



Michael Holland  
Ability Projects  
mholland@abilityprojects.com  
00441202305800  
00447712895331

## The Relative Energy Efficiencies of Active Chilled Beams and Fan Coil Unit Systems

CHICAGO 2015 Winter Conference

## Learning Objectives

1. Provide commonly used standard operating parameters for both Fan Coil Unit and Active Chilled Beam systems
2. Explain why these commonly used operating parameters are what they are
3. Provide an overview of the energy studies completed and the software used
4. Describe the plant systems within the energy study model
5. Present the results of these energy studies
6. Compare the relative energy efficiencies that result from the studies completed

ASHRAE is a Registered Provider with The American Institute of Architects Continuing Education Systems. Credit earned on completion of this program will be reported to ASHRAE Records for AIA members. Certificates of Completion for non-AIA members are available on request.

This program is registered with the AIA/ASHRAE for continuing professional education. As such, it does not include content that may be deemed or construed to be an approval or endorsement by the AIA of any material of construction or any method or manner of handling, using, distributing, or dealing in any material or product. Questions related to specific materials, methods, and services will be addressed at the conclusion of this presentation.

## Acknowledgements

- Dr Alan Jones, EDSL
- Ian Highton, EDSL
- Federation of Environmental Trade Associations, UK
  - HVAC Fan Coil Unit Group

## Outline/Agenda

- Software used for the studies
- Brief description of what types of Active Beam and FCU were modelled
- Standard operating parameters
- Plant systems within the energy study model
- Present and analyse the results of these energy studies
- Questions and Answers

## Simulation Software

## The Simulation Software

### EDSL Tas

Complete Building Simulation package

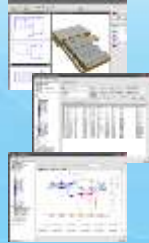
- 3D Modeller to create buildings
- Building Simulator
- Results Viewer



## The Simulation Software

Complete Building Simulation package

- Energy Performance Certificate, EPC
- UK Building Regulations Part L2
- Building Energy and Environmental Modelling (BEEEM)
- ASHRAE 140-1 Compliant
- BS EN ISO standards 13791, 13792, 15255 and 15265 Compliant



## The Contenders

### The Active Chilled Beam



### The Fan Coil Unit



## Standard Operating Parameters

### Standard Operating Parameters

|                          | <b>ACB</b>               | <b>FCU</b>  |
|--------------------------|--------------------------|---|
| Water Supply Temperature | 14°C<br>(57°F)           | 5°C 6°C 8°C 10°C 14°C<br>(41°F)(43°F)(46°F)(50°F) (57°F)    |
| Water Return Temperature | 17°C<br>(62°F)           | 11°C 12°C 13°C 15°C 17°C<br>(52°F)(54°F)(55°F)(59°F) (63°F) |
| Return Air Temperature   | 20 – 24°C<br>(68 – 75°F) | 20 – 24°C<br>(68 – 75°F)                                    |
| Relative Humidity        | 40 – 60%                 | 40 – 60%  |
| Operating Pressure       | 100 Pa<br>0.4 inH2O      | Not Applicable  |

## UK Building Regulations

**ACB** Not directly effected

**FCU** Limiting **Specific Fan Power**, Watts per Litre/Second

2006 – 0.8 W/(L/S) - 0.37 W/(CFM)

2010 – 0.6 W/(L/S) - 0.28 W/(CFM)

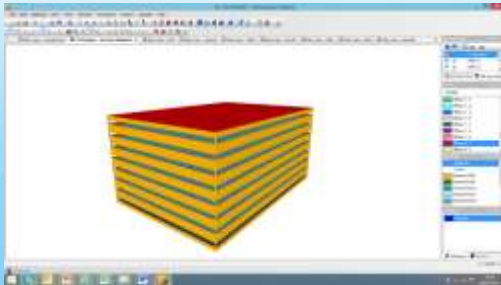
2013 – 0.5 W/(L/S) - 0.24 W/(CFM)

**TYPICAL UK PROJECT SPEC**

0.25 W/(L/S) - 0.12 W/(CFM)

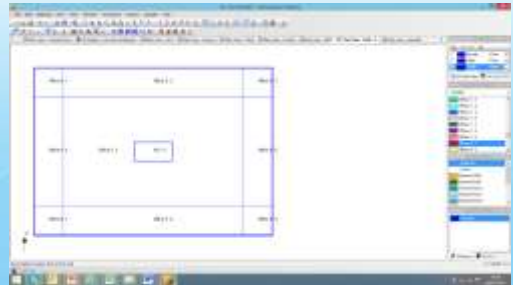
## Simulated Building

### The Simulated Building



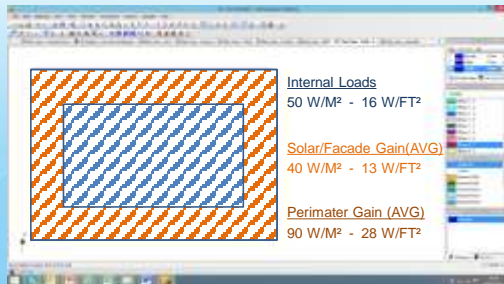
35m X 50m – 114 ft X 164 ft footprint  
8-Story  
2.8m - 9' 2" Floor to Ceiling Height  
Open Plan

### The Simulated Building



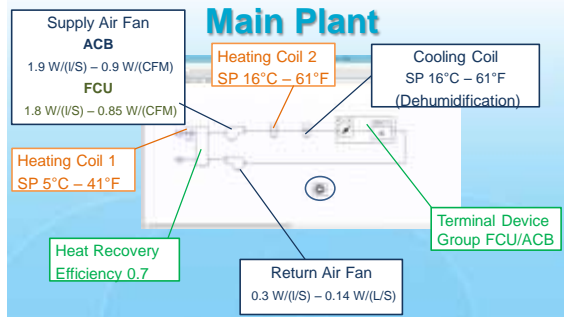
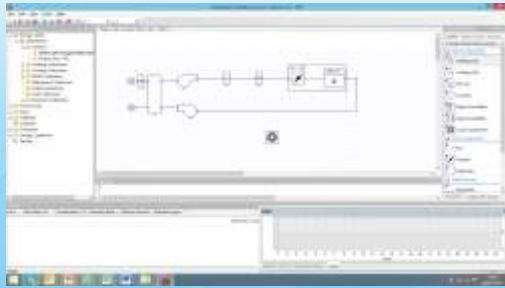
6 m – 19' 8" perimeter zones

## Building Loads - Cooling



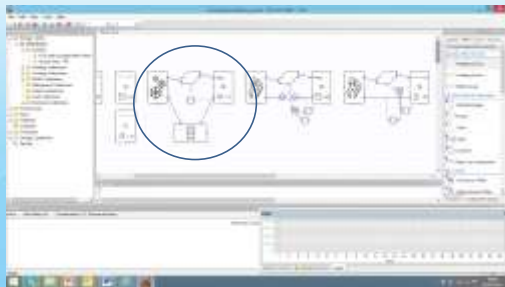
## Simulated HVAC Plant

### Air Handler Details

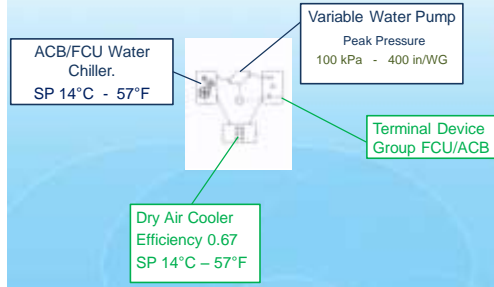


Fresh Air Rate for both systems set at 12 L/S, 25 CFM, per person complying with ASHRAE 62-2004 and UK standards.

### ACB/FCU Chilled Water

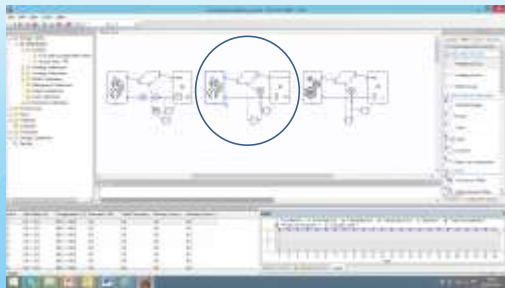


### ACB/FCU Chilled Water

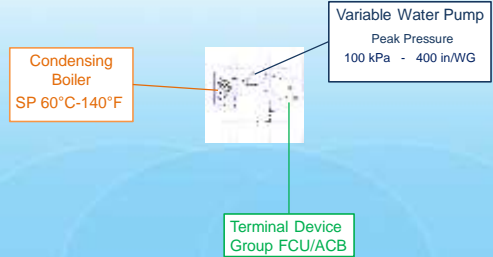


Chiller and DAC performance was base on a commonly used models, with performance varying with load and outside air temperature

### ACB/FCU Hot Water

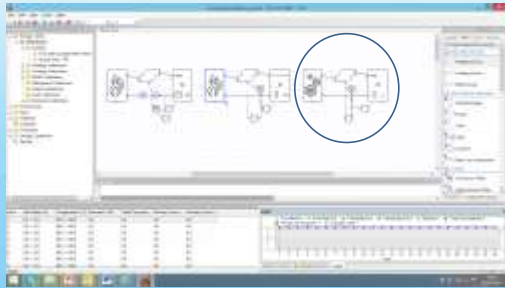


### ACB/FCU Hot Water

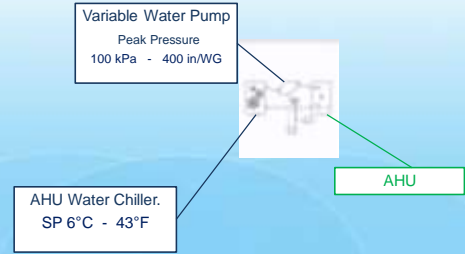


Boiler efficiency varied with return water and also outside wet bulb correctly accounting for actual condensing performance.

### AHU Chilled Water



### AHU Chilled Water



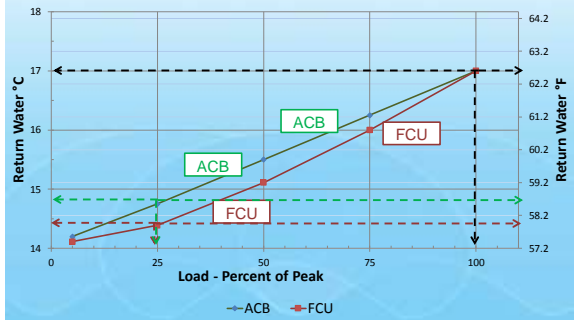
### Optimized Free Cooling



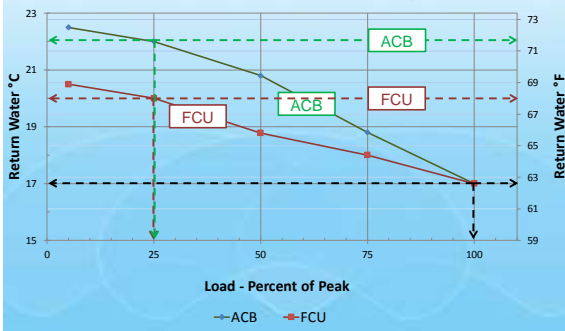
- Dry Air Cooler on the return water
- Optimize ACB/FCU controls
- 2 Port Control and variable speed pumps



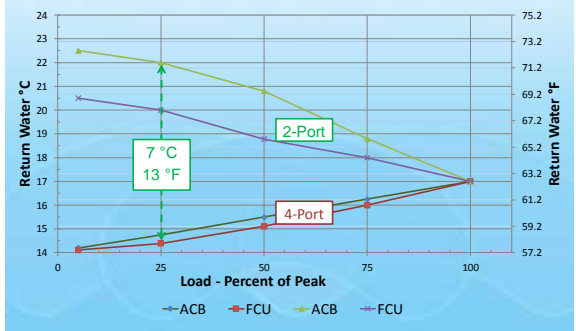
### Water Flow Return Characteristics, 4-port



### Water Flow Return Characteristics, 2-port



### Water Flow Return Characteristics, 4-port



## Room Temperature Control

### ACB

### FCU

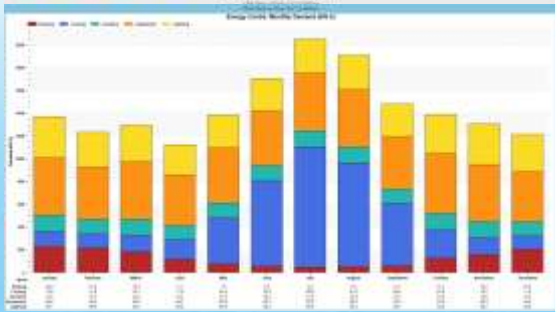
Water Flow Rate    2-Port Modulating    2-Port Modulating

Secondary Airflow    N/A    Variable Secondary Airflow  
Turn down to 50%

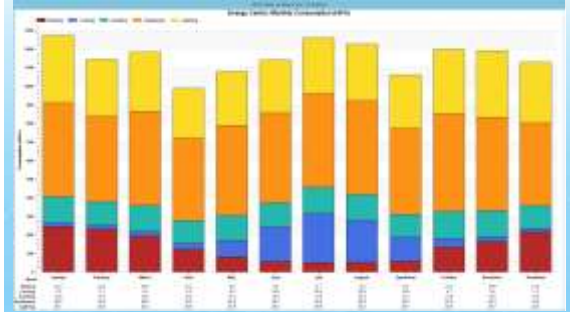


## Results

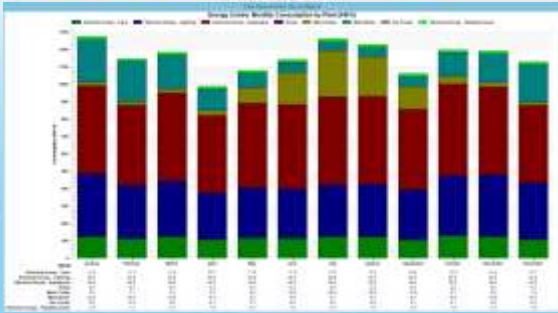
### Results - Demand ACB



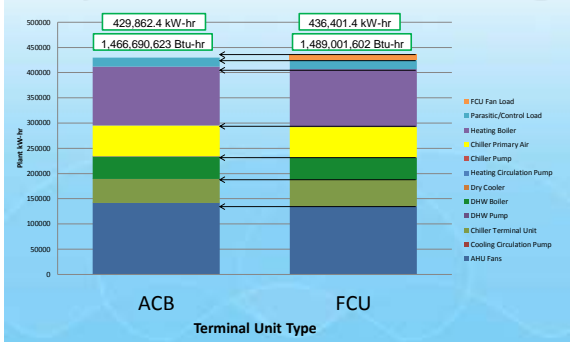
### Results - Consumption ACB

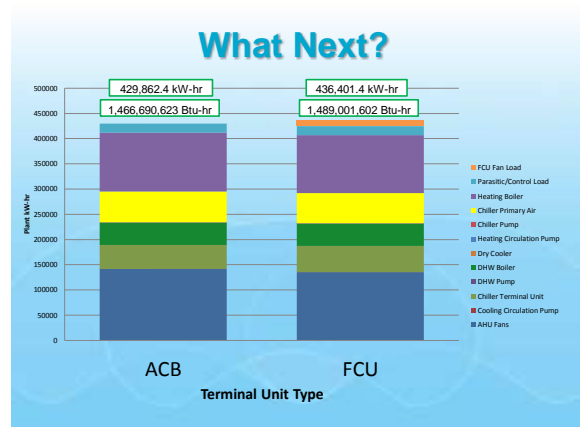
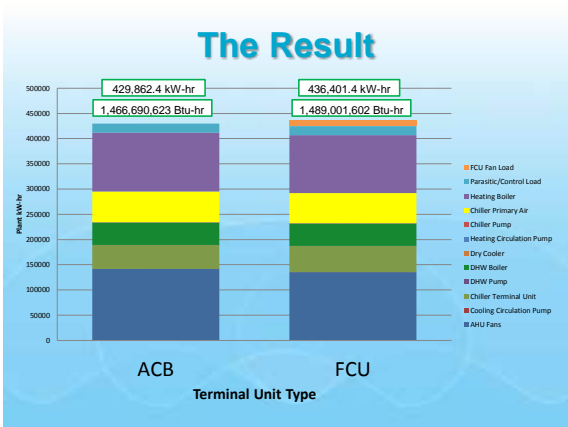
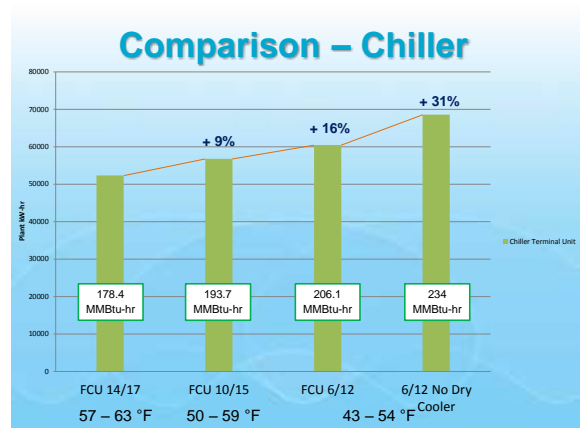
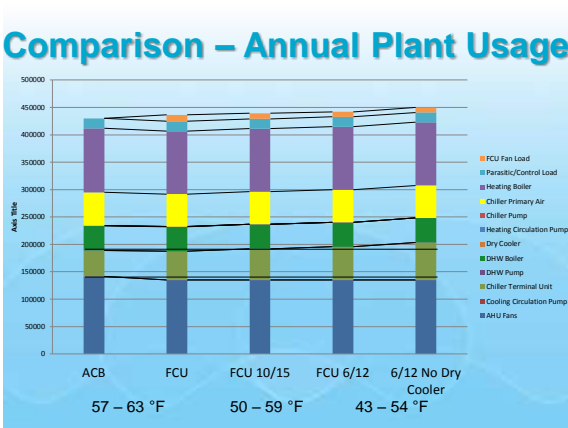
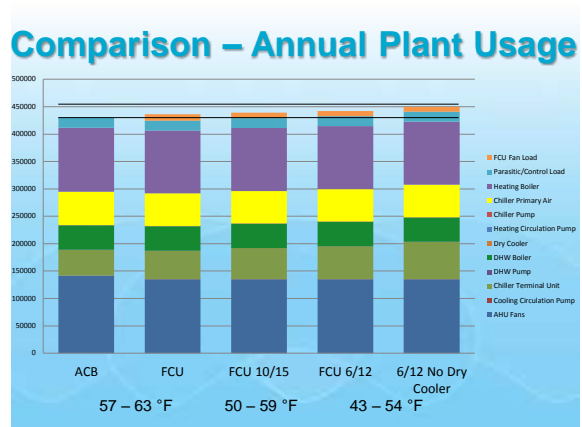
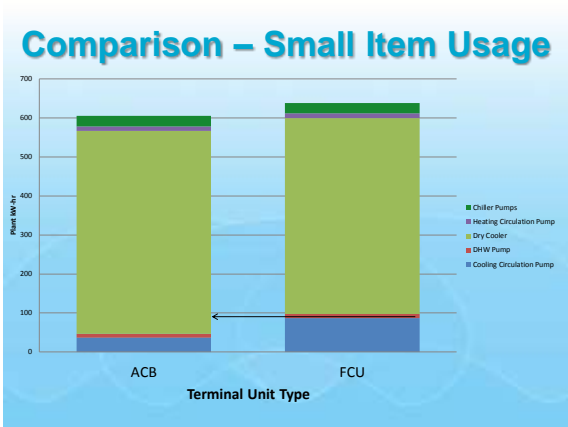


### Results - Plant ACB





### Comparison – Annual Plant Usage

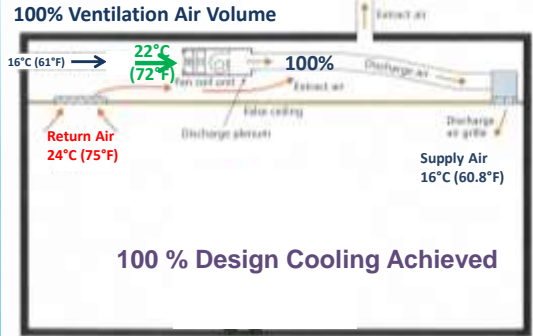




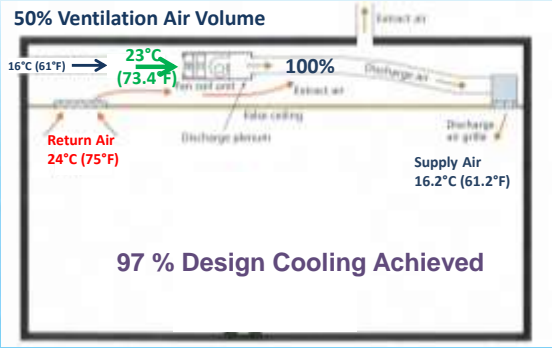
## Potential Cooling Available with Demand Controlled Vent

| Ventilation Rate |  |  |
|------------------|---|---|
| 100 %            | 100 %   | 100 %   |
| 75 %             | 75 %  | 98 %  |
| 50 %             | 50 %  | 97 %  |
| 25 %             | N/A   | 95 %  |
| 0 %              | N/A   | 94 %  |

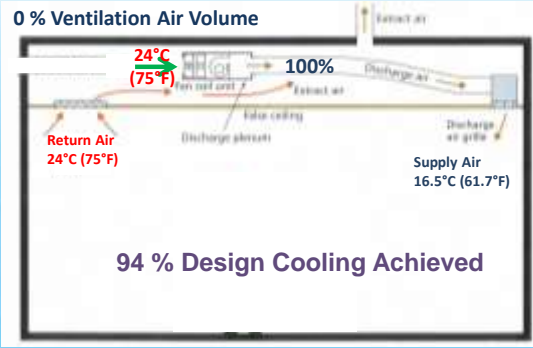
### FCU





### FCU



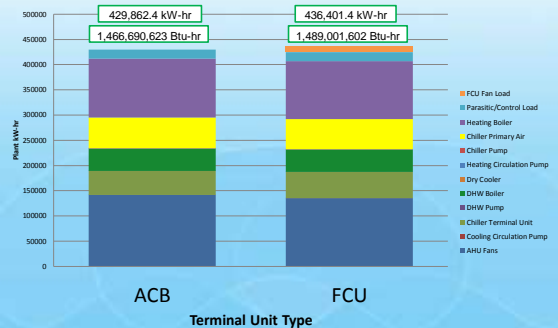
### FCU



## Potential Cooling Available with Demand Controlled Vent

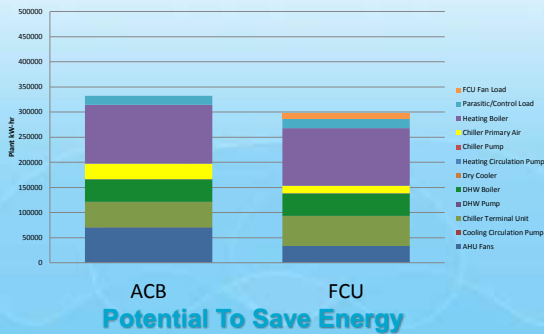
| Ventilation Rate |  |  |
|------------------|---|---|
| 100 %            | 100 %   | 100 %   |
| 75 %             | 75 %  | 98 %  |
| 50 %             | 50 %  | 97 %  |
| 25 %             | N/A   | 95 %  |
| 0 %              | N/A   | 94 %  |

### What Next?





## With Demand Controlled Vent



## References

- UK Federation of Environmental Trade Association (FETA)
  - HVAC Fan Coil Unit group
    - **A Comparative Study of Active Chilled Beam and Fan Coil Unit Energy Consumption**
- National Calculation Methodology (NCM) modelling guide (for buildings other than dwellings in England and Wales)

## Questions?

Michael Holland  
mholland@abilityprojects.com