The Hong Kong University of Science and Technology

# Department of

# Mechanical Engineering

# Jockey Club Controlled-Environment Test Facility

HOKLAS/HKAS Accredited:

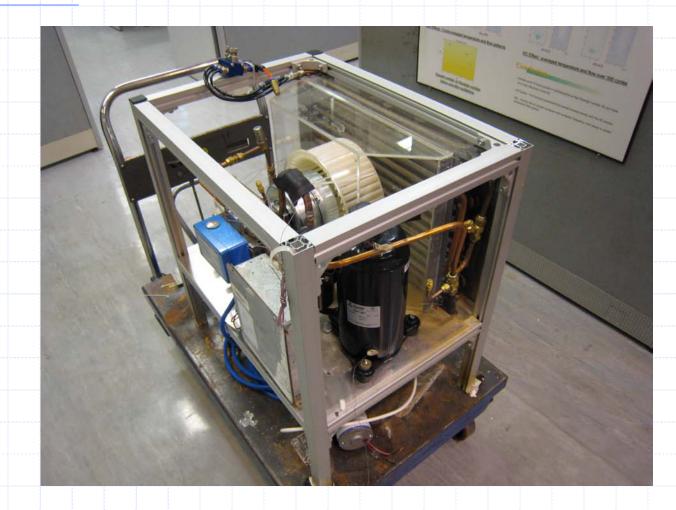
**Energy Efficiency Tests of Air Conditioners, Refrigerators, and Dehumidifiers** 

**Development of Energy Efficienct Products** 

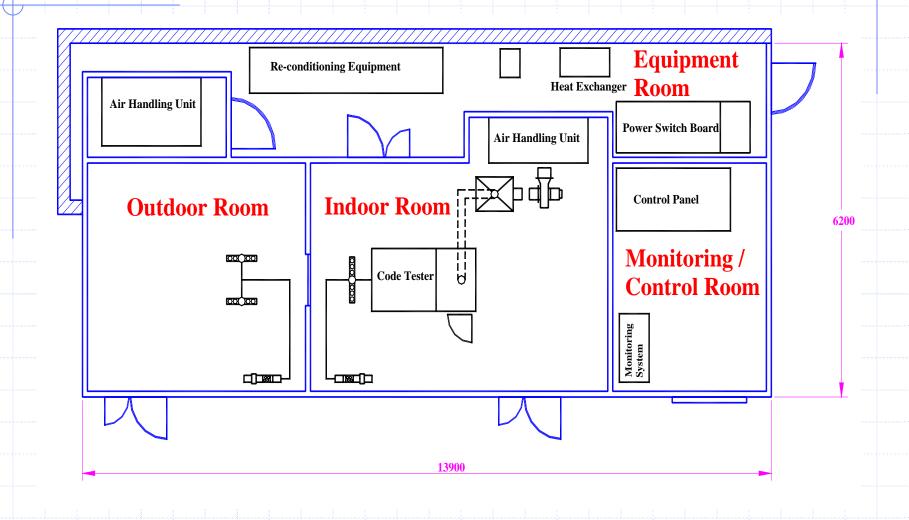
EMSD Qualified:

Energy Efficiency Labeling Scheme for LCD monitors and Televisions

# Split-type Air-Conditioners with New Evaporative Condensers



# Layout Plan



# **Specifications**

Indo	or:	
	Temperature Control	5°C ~ 40°C
	Humidity Control	40%RH ~ 95%RH
Outd	loor:	
	Temperature Control	$-10^{\circ}\text{C} \sim 60^{\circ}\text{C}$
	Humidity Control	20%RH ~ 95%RH
Accu	racy:	
	Temperature	±0.3°C Overall/±0.1°C Selected Temp.
	Humidity	±3%RH



## **Code Tester**



## **Air-Conditioner Testing**



**Refrigerator Testing** 



## **Class 100 Clean Room**

New HKUST Building Energy Research Platform

 Nansha Fok Ying Tung Graduate School (Building Energy Technology Center, 2010)



# **Building Energy Research**

Solar Thermal System (adsorption cooling; desiccant dehumidification) Advanced Air Treatment Technology Personalized Air Supply and Smart Sensor Technology Energy-Efficient Building Environment Others (BiPV, Wind, Battery, Building) Insulation, Window, LED)

## Integrated Adsorption Cooling System for Air Purification and Conditioning

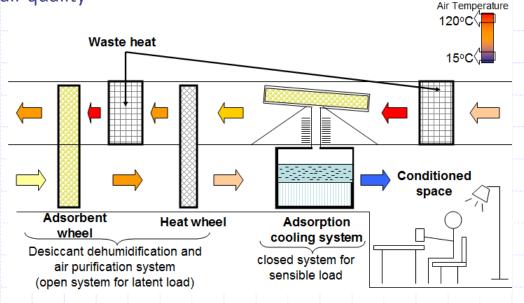
Low-energy integrated HVAC system using advanced synthetic materials with solar energy input

#### Dual mode cooling/ desiccant system

- Open system for latent load
- Utilize solar thermal energy
  Low electricity consumption
- Closed system for sensible load
- No compressor

# Decoupled cooling and dehumidification can enable individual control of thermal comfort and air quality

 Flow rate, air temperature, relative humidity and indoor air quality



# Catalytic Ozonation of VOCs over Porous Materials

Advanced gaseous and particle phase air purification technology

## **Objective**:

- An energy efficient air purification technology for low concentration VOCs
- To understand the basic mechanism of the ozonation effects over various porous materials
- To identify the limitations of this technology, e.g. residual ozone issues

#### Traditional air purification technologies

- Adsorption
  - Frequent regeneration
  - Transfer the contaminant from one phase to another
- Catalytic combustion
  - Energy intensive high temp.
  - High pollutant concentration
  - Ultra violet photo catalytic oxidation (UV-PCO)
    - Energy intensive UV light
    - Intermediate emissions

# **Personalized Ventilation**

Predicted Mean Vote (PMV) sensors integrated with personalized ventilation devices



Technical University of Denmark, ICIEE Traditional ventilation strategy: -supplies cooled fresh air to the whole room without looking into the individual comfort need -energy is wasted in cooling the air outside the thermal comfort perception zone of the occupants Personalized ventilation (PV) strategy: -supplies cooled fresh air directly to the occupants -able to integrate senor technology to consider individual comfort need -energy saving and enhance health and comfort

-energy saving and enhance health and comfort PMV based smart sensor development: Collecting physiological data directly for control

#### **Traditional ventilation strategy**

Thermal comfort perception zone



Air terminal device



# **Personalized Ventilation**

### **Different air terminal devices and sensor developments**



#### **Movable panel**



**Computer monitor panel** 

Personalized ventilation contains more flexible components than the traditional one, which is more compatible to demandcontrol air supply for both energy saving and comfort need.



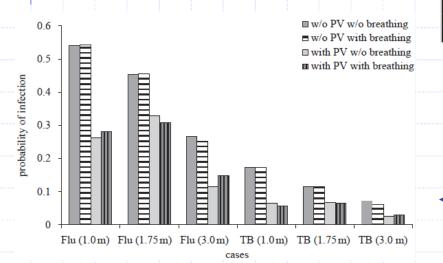
Desktop type

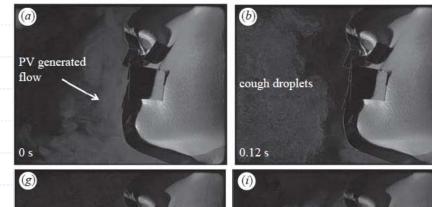
Joint Project with National University of Singapore Laser Diagnostics on the fluid flow field and pollutant transport/ CFD study

# Respiratory Protection by Personalized Ventilation

Personalized ventilation supplies clean air directly to the breathing zone with little mixing with the room air loaded with contaminants; it is able to offer respiratory protection to the user.

Exposure and health risk toward indoor air contaminant such as VOCs, PM and airborne pathogen can be mitigated by personalized ventilation.





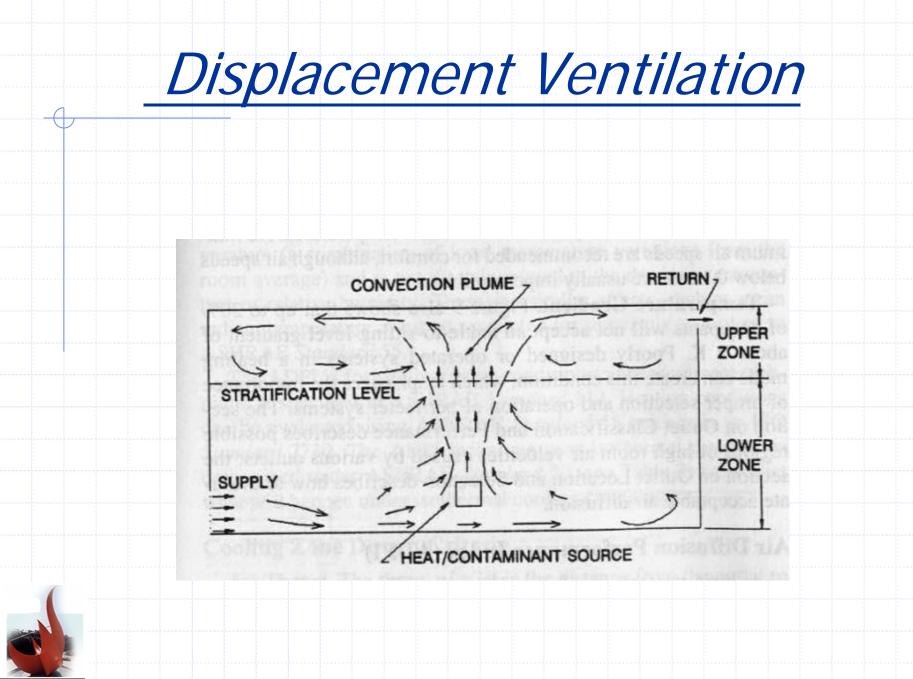




Flow visualization by laser technique. The seeded area is the air supplied by the PV. Even with a cough direct to the PV user, the PV airflow can push the expiratory aerosols away from the breathing zone in a very short time.

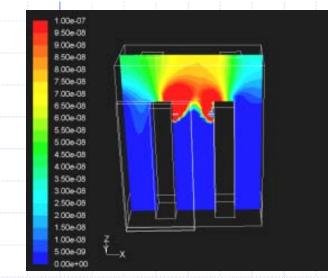
 PV can reduce the infection risk of influenza (Flu) and tuberculosis (TB) by 27-65%.

Pantelic J, Sze To GN, Tham KW, **Chao CYH**, Khoo YCM., Personalized ventilation as a control measure for airborne transmissible disease spread, Journal of Royal Society Interface, 6, pp. 715-726, 2009.

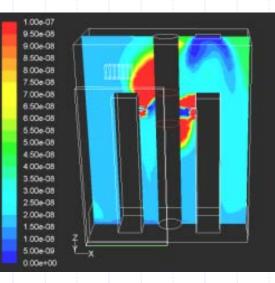


# Displacement Ventilation in Contaminant Removal

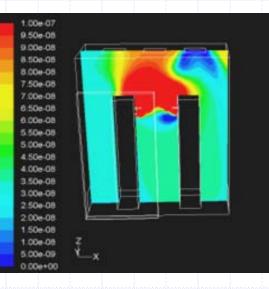
Contour plots of ETS tracers concentration in 2-smoker room under full-load scenario:



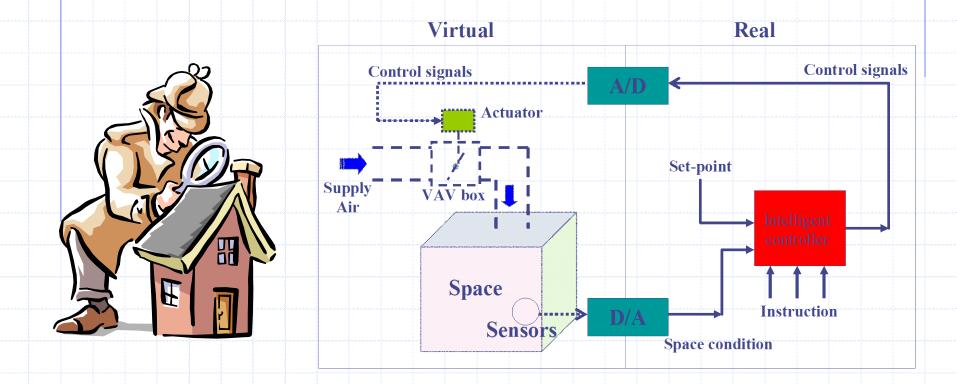
### Displacement



Local Exhaust



## **Intelligent Control for Building Environment and Energy Saving (eg. Demand Control Ventilation)**



# **Other Areas**

- Integrated photovoltaic and wind power generation in buildings – solar panel performance at different sunlight incidence, software development; development of transparent solar panels using TiO2 coated with light absorbing organic dyes; wind power generation using supercapacitor design.
- Battery energy storage development of Lithium battery system to integrate with the BiPV and wind power generation systems.
- Advanced building insulation technology fabrication of panels with foam beads and paraffin through extrusion process; sandwich panels with composite skins and foamed concrete interior to cut down energy loss via heat transfer via building envelopes; low energy transmission window technology



## **Photovoltaic System**



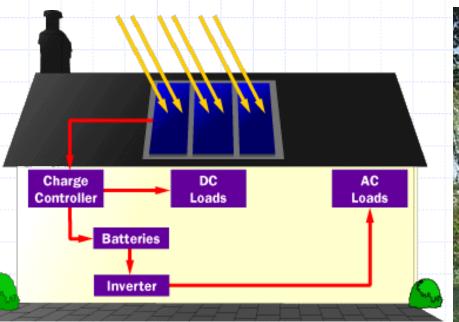
## **Specifications:**

Type : Stand-alone Power rate : 880Wp PV module area : 6.8m2 DC voltage : 24Vdc AC voltage : 220V Battery capacity : 720Ah

# Powering a House by Solar PV and Wind Turbine

Integration of energy supply from solar PV and wind turbine in buildings

General schematic of a residential PV system with battery storage





# Building Integrated Photovoltaic (BiPV)

- Building Integrated Photovoltaics (BIPV) is the integration of photovoltaics (PV) into the building envelope.
- The PV modules serve the dual function of building skin—replacing conventional building envelope materials—and power generator.
- By avoiding the cost of conventional materials, the incremental cost of photovoltaics is reduced and its lifecycle cost is improved.
- New development in BiPV includes thin flexible solar panels and panels with different colors to match the building envelops.



#### Starts on a Roll

#### Roll-To-Roll Manufacturing

Roll-to-roll manufacturing significantly reduces manufacturing costs. Our company was the first and remains the only company in the world that manufactures and sells monolithically-integrated solar panels on plastic using a true roll-to-roll manufacturing process.

#### Polymer Substrate Flexible yet durable polyimi

Flexible yet durable polyimide substrate results in enhanced flexibility, paper thinness, and lighter weight. The substrate is as thin as 1 mil (0.025mm) thick.

Thin Film Amorphous Silicon Amorphous silicon is the absorber layer in the solar parels. The amount of silicon used in PowerFilm solar panels is as low as 1% of the amount used in traditional solar panels. PowerFilm has a strong environmental profile and is cadmium free. Single and trandem junction devices are encapsulated in materials appropriate for the application environment.

#### 13 Inches Wide Up to 2400 Feet Long

#### Monolithic Integration

Monolithic integration is the automatic built-in connection of individual solar cells. Monolithic integration reduces manufacturing costs (eliminates expensive labor for manual connection) and increases durability (eliminates stress-prone manual connections of individual solar cell

Product and Building Integration Technology

PowerFilm Solar also has developed low-cost technology to integrate the solar panels with products and building materials

#### Encapsulation

To optimize the tradeoffs between product functionality, lifetime, and cost, the core solar panels are encapsulated in a variety of materials to meet the requirements of diverse applications and use environments. **Backing Materials** 

The solar panels can be combined with several backing materials, including fabric, metal, and fiberglass.

Ends on a Roll

Photo of Actual Product



# Τηανκ Ψου

