

# 空調智能控制打造低碳綠建築

施駿達  
LEED AP, HVAC&R P. E.

Engineering GREAT Solutions

- IMI PNEUMATEX
- IMI TA
- IMI HEIMEIER

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## 建築物的能耗

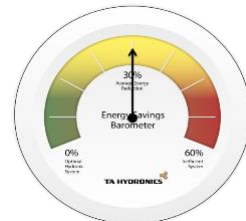


用戶分類	空調設備	照明設備	冷凍冷藏設備	事務設備	送排風設備	給水污水設備	電梯設備	其它設備
學校	59.61	17.83	2.67	7.88	1.78	2.64	3.08	4.51
辦公大樓	56.42	13.34	0.50	9.81	4.05	3.43	7.25	5.20
醫院	57.66	13.81	3.24	4.70	4.19	4.01	5.83	6.56
量販店	50.29	12.02	17.74	2.16	4.38	2.69	6.50	4.22
百貨公司	55.23	15.60	4.98	2.59	6.27	3.22	6.39	5.71
旅館	57.99	11.35	6.15	2.75	5.35	4.07	5.49	6.85
政府機關	54.22	14.10	1.64	10.89	3.75	3.08	5.75	5.93

2021年能源查核年報

全世界的總能源消耗中有40%是用在建築物上\*  
在其中**空調系統**的耗能就約佔**50%\***

(\* Sources: European Commission EPBD (point 6, pp1) & US Department of Energy's "Buildings Energy Data Book")



## 冰水回水溫度偏低， 會導致冰水主機運轉效率降低

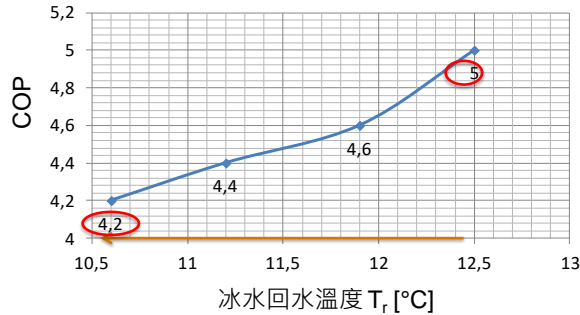


### › Studied by Carrier :

冰水主機: 200 tons (703 kW)

冷凝器溫度條件: 29,5°/35°C

冰水供水溫度  $T_s$  : 7°C



› 冰水回水溫度降低 2°C 會造成冰水主機效率 COP 降低 15%



## 為何冰水回水溫度低於設計溫度？



當 FCU 的 ON-OFF 控制二通控制閥變流量操作於部分負載時，

有些控制閥全開時：

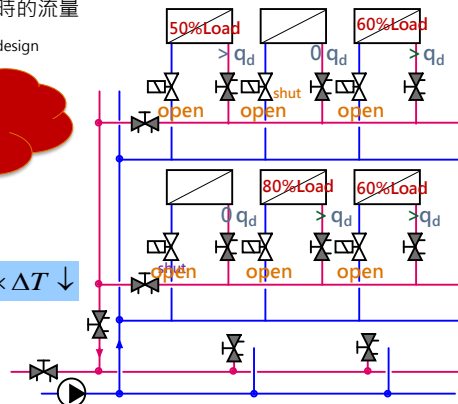
- 造成系統中管路的總流量與摩擦損失降低
- 造成其他區域控制閥全開時的流量會比其設計流量大  $q > q_{design}$

水路平衡沒做好  
將使問題更惡化

冰水過流量

$$Q = M \uparrow \times C \times \Delta T \downarrow$$

冰水回水溫度降低



## 適流量系統概念



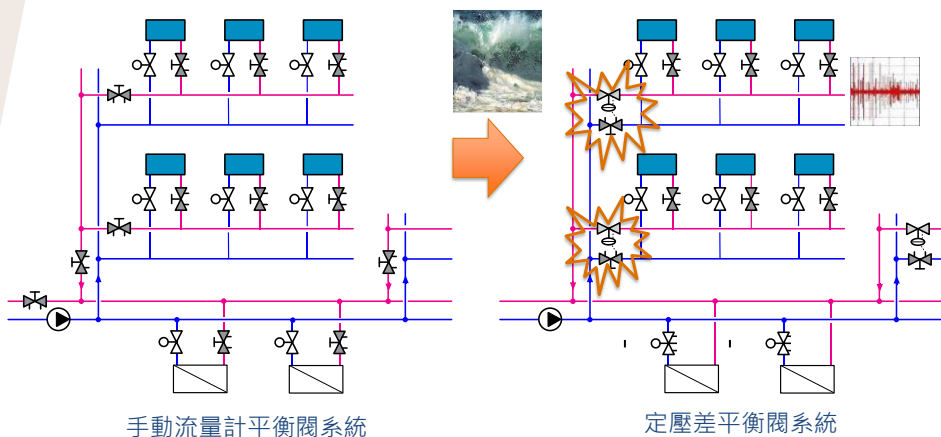
No More.....No Less  
恰到好處 不多也不少

### 系統

即時符合系統部分負載需求  
調節適當的冰水流量  
除了達到空調品質及舒適度  
兼具空調系統的節能  
為客戶帶來能源成本的降低



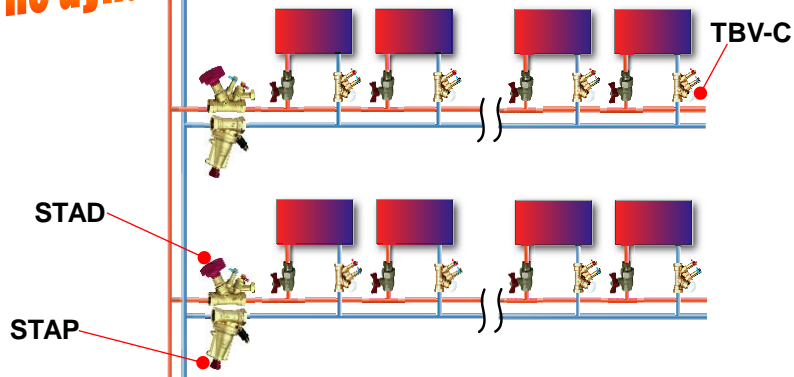
## SmartFlow 適流量系統應用



## 定壓差平衡閥組於迴路兩端



### The dynamic branch



*Excellent performance/cost ratio.*



## 定壓差平衡閥組 於空調箱控制閥兩端



# CASE STUDY by ITRI - 工研院

## 空調水路系統最佳化控制節能案例



15<sup>th</sup> Asia Pacific Conference on the Built Environment  
5R Technology for Building Environment  
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### CASE STUDY FOR HYDRONIC SYSTEM CONTROL OPTIMIZATION IN HVAC SYSTEM

Wen-Te Hung<sup>1</sup>, Chun-Ta Shih<sup>2</sup>, Yu-Chin Chen<sup>1</sup>, Wei-Hao Chen<sup>1</sup>

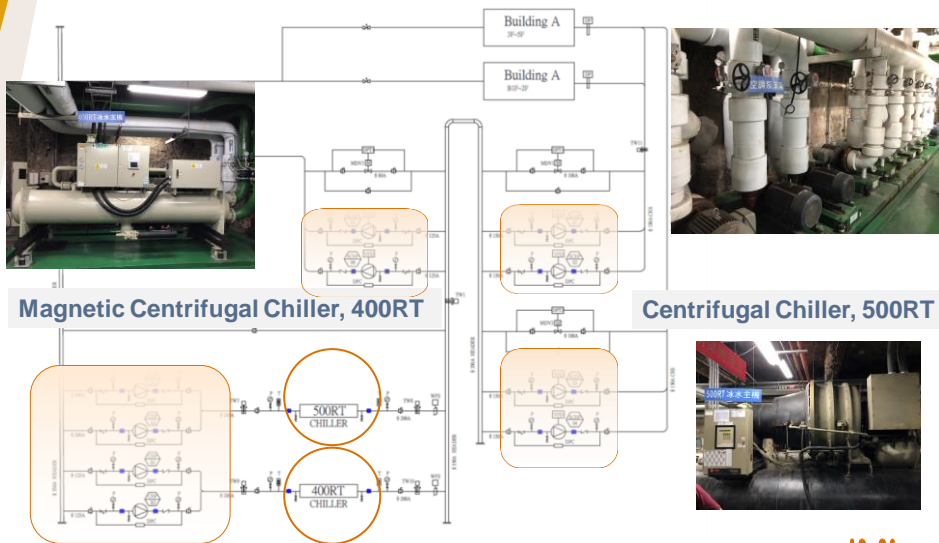
<sup>1</sup>Facility Engineering Division, Industrial Technology Research Institute, Hsinchu, Taiwan,  
<sup>2</sup>HVAC&R P.E.



發表於ASHRAE 國際研討會  
The 15<sup>th</sup> Asia Pacific Conference  
on Built Environment



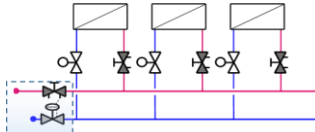
# HVAC SYSTEM OF EXISTING BUILDING



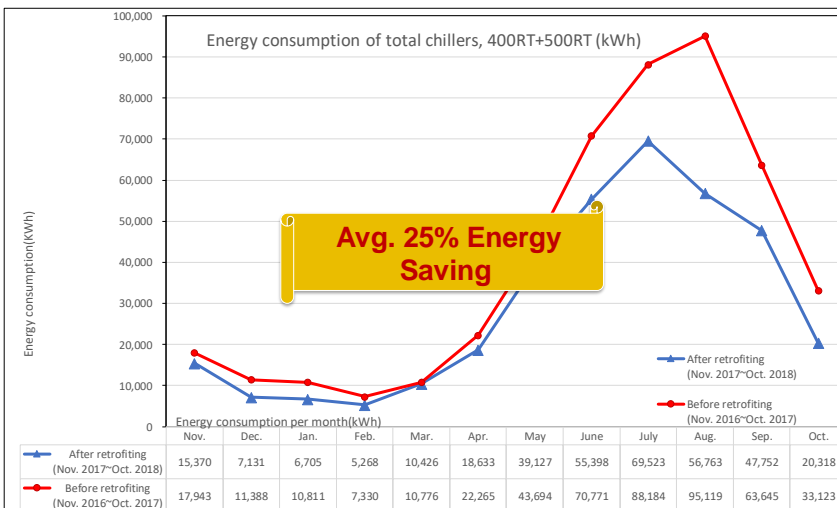
# CASE STUDY by ITRI - 工研院



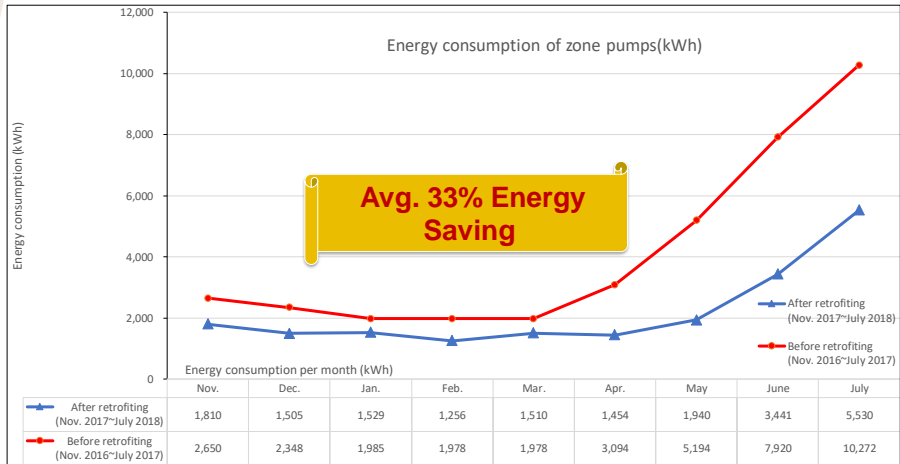
-節能改善策略-  
定壓差動態平衡閥



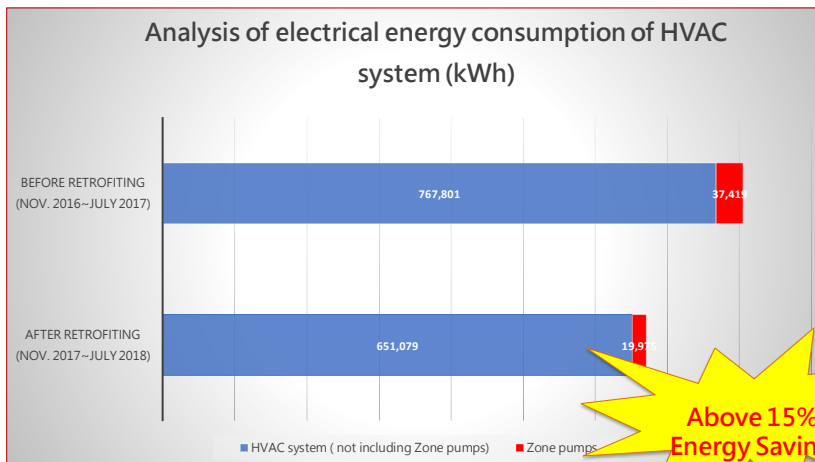
# Analysis of Energy Consumption- 400RT + 500RT Total Chillers



## Analysis of Energy Consumption- Total pumps



## Analysis of Energy Consumption – Whole HVAC System



Energy Saving around 130, 000kWh for 9 months.



# IMAGINE.....



BTU  
Meter



流量計  
平衡閥



精準  
溫控閥



定壓差  
平衡閥

+ DDC + 能源管理 + 最佳控制  
邏輯軟體 + .....

27 P

IMI Hydronic  
Engineering

Valve Construction – True Engineering Innovation



1. **高精度** 超音波流量計
2. PT 1000 溫度感測器 x 2 (PT 1000 Class AA pair calibrated in factory)
3. BTU Meter – EN1434 ; MID 2014/32/EU
4. **高可控制度與高權度** 溫控閥 – Rangeability : 200,  $\beta \cong 1$
5. DDC Controller
6. **全能** 能源管理之監控軟硬體
7. 數位化即時平衡調整 e-TAB (Electronic Digitalized TAB)

IMI Hydronic  
Engineering



## TA-Smart 全能智能控制閥



- 1.內建高精度超音波流量計可由手機或遠端直接量測、控制現場流量
- 2.優異流量控制, 由最大流量到最低0.5%的流量控制範圍內皆可穩定控制流量
- 3.業界中流量與溫度量測精準度最高, 應用的量測溫度範圍最廣
- 4.手機或遠端即可顯示水路系統資訊, 讓系統診斷更便利
- 5.業界中尺寸最小, 牙口式突破傳統設計, 無直管距離仍維持高精準流量量測



## 智能控制閥



**Functions:**

- ▶ **Control** (q, P, position, dT)
- ▶ **Pre-setting** (max./min. q, max. P, max./min. position)
- ▶ **Reading** (q, P, Tsupply, Treturn, ΔT, position, energy)

**Logging time-frame options:**

- ▶ **Xtra Long Logging** (13 months, every 1 hour)
- ▶ **Long Logging** (31 days, every 1 minute)
- ▶ **Fast Logging** (7 days, every 15 seconds)
- ▶ **Xtra Fast Logging** (12 hours, every 5 seconds)

**IMI TA**

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## 流量量測 - 精準且範圍廣

**METR**

在全流量與溫度控制範圍內:

- ▶  $\pm 2\%$  from 100% to 5% of  $q_{nom}$  for **water**
- ▶  $\pm 3\%$  from 100% to 5% of  $q_{nom}$  for **water + glycol**

Certain manufactures do **not ensure measurement in water-glycol mixtures or differentiate the accuracy for these mixtures.**

Other manufactures do not guarantee any measurement accuracy **below 20% of controlled flow**.

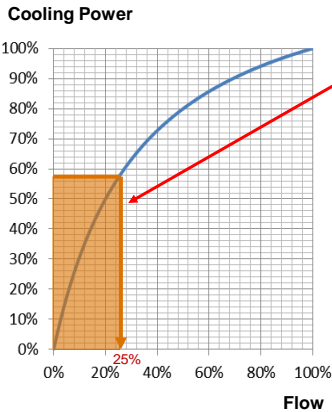
**5~20%的流量量測與控制  
決定空調控溫精準!**

IMI TA provides **high flow/dT measurement accuracy aligned with EN1434 MID - Class2** for water at any temperature.

**IMI Hydronic Engineering**

# 冷卻盤管特性曲線

Cooling coil curve @  $dT=6\text{ k}$



**Below 25% of flow, some manufactures do not guarantee any measuring and control accuracy, which is essential for valve's performance.**

**This contributes to 58% of cooling load of AHU/MAU and represents a big part of cooling season.**



IMI Hydronic Engineering Confidential



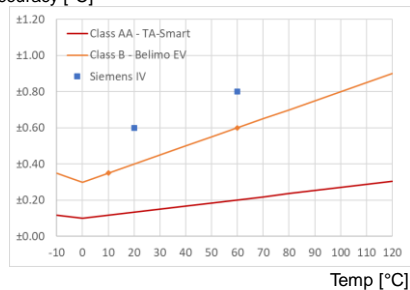
## Temperature measurement accuracy

› Temperature sensors used by TA-Smart (internal and remote) are Pt1000 EN 60751 class AA

› Pt1000 EN 60751 Class B sensors are very common in energy metering devices



Accuracy [°C]



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## Differential temperature ( $\Delta T$ ) measurement accuracy

- › The 2 Pt1000 class AA sensors of TA-Smart are pair-calibrated to provide improved accuracy at low  $\Delta T$

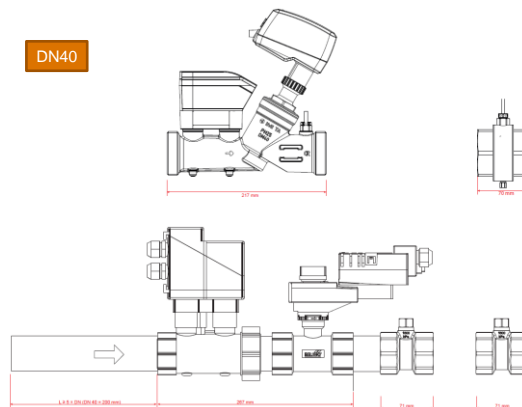
Temp. regime			TA-Smart		Belimo EV	
Supply Temp [°C]	Return Temp [°C]	$\Delta T$ [K]	Accuracy [K]	Accuracy [%]	Accuracy [K]	Accuracy [%]
6	12	6	$\pm 0.06$	1.1%		
15	18	3	$\pm 0.03$	1.2%		
40	30	10	$\pm 0.08$	0.8%		
70	50	20	$\pm 0.17$	0.9%	$\pm 0.18$	1.8%
					$\pm 0.23$	1.2%



## 安裝便利且體積更小



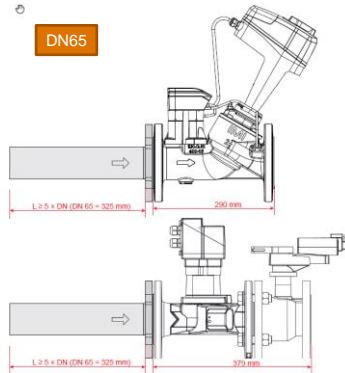
- › TA-Smart DN32-50
  - The shortest, by far
  - Two bodies (4 fittings to achieve only)
  - **0D** requirement upstream
- › Other Energy Valve
  - 60% longer (DN40)
  - Three bodies (6 fittings)
  - 5D requirement upstream



## 安裝便利且體積更小



- › TA-Smart DN65-80
  - F1 length ! (Face-to-face length EN-558-1)
  - Remote temp. sensor to be fitted separately
  - 5D requirement upstream
- › Other Energy Valve
  - 31% longer (DN65)
  - Remote temp. sensor to be fitted separately
  - 5D requirement upstream



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## Control:

*Translating accurate measuring into cost effective comfort and energy management to improve PUE performance in data center*



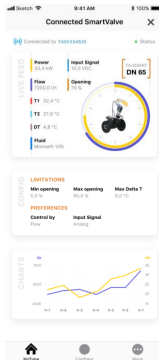
# 多元通訊界面



## Bus comm

- BACnet MS/TP AS/BS
  - Modbus RTU
  - BACnet IP
  - Modbus TCP
- from/to BMS

0-10 VDC (or 0-20 mA)  
from BMS (PLC)  
0-10 VDC feedback  
to BMS (PLC)



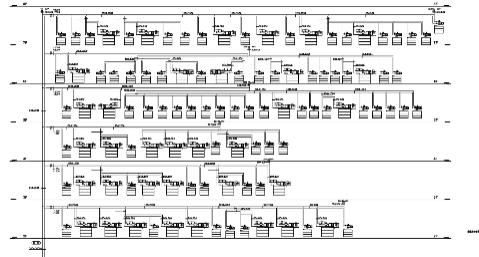
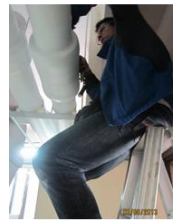
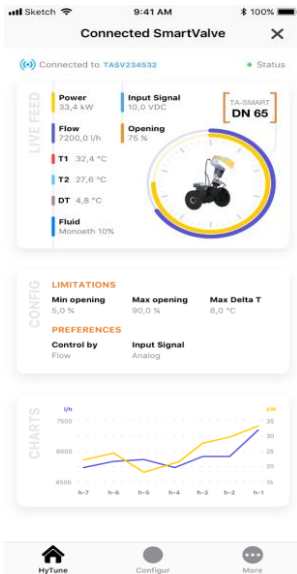
**BLE 5.0 (BLE 4)**  
to smartphones and tablets  
(Android and iOS)  
*No laptop, no cable, no dongle needed*



**MQTT**  
to and from Cloud



# 數位化現場平衡調整 e-TAB (Electronic Digitalized TAB)



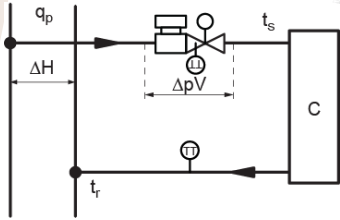
2-way control valve with EQM characteristics with flow, temperature and power measurement (TA-SMART) for CRAC unit



VERTIV™

### TA-SMART CONTROL APPLICATIONS

METR



Different Types of CRAC units (Ceiling/ Row/ Floor standing/ CAHUs)

IMI Hydronic Engineering

## TA-Smart 全能智能控制閥



- › **全能控制:** 精準多圈多轉球型EQM特性控制閥, 控制能力( $\beta=1$ )達到精準控溫目的
- › **功能整合:** 整合BTU表, 比例式二通控制閥, 流量計平衡閥, 定壓差功能, DDC控制器
- › **優異量測與控制精度:**
  - ✓ 在全流量與溫度控制範圍內, 流量量測精準度:  
 **$\pm 2\%$  from 100% to 5% of  $q_{nom}$  for water**  
 **$\pm 3\%$  from 100% to 5% of  $q_{nom}$  for water + glycol**
  - ✓ 搭配高精度溫度感測器 **Pt1000 EN 60751 class AA**
  - ✓ 最大流量到**最低0.5%**的流量控制範圍內皆可穩定控制流量
- › 能量可視化監控
- › 現場系統診斷量測與TAB更容易
- › 節省安裝工時與成本
- › 多元通訊界面 · 整合大數據系統節能分析
- › 精準且穩定的溫度控制讓空調舒適度與節能同時兼顧



**TA-Smart – test site @ Capitaland’s Creative building  
in Singapore from 2021 December till present**

Engineering  
GREAT  
Solutions

IMI PNEUMATEX

IMI TA

IMI HEIMEIER





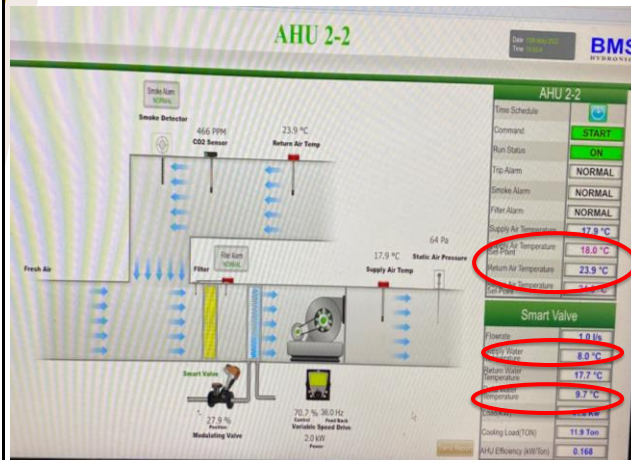
Design flow – 11.8 l/s

Design dT – 5.5 °C

SV is controlled by Supply air temperature sensor set @ 18.0 °C.

AHU is serving lobby and 1 vacant tenant unit only. Therefore load is very low.

Control/feedback: BacNet MSTP

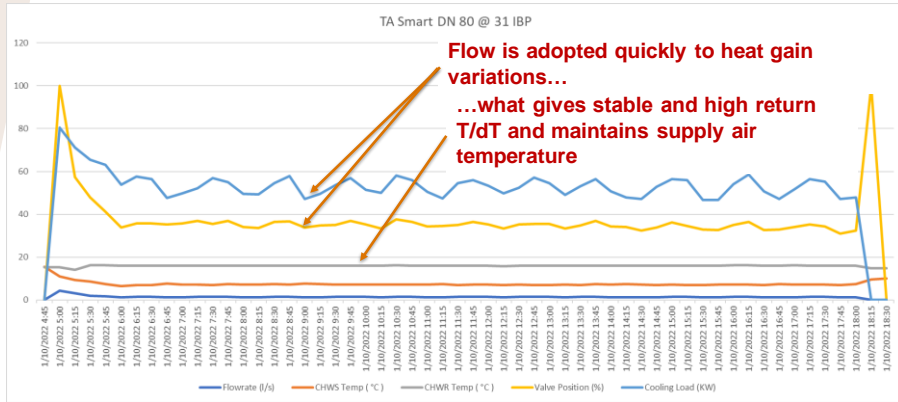


Supply air temperature maintained @ 17.9 °C

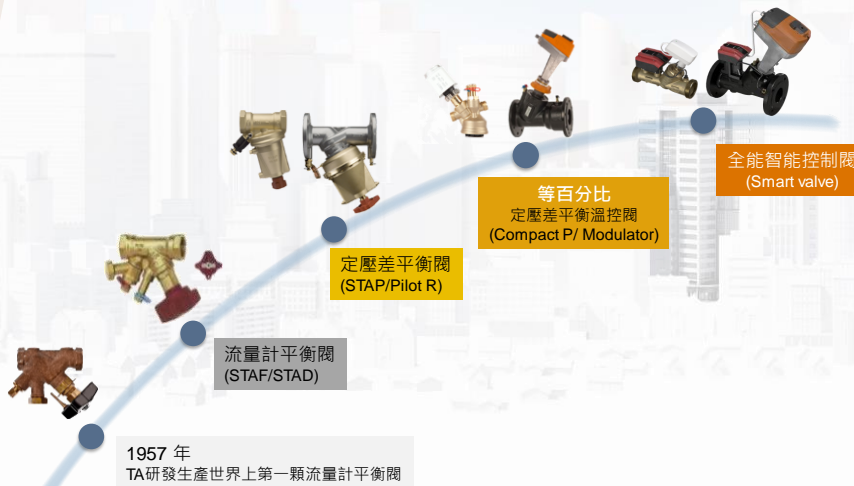
Operating flow is 1 l/s (8.5%)

Actual dT – 9.7 °C



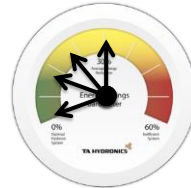


## TA水路平衡控制的發展



## 結 論

適流量系統節省總空調系統耗能**15%以上**



- › 空調冰水主機側的節能：
  - 維持高冰水回水溫度
- › 降低冰水系統中泵的耗能
- › 系統化平衡使變頻泵能在設計條件時以最低能耗達到設計流量，
  - 部分負荷時，利用變頻泵搭配適流量系統滿足所有負荷流量需求。
- › 最低能耗下穩定控制室內溫度
- › 比例式控制閥必須要讓泵耗能最低情況下達到最佳控制能力。

Thank you  
For your attention

TA訓練教室 HVAC TRAINING CENTRE



Seeing is Believing

