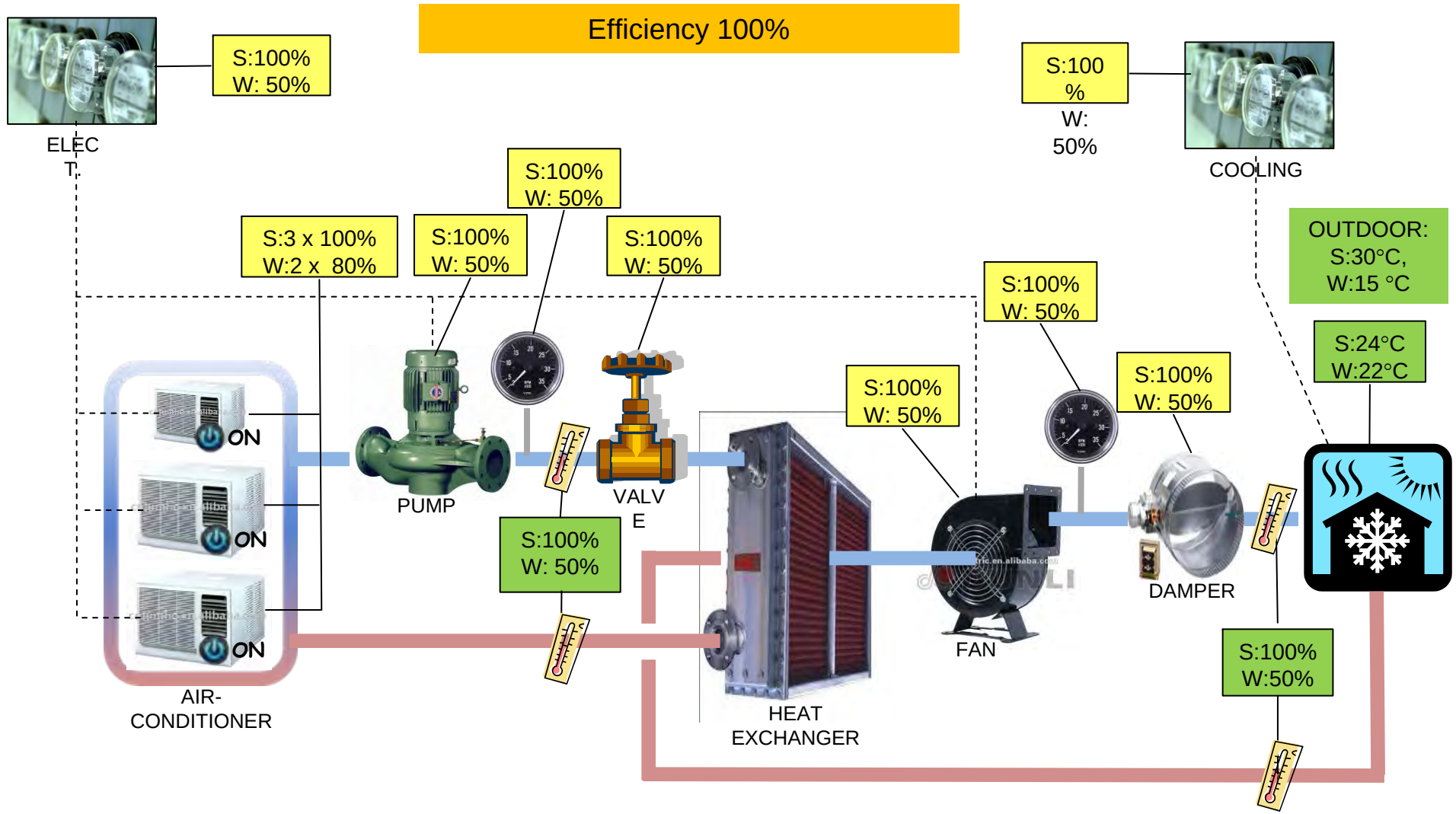

A 0.5 unit of COP drops which equivalent to 13% of energy wasted at this operating range

# System Optimization

objective:

Maintain overall high system efficiency under building in-use operating conditions

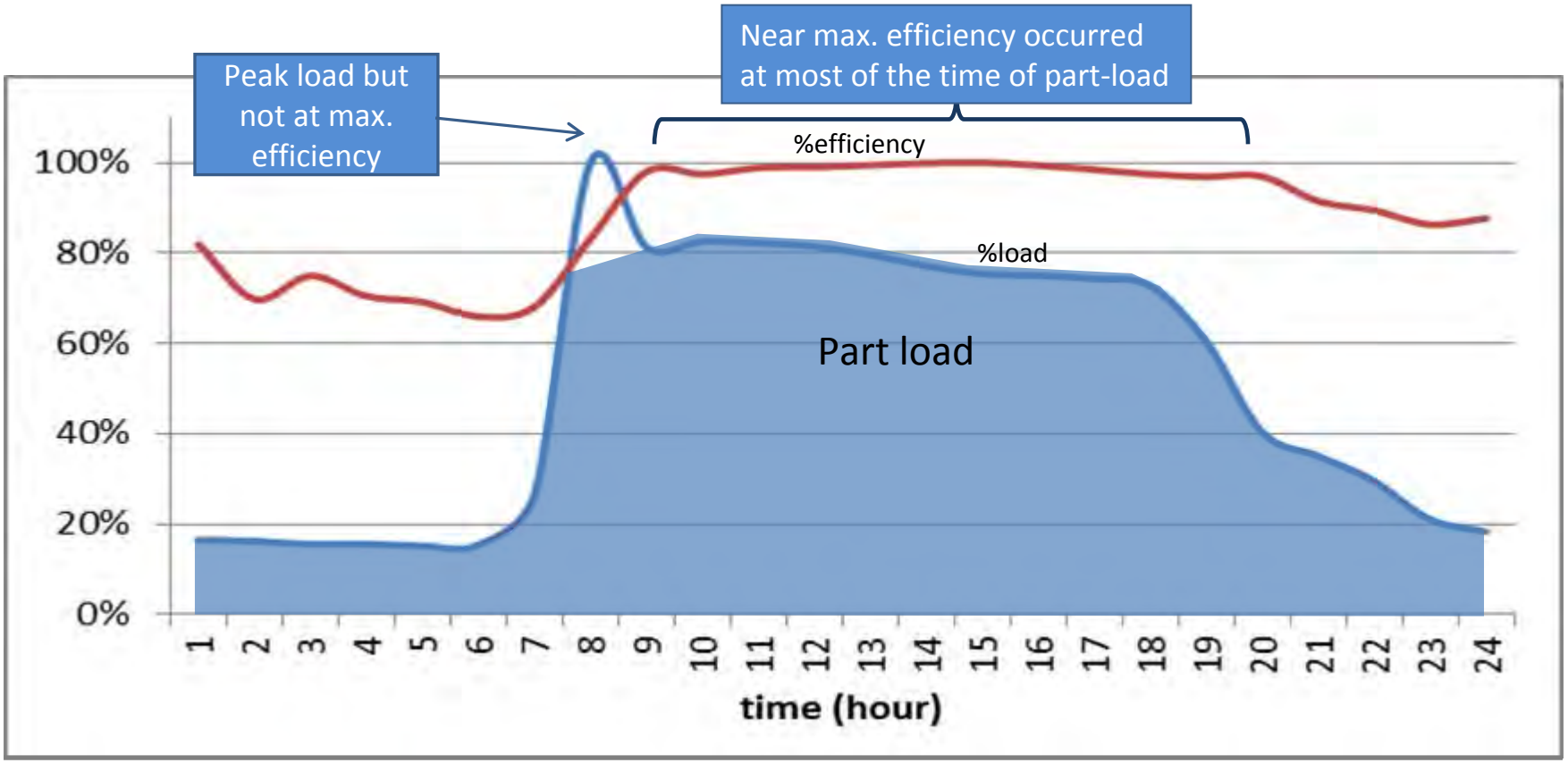
# Design Condition




Remarks: S = Summer, W = Winter

# Operation at Part Load

For air-conditioning system, >99% of time operate at part load.
i.e. Part load efficiency is more important than that of peak



# How to Optimize?

1. **Understand** change in demand & system efficiency with time and part load
2. **Reset temperature & pressure** to match with demand & equipment's operating range
3. Fine tune **logic, time constant of control process** to enhance control stability
4. Fine tune **speed control & operating sequencing** of multi-stage variable speed equipment to maximize system efficiency
5. **Keep reviewing** operation schedule/changes in requirement

# Scope


## Fine Tuning

- Control logic
- Time constant of control process
- Opening of control valve/damper
- Peak shedding

## Setting Adjustment

- Raise supply temperature
- Lower condensing temperature
- Lower pressure set-point
- Maintain high temperature differential

## System Review

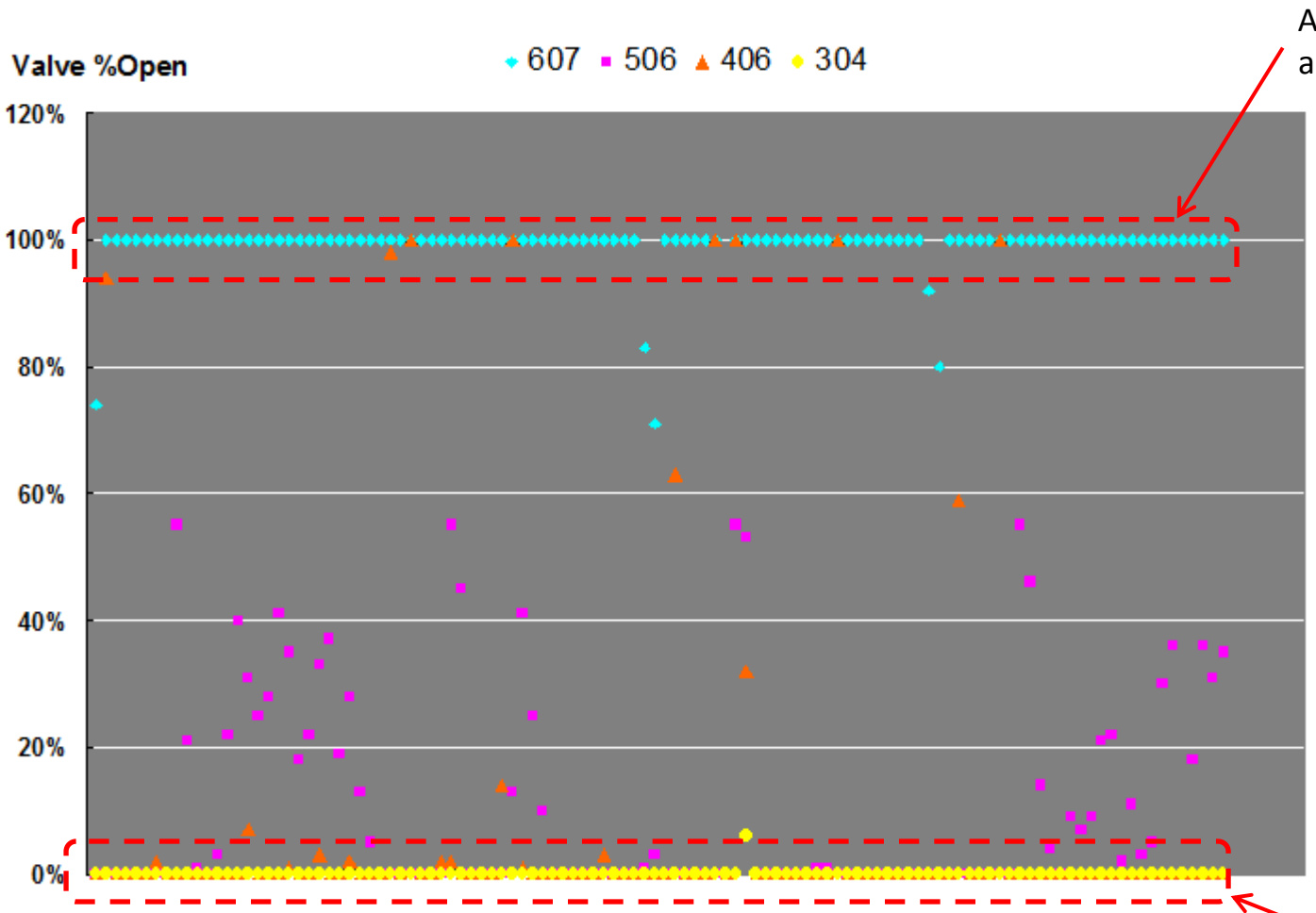
- Reduce pipeline accessories
- Primary variable flow
- Lift counterweight
- Fresh air requirement
- Reschedule operation

EFFICIENCY ↑

EXAMPLE

1. Improvement of valve opening
2. Reduction in pressure setting
3. Improvement of chiller sequencing
4. Time constant tuning for control valve

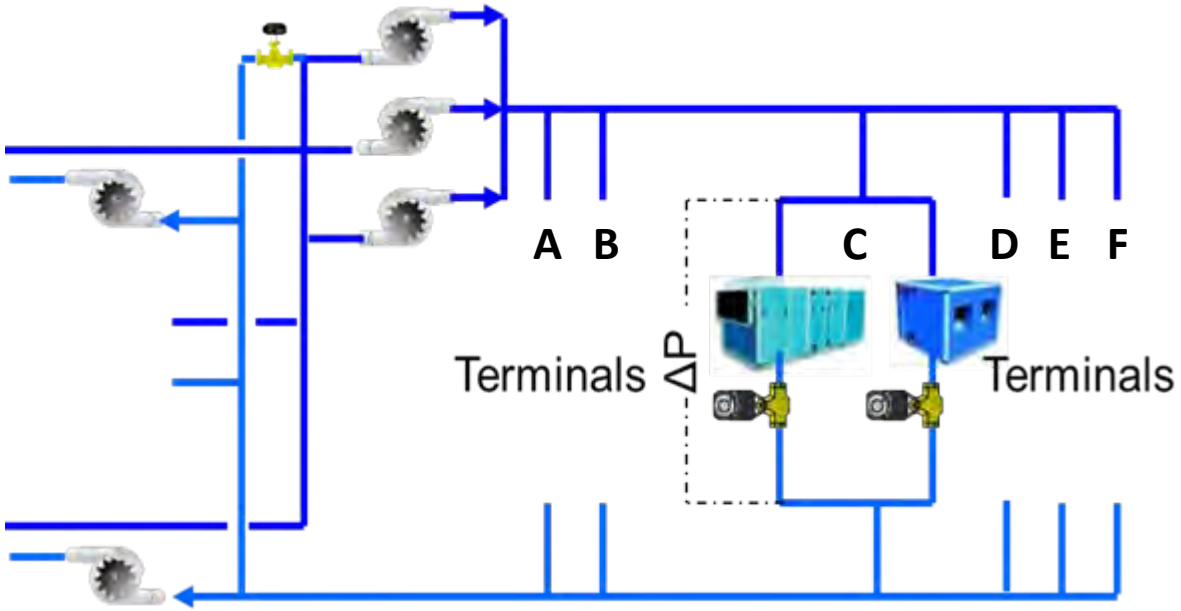
# Ex 1: Control valve always open/close




Load rescheduling can achieve 3% saving on air-conditioning system

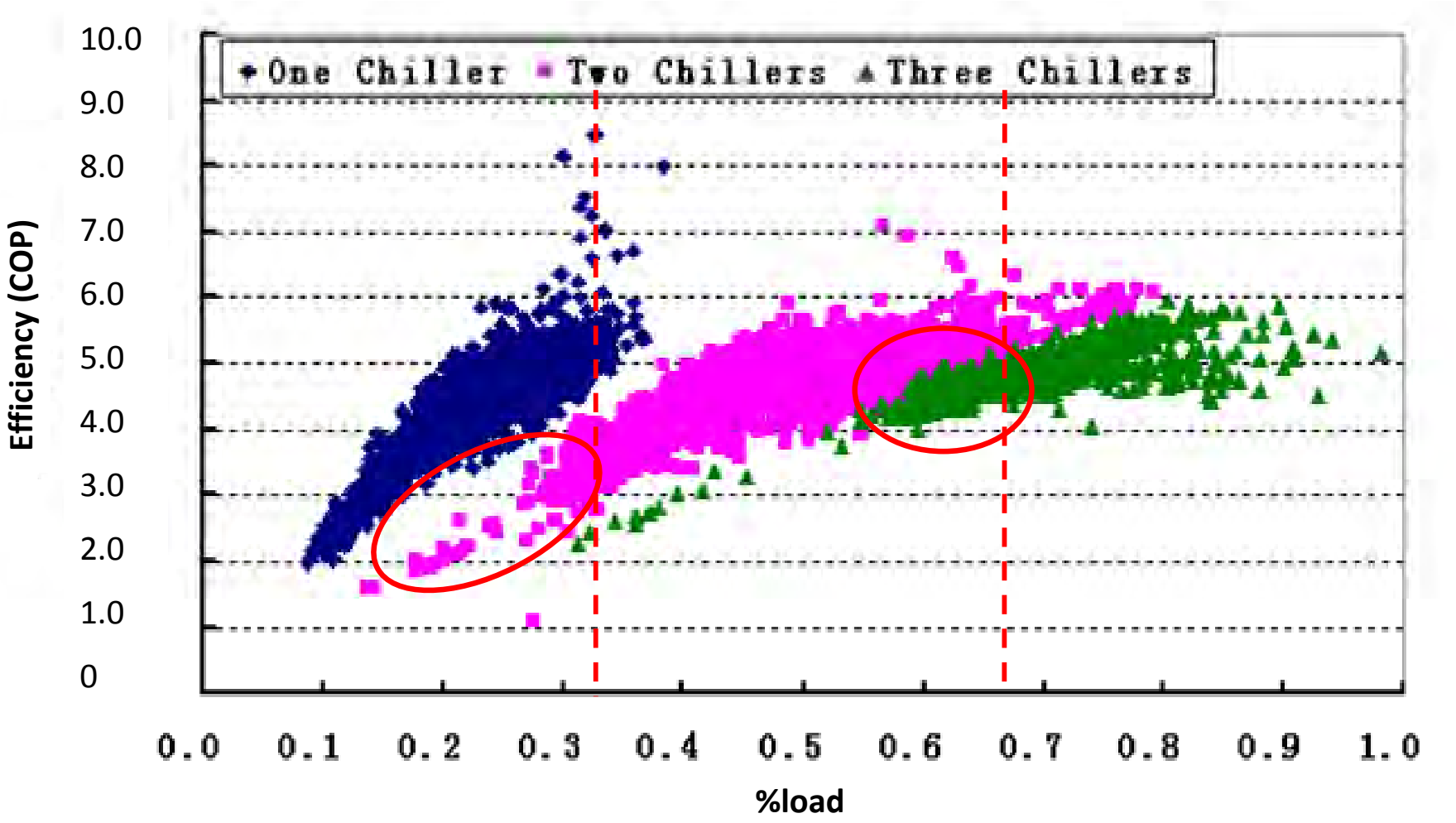
# Ex 2: Pressure setting > pressure loss

- **Riser A:**
  85 ➡ 70 ➡ 50
- **Riser B:**
  110 ➡ 70 ➡ 50 ➡ 40
- **Riser C:**
  95 ➡ 70 ➡ 50
- **Riser D:**
  95 ➡ 70 ➡ 50 ➡ 40
- **Riser E:**
  100 ➡ 70 ➡ 50 ➡ 40
- **Riser F:**
  100 ➡ 70 ➡ 50



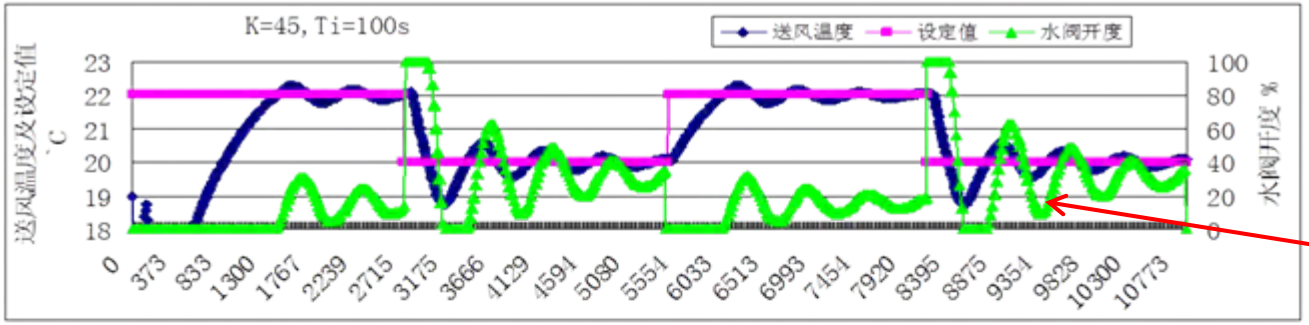

A 30% saving on pump energy without sacrificed the demand of flow

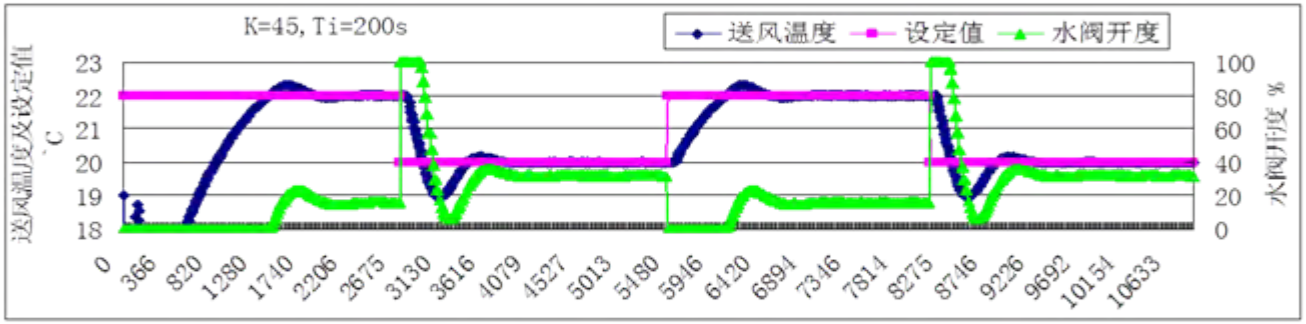
# Ex 3: Chillers operate at low efficiency

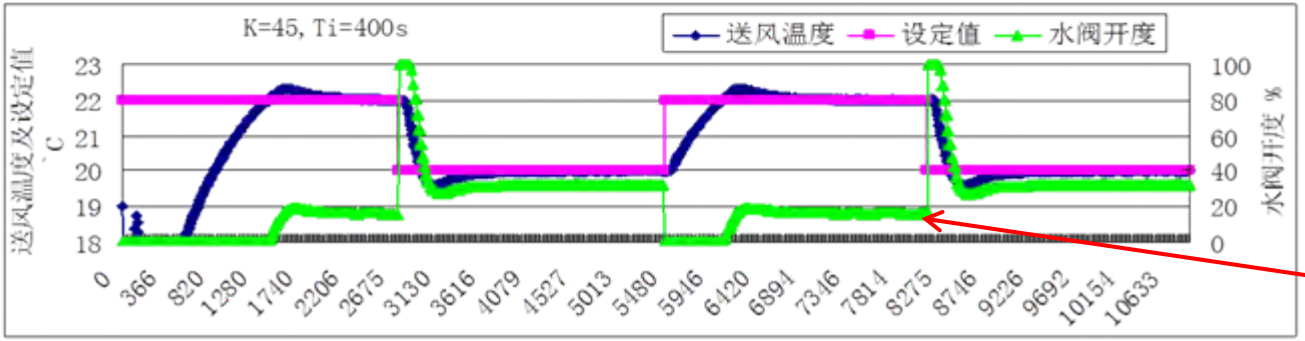



A 3% waste in chiller consumption

# Ex 4: Fluctuation of Valve control




Fluctuation of valve opening

Stable valve opening control

**A 5-15% more in chilled water flow control cause 5% waste in pump power**

# Thank You

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