

# Cooling India

India's foremost Monthly dedicated to the growth of HVACR Industry

## Advanced Heat Exchangers for Biogas Plants



Expecting to Grow at CAGR of more than 5%

Saving Energy through Better Buildings Challenge Partners

Cold Chain Market to be USD 271.30 bn by 2022

Behind Machinery of Tomorrow's Smart Cities

Government Measures for Reducing Growing AC Use

Boston Remains Most Energy-Efficient US City

## Retrofitting Mumbai HPCL Office



## Energy Conservation for Air Conditioner



## LEED: Revolutionizing Green Building Projects



Scan the QR Code to visit our website about Cooling India Website





**Series 616KD**  
Dwyer Differential Pressure Transmitter



**Series SAH**  
Dwyer Smart Air Flow Hood  
**ALM** is the Ambassador for Smart Air Hood in India.



**Series DPT-Flow**  
Aerosense Differential Pressure cum Air Flow Transmitter with Multipoint averaging flow sensor



**Series AVT**  
Aerosense Air Velocity cum Temperature Transmitter



**Series UHH**  
Dwyer Universal Handheld Instrument measures Differential Pressure, Temperature, Air Velocity, Volume flow & RH & can be connected to Apple, Android phones & tabs.



**Model VP1**  
Vane Thermo Anemometer



**Series 160 - Pitot Tube**



**Psychlone**  
Handheld Thermo-Hygrometer



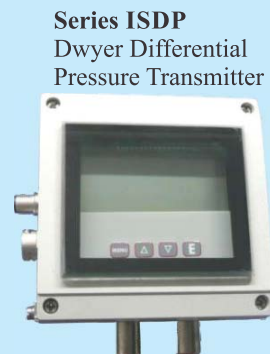
**Series TTD/TTW**  
Aerosense Temperature Transmitter



**Series 477AV**  
Dwyer Handheld Digital Manometer



**Series HHT**  
Dwyer Hazardous Area Humidity/Temperature Transmitter



**Series ISDP**  
Dwyer Differential Pressure Transmitter



**Series CDTA**  
Dwyer Wall Mount Carbon Dioxide / Relative Humidity & Temperature Sensor / Transmitter.



**Series CMT200**  
Dwyer Carbon Monoxide Transmitter



**Series MSII**  
Dwyer Magnesense II Differential Pressure Transmitter with modbus/BACnet & Flow Options.



## ALM ENGINEERING & INSTRUMENTATION PVT. LTD.

304, Damji Shamji Industrial Complex, L.B.S. Marg, Kurla (W), Mumbai-400070. INDIA

Tel.: +91 22 25126500 • Email: [info@almontazar.com](mailto:info@almontazar.com) • [sales@almontazar.com](mailto:sales@almontazar.com)

Internet: [www.almontazar.com](http://www.almontazar.com)

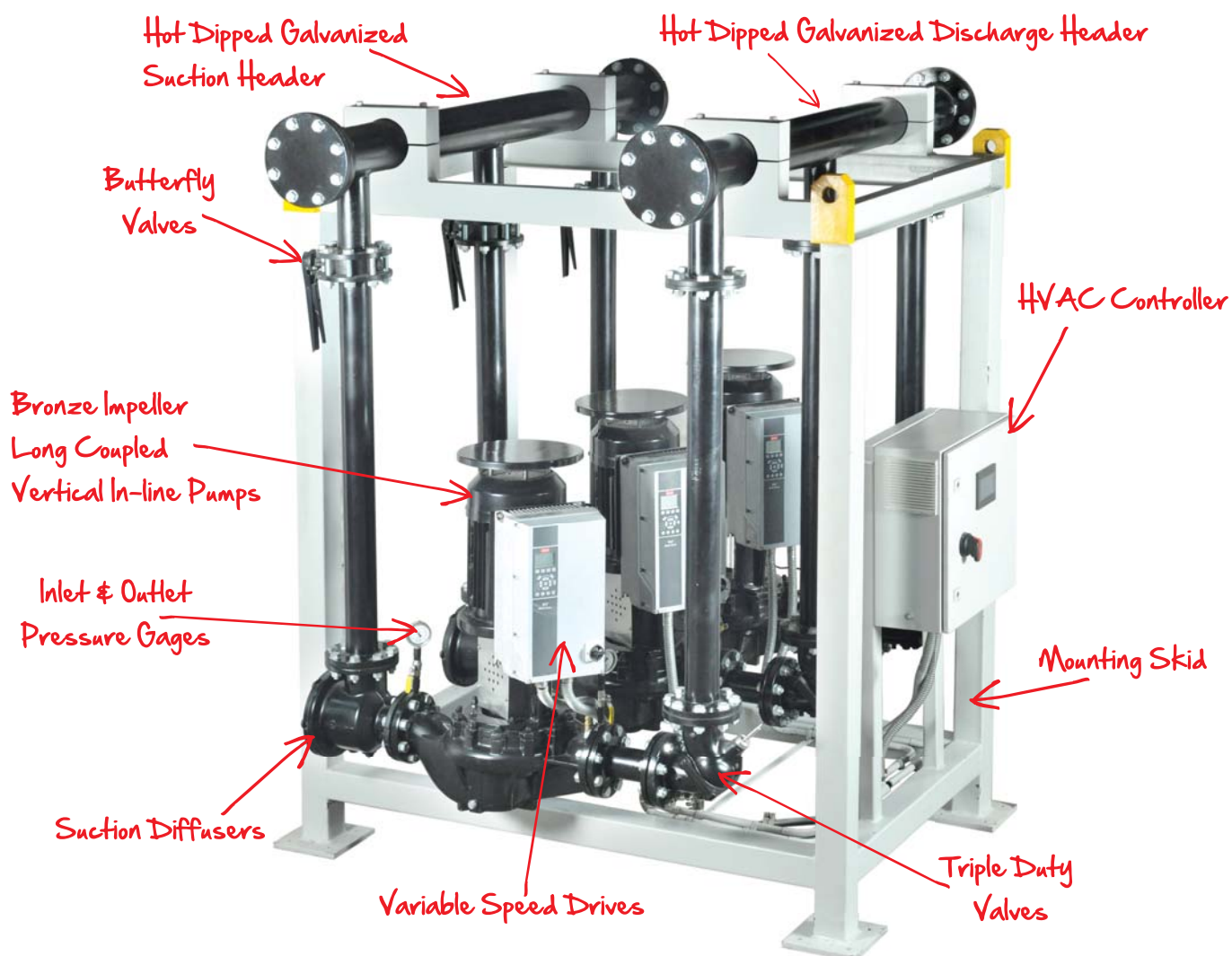


www.lubipumps.com

# Lubi

## HVAC Packaged Pumping Systems

QUALITY • INNOVATION • SUSTAINABILITY



- Factory Assembled & Tested
- Plug & Play Installation
- Space Saving Vertical In Line Pumps
- Smart Intellicon Controller with Touch Screen Controls

### LUBI INDUSTRIES LLP

Near Kalyan Mills, Naroda Road, Ahmedabad - 380 025, Gujarat, India. | Tel: +91 79 30610238 | Fax: +91 79 30610300  
Email : [indsales@lubipumps.com](mailto:indsales@lubipumps.com) | Website : [www.lubipumps.com](http://www.lubipumps.com)



MA24-00



# Publisher's Letter

Hello and welcome once again to Cooling India. In the beginning of this month, US president Donald Trump withdrew from the Paris Climate Accord and thus invited severe criticism from several world leaders and environmentalists. For once, the developed world united in condemning the US decision. Many feel the Climate Accord, all about reducing global warming by a few degrees Celsius, was the best thing that could happen to humans on Earth.

Even within the United States there have been many voices supporting the Paris Climate Accord. With regards to the air conditioning and refrigeration industry, I must say there is complete support for the global cause. The Air conditioning, Heating and Refrigeration Institute (AHRI) has stressed that Trump's decision will not change the commitment of the HVACR industry to energy efficiency and environment stewardship.

Similarly ASHRAE, a global society of more than 57,000 professionals in over 130 countries has categorically stated that it will not change or alter its commitment to accelerate the transformation to a more sustainable global built environment. In fact, recently the association announced a substantial investment in researching alternative global warming potential refrigerants. The US Green Building Council on its part is already working to address business risks from climate change and to adapt their businesses to domestic and global opportunities created around climate-mitigation needs. Its president and CEO Mahesh Ramanujam while expressing his deep disappointment has stressed that the world has reached the point where the transition to a low-carbon economy is inevitable.

Prime Minister Narendra Modi will meet US president later this month in Washington. The latter has blamed India for his decision to withdraw from the Accord. Despite Trump's overt skepticism on this issue and subsequent pulling out of the Accord, the two leaders may find a middle ground. Trump is feeling isolated and has realized that he is leaving a huge leadership vacuum in the world politics of climate. On the other hand leaders like French president Macron and Modi apart from Xi from China are taking the center stage by voicing the concerns. Thank goodness engineers spend every day looking for energy efficiency and less toxic solutions to real problems and stay out of politics of the Carbon hype. Lets wait for the outcome of the all important meeting later this month. Till then, wish you a very happy reading. Do send in your comments to me at [pravita@charypublications.in](mailto:pravita@charypublications.in)

**Pravita Iyer**

*Publisher & Director*

*Member, Indoor Air Quality Association (IAQA)*



**Directors**

Mahadevan Iyer  
Pravita Iyer

**Publisher**

Pravita Iyer  
[pravita@charypublications.in](mailto:pravita@charypublications.in)

**Editor-in-Chief**

Mahadevan Iyer  
[miyer@charypublications.in](mailto:miyer@charypublications.in)

**Associate Editor**

Supriya Oundhakar  
[editorial@charypublications.in](mailto:editorial@charypublications.in)

**Editorial Coordinator**

Nafisa Kaisar  
[nafisa@charypublications.in](mailto:nafisa@charypublications.in)

**Advertising Department**

[adv@coolingindia.in](mailto:adv@coolingindia.in)

**Design**

Nilesh Nimkar  
[charydesign@charypublications.in](mailto:charydesign@charypublications.in)

**Subscription Department**

Priyanka Alugade  
[sub@charypublications.in](mailto:sub@charypublications.in)

**Accounts**

Dattakumar Barge  
[accounts@charypublications.in](mailto:accounts@charypublications.in)

**Response Department**

Sonali Pugaonkar  
[mktg@charypublications.in](mailto:mktg@charypublications.in)

**Digital Department**

Ronak Parekh  
[dgmarketing@charypublications.in](mailto:dgmarketing@charypublications.in)

₹ 100/- Per Copy

₹ 1000/- Annual Subscription

**Disclaimer:** Chary Publications does not take responsibility for claims made by advertisers relating to ownership, patents, and use of trademarks, copyrights and such other rights. While all efforts have been made to ensure the accuracy of the information in this magazine, opinions expressed and images are those of the authors, and do not necessarily reflect the views/collection of the owner, publisher, editor or the editorial team. Chary Publications shall not be held responsible/ liable for any consequences; in the event, such claims are found - not to be true. All objections, disputes, differences, claims and proceedings are subject to Mumbai jurisdiction only.

Printed by Pravita Iyer and Published by Pravita Iyer on behalf of Chary Publications Pvt Ltd., and Printed at Print Tech, C-18, Royal Ind. Est., Naigaum Cross Road, Wadala, Mumbai 400031 and Published at 906, The Corporate Park, Plot 14&15, Sector - 18, Vashi, Navi Mumbai - 400 703.

**Editor: Mahadevan Iyer**



[www.facebook.com/coolingindiamagazine](http://www.facebook.com/coolingindiamagazine)



[www.linkedin.com/in/coolingindia](http://www.linkedin.com/in/coolingindia)



[www.twitter.com/coolingmagazine](http://www.twitter.com/coolingmagazine)

Subscribing  
Cooling India is now a  
click away  
Just log on to  
[www.coolingindia.in](http://www.coolingindia.in)



# LOUVER TYPE MIST COOLING SYSTEM

*For*

## CHILLERS

**A Superior Alternative to Cooling Tower**



▲ *Louver Type MCS*

**Assured Approach of 1°C to WBT.  
Guaranteed Power Saving with Small Foot Print...  
Not a miracle, a reality!**

### Other Superior Features of LTMCS

- **NO FILLS / NO FINS, NO FANS**
- Zero Maintenance due to all Non-moving parts, Choke-less Nozzle design and Special non-corrosive MOC
- Extremely easy operation
- Life of more than 15 to 20 years

**Over 300  
installations**

### Typical case study data of a 1200 TR Chiller

Sr. No.	Parameter	Cooling Tower (Induced Draft)	LTMCS
1	Wet Bulb Temperature	29°C	29°C
2	Chilled Water Temp in °C (Assumed)	5°C	5°C
3	Supply Temp. from CT / LTMCS	33°C	30°C
4	Approach to WBT	4°C	1°C
5	<b>ΔT for Chiller</b>	<b>28°C</b>	<b>25°C</b>
6	Chilled Water Compressor Motor Kw for 1200 TR	720	643
7	Energy Saved in %	-	10.7%
8	<b>Energy Saved in Kw</b>	-	<b>77 Kw/Hr</b>
9	Total Running Hours per Annum	8640	8640
10	<b>TOTAL POWER SAVED PER ANNUM</b>	-	<b>6,65,280 Kw</b>



*Mist Ressonance Engineering Pvt. Ltd.*

Regd Office : 'Anandi', 1304-1/7, Shukrawar Peth, Bajirao Road, Pune - 411 002. INDIA.

Tel : (+ 91 20) 2447 2726 / 2447 1184 ■ Fax : (+91 20) 2447 4972

E-mail : mistcreation@gmail.com ■ mistcool@vsnl.com ■ Website : www.mistcreation.com



# Contents

Vol. 12 No. 11 | June 2017

## Articles

### Energy Conservation for Air Conditioner 22

– Paresh Modha, Rajan Modha, Minesh Joshi

### LEED: Revolutionizing Green Building Projects 30

– Mahesh Ramanujan

### Retrofitting Mumbai HPCL Office 38

– Shashi Ray, Sneha Zagade

### Advanced Heat Exchangers for Biogas Plants 42

– Ankit Kumar

### Sustainability through Structural Cooling 50

– Aparna Dwivedi, M V Khire, B K Mohan

### Ground-source heat pump system for buildings heating & cooling 58

– Abdeen Mustafa Omer



## Features

### 20 Saving Energy through Better Buildings Challenge Partners

### 37 Expecting to Grow at CAGR of more than 5%

### 45 Behind Machinery of Tomorrow's Smart Cities

### 48 Boston Remains Most Energy-Efficient US City

## Interviews



"Smart probes are one stop solution for entire HVACR industry"

# 34

**Kalidas Bhangare**

Managing Director, Testo India Pvt Ltd



"Implementation rigor & performance tracking holds the key to success of programs"

# 46

**Mili Majumdar**

Managing Director, Green Business Certification Inc (GBCI)



## Departments

### 4 Publisher's Letter

### 6 Contents

### 8 News

### 16 Appointments

### 18 Awards

### 66 Statistics

### 67 Product Profile

### 69 Event Calender

### 69 Index to Advertisers

### 70 Cooling Museum

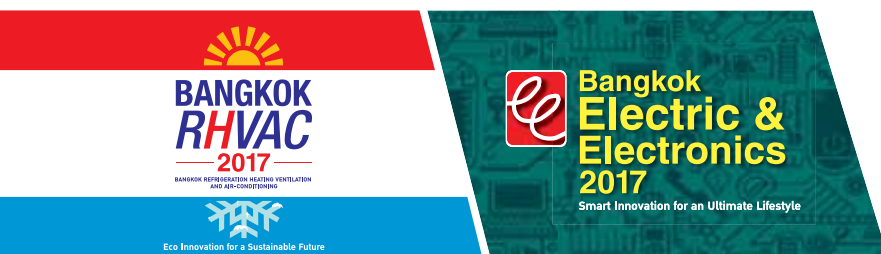




## Bangkok RHVAC 2017 and Bangkok E&E 2017 Two Events, Multiple Benefits

Switch on your business potential and make successful deals at the world's forefront trade events of refrigeration, heating, ventilation, air-conditioning, electric and electronic products.

- ✿ **Explore** a grand showcase of latest eco-friendly technologies and energy-efficient innovations being offered by over 330 leading companies from across the globe covering 1,000 exhibition booths.
- ✿ **Spark** business opportunities and meet face-to-face with over 10,000 prominent traders and world's key players.
- ✿ **Expand** knowledge through a series of insightful seminars focusing on eco-friendly technologies and energy-efficient innovations.



**Trade Days**  
7-9 SEPTEMBER 2017  
**Public Day**  
10 SEPTEMBER 2017  
**Time**  
10 AM - 6 PM  
**At**  
Hall 98-100 BITEC, Bangkok, Thailand

For more information and pre-registration, visit  
[www.bangkok-rhvac.com](http://www.bangkok-rhvac.com), [www.bangkok-electricfair.com](http://www.bangkok-electricfair.com)  
[www.ditp.go.th](http://www.ditp.go.th), [www.thaitradefair.com](http://www.thaitradefair.com)  
Tel: (66) 2507 8374-8, Fax: (66) 2547 4282  
E-mail: [rhvac@ditp.go.th](mailto:rhvac@ditp.go.th), [bee@ditp.go.th](mailto:bee@ditp.go.th)

Organized by  
**DITP**  
Department of International Trade Promotion  
Ministry of Commerce, Thailand

Co - Organized by  
**ETP**  
Energy Technology Promotion  
Ministry of Energy, Thailand



**DITP** THINK THAILAND

## New Office of Goodman in US

The Goodman Global Group, (Headquarters: Houston, Texas), a North American subsidiary of Daikin Industries, held an opening ceremony recently to mark the completion of its new base. The new facility named Daikin Texas Technology Park (DTTP) is located in a Houston suburb. Noriyuki Inoue, Daikin's Chairman of the Board and Chief Global Group Officer, expressed the company's expectations for the new production facility: "We hope to achieve a Digital Factory that utilizes IoT and M2M and



mobilizes here all of the manufacturing know-how that the Daikin Group has cultivated worldwide. Together with offering air conditioning systems that delight American customers, we intend to be a good corporate citizen that contributes to the development of Texas and the United States by continuing to invest and create jobs in America."

As the largest production facility in the Daikin Group, DTTP will manufacture all of the products sold in the United States, including both residential and commercial-use products and heating equipment. Established to integrate the four factories that Goodman currently operates in the United States and the logistics base, the new base will consolidate marketing and customer support activities to provide even greater operational efficiencies within the company. Moreover, a new R&D function will be created, and the local product development system will be further enhanced. The new factory will showcase a state-of-the-art production technology system that utilizes a modular production line that responds to fluctuations in production amount and automatically controls production progress by taking advantage of IoT technology. ■

## 'Demand for green building products to touch USD 300 bn by 2022'

The Government is working on the process of effectively procuring green products on the basis of 'life cycle costs', instead of L1 process followed at present, for government buildings to be built in future, said Ashish Kumar Singh, Principal Secretary, Public Works Department, Government of Maharashtra at the Conference on GreenPro organised by the CII. The demand for green products is projected to touch USD300 billion (or about Rs 19,80,000 crore) by 2022. India having the second largest green buildings in the world is targeting to increase its footprint to 10 billion square feet by 2022, from 4.5 billion (450 crore) square feet of footprint at present.

"We are discussing with Indian Green Building Council (IGBC) on the process of procuring green products in the government and how to build competitive environment in which bidders can compete by writing contracts which makes life cycle costs become more relevant than

just L1 kind of an understanding of procurement," said Singh. Green buildings bring down energy and water consumption levels by 40-50 per cent by using environmentally sustainable products. Singh said, "About 70 per cent of India's



infrastructure is yet to be built. We should not miss this opportunity. All government buildings that will be built in future in Maharashtra will be green buildings," said Singh. The government has also decided to identify one iconic building in each of the six regions in the state for retrofitting and ensure that they are net zero (conventional) energy buildings," Singh added. ■

## Indian Cement Sector Adopting Energy Efficiency Measures

Speaking at the 13<sup>th</sup> edition of CII Green Cementech jointly organised by CII - Godrej GBC and Cement Manufacturers' Association (CMA), Philip Mathew, Chief Manufacturing Officer, ACC Limited underlined that, globally cement sector has been in the forefront in adopting sustainability initiatives in their operations. He also highlighted the sustainability challenges faced by cement industry and called on the need for reducing carbon footprint from logistics operation in the near future. Indian cement sector should work to keep improving and setting higher standards and newer benchmarks in sustainability and environment management, he underlined.

K N Rao, Co-Chair, CII Green Cementech 2017 said that cement sector is leading with example and in the last few years, sustainability has become one of

the strategic areas for the sector. The sector is conscious about the impact they are creating and are taking extensive initiatives to minimize the negative externalities and maximize the positive externalities, he added. CII-Godrej GBC has launched the annual Green Cementech to foster and promote sustainable initiatives in Indian cement industry, he informed.

Dr S K Handoo, Advisor - Technical, CMA, underlined that Indian cement sector by adopting the latest technological innovations, has become one of the most energy efficient sectors in the world. He called on the need and importance of promoting alternative energy fuel sources. Cement manufacturing process allows co-processing of waste in an environment friendly manner and address issues of waste management, he added. ■





# AEROFOAM<sup>®</sup> XLPE

## INSULATION SOLUTIONS

CLASS 0

ASTME94



CROSS LINKED CLOSED CELL  
POLYOLEFIN FOAM SUITABLE FOR  
CONDENSATION CONTROL  
THERMAL INSULATION  
SOUND ABSORPTION  
DUCT INSULATION  
ROOF, WALL INSULATION  
LOW VOC EMISSION  
DUST AND FIBRE FREE



HIRA TECHNOLOGIES PVT. LTD.

Plot No.I-02, (Part - II), Khed Industrial Park DTA, Village, Kanhersar, Tal- Khed, Dist - Pune (India) Pin code 410505  
Tel: 7767809341 / 7767809350 | Email: info@rhira.com Website: www.aerofoam.co.in

**Hira**  
TECHNOLOGIES

www.rhira.com  
www.aerofoam.co.in



# MAICO



**DYNAIR**  
INDUSTRIAL VENTILATION



**elicient**  
ventilation specialist



Impulse Jet Fan



Induction Jet Fan



Smoke Spill  
Axial Fan



Axial Roof Fan



Axial Bifurcated  
Fan



Axial Upblast  
Roof Extract



Acid Proof  
Fan



Centrifugal  
Roof Fan



Inline Fan



Box Inline Fan



DIDW- Cabinet  
Fan



SISW- Backward  
Curved Fan

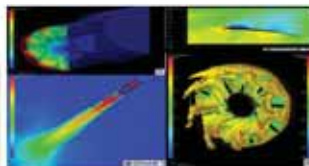


SISW- Forward  
Curved Fan



Window/Wall  
& Duct Inline  
Mounted Fans

### TESTING AND R&D FACILITIES



### CERTIFICATIONS



### CONTACT US

Plot I-02, (Part-I), Khed City, Zone DTA, Kanhersar, Tal - Khed, Raigurunagar, Pune - 410505  
Tel: 7767 8000 15 / 16 | Email: info@maico.co.in | Web: www.maico.co.in

## Carrier to Bring Efficiency to Malaysia's Tallest Tower

Carrier Malaysia was selected to supply six AquaEdge 19XR centrifugal chillers, two AquaEdge 19XR6 and 430 air handling units for Merdeka PNB118. Upon completion in 2020, Merdeka PNB118 will become Malaysia's tallest tower. Carrier, a world leader in high-technology heating, air-conditioning and refrigeration solutions, is a part of UTC Climate, Controls & Security, a unit of United Technologies Corp.



To meet the customer's demands for high refrigeration tonnage and environmentally sustainable products, Carrier will supply AquaEdge 19XR two-stage centrifugal chillers that use state-of-the-art two-stage compressors and heat transfer pipes with three-dimensional enhancement. The chillers can achieve a coefficient of performance of up to 6.5 under Air-Conditioning, Heating, and Refrigeration Institute operating conditions. "We applaud Merdeka PNB118 for its leadership in using energy-efficient technologies to build an environmentally responsible landmark in Malaysia," said Victor Yu, Managing Director, Carrier Malaysia. ■

## ASHRAE Commits to Sustainability

The recent decision to withdrawal of US from the Paris Climate Accord does not change or alter ASHRAE's commitment to accelerate the transformation to a more sustainable global built environment. "Our member-established mission underscores our mandate to serve humanity and create a more sustainable world," says ASHRAE President Tim Wentz.



"ASHRAE is a global Society of 57,000 dedicated professionals in more than 130 countries, committed to reducing the environmental impact of buildings by making them more energy efficient. Our mission will not waiver as geopolitical tides rise and fall."

"Now, more than ever, ASHRAE affirms its mission to advance the arts and sciences of heating, ventilation, air

conditioning and refrigeration to serve humanity and promote a sustainable world," Wentz says. ASHRAE recently announced a substantial \$1.3 million investment in researching alternative low-GWP (global warming potential) refrigerants. "ASHRAE's work is based on research and science. The Society will continue to establish best practice standards for the design and operation of buildings that have lower environmental

impacts and concurrently optimize health and human comfort for occupants," says Wentz.

"Our Society remains dedicated to engineering excellence in environmental stewardship. In fact, the recent Paris Accord announcement makes the critical role of ASHRAE members in reducing the environmental impact of buildings more important than ever before." ■

## Trump Announces US Withdrawal from Paris Climate Accord

President Donald J Trump recently announced that the United States will withdraw from the Paris Climate Accord, and begin negotiations to either re-enter or negotiate an entirely new agreement with more favorable terms for the United States. The decision is a fulfillment of the promise President Trump made to the American people during his campaign. The President vowed that the US would maintain its position as a world leader in clean energy, while protecting the economy and strengthening the work force. The Paris Climate Accord cost the US economy nearly \$3 trillion in reduced output, over six million industrial jobs, and over three million manufacturing jobs. Today's announcement is yet another example of the President's commitment to

put America and its workers first.

According to a study by NERA Consulting, meeting the Obama Administration's requirements in the Paris Accord would cost the US economy nearly \$3 trillion over the next several decades.

President Obama committed \$3 billion to the Green Climate Fund - which is about 30 percent of the initial funding - without authorization from Congress. The Obama-negotiated Accord imposes unrealistic targets on the US for reducing



our carbon emissions, while giving countries like China a free pass for years to come. Under the Accord, China will actually increase emissions until 2030. According to researchers at MIT, if all member nations met their obligations, the impact on the climate would be negligible. ■



Protect your life and  
property from fire with  
air master fire dampers



# air master

## UL Classified Fire & Smoke Dampers



### India:

Air Master Fire Safety Equipments  
#2, K Narayanapura Main, Road,  
Thanisandra, Bangalore 560077  
+91 80 28444569 / 70  
sales@airmaster.co

### Middle East:

Air Master Equipments Emirates LLC.  
PO Box. 3180, Ajman, U.A.E.  
+971 6 7436900  
sales@airmaster.ae



Motorised Fire Damper  
Motorised Smoke Damper  
Combinaion Damper  
Curtain Type Damper

Vsiti website for more detials:  
**[www.airmaster.co](http://www.airmaster.co)**



Air Distribution

Air Control

Fire & Smoke

## California Commissions Ice Batteries for Commercial, Industrial Buildings

**A** Santa Barbara-based company called Ice Energy has partnered with NRG Energy to deliver 1,800 ice batteries to commercial and industrial buildings served by electric utility Southern California Edison (SCE). The units are expected to reduce air conditioning bills by up to 40 percent and eliminate 200,000 tons of CO<sub>2</sub> over the next 20 years. Ice Energy has been building ice-based cooling systems since the early 2000s. Ice Energy essentially stores electricity by drawing power from the grid at non-peak times to freeze water in a special container. Then at peak times, when the cost of



electricity is high and grid operators are struggling to keep up with demand, Ice Energy's systems kick in and use that block of ice to cool the space that the air conditioning unit normally serves. Although the system isn't storing energy like a lithium-ion battery does, it draws energy to charge and replaces the energy that would be needed to run an AC unit when it discharges. That's good for the environment because air conditioning compressors are energy-intensive, and when a city like Los Angeles suffers a heat wave, people tend to run their ACs more. Grid operators have to meet that demand, and, to do that, they'll often turn to fossil fuel-burning additions like natural gas peaker plants, which can be brought online relatively quickly. But if local, behind-the-grid energy-storage systems can meet the additional needs of a home or business before they have to turn to the grid that reduces the demand that grid operators would otherwise have to meet. ■

## 'Agro Business Synergy - Focus North Bengal' Organized

**D**epartment of Industry, Commerce and Enterprises in collaboration with Departments of Agriculture, Agri Marketing, Food Processing & Horticulture, Animal Resource Development, Food & Supplies, Fisheries, Biotechnology, North Bengal Development Department, Siliguri Jalpaiguri Development Authority, Government of West Bengal in partnership with CII & Food and Agriculture Centre of Excellence (FACE) organized two days 'Agro business Synergy – Focus North Bengal' on 18-19 May 2017 at Siliguri. Around 435 entrepreneurs participated during the event from 8 districts of North Bengal. At the event, there were dedicated Help Desks of 8 districts, food processing & horticulture, fisheries, agriculture, floriculture, bio technology, tea, meat &

poultry, paddy processing unit, maize, cold chain and financial service for one to one interaction with the concerned department officer. P Ravichandran, Chairman, CII National Task Force on Cold Chain Development & President, Danfoss Industries during the 'Agro Business Synergy- Focus North Bengal' pointed that North Bengal suffers 20-22% post-harvest loss due to the lack of connect between farmers and market. Hence he felt it was important to have pack houses for enhancing the value of farm produces. He also mentioned that it was important that the region should have state-of-the-art facilities for grading, sorting, packaging and branding, which would really add value to the agri and horticulture produce from the region. Linkage with the right market was equally important. ■

## MIT Opens Energy-Use Data to Community

**M**IT has launched a new website in beta form, making available a broad swath of detailed information about energy use and carbon emissions on campus. This rich resource is available to the Institute's students, faculty, and staff, for education, research, and decision-making purposes. The rollout of this central data "dashboard," called Energize\_MIT, is the latest in a series of steps implementing the goals and commitments set out



in MIT's 2015 Plan for Action on Climate Change. The site offers a single web-based entry point to a centralized pool of data, which will improve collaboration across operational and departmental groups. The site provides two kinds of information. First, a set of interactive graphic visualizations depicts information such as campus-wide and building-by-building details about use of electricity, natural gas, fuel oil, steam, and chilled water, as well as the greenhouse gas emissions associated with energy use. And second, datasets can be downloaded

and used to drill down into details of energy use, including some as fine-grained as energy-use measurements in 15-minute increments. Energize\_MIT was developed as the first detailed campus sustainability data dashboard available to the MIT community providing comprehensive

information on energy use and greenhouse gas emissions. The plan called for the creation of an open data platform for campus energy use in order to provide faculty, staff, and

students with a useful resource for research and intelligent decision-making."

"Energize\_MIT is an invaluable tool not just for helping us to better understand and manage campus energy use, but also for engaging the MIT community in finding ways to reduce our energy consumption and greenhouse gas emissions," says Maria T Zuber, MIT's Vice President for research. "This is an important part of MIT's climate action plan. I am grateful to the members of the Energize\_MIT team for their hard work in bringing this platform online." ■





**TRANE**

**GEN YUE**

FULL DC INVERTER SYSTEM

# Variable Refrigerant Flow (VRF)

Effortless & Efficient Integration For Every Building

**TRANE GEN YUE is committed to improving the environments in our customer's buildings, thinking and doing more than they expected.**

## EXPERTS IN

**HOSPITALITY | HEALTH CARE | PREMIUM RESIDENTIAL**



### Superior Efficiency

Highest IPLV upto 6.90



### High Reliability

Wide operating range for ambience upto 50°C



### Convenient Operation

Advance Controllers like Touch Screen Controller



### Flexible Design

Longest pipe length of upto 200 meters



★★★★★  
Lifestory Research®

**AMERICA'S  
MOST TRUSTED®**

HVAC Brand

2015 • 2016 • 2017

### Trane Unitary Product Lineup.



Cassette



Concealed



High Wall



LCU



Rooftop/Packaged



VRF



**SMART CARE**

**1800 102 9986**

[smartcare@trane.com](mailto:smartcare@trane.com)

For more details login to [www.traneindia.com](http://www.traneindia.com)

SMS TRANE VRF 55 454

Live assistance at  
[www.traneindia.com](http://www.traneindia.com)

**IR** Ingersoll Rand

## Danfoss Delivers Strong Growth in First Quarter

In the first three months of the year, Danfoss continued the progress and increased its net sales and earnings. Net sales grew DKK 1.3bn to reach DKK 10.7bn – a growth of 13%, corresponding to 11% local currency growth. The higher sales lifted earnings (EBIT) by 7% to reach DKK 1.0bn, while the net result was up 12 % to DKK 691m. The cash flow from operating activities increased 20% to DKK 528m.



"We maintain momentum and had a strong start to the year. We are gaining market shares and grow faster than the industry and the overall global economy. We see that our growth initiatives are working, and we have invested in new companies, innovation and the development of new digital solutions to the benefit of our customers. So, it is a strong combination of organic growth and the impact from acquisitions, which are driving growth," President & CEO Niels B Christiansen says.

The progress of the Group is broadly based across its markets, including Danfoss' two largest markets, Europe and North America; but, it is increasing sales in the BRIC countries, in particular, that have driven the increase in total net sales in the first three months of the year. India has, for a long time, delivered high double-digit growth rates, and as a result of considerably increasing demand for energy-efficient technologies, growth in China has increased and reached the same high level. At the same time, there are indications of improved market conditions in Brazil and Russia, which have suffered from an economic slowdown. ■

## Panasonic Supplies Fluorocarbon-Free CO<sub>2</sub> Refrigerant in Malaysia

Panasonic Corporation announced it has supplied its CO<sub>2</sub> refrigerant-based condensing unit to the Mutiara Tropicana store of Malaysian supermarket chain Jaya Grocer as its first supermarket customer for such systems outside Japan. Panasonic Commercial Equipment Systems developed the fluorocarbon-free condensing unit and supplied through its local sales agent Coolcare (M) Sdn Bhd. It was assisted with the funding provided under the Multilateral Fund for the Implementation of the Montreal Protocol by the Department of Environment of the Ministry of Natural Resources and Environment of Malaysia (NRE). Supermarket operators are faced with the challenges of cutting power consumption of refrigeration and freezer systems in their stores as well as reducing environmental impact from the refrigerants used in such systems.

Amid growing awareness of greenhouse effect of fluorocarbons, CO<sub>2</sub> refrigerant is drawing attention as a next-generation

refrigerant. Compared to hydro chlorofluorocarbons (HCFC) and hydro fluorocarbons (HFC) currently used in most stores, natural CO<sub>2</sub> refrigerant has an ozone depletion potential (ODP) of zero and the extremely small global warming



OCU-CR2001MV



Jaya Grocer Mutiara Tropicana store

potential (GWP) of 1/1,430 to 1/3,920. Panasonic started verification testing of fluorocarbon-free condensing units using CO<sub>2</sub> refrigerant in 2009. Since September 2010 to date, the company has supplied around 6,000 units to Japanese retail companies, while promoting its environmentally friendly condensing units in other countries. Malaysia, which has ratified the Paris Agreement, is tackling the global warming problem at a national level. ■

## IIAR Developing Safety Guidance for CO<sub>2</sub> Refrigeration

As it continues to branch out from its focus on traditional large-charge ammonia systems, the International Institute of Ammonia Refrigeration (IIAR) is developing a standard for CO<sub>2</sub> that will specify criteria for the safe design and operation of CO<sub>2</sub> refrigeration systems like cascade and trans-critical. "We hope to complete it a year from now," said Eric Smith, Vice President and Technical Director of IIAR.

IIAR is also developing guidelines for low-charge ammonia systems that will enable end users "to be compliant with the (EPA's) General Duty Clause" for safety, added Smith, who expects the guidelines to be ready in six months. IIAR is based in Alexandria, Va.

On the training front, IIAR's year-old education program, Academy of Natural Refrigerants has certified about 100 people who have taken a course on the IIAR-2 operational and safety standard for ammonia refrigeration, which was updated last year.

IIAR will add classes on IIAR standards 4, 5 and 8 on installation, start-up and decommissioning, and will introduce courses on CO<sub>2</sub> next year, Smith noted. IIAR's Ammonia Refrigeration Foundation (ARF) is partnering with the US Department of Defense and RETA (Refrigeration Engineers and Technicians Association) to help military veterans find jobs in the HVAC&R industry, and is also working with Praxair on a diversity grant that would offer opportunities to low-income individuals to "be exposed to our industry," he said. Smith acknowledged that while IIAR has traditionally served the industrial refrigeration industry, it "has a real interest in using natural refrigerants for commercial systems". To that end, the group is "hoping to gain interest from more people in the commercial world".

The IIAR-2 standard's recent update aims to promote the use of ammonia in the commercial industry, including new information on low-charge packaged systems, Smith said. ■



# Big Smart Fan

High Volume Low Speed ( HVLS)



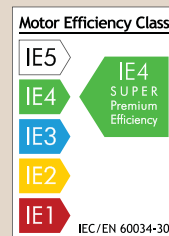
An European Product

## Benefits

- Low Capital, Installation and Maintenance costs
- Low noise level < 45 dBA with standard gear reducer
- Sizes are available between 2.5m till 7.3m
- IE4 SUPER Premium Efficiency motors are available
- Permanent Magnet motors available
- Low noise levels <35 dBA with permanent magnet motors
- High performance & Energy saving
- Lower power consumptions lead to power saving more than 30% compare to a conventional ventilation methods
- Summer Cooling - Winter Destratification
- Pole installation option available for open areas
- Solar powered Outdoors fans available for warm climates

## Recommended Applications

- Places with maximum air movement required e.g. Farms, Animal Husbandry Facilities etc.
- Big buildings with high ceilings e.g. warehouses, Hangers, Industrial facilities, Malls, Shopping centres, Sports Halls etc.
- Intensively used areas where people come together e.g. Entertaining centres, Cafeterias, Libraries, Museums, Mosques, Temples, Gurdwaras, Theatres, Opera, Concert halls, Exhibition Centres, showrooms etc.



## GAPS Engineering & Consultancy

416, JOP Plaza, Sector-18, Noida U.P. - 201301

Tele: +91-120-4311197 ♦ Mob: +91 98 715 66 133 ♦ E-mail: gaurav@gapsenco.com

Web: [www.gapsenco.com](http://www.gapsenco.com)

### Alex Rasmussen to Lead Eurovent Association

**D**uring their 60<sup>th</sup> Annual Meeting in Versailles, France, members of the Eurovent Association from more than 20 countries have unanimously confirmed the presidency of Alex Rasmussen, who is going to serve Europe's Industry Association for Indoor Climate (HVAC), Process Cooling, and Food Cold Chain Technologies for an additional year. Rasmussen has been leading the Eurovent Association since May 2015 on a mandate of the Danish Ventilation association.

While the usual term of a Presidency is limited to two years, the recent retirement of a First Vice-President from the Board has led members to ask Alex Rasmussen to lead the association for an additional year. The President will be supported by Naci Sahin (Association: ISKID, Company: FRITERM, Turkey) as First Vice-President and either newly or re-elected Vice-



Alex Rasmussen

Presidents that constitute the Eurovent Board of Directors. Alex Rasmussen stated following his re-election, "It is an honour for me to serve our European industry family for another year. I thank all members for the continued support and trust in my work. Together with my fellow Board members, I will do my utmost to further develop the association's structure and activities following our Statement of Principles while strengthening the unity of our industry in Europe and abroad." Rasmussen (born 1948) is of Danish nationality and has held various positions in the refrigeration and ventilation arena. Since 1998, he has been CEO of Systemair Denmark until becoming Senior Advisor of the Systemair Group at the beginning of this year. Rasmussen took over the Presidency from Christian Herten, GEA Group, who had been leading Eurovent from 2013 to 2015. ■

### Nigel Hammond Joins Fujitsu

**F**ujitsu has strengthened its support to distributors with the appointment of Nigel Hammond as distribution account manager for the south. Nigel Hammond will cover all southern England and parts of Wales, reporting to national



Nigel Hammond

distribution sales manager Nick Wilks.

With some 14 years' experience in the refrigeration and air-conditioning distribution industry, Hammond's previous employers have included Climate Centre, HRP and Kooltech. ■

### Cinnamo Joins Nexstar Legacy Foundation

**N**exstar Legacy Foundation and Nexstar Network have welcomed the new member Kate Cinnamo as the foundation's new Executive Director. The Nexstar Legacy Foundation, a Saint Paul-based non-profit organization is bringing veterans and young people into the plumbing, heating, cooling and electrical (PHCE) trades. The foundation has joined hand with Nexstar Network, a best-practices organization for residential contractors in the PHCE trades along with others to accomplish this goal.

Cinnamo has more than a decade of experience in non-profit fundraising and development. As Executive Director, she



Kate Cinnamo

will provide strategic vision and planning to bring the message of the foundation nationwide. "We are proud to have Kate at the helm of the foundation," said Bill Raymond, President of the foundation's board of trustees. "She'll do an excellent job of carrying the torch of the foundation forward and getting the word out about the amazing opportunities waiting for people in this industry." Troops to Trades and Explore the Trades, foundation's two programs aim to reach young people and veterans.

The foundation plans to give away \$115,000 in scholarships this year, Raymond said. ■

**Now  
Subscribe/Renew  
Online**

**Cooling India**

**Just Log on to: [www.coolingindia.in](http://www.coolingindia.in)**



# WHO GIVES YOU THE BEST STORAGE SYSTEM SOLUTION?

SSI SCHÄFER is the only company in the market that can offer a total solution in Intralogistics. Being a specialist in our field, customers get the added advantage when working with us as we can provide a customised solution that meets your future intralogistics requirement. Contact us and have a chat with our specialist to learn the best solution that suits your needs. The right solution can help you achieve:

- Space saving
- Improved ergonomics
- Increased efficiency
- Extra capacity

+91 22 71170101 | [info.in@ssi-schaefer.com](mailto:info.in@ssi-schaefer.com) | [ssi-schaefer.com](http://ssi-schaefer.com)

**SSI SCHÄFER**

## Danfoss Wins Product Innovation Edison Award

**D**anfoss, the pioneer and leader of oil-free, magnetic bearing, variable speed centrifugal compressors for high-efficiency air-conditioning chillers, has been voted a Bronze Winner in the Edison Awards, a program that honors innovation and excellence in the development to new products and services. The awards were presented recently at The Capitale in New York City during a ceremony.

"Our judges recognized the Danfoss Turbocor VTT compressor as a true innovator out of the many products in its category," said Frank Bonafilia, Executive Director of the Edison Awards. Danfoss was recognized as part of the program's Energy & Sustainability category. Intended for water-cooled chillers and with capacities of 350 tons per compressor, Danfoss Turbocor VTT (Variable Twin Turbo) compressors are oil-free, variable speed, magnetic bearing centrifugal compressors ideal for commercial air-conditioning or process cooling chillers reaching upto 1,000 tons or more.

The Turbocor VTT series introduces IntraFlow, an innovative



Danfoss recognized for its innovative Turbocor VTT compressor, receives award during ceremony in New York City

and patent-pending technology that improves efficiency and provides an extended stable operating range while simplifying capacity control. It also enables chiller manufactures to provide the best life cycle cost for commercial buildings, helping end users to save significant money and meet their targets to reduce CO<sub>2</sub> emissions.

Because Danfoss Turbocor

compressors are frictionless, with no wearing parts, the compressors maintain high performance over time, allowing end users to experience expected energy savings and lower maintenance costs.

President of Danfoss Turbocor Compressors Ricardo Schneider, who received the Edison Award, said, "It is a tremendous honor to be recognized among the most innovative companies and leaders, representing the best teams around the globe that bring creative solutions to customers' problems. With this award, we celebrate and thank our customers – our partners – for their continued innovation and leadership in bringing revolutionary Turbocor compressors to the market." ■

## Gel-Clear a Two-Times Winner

**G**el-clear is the award winning condensate drain tablet. Proven to immediately reduce operational costs and risks, with between 90-100% reduction in water leak call outs. Gel-Clear has picked up a second award in the last 12 months for its refrigerated cabinet condensate drain treatment tablet. Named Refrigeration Product of the Year at last year's Cooling Industry Awards, Gel-Clear has now added an Innovation Award from the 2017 Hive Blackburn and Darwen Business Awards.

Gel-clear is the simple, low cost, effective solution to blocked condensate drains. Gel-clear's proprietary formula makes it the award winning condensate drain tablet for the food retail display case, and the treatment of biofilm jelly in refrigeration drainage. Effective for 12 months, Gel-clear condensate drain tablets are a unique approach to blocked condensate case drains preventing the buildup of microbial mass, jelly and slime. By comparison, the most cost effective condensate drain treatment on the UK market. Gel-clear is safe to use with condensate pumps and Evac systems, being approved pump safe by Aspen Pumps Ltd, the world's



Effective for 12 months, Gel-clear condensate drain tablets are a unique approach to blocked condensate case drains preventing the buildup of microbial mass, jelly and slime.

leading condensate pump manufacturer and NSF approved for food display chillers. According to Gel-Clear Director Paurick Gaughan, 50% of reactive call outs can be attributed to water leaks, and that between 90-100% of these leaks are caused by biofilm blockages.

Hive network was established in 2012 to unite, develop and promote business across Blackburn and Darwen. Its annual business awards, now in their third year, are designed to celebrate the very best of business in the borough. Speaking at the

awards dinner at Blackburn's King George's Hall, Paurick Gaughan said "It is a real honour to receive this recognition; we were up against some fantastic innovations that seemed to dwarf our tablet. The judges recognised our intensive work with our manufacturer in product development since 2009, and with our end user developing a simple product, a context specific solution to a common industry problem. Our proprietary formula is unique in how it tackles the biofilm problem; we target the 'Off switch' in the microbial life cycle, preventing the secretion of exopolymers." ■



Delivering water with passion, everywhere  
since

1959



ITALIAN MADE

QUALITY • COMMUNITY • ENVIRONMENT



### Pumping Solution for

- | Industrial | HVAC | Ground Water |
- | Domestic & Residential |
- | Agriculture & Irrigation | Fire Fighting |
- | Swimming pools | Drainage & Sewage |



## Calpeda Pumps India Pvt. Ltd.

#953/A, 3rd Floor, 2nd Main, 4th Block, Rajajinagar, Bangalore-560010. Tel : +91 80 2315 9678,  
Fax : +91 80 2315 9655, E-mail: [info\\_india@calpeda.it](mailto:info_india@calpeda.it), [service\\_india@calpeda.it](mailto:service_india@calpeda.it) [www.calpeda.com](http://www.calpeda.com)

# Saving Energy through Better Buildings Challenge Partners

More than 1,000 Energy-Saving Solutions Now Available to the Market



The US Department of Energy (DOE) recently announced the energy-efficiency progress made by the 345 leading public and private sector organizations in the Better Buildings Challenge. These efforts have led to a combined 240 trillion Btus and an estimated \$1.9 billion in cumulative energy and cost savings. These results are summarized in the 2017 Better Buildings Progress Report released that highlights accomplishments across the broader Better Buildings Initiative. The goal of this initiative is to make commercial, public, industrial, and residential buildings 20 percent more energy efficient over the next decade by focusing on overcoming market barriers and sharing partner created solutions.

"Through the Better Buildings Initiative, hundreds of leaders from the public and private sectors are demonstrating innovative approaches and deepening American investments in critical building infrastructure," said US Secretary of Energy Rick Perry. "By planning ahead and investing in cost-effective energy efficiency strategies, partners are bringing better buildings to our communities and improving the everyday places Americans live and work, while creating new and lasting jobs."

The more than 345 organizations from diverse sectors that have stepped up to the Challenge committed to improve the energy intensity across their entire building portfolio by at least 20% within a decade.

These organizations represent more than 4.4 billion square feet of building space, include more than 1,000 industrial facilities, and have committed \$7 billion

financing.

Partners have shared energy performance results for nearly 38,000 properties. On average, partners are improving by more than 2% per year, and are staying on track to meet their energy savings goals of 20% over the next 10 years. This year, 18 Better Buildings Challenge partners and allies met their energy, water, or financing goals. Since the start of the program, 40 Challenge partners have met their energy goals, six have met their water goals, and 12 financial allies placed sufficient investments to meet their financing goals.

**This year's 14 energy and water goal achievers are:**

- Celanese International Corporation
- Chesapeake College
- CKE Restaurants Holdings, INC.
- Deutsche Asset Management
- Digital Reality Trust
- General Motors (Water)
- Jewish Community Housing for the Elderly
- Johnson Controls
- Macy's
- Schneider Electric
- Shorenstein Properties LLC
- Staples (Water)
- The Tower Companies
- Towson University

**The four financial allies that have also met their goals this year are:**

- Biostar Renewables
- CleanFund LLC

- LISC
- Renew Financial

More than 35 partners and financial allies joined the Better Buildings Challenge over the last year, committing 200 million square feet of building space, nearly 40 plants, and \$650 million for efficiency projects. These partners are contributing to the more than 1,000 proven solutions now available online in the Better Buildings Solution Center. When partners share their energy and water savings strategies and results, they demonstrate their collective leadership by making it easier for others to replicate their success.



Though Better Buildings, DOE aims to make commercial, public, industrial, and residential buildings 20 percent more energy efficient over the next decade. This means saving billions of dollars on energy bills, reducing emissions, and creating thousands of jobs. Better Buildings partners represent public and private sector organizations across the country, and are working together and with DOE to share and replicate positive gains in energy efficiency. The Energy Department is currently pursuing strategies within four interrelated key areas. Read about how partners are increasingly working to catalyze change and investment in energy efficiency, and their proven solutions, in the Better Buildings Solution Center. ■



The architect  
outdid himself.  
So did the  
HVAC designer.



Creating the best commercial space means agonizing over every detail. That includes the comfort of the space as well. Never too hot. Never too cold. Always just right. That's where Emerson comes in. Our complete line of Copeland Scroll™ variable speed compressors enables unparalleled comfort with maximum energy efficiency. With these innovative solutions, you'll feel comfortable with Emerson — and your customers will too. For more information go to **[EmersonClimate.com/India](http://EmersonClimate.com/India)**



The Emerson logo is a trademark and a service mark of Emerson Electric Co. © 2017 Emerson Electric Co.

**EMERSON. CONSIDER IT SOLVED.™**

# Energy Conservation for Air Conditioner

In this article, authors have explained about the basic working mechanism of Air Conditioner and with the case study of real example of split units of AC have tried to explain the basic calculations, how to select the AC for home requirements. Moreover, the very important energy saving tips and BEE guidelines for star rating is also explained.

**A**ir conditioners are used to vacate heat from specific area called controlled area. Chill water plant, central AC plant and package units are used for big premises. For home and office small units of capacity 1 to 2 tonnes are mostly used.

Window units used earlier are now obsolete and split units are most common. Normally controlled area is closed and inside air is circulated in close loop. Here controlled area is room. Air conditioning units are used for small area like bed room, seating room, cabin, laboratory, etc.

## Heat Transfer

Heat flow from higher temperature to lower temperature in natural course. But in this case, heat is required to transfer from lower temperature area to comparative higher temperature area and therefore, has to be forced by some means. This is achieved by means of circulating refrigerant in closed path. By compression, refrigerant gets heated up to temperature higher than ambient and is sent to condenser where heat is thrown off to

atmosphere by forced air by fan and the gas condenses to liquid. This liquid is allowed to expand (release pressure) when it cool down below the room temperature and sent to evaporator cooling coils.

The air blower forces the air over cooling coils where refrigerant absorb heat from air and evaporate to gas whereas the air loose heat and cool down and is delivered in the room.

## Analogy

The whole process is similar to removing splashed water from the floor. House maid unfolds mop and spread over the water. Mop absorbs some water and then she takes it out and squeeze to release water. This process is repeated continuously so that water from floor is transferred outside. Refrigerant in air conditioner works as mop to absorb and release the heat.







## Electricity used in A/Cs

Electricity supplied to air conditioner for its functioning is principally consumed by following three motors.

### 1. Compressor Motor

- This motor is of highest capacity in the unit.
- Consume maximum energy during operation of air conditioner.
- Motor runs intermittently as per signal from thermostat.

### 2. Condenser Fan Motor

- This motor drives fan having three or four blades that forces air through condenser coils to discharge maximum heat of refrigerant.
- This fan works only when compressor is working.

### 3. Air Fan Motor

This motor drives blower that circulates cold air in the room. Comparative hot air is drawn from the top and forced to pass through evaporator (cooling coils) and after cooling delivered in the room.

This motor runs continuously till air conditioner is on.

#### Other motor :

- There may be very small motors for movement of louver for distribution of cold air as desired.
- These motors run as per requirement of operator but its energy consumption is insignificant.

## Thermostat

The function of thermostat control is very important. Desired temperature can be set by operator. When room temperature falls below the set value, the supply to compressor and condenser fan is cut off

and further cooling is suspended. As result of stoppage of these two motors, power consumption is reduced.

Afterward when room temperature rises above the set value, the compressor and condenser motors are again started.

## Thermostat Setting

Thermostat temperature setting has important role in economical operation of air conditioner. Start and stop of compressor and condenser motors are controlled by thermostat. When thermostat setting at lower temperature, compressor and condenser ON period is long and OFF period is short.

Whereas when thermostat setting at higher temperature, ON period is short and OFF period is long. Power consumption of air condition unit depends on running period of these main motors. Higher the Run/Rest ratio of compressor, more is energy consumption. It is estimated that rising of temperature setting by 10C, results in reduction of about 2.5 % in energy consumption.

## Comfort Zone in AC Environment

Ambient temperature in hot zone is uncomfortable and so also temperature in cold zone is uncomfortable. Whenever temperature is abnormal, it can be brought in comfortable zone by operating air conditioner. The comfortable zone may be in the range of 22°C to 28°C depending on metabolic 28°C rate of user.

Cooling down to very low temperature is uncomfortable as well uneconomical also. Hence, it is to be avoided. But practically some air conditioners are operating in cold zone as under.

## Over Cooling in the AC Environment

When person from outside hot atmosphere enters the room and start air conditioner, he feels very poor cooling. Actually, the body including cloths and accessories is at atmospheric temperature. Air conditioner has to draw out all this additional heat also and therefore, it may take little some time.

But due to impatience and ignorance temperature setting is reduced to minimum. In fact, cooling cannot be fast by reducing temperature setting but it takes own time as per capacity of the unit. Eventually, lower setting continues and result in over cooling.

Some air conditioners have facility of turbo cooling mode. This may serve the purpose for fast cooling but care has to be taken to switch to normal operation. As far as possible setting should not be disturbed and kept at comfort zone only.

## Pre Cooling

Other way is to start air conditioner in advance so that by the time of entry, room is already cool. This can be possible by instruction to watchmen/attendant/assistant to start the air conditioner before time of arrival.

Some air conditioners have facility of remote operation through device like mobile. This can be used for advance starting for pre-cooling. However, care should be taken not to start much in advance because it may be wasteful act.

Almost similar situation occurs in the case of bed room. At the time of entry in the room cooling seems to be insufficient.



As usual temperature setting is kept minimum for fast cooling.

At late night temperature drops and has to use blanket. Similar observation may be in air conditioned train. At the start, few passengers complain to attendant for insufficient cooling but at late hours most of the passengers are using blanket.

Does it not seem to be ridiculous that on one hand to spend money for over cooling and on other hand face shivering and use blanket for protection?

Such situations can be solved by pre cooling the bed room and using sleep mode that raise the setting in steps at late night.

## Ignorance

Some users just start the air conditioner when required but unaware of significance and implementation of temperature setting. So, air conditioner runs on default minimum setting.

## Important Tip

Increasing setting from 22°C to 26°C results in 10% saving of energy. In many cases, setting is at 18°C or 20°C. If this is revised to 26°C or 28°C, there may be energy saving of 20%. So, the first and foremost tip is to have proper temperature setting.

## Other energy saving tips:

### During the Installation:

#### a. Internal unit

Internal unit should be installed in such a way that air flow is not obstructed. Air is taken in the unit from the top. There should be sufficient space at top and there should

not be any decorative hanging etc in the air path that obstructs the air circulation. Cooled air is delivered from bottom. There should not be any cupboard, curtain, etc under the unit that obstruct the air path.

Any obstruction can reduce air flow and result in less cooling. Ultimately to reach set temperature, compressor has to work for long time requiring more energy. Also fan load increase due to obstruction in the air path and consume more energy.

#### b External unit

External unit should also have the similar arrangement for free air flow. There has to be sufficient space on back and top of the unit.

Location of the unit should be such that it may not be in direct sun rays during period of operation. Condenser unit has to reject the maximum heat of compressed refrigerant in atmosphere. Direct sun rays heat the unit and condensing may be partial. Mostly, air conditioner is operated in afternoon and night and therefore, external unit should be on east side. However, due to practical constraint, it is on west side, it should have shed to protect from direct sun ray in such way that air flow is not blocked.

## Heat Ingress

Air conditioners are used when outdoor is very hot. If this external heat enters the room, the machine has to draw out this additional heat also to attain temperature as per setting. This results in longer running of compressor consuming more

energy. Therefore, all efforts have to be made to restrict the entry of heat in the room. From Terrace, If the room is on top floor, the terrace is heated by sun ray and this heat is conducted to the room. This can be avoided or minimized by painting terrace with white glossy paint so that sun ray is reflected.

Alternatively for better and lasting solution, white glassed tiles or mosaic with pieces can be fixed in terrace. Additionally, shedding green net can be installed at about two feet above the terrace which may prevent sun ray striking and heating the terrace. The air trapped between terrace and net act as insulation.

Ceiling of the room can have thermocol lining as heat insulator or false ceiling made of plaster of parish or gypsum board. Air trapped between ceiling and false ceiling act as insulator.

From Walls, where the wall of the room is facing the west, it is heated by sun ray in the afternoon. This heat is conducted in the room and increase the heat load of air conditioner. The outer side of the wall can be painted with light color glossy paint so sun ray is reflected and heating is minimized. Wooden or thermocol lining can be provided on inside of the wall.

Window of the room having glass shutters and facing west can be covered with sun ray control film. Double glass (inside and outside) shutters will be better as the air trapped between glasses will act as thermal insulation. Additionally light colored cotton curtain on window is also helpful.



### Star level valid for split type air conditioners

(From 1st January 2016 to 31st December 2017)

Star level	Energy Efficiency Ratio (Watt / Watt)	
	Minimum	Maximum
1 Star*	2.70	2.89
2 Star**	2.90	3.09
3 Star***	3.10	3.29
4 Star****	3.30	3.49
5 Star*****	3.50	

Light color reflects the sun ray and air between shutter and curtain act as insulator.

### Intermix

Care is required to avoid intermix of cold air in the room and hot air outside. Any vent or gap in door/window/partition should be sealed to avoid transfer of air. Generally, there is gap between bottom of door and floor. Door Seal Strip available at hardware shop should be fixed. Door and window should remain closed when air conditioner is operating. Door closer should be installed to avoid instances of open door by mistake. Air curtain or automatic door control (open close device) can be installed where frequent entry / exit is expected. Air buffer is better solution where feasible. It is intervening closet having two doors, one to the room and other outward. Doors are interlocked not to open simultaneously and may have door closers.

### Words of Caution - Bed Rooms

For bed room condition is different

Long period of about 6 to 8 hours is passed continuously sleeping. Person is inattentive to any abnormalities in the room. Air conditioner running with minimum setting and without sleep mode may cause over cool during last segment of the night. Blood may have comparative

higher viscosity at low temperature requiring more pressure for circulation. Also due to breathing of occupant oxygen is consumed and carbon dioxide is released. In totally, sealed room proportion of oxygen reduce and that of carbon dioxide increase. Condition may be worst during last segment of the night and may be harmful for occupant. Therefore, intentional slit has to be provided to maintain proportion of oxygen and carbon dioxide by diffusion through it. This is more relevant to those having cardiac and breathing problems. Doors and windows of the car have rubber lining and hermetically sealed. The volume of air in car is very less as compared to room. Number of occupants may be up to 5 as against 2 in bed room. Air conditioner is operated in air circulation mode and windows are closed for better cooling.

In long run oxygen and carbon dioxide proportion is disturbed due breathing of passengers. Even though comfortable temperature and seating condition, passengers may feel weary.

Therefore, while on long run it is important to change from air circulation mode to fresh air mode for one minute at every hour.

### Capacity of AC

Capacity required for air conditioner

depends on following:

- Air volume (room size)
- Numbers of occupants (persons in the room)
- Heat load (heat ejected by gadgets in room)
- In case of capacity is less than required, desired cooling is not achieved and compressor runs continuously without rest and chances of failure.
- Similar condition occurs where room is open to kitchen, other room or up stair.

### Maintenance of AC

- Air filters of internal unit should be cleaned periodically.
- Reverse air blow through condenser and evaporator coils by vacuum cleaner is required to remove any deposition and blocking.
- Any blocking may restrict air flow resulting in less heat transfer and lesser cooling and longer compressor operation.
- Check gas pressure. Add gas if low.
- Check for gas leakages. Block any leakage.

### Avoid Waste By

- Occupancy sensors are useful to avoid wasteful running of air conditioner in absence of occupant.
- Iron or hot plate / stove should not be used in the air conditioned room. It has dual disadvantage.
- It adds undue heat load increasing energy consumption.
- Part of the heat generated by iron or hot plate is taken away by air conditioner and hence iron or plate consumes more energy.
- Stove consumes oxygen and emits carbon dioxide in the closed room.

**The No1 compressor brand in America**  
now available in India.

Embraco: leading technical innovation for over 46 years.



**embraco**

www.embraco.com

## Vast Scope for Energy Saving can be done by:

Primarily, above measures are useful for energy saving and cut in electricity bill. At the same time, this will indirectly control emission of green house gases and ultimately global warming. Air conditioner is the high energy consuming gadget compare to geyser and fridge. Up to 30% energy saving is possible by implementation of applicable measures from the above.

## Star Rating of AC

Now as per rule star rating is compulsory for air conditioners. Regulating authority is Bureau of Energy Efficiency (BEE). The star rating is related to Energy Efficiency Ratio. Higher the star rating, higher is the EER and lower the power consumption. High star rated unit may be costlier.

Case Study for Air Condition Selection (For Split Units)

## Cost-Benefit Analysis

Price of higher star rated AC is more but the additional cost is recovered as saving in electricity bill.  
Comparison of 1.5 ton, 5 star and 1 star air conditioner  
One ton equals 3,515 watts cooling capacity.

Average Power = cooling capacity ÷ EER  
For 1.5 ton 5 star unit:

Power =  $3515 \times 1.5(\text{ton}) \div 3.3(\text{EER}) = 1598 \text{ Watts} = 1.598 \text{ Units per Hour}$

For 1.5 ton 1 star unit

Power =  $3515 \times 1.5(\text{ton}) \div 2.5(\text{EER}) = 2109 \text{ Watts} = 2.109 \text{ Units per Hour}$

Price difference of same type 1.5 ton, 5 star and 1 star A/C is taken as Rs 8000/-  
Annual variable cost on account of interest, depreciation and maintenance taken as 20% of capital cost.

Annual variable charges for additional cost =  $8000 \times 20 = 1600/-$

Energy charge average Rs 6.5 per unit.

## Case A for Regular Bed Room

Normal usage period : Noon From 12 Hrs to 17 Hrs = 5 Hrs

Night From 23 Hrs to 07 Hrs = 8 Hrs

Total usage hours per day = 13 Hrs

Annual utilization about 140 days (includes summer days and period between end monsoon and start winter.)

Annual saving on energy bill =  $(2.109 - 1.598) \times 13 \text{ Hrs} \times 140 \text{ days} \times 6.5 \text{ Rs/Unit} = \text{Rs } 6045 \text{ per year.}$

Annual Net Saving =  $6045 - 1600 = \text{Rs } 4445 \text{ per year}$

Additional cost of Rs 8000 is recovered almost in 2 years.

Hence, it is acceptable.

## Case B for Guest Room

Normal usage period

Night From 23 Hrs to 07 Hrs = 8 Hrs

Annual utilization about 25 days (includes summer days and period between end monsoon and start winter.)

Annual saving on energy bill =  $(2.109 - 1.598) \times 8 \text{ Hrs} \times 25 \text{ days} \times 6.5 \text{ Rs/Unit} = \text{Rs } 664 \text{ per year.}$

Annual Net Saving =  $664 - 1600 = \text{Rs } -936 \text{ per year is negative}$

Additional cost of Rs 8000 could not be recovered.

Hence, it is not acceptable.

High star rated A/C is better where long running hours.

## Conclusion

In this article, authors have tried to cover the basics of Air Conditioner and done case study (For Split Units). The case study clearly indicates how to select the AC for the room. From the case study it can be clearly found that, high star rated AC is better where long running hours. Authors have also shown the updated BEE Star labeling scheme and list out the points by which energy conservation can be done effectively. By this way, the energy can also be saved and individual can save money too. ■

**Paresh R. Modha**

Assistant Professor in EE  
Department, ADIT, New  
Vidyanagar, Gujarat



**Rajan R Modha**

Assistant Professor in EE  
Department, VIER,  
Kotambi, Vadodara, Gujarat



**Minesh K. Joshi**

Assistant Professor in EE  
department, ADIT, New  
Vidyanagar, Gujarat



India's foremost magazine  
dedicated to HVACR  
Industry

- ~ Pitch new clients
- ~ Reach nationwide
- ~ Boost sales
- ~ Increase Company visibility
- ~ Standout in industry
- ~ Be ahead in competition

**Move your  
business forward...**

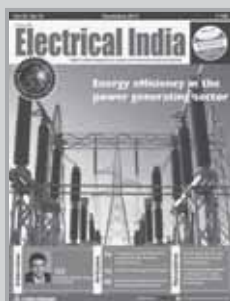
Advertise in

**Cooling India**

Contact - +91 22 27777 177

[www.coolingindia.in](http://www.coolingindia.in)





Since 1961

The Subscription In-charge  
**Electrical India**  
Chary Publications Pvt. Ltd.  
906, The Corporate Park, Plot No. 14 & 15,  
Sector - 18, Vashi, Navi Mumbai - 400 703  
Email: sub@charypublications.in

If you are already a Subscriber,  
Enter your  
Subscription/Order no. \_\_\_\_\_

**SUBSCRIBE / RENEW  
ONLINE**  
**Log on to –**  
**www.electricalindia.in**

Yes, I would like to subscribe **Electrical India** for \_\_\_\_\_ years  
at ₹ \_\_\_\_\_ (US\$ \_\_\_\_\_ overseas subscribers)

**Payment details:**

Cheque / DD No. \_\_\_\_\_ dated \_\_\_\_\_  
drawn on bank \_\_\_\_\_ branch \_\_\_\_\_

In favour of **CHARY PUBLICATIONS PVT. LTD.**

**Bank details for Wire Transfer**

Bank Name: **Bank of India** Branch: **Chembur, Mumbai - 400 071** Pan No.: **AABCC 6078J**  
IFSC Code: **BKID 0000009** Bank a/c number: **000920110000322** SWIFT CODE : **BKIDINBBCHM**

Name: \_\_\_\_\_

Company: \_\_\_\_\_ Designation: \_\_\_\_\_

Address: \_\_\_\_\_

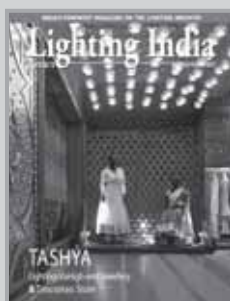
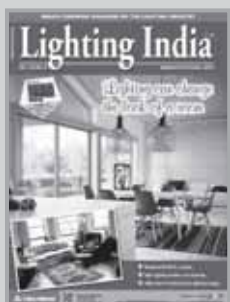
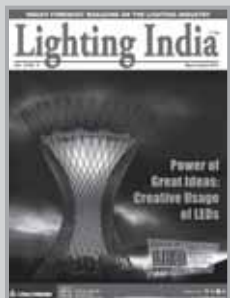
City: \_\_\_\_\_ Pin: \_\_\_\_\_

Phone: \_\_\_\_\_

Email: \_\_\_\_\_

Signature: \_\_\_\_\_

No. of Years	Amount	US \$	Tick ✓
<input type="checkbox"/> 1 (12 Issues)	1000	300	
<input type="checkbox"/> 2 (24 Issues)	1750	560	
<input type="checkbox"/> 3 (36 Issues)	2500	720	
<input type="checkbox"/> 5 (60 Issues)	4000	1000	



Lighting India

The Subscription In-charge  
**Lighting India**  
Chary Publications Pvt. Ltd.  
906, The Corporate Park, Plot No. 14 & 15,  
Sector - 18, Vashi, Navi Mumbai - 400 703  
Email: sub@charypublications.in

If you are already a Subscriber,  
Enter your  
Subscription/Order no. \_\_\_\_\_

**SUBSCRIBE / RENEW  
ONLINE**  
**Log on to –**  
**www.lightingindia.in**

Yes, I would like to subscribe **Lighting India** for \_\_\_\_\_ years  
at ₹ \_\_\_\_\_ (US\$ \_\_\_\_\_ overseas subscribers)

**Payment details:**

Cheque / DD No. \_\_\_\_\_ dated \_\_\_\_\_  
drawn on bank \_\_\_\_\_ branch \_\_\_\_\_

In favour of **CHARY PUBLICATIONS PVT. LTD.**

**Bank details for Wire Transfer**

Bank Name: **Bank of India** Branch: **Chembur, Mumbai - 400 071** Pan No.: **AABCC 6078J**  
IFSC Code: **BKID 0000009** Bank a/c number: **000920110000322** SWIFT CODE : **BKIDINBBCHM**

Name: \_\_\_\_\_

Company: \_\_\_\_\_ Designation: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ Pin: \_\_\_\_\_

Phone: \_\_\_\_\_

Email: \_\_\_\_\_

Signature: \_\_\_\_\_

No. of Years	Amount	US \$	Tick ✓
<input type="checkbox"/> 1 (6 Issues)	750	150	
<input type="checkbox"/> 2 (12 Issues)	1350	275	
<input type="checkbox"/> 3 (18 Issues)	2000	400	
<input type="checkbox"/> 5 (30 Issues)	3000	600	

Electrical India

SUBSCRIBE

EI \ June 2017

SUBSCRIBE

EI \ June 2017

# Electrical India walking hand in hand with the power industry for over 5 decades

## Who can Subscribe?

### Industries:

- Power Generation Equipments
- Transmission and Distribution
- Rectifiers
- Switchgears & Controls
- Transformers, Transformer Oil and Lubricants
- Financial Institutions Financing Power Plants
- Automation, Electronics and Instrumentation
- Test and Measuring Equipments
- Energy Management
- Power Generation
- Motors, Starters and Pumps
- Lighting and Lighting Components
- Safety Devices
- Nuclear Energy
- Capacitors and Condensers
- HVAC
- Circuit Breakers & Relays
- Cables, Contractors and Accessories
- UPS

... and related accessories.

## Professional Readers - EI

### Industries:

- Manufacturers of Electrical/Electronic Goods
- Power Generation
- Fertilizers, Chemicals and Petrochemicals
- Oil and Gas
- Paper and Pulp
- Independent Power Producers
- Military / Defence
- Textile
- Drugs and Pharmaceuticals
- Sugar
- Construction & Packaging Industry
- Renewable Energy & SEB's
- Govt. and Semi-Govt. Bodies
- Institutions

### Professionals:

- Engineers & Policy Makers
- Corporate Management
- Distributors, Traders, Contractors and Suppliers
- Wholesalers, Agents, Retailers
- Advisors / Consultants
- Purchase Managers & Diplomats
- Entrepreneurs & Investors
- Technical Management and Education / Research Training
- Architects

Several Others...

“We travel nook & corner to get the world at your door step”

## Who can Subscribe?

### Industries:

- Shopping Plazas, Cinema Halls and Theatres
- Entertainment Industry: eg. Hotels, Restaurants, Gymnasium & Malls
- Stage & Studio Lighting
- Automobile Industry
- Manufacturers
  - Lighting
    - Neon Lamp
    - Pole
    - Decorative Luminaire
    - Glass & Glass Furnace
  - Machine
  - LED
  - Switch & switchgear
  - Electric Measuring Instrument
- Suppliers
  - Chemical
  - Starter
  - Lighting Products
  - Brass Component
  - Plastic Component
  - Gas
  - Cable Wire
  - Lamp Component
  - Electric Component
  - Steel Component
- Research & Testing Laboratories
- Electronics in Lighting
- Furnace Refractories

... and related accessories.

## Professional Readers - LI

### Industries:

- Top Industrialists & Manufacturers
- Lighting Engineers & Designers
- Architects & Interior Designers
- Event Managers
- Consultants, Contractors & Traders, Project Managers
- Plant Engineers of Large Companies
- Builders & Developers
- Mechanical & Electrical Engineers
- Lighting Products Manufacturers, Suppliers & Distributors
- Entertainment Industry
- Construction Industry
- Hotels & Restaurants
- Fitness Centers
- Hospitals
- Airports Authority of India
- Importers & Exporters
- Municipal Corporations All Over India
- Government Utilities:
  - Ministry of Power
  - Central Public Works Department
  - Electricity Utilities
- Non-conventional energy providers
- Manufacturers from other allied industries
- Universities, Technical & Research Institutions

Several Others...



## Cold Chain Market to be USD 271.30 bn by 2022

The global cold chain market is projected to reach USD 271.30 Billion by 2022 in terms of value, at a CAGR of 7.0% from 2017 as per Markets And Markets research...

The global cold chain market is expanding with considerable growth potential over the next five years. The growth of this market can be attributed to the growth of international trade of perishable foods, technological advancements in refrigerated storage & transport, government support for infrastructure development of the cold chain industry and increase of consumer demand for perishable foods. Also, expansion of food retail chains by multi-nationals will enhance international trade and impact the growth of the cold chain market.



### Dairy & Frozen Desserts

Dairy & frozen desserts is estimated to account for the largest market share in the cold chain market in 2017, due to their need for constant temperature control being temperature sensitive products, dust, and exposure to sunlight. Dairy & frozen desserts are witnessing high demand due to economic growth and rapid urbanization, along with sophisticated marketing channels which have led to significant changes in dietary patterns. Government guidelines in China state that milk is a major source of calcium and protein, and recommend regular milk consumption, which has led to milk and dairy products being incorporated into the daily diet of consumers.

### Frozen Products

The frozen products segment is estimated to account for the largest share in the cold chain market in terms of value

in 2017. A wide variety of products such as ice cream, meat, and seafood are stored at freezing temperatures of between -18° C to -24° C. Freezing preserves the taste, texture, and nutritional value of foods better than other preservation methods. Cold chain for frozen foods provides uninterrupted handling of the product within a low temperature environment during the steps of the value chain, which include harvest, collection, packing, processing, storage, transport, and marketing until it reaches the final consumer.

As per Technavio research, the demand for seafood continues to increase globally, and the significant population growth in China, India, and Brazil constitutes an important demand driver in the frozen fish and seafood industry. Increased demand for seafood has led to a rise in its imports and exports among countries, which require cold storage and transportation. China and Norway were the largest exporters of seafood in 2015.

The research further highlights that growth in the global perishable commodity production has resulted in the reefer

manufacturers increasing the capacity of their containers. Globally, there is a change in the food consumption pattern, where consumers prefer ready-to-eat frozen prepared meals that are convenient. Hence, these require efficient logistic services.

### Europe the Most Lucrative Market For Cold Chain

In 2017, the European region is estimated to hold a significant share in the global cold chain market. The major drivers for this significant share of the European region are due to the consumers demand for quality attributes such as safety, taste, and freshness in their food. The current trend in the refrigerated transport market in Europe is that food product manufacturers and retailers move from local service providers to larger Pan-European service providers due to the development of network-focused technological solutions, technological upgradation in refrigerated systems & transport, and focus on implementation of quality standards set by public and private sectors.

# LEED: Revolutionizing Green Building Projects

Wise planning and building, including the use of LEED, minimizes the consumption of natural resources and environmental impact and will smartly position India for the future and improve the lives of millions across the country...

As is the case with many nations, India also faces many social and environmental issues, including overpopulation, land degradation, energy shortages, water scarcity, waste accumulation and air quality issues.

Most of these challenges are due to rapid urbanization; the urban population in India has nearly doubled in the past 20 years alone. Though India accounts for 2.4% of the world's land, it supports nearly 16% of its people, and over the last two decades, overpopulation in India and the issues associated with it have contributed to compromising much of the country's land.

Thankfully, a movement to address these challenges is well underway—one

that will help provide a more sustainable future for millions and help facilitate the development of smart cities across India.

## A rare opportunity to embrace change

The opportunity to take constructive action and create a more sustainable future in India is more advantageous now than ever, and it stems from the unprecedented rural-to-urban migration of India's population. According to 2014 United Nation data, in 2001, India's urban population was 285 million and by 2021, it will exceed 473 million.

To accommodate this massive population shift, many new buildings will need to be constructed – homes, offices,

factories, schools, hospitals, retail outlets and more. In fact, 70 to 80% of the buildings needed in India by 2030 haven't even been built yet. How these new buildings are developed will compound and not only impact Indian society, but also its economy and environment.

While India's urban migration creates environmental and planning challenges, it also creates unique building opportunities. All of the issues in India associated with urbanization can be addressed by building better buildings and communities where human health is prioritized and enhanced. Sustainable development is not just about better buildings or good design, it's about conserving resources so that we can make sure there are enough to go around. The LEED rating system, developed by the US Green Building Council and locally administered in India by GBCI is changing the way we think about how buildings and communities are planned, constructed, maintained and operated. Wise planning and building, including the use of LEED, minimizes the consumption of natural resources and environmental impact and





will smartly position India for the future and improve the lives of millions across the country.

India boasts one of the world's fastest growing green building industries and has also committed to the creation of 100 smart cities by 2020.

### The smart cities mission

To properly connect the concepts of smart cities to green buildings, it is important to have a clear understanding of what it means to be a smart city. The Indian Ministry of Urban Development's definition of a smart city reads, "In the imagination of any city dweller in India, the picture of a smart city contains a wish list of infrastructure and services that describes his or her level of aspiration. To provide for the aspirations and needs of the citizens, urban planners ideally aim at developing the entire urban eco-system, which is represented by the four pillars of comprehensive development: institutional, physical, social and economic infrastructure."

The Ministry of Urban Development also identifies eight more specific smart city features, which serve as guidelines for its urban planners and developers. Some of the points that are most relevant involve:

- The promotion of mixed land use
- Housing for all
- Walkable localities
- The preservation of open spaces
- Transit-oriented development
- Accountability and transparency through digital technology
- Preservation of the metropolitan identity – and corresponding economy
- Applying smart solutions to development projects – resilience, minimal waste, more efficient use of resources

According to the Ministry, the most meaningful smart city developments will emphasize city improvement (retrofitting), city renewal (redevelopment), and city extension (greenfield development).

Most people recognize that when it comes to smart city development, green buildings are the smartest approach. This is because green buildings are an easy

way to truly achieve the smart city mission as detailed by the eight essential features that the Ministry of Urban Development has identified as being integral to these projects.

### LEED: Where green buildings and smart cities intersect

Given my role as President and CEO of both the US Green Building Council (USGBC), the creators of the LEED green building rating system, and Green Business Certification Inc. (GBCI), the organization that certifies all LEED projects globally, I can best speak to the parallels between green buildings and smart cities through my experience with LEED.

For those who are unfamiliar with LEED, the program started in the United States in 2000 in and has since quickly expanded to 165 countries and territories around the globe. Over the last two decades, it has revolutionized the practice of green building design, construction, operation and maintenance. Today, it is the most widely used and trusted green building program in the world with more than 90,000 registered and certified commercial projects and more than 19.14 billion square feet of space participating in LEED.

Behind the LEED program is an immense infrastructure developed to support the leaders in the industry as they innovate and create cutting-edge, high performance buildings. Each year, significant investments are made to maintain, operate and improve LEED and its delivery. LEED v4 is our latest version of LEED and focuses on achieving greater transformation and performance by demanding stronger energy performance, better materials, increased water efficiency and accounting for human experience. LEED is fully compatible with the course of action that the Ministry of Urban Development has recommended for smart cities—and there are four very important reasons why:

#### 1. LEED works for all buildings at all phases of development—even

#### projects involving neighborhoods, sections of a city or an entire city.

The rating system works for all buildings at all phases of development—from new construction to existing buildings—and all building sectors—from homes to hospitals to corporate headquarters. And LEED addresses every building type at every lifecycle phase in any climate or region, including homes, offices, hospitals, retail spaces, banks, factories, stadiums, college campuses and more. LEED does this through offering a number of distinct rating systems:

- LEED: Building Design and Construction is the LEED rating system for new construction and major renovation.
- LEED: Interior Design and Construction



Behind the LEED program is an immense infrastructure developed to support the leaders in the industry as they innovate and create cutting-edge, high performance buildings.

applies to interior spaces requiring a complete fit-out.

- LEED: Building Operations and Maintenance, for buildings that are fully operational, and that are undergoing very little construction or simply looking to upgrade their operations or maintenance programs.
- LEED: Homes Design and Construction accommodate all types of residences, from multi-family high rises to single family dwellings.
- LEED: Neighborhood Development is for new land development or redevelopment projects of greater scale. This includes city improvements, city renewals, and city extensions.
- LEED for Communities and LEED for Cities, which are two new certification programs that were recently introduced in 2016. These programs are designed to be applicable to cities, communities, neighborhoods, districts, townships and counties.

Given the complexity of Smart City

developments, the flexibility to address all project types is critical – and LEED delivers and performs.

**2. LEED encourages project teams to set strategic goals that are aligned with Smart City thinking – and it does so by asking one critical question: What should this LEED project accomplish?**

It then goes on to provide important guidance through seven distinct impact categories that ask the project team to determine how the project will:

- Make a Reverse Contribution to Global Climate Change?
- Enhance Individual Human Health and Well Being?
- Protect and Restore Water Resources?
- Protect, Enhance and Restore Biodiversity and Ecosystem Services?
- Promote Sustainable and Regenerative Material Resources Cycles?
- Build a Greener Economy?
- Enhance Social Equity, Environmental Justice, and Community Quality of Life?

Clearly, these LEED Impact Categories are all directly aligned to the Ministry of Urban Development's Smart City Mission and Smart City Features. What's more, the

structure of LEED v4 is set up to incentivize progressively higher credit achievement and thus, progressively higher compliance with credits whose outcomes accomplish project goals that are linked to impact categories, and that address important social, environmental and economic considerations.

**3. Once project teams have identified what they want their project to accomplish, LEED guides them through a system-oriented, integrated path to completion.**

It does so through its six core and two optional credit categories:

- Energy and Atmosphere credits not only emphasize improving building performance, but also reward the use of renewable energy, smart grid thinking, and ongoing operational performance.
- Sustainable Sites credits encourage strategies that minimize a project's impact on ecosystems, including ecosystems involving multiple buildings.
- Water Efficiency credits account for water use inside and outside of a building. Whole-building-level water metering ensures smart city projects

can effectively monitor and manage their water use.

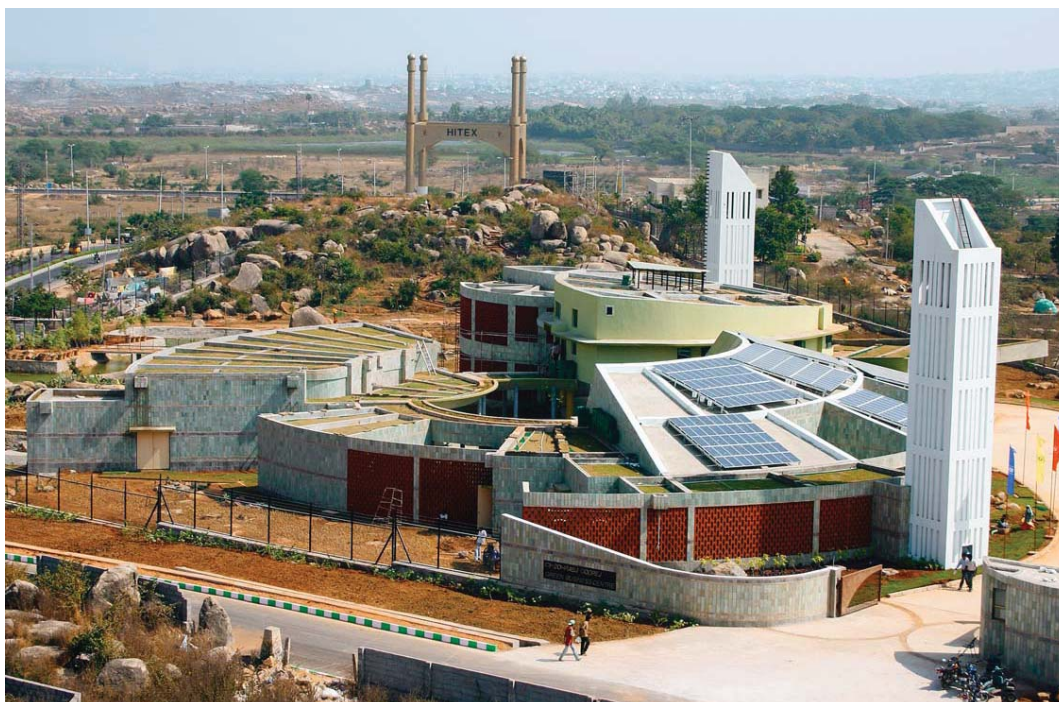
- Materials and Resources credits encourage the use of sustainable building materials and reduced waste. Considerations include life-cycle assessment, transparency, and recycled content.
- Indoor Environmental Quality credits promote clean air, good acoustics, ample lighting, natural views, and overall occupant comfort.
- Location and Transportation credits encourage compact development, alternative and public means of transportation, and a walkable connection to parks, restaurants, shopping, employment, schools, and more.

Additionally, projects can earn credits for Innovation in Design and for addressing Regional Priority needs.

**4. LEED projects are now supported through Arc, a state-of-the-art digital platform that supports continuous progress toward better buildings, communities and cities, and a higher quality of life.**

Arc allows any project—whether a single building, community or even an entire city—to capture data, measure improvements through strategy implementation, and benchmark against itself and projects around it.

Two programs: LEED for Communities and LEED for Cities are also administered through Arc and allow participants to capture metrics across an expandable array of performance indicators, and deliver it in an easily understood way that drives engagement and healthy competition. Arc measures and communicates city performance across the metrics that a city cares about and just as with buildings, measuring



The rating system works for all buildings at all phases of development — from new construction to existing buildings—and all building sectors



performance helps cities improve. Metrics include energy, water, waste, transportation and human experience (education, equitability, prosperity, public health and safety).

Cities can start with a modest number of data streams and metrics, and expand as they become familiar with the tool and seek deeper engagement. And these are data points that cities are already collecting—Arc and LEED for Cities provides cities an already established platform on which to assemble measure and compare these data points. By monitoring data, Arc ensures that a building, district or cities continues to operate efficiently and effectively. This translates into the economic benefit of accountability, guaranteeing that today's LEED projects continue to meet desired standards day after day, and year after year. In other words, where green building performance is concerned, LEED and the Arc platform have raised the bar. And they have done so in a way that is compatible with the course of action India's Ministry of Urban Development recommends for smart city developments. Arc will take LEED and the global green building movement to the next level through the shared use of technology, feedback and recognition of excellence.

## The Bottom Line

So what does LEED and green building mean to India's aggressive Smart Cities initiative?

Quite simply, LEED has evolved so that it can be applied to the Smart City initiative at every step of the way. Project teams can use LEED in the planning stages to set goals, refine strategies and determine what they want their projects to accomplish.

Through its diverse array of rating systems and eight credit categories, LEED acts as a very precise and detailed framework to set system wide performance goals. It then guides project teams from those early planning stages to project completion.

Finally, through the Arc monitoring platform, the LEED approach ensures that your project continues to perform at peak efficiency. And if it doesn't, Arc provides timely perspective regarding when and where adjustments are necessary to help you make improvements and become as efficient as possible.

From the first day of a project to the end of a building's lifecycle, these are all very valuable and very compatible contributions to India's Smart City development program.

As a native son of India, I am happy to tell my associates around the world that the Indian building community was among the first to embrace and support LEED.

The LEED rating system uses an open-source model and has always been freely available. This enables projects to understand the LEED system at a deeper level and adapt the system so that strategies can be applied for the project's desired outcomes. Continuous improvement doesn't stop at the rating system itself: it also applies to the entire built environment. That's where tools like LEED for Existing Buildings, LEED for Cities and Arc come into play. By 2020, our goal is to transform LEED from a building rating system to a platform to comprehensively support the varied facets of sustainability in our built environment.

At USGBC and GBCI, we strive to help building owners and community leaders continuously improve their building and

community performance, whether through saving more water, energy or waste or enhancing the human experience and making occupants and citizens more comfortable. Sustainability is not possible without human health and wellness considerations, and USGBC and GBCI are the leaders that will drive forward a vision of human health in all aspects of the built environment.

Through this vision, we expect to move closer to achieving the vision of green buildings, communities, and cities for all within a generation. Buildings don't exist in a vacuum. Technology is blurring the lines, driving the need for a more integrated understanding of the essential interplay between buildings and energy generation, transmission and land usage; development, human health and well-being, city infrastructure, financing and investing; and everyday activities like driving to work, taking a train or walking into a grocery store. USGBC and GBCI seek to enhance this interconnectedness and transform the built environment through cross-sector; outcome-driven collaborations that strive to make the world a better place and improve the quality of life of millions around the world.

Please keep building. Keep working. Keep raising the bar on the quality of our built space. Keep volunteering and keep pushing our movement forward. At USGBC, we stand with you—all of you. We are all in. ■

***Together, let's continue to LEED ON!***

**Mahesh Ramanujan**  
Managing Director and  
Chairman, USGBC



**Russ Air**  
ENVIRONMENT YOU TRUST!

GLOBAL LEADERS IN TECHNOLOGY

INDUSTRIAL AIR CURTAINS & AIR DOORS  
PVC STRIP CURTAINS & ROLLS  
INSECT KILLERS & ARRESTORS

Projects In Pharma | Food & Beverage | Cold Storages | Automotive | Chemical | Real Estate | Retail | Hospitality | Healthcare

Tel: +91 22 2600 7979 | +91 8691912000 | Email: sales@russairtec.com | Web: www.russairtec.com



**“Smart probes are one stop solution for entire HVACR industry”**

Established in 2006, Testo India Pvt Ltd is a 100% subsidiary of Testo. With its head office located in Pune, it caters to different industrial sectors across India ranging from steel & cement to food & pharma. The measurement technology expert convinces over 650,000 worldwide customers with highly precise measuring instruments and innovative solutions for the measurement data management of tomorrow. **Kalidas Bhangare, Managing Director, Testo India Pvt Ltd** sheds light on various trends in HVAC&R industry, products and services offered by the company, his expansion plans in India and much more in an interaction with **Cooling India...**

### **Please take us through the journey of Testo in India.**

Testo SE & Co KGaA, is a world leader in design, development and manufacturing of electronic portable test and measuring instruments. Backed by 60 years of measurement engineering experience, Testo as a group is headquartered in Lenzkirch, Germany.

Established in 2006, Testo India Pvt Ltd is a 100% subsidiary of Testo SE & Co KGaA. With new products and innovations getting added to the basket year after year, extending our reach throughout the nation, increasing our support and services in every aspect we gained incredible

acknowledgement from the Indian market as well. We have shown phenomenal growth over the last 11 years. With our head office in Pune and PAN India sales and channel partner network, Testo India now enjoys a prominent position in Test & Measurement industry. We have an established state-of-the-art service & calibration lab located at Pune that is accredited by Germany.

We have been, therefore, providing not just sales but also after-sales services to industries ranging from food & pharma to cement & steel, HVACR among others.

**What are the trends in current HVAC&R market? How would you**

**envisage the growth with particular emphasis on energy efficiency and sustainability in global markets?**

As we see the latest trends and technologies that we are witnessing are coming from the digitization of the existing systems. The traditional methods and processes are now getting replaced with smart solutions & we believe in keeping pace with the new advancements prevailing around. Thus, our new product range for instance, the air capture hood testo 420 and the new range of Smart Probes equip the users with smart and easy measurement techniques using the



smartphone interface. Our latest solution to the industry is new range of Thermal Imagers with smartphone integration designed to deliver networked thermography. Their wireless operation, with the ease of saving & transferring data over networks, make our instruments more user-friendly and cost effective. Also, our products are in compliance with the environmental standards focusing on the energy efficiency and conservation. Our solutions for preventive maintenance, air quality measurement, gas/emission analysis, facility management etc can ensure our emphasis on energy efficiency & sustainability.

**What kind of technological innovations would you like to incorporate in your products considering rising global temperature?**

Testo is very much aware of the changes in the environment and our focus has always been to share a solution which is not only advanced but are also in-line with the necessary environmental norms and specifications. We are extending our range of HVAC/R tools keeping in mind these changes. It is owing to the environmental changes that HVAC/R is gaining more importance and its efficiency management even more!

**What are the products offered by the company and in particular catering to Indian markets?**

With so much vibrancy in the industry, Testo brings out its latest and the smartest solution for the HVAC sector. An entire range of smart measuring instruments called as the Smart Probes are unique in the measurement system. These are small and compact instruments with higher accuracy and are available in special sets for HVACR contractors. Testo 420, a new innovation for measuring the air volume flow has made the measurements easier even at the turbulent inlets/outlets. These pro measuring instruments can be intuitively operated by smart phone via a free App. Testo has a range of electronic refrigeration manifolds/analyzers that not only help to measure pressure but also



Testo Smart Probes

calculate accurately the sub-cooling and superheating temperatures, based on the refrigerants selected. In addition to electronic refrigeration manifolds, Testo also has digital vacuum measuring instrument like testo 552 for the evacuation of refrigeration/air conditioning systems and heat pumps.

**What is the USP of your products? Do you have R&D activities in India in order to give better quality of the products?**

Our products are for sure best in class when it comes to the technology, features and superior design. We claim to provide our users, the experience of a smart world of measurement. About USPs, our products are smart, intuitive, user friendly, advanced and precise. Most of them could be governed even via a smart phone or tabs. Data transfer, report storage and sharing can be done on site. You can inspect and check the status of any desired set up from anywhere and in case of any ambiguity you even receive alerts via mail and message. Reduced human involvement is assured with our products which ultimately improves accuracy, reduces downtime of facilities and reduces errors, which is almost everything you seek. We actually have our manufacturing in Germany and thus, the R&D is taken care at the HQ. But in India, we also do offer certified calibration according to all valid

guidelines. The calibrations take place at Testo's own accredited high-tech laboratory at our facility in Pune so that the instruments can be calibrated & serviced locally maintaining international standards.

**How would you differentiate Indian HVAC&R markets from the Global markets, particularly, European and American markets while offering your services and products? Do you face any competition in Indian markets?**

European market is certainly way different to our Indian market. Heating, for example, forms a major part of the HVAC&R market due to the cold weather conditions prevailing there. In India, heating needs are almost close to nil. The demand for VAC & R efficiency monitoring and management is at its peak during the summer season. Facility Management too is becoming an important market owing to the spurt of huge IT buildings, malls, hospitals etc. The concept of green building too is taking strong footing in the Indian market.

**What are the growth drivers of your products in India?**

The most important factor that can really drive our industry is the policies of the government. Testo India caters its services to a wide range of sectors beginning from general industries to food, pharma & HVAC. It is very necessary to have



Testo Capture Hood



Testo 805i - Non contact Temperature Measurement - With App

stringent norms & guidelines in these sectors to improve efficiency and quality as well. Our products are designed with special features that comply with standard norms which are actually very vital for safety and health purposes. Another aspect that can be really helpful would be the awareness of the user about the importance and advantages of these policies and guidelines as it will encourage them to select Testo as their partner.

**How competitive and technologically superior are your products as compared to your peers? How strong is your after sales service network?**

All we can say is that they are more purposeful, distinct and with unique features. Our smart probes are one stop solution for the entire HVACR industry. They are small, user friendly, easy to carry,

and considering how advanced they are they come at a very convincing price as well. If you talk about the technology, our products are definitely a step ahead both in terms of the measurement range and precision obtained with them.

As far as the post sales service is concerned, already mentioned, we have a certified testing and calibration lab that in association with our sales team are always on their toes to provide necessary service and correct solution to our clients even after sales.

**What are your expansion plans in India? What potential do you foresee for your company with the Indian Government's focus on development of infrastructure like smart cities, urban transportation projects?**

India is termed as an emerging market and

the numbers are only growing. In a very short span of time from its inception, Testo India grew from a small-sized subsidiary to a mid-sized one and is on its way ahead further to increase its sales turnover exponentially. We plan to launch several new products & extend our arms to all possible regions, industries and applications in the upcoming years.

Now when the government has also become so focused on the upcoming concepts like smart cities, the testing & measurement industry is sure to see a great future ahead as the applications are going to increase and so are the solutions required. And we hope to offer many technologically advanced products which will help Testo touch the new zenith of technology not only in India but also in the surrounding markets of Nepal, Bangladesh and Sri Lanka with its channel partner network. ■



## Expecting to Grow at CAGR of more than 5%

Technavio, a tech-focused market research firm, has published a new report on the global indoor air quality market, which is expected to grow at a CAGR of more than 5% during the forecast period 2017-2021...

**T**op three contributors for the global indoor air quality market are elaborated below:

Indoor air quality market in the Americas: Increasing health awareness and government regulations are the major driving forces behind growth of the indoor air quality market in this region. The Government regulations such as OSHA and the American society of heating, refrigerating and air conditioning engineers (ASHRAE) in the US focus on improving indoor air quality. Industry analysts at Technavio estimate the indoor air quality market in the Americas to account for a revenue of around USD 11 billion by 2021.

According to Technavio, "The US EPA has introduced a mobile app, especially for schools, to assess the indoor air quality. This app addresses critical air quality issues, such as ventilation, environmental asthma triggers, integrated pest management, and radon."

Indoor air quality market in EMEA: Guidelines issued in countries such as the UK and Germany with respect to the control of indoor air pollutants is one of the fundamental driving forces for the growth of the indoor air quality market in EMEA. The European Union has taken certain measures to reduce the level of indoor air pollutants. For instance, currently, seventeen countries in the European Union have smoke-free laws. Certain countries, including the UK, Ireland, Greece, Malta, Bulgaria, Hungary, and Spain, have strict provisions, with a complete ban on smoking in public transport and enclosed public places.

Indoor air quality market in APAC: Non-governmental organizations, such as the Asia-Pacific Research Center for Indoor Environment (APARCIE) develop indoor air cleaning systems, conduct health risk assessments, and support institutions to meet the monitoring standards of indoor air quality. They operate in countries, such as Cambodia, India, Indonesia, Laos, Mongolia, Nepal, Thailand, and Vietnam. APARCIE is also focusing on the sick house syndrome and asbestos, balancing the indoor air quality and the economic criteria. The indoor air quality market in APAC is projected to experience steady growth in the coming years to account for a revenue of more than USD 7 billion by 2021.

The leading vendors operating in the global indoor air quality market are:

- Carrier
- Trane
- TSI
- 3M

Other prominent vendors in the market include Camfil, Clarcor, Fluke, Aprilaire, Filtration, Lennox International, FloCore, and Bluepoint Environmental. ■

## India's Largest Exhibition on Dairy Products, Processing & Packaging Machinery and Allied Industries

7th  
Edition

# DairyTech India 2017

28-29-30  
AUGUST  
2017

BIEC, Bangalore, India

Concurrent Events:

6th INTERNATIONAL  
POULTRY  
& Livestock Expo 2017

9th Edition  
Agri Tech  
India 2017



Organised by :

Supported by\* :



National Center for Cold-chain Development



CLFMA of India



Karnataka Milk Federation



Progressive Dairy Farmers' Association



Food Processing & Packaging Machinery Industry Association, India

Media Partners:



Book  
your stall  
now!

For stall booking & other details please contact:

Media Today Pvt. Ltd.

Tel : +91-11-41859815 / 41407851

E-mail : dairytechindiamtpl@gmail.com, Visit us at : www.dairytechindia.in

\*Proposed

# Retrofitting

## Mumbai HPCL Office

People spend 90% of the time indoors. Therefore, indoor aesthetics, air quality and comfort are of paramount importance to occupants. Thus, when the IMM office was undergoing renovation, HPCL wanted to redesign their interiors considering these key elements. With this vision, HPCL attempted Green Certification under IGBC Green Interior rating program. This rating system was instrumental in providing guidelines and measurable parameters to implement green & sustainable measures in their office.

**H** PCL - IMM Office at Petroleum House in Mumbai was awarded Platinum Rating by Indian Green Building Council (IGBC) under their Green Interior Rating Program which is the highest possible award in this category with guidance from Godrej & Boyce who were Green Building Consultants for this initiative.

Indian Green Building Council (IGBC),



Project: IMM OFFICE  
 Owner: HPCL  
 Location: Petroleum House, Churchgate  
 City: Mumbai

Type: Existing Office  
 Category: IGBC Green Interior (Existing)  
 Rating: Platinum  
 Score: 55 out of 75 points





part of the Confederation of Indian Industry (CII) formed in the year 2001, administers and certifies Green Building in India. IGBC is working towards a vision to make India one of the global leaders in the sustainable built environment by 2025.

### Green Vision

People spend 90% of the time indoors. Therefore, indoor aesthetics, air quality and comfort are of paramount importance to occupants. Thus, when the IMM office was undergoing renovation, HPCL wanted to redesign their interiors considering these key elements. With this vision, HPCL attempted Green Certification under IGBC Green Interior rating program. This rating system was instrumental in providing guidelines and measurable parameters to implement green & sustainable measures in their office.

### Green Features & Implementations

HPCL went about this process by evaluating all the parameters of Green Interior Rating system and then implementing those which aligns with their key objective of enhancing occupant comfort and well-being with optimized energy & water consumption.

### Green features of the office space:

- **Architectural Design:**

Petroleum House built in the year 1954 stands apart from the other traditional building located in the area. The building was an early experiment in green design, using louvers to reduce heat, a technique that was more famously deployed to modulate light by Le Corbusier in Chandigarh. The vertical & horizontal louvers wrap the building, reducing the heat load providing shades throughout the day. Because of extensive shading, glass area could be balanced to ensure proper penetration of daylight and views for the occupants. This further enabled designer to maximize the space utilization by having an extensive open office concept. This futuristic design was achieved more than 60 years ago which broke new ground architecturally while displaying the fervor sought to be realized by Nehru in his vision of a modern India.

- **Circulation Spaces:**

IMM redesigned their space with open office concept, which maximized the circulation spaces to extent of more than 50% of carpet area.

- **Public Transportation access:**

Close proximity to Bus & Rail services enables majority of the building occupant to use public mode of transportation, thereby, reducing impacts associated with individual vehicle usage.

- **Water Efficient Fixtures:**

Efficient plumbing fixture installed enables project to save more than 30% water use with respect to conventional building

- **Energy Efficient Lights:**

Office space use LED Lights which is 30-40% more efficient than conventional lighting. Additionally use of LED lights eliminates the problems associated with mercury disposal additionally has a 40% more burning hours compared to conventional lamps.

- **Energy Metering:**

Energy meters and sub-meters are installed to continuously monitor the building consumption & performance.

- **Eco-certified & Ergonomically Designed Furniture:**

Office space has been renovated with environment friendly & green range of Godrej make furniture which has achieved



Green Guard certification. This furniture also meets highest standards of ergonomics, thereby, enhancing human health, comfort and well-being.



- **Thermal Comfort & Fresh Air:**  
Office space is conditioned maintaining comfortable range of temperature throughout the year. Additionally, fresh air

system has been designed, which helps to improve Indoor Air Quality by meeting ASHRAE 62.1.2007 standards of ventilation rates.

### Sustainable Site Strategies

- Basic amenities and bus stop are within the 0.5 miles from the site entrance.
- Strategically located car charging sockets to encourage tenant to switch to electric vehicles.
- Preserving natural topography more than 50% by limiting the development footprint
- Grass pavers on surface car parking and high SRI paint on terrace to reduce heat island effect.
- Rain water harvesting pit to recharge aquifer.
- Reducing external light pollution using efficient lighting and no facade lighting.

### Potable Water Use Reduction Strategies :

- Large part of landscape has been planted native and drought species for landscaping with efficient irrigation system.
- On-site sewage treatment plant to treat sewage up to tertiary standard and





reuse treated water for flushing, landscaping and cooling tower make up.

- Reducing the potable water requirement for flushing by 100%
- Reducing the cooling tower make up potable water requirement by 50%
- Low flow fixtures reducing the generation of sewage by 45%.

## Waste Management Strategies

- Common segregation area for whole facility
- Three bin system in all common areas
- Agreement with third party agency to collect waste from facility
- Guidelines for tenant facility team to segregate the waste at source

## Efficient Envelope Strategies

- Use of AAC block for external walls and 50 MM XPS under deck insulation on roof
- Use of double glazing units with low SHGC value
- Facade longer axis at east west direction to reduce thermal heat gain

## Green Chemicals

- Project uses Green Seal Certified range of Housekeeping chemicals which reduces impact on both environment & human.

## Indoor Plants

- To further enhance the Indoor Air Quality and enhance oxygen in the space, project has planted some Indoor Plants. This further makes space visually appealing adding greenness to the space.

## Daylight & Views

- Open office concept, appropriately sized glass & shaded areas results in good amount of daylight in the office. Additionally, occupants have ample of access to external views, which further improves connectivity with external environment.

## Waste Management

- HPCL has provided color coded bins to facilitate waste segregation at source. Similarly, they have also banned use of plastic in the office space, thereby,



reducing the waste generation itself. All these features enabled project to achieve 55 out of total 75 points, making it a Platinum rated office. IGBC audited the

space before issuing the final certification. This was a remarkable achievement in the field of existing office space and has set an example for other HPCL offices to follow. The efforts taken by HPCL redefine how the sustainability is looked at particularly in existing interior spaces undergoing retrofits or renovations. HPCL through this initiative has also demonstrated that there is no need to look at Green Certification exclusively; it

can be a part of standard practice which helps to not only save energy & water but also would make people happy and comfortable. ■

**Efforts of HPCL can be summarized as**  
*'The small step towards clean and green India'*



# Advanced Heat Exchangers for Biogas Plants

Our modern society is dependent on many substances and processes which are directly or indirectly responsible for the release of key greenhouse gases (GHGs) including carbon dioxide, methane and nitrous oxide. Globally, agriculture produces around 17% of total GHGs, with a further 7-14% due to changes in land use. AD produces green renewable energy in the form of biogas through the bacterial breakdown of organic materials under anaerobic conditions. It is required to introduce heat exchangers and other hi-tech machinery to biogas plants that can ultimately increase the profit...

**B**iogas is a gaseous fuel containing large amounts of methane (biomethane), which is produced by the anaerobic digestion of biological material under anaerobic conditions. Anaerobic digestion (or AD) produces biogas and co-product called digestate, which can be a solid, liquid or combination of the two. AD produces green energy in the form of biogas through the bacterial

breakdown of organic materials under anaerobic conditions. In doing so, not only does it create a highly versatile energy carrier (biogas can be used to produce electricity, used as a replacement for natural gas or used as a transport fuel), but the residue left behind after the process is a nutrient-rich organic fertiliser and soil conditioner. Furthermore, by treating waste, including food, crop residues and

livestock manures in an AD plant, any methane emissions which they may have emitted to the atmosphere during their decomposition or treatment via other means, are captured and utilised, preventing the emission of a particularly potent GHG.

In order to maximise the greenhouse gas savings which AD can provide, it is important that the feedstocks used are both sustainable and produced with as low a carbon footprint as possible. It is also important to make sure that the process is as efficient as possible and that every possible unit of energy is used. Using heat exchangers to recapture heat for reuse in the AD plant or elsewhere is one of the most cost-effective ways to do this. This article describes various heat exchangers and other systems for use throughout the anaerobic digestion process, including:

- Exhaust gas cooling and energy recapture
- Feedstock and/or sludge heating
- Feedstock or digestate pasteurisation

Photo: [www.kriegfischer.de](http://www.kriegfischer.de)







Figure 1: Exhaust Gas Cooling

- Digestate concentration & evaporation
- Thermal hydrolysis for enhanced gas production

### Exhaust Gas Cooling

Cooling and recapturing the heat from exhaust gases can increase the efficiency of combined heat and power (CHP) plants used to generate electricity using biogas. Using heat exchangers with corrugated tubes on the exhaust recovers energy which can be used elsewhere in the plant, including feedstock and digester heating, pasteurization and digestate concentration.

### Feedstock and Sludge Heating

The contents of the digester must be heated to maintain the ideal temperature for the bacteria to work. In addition, pre-heating the feedstock prior to putting it in the digester can reduce the amount of heat needed in the digester itself and improve the overall efficiency of the digestion process.

For such applications double tube heat exchangers can be used. It is an industrial double tube heat exchanger, comprising a tube within a tube. The inner tube is corrugated for increased heat transfer and reduced fouling without the risk of obstruction or blockages associated with spiral heat exchanger systems, thus, ensuring continuous operation in such a harsh environment. The product flows

through the inner tube and the service fluid through the annulus between the inner and outer tube. Because of its geometry, the double tube heat exchanger is a true counter-current heat exchanger. An expansion joint (bellow) is fitted in the shell to allow for differential expansion of the inner and outer tube during operation. Multiple units can be interconnected and have the options of frame mounting, insulation and cladding in stainless steel.

### Feedstock or Digestate Pasteurization

During the anaerobic digestion process, quality of digestate can be improved by pasteurization.

Digestate Pasteurization System (DPS) has been specifically designed to meet the requirements of pasteurisation in the anaerobic digestion and renewable energy sectors. The DPS is capable of pasteurizing digestate, feedstocks, sludge and similar materials and is suitable for both pre-and post-digestion pasteurization, allowing operators to maximize the efficiency of their overall process.

### Digestate Concentration and Evaporation

After digestion and biogas production, the digestate is normally separated mechanically in solid and liquid phases which can then be used as biological fertilizer, although the two streams will have different storage and handling requirements. In some cases biogas operators will have to pay for waste handlers to take care of the removal of the digestate which means extra cost.

Whether or not you have a use or market for digestate, reducing its volume



Figure 2: HRS make double tube heat exchanger

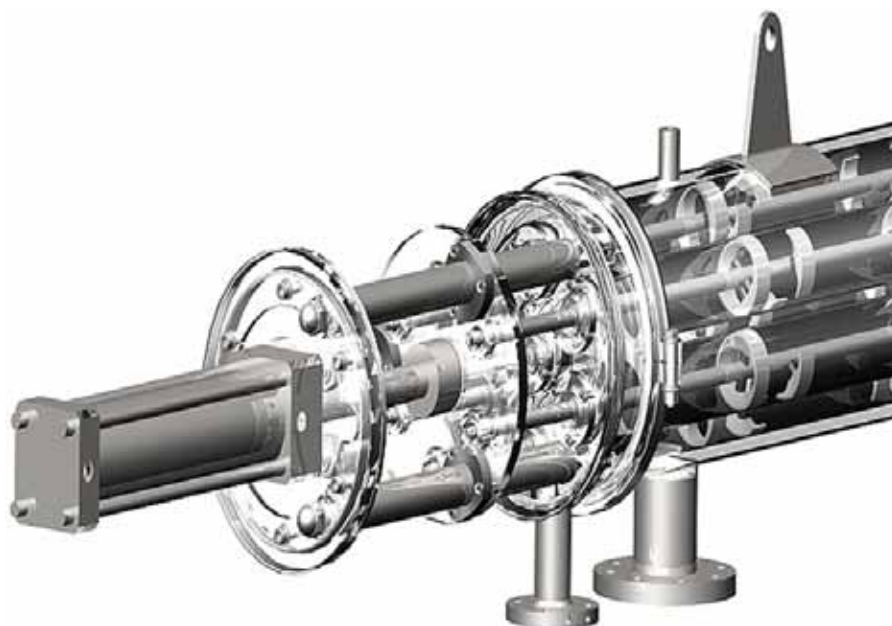


Figure 3: Thermal hydrolysis for enhanced biogas production

also reduces storage, transport, application and disposal costs. The Digestate Concentration System applies an evaporation process to concentrate the digestate. In a multi-stage evaporation process, the digestate volume can be reduced to less than 20%.

The numerous benefits of the Digestate Concentration System (DCS) system include:

- Removal of upto 80% of the water volume to produce a material containing 20% dry solids.
- Increase the nutrient concentration of the digestate accordingly with minimal loss of nutritional value.
- Reduces the handling, storage, transportation and application requirements along with associated operational, overhead and capital cost savings. For example, the amount of

storage (and transport) required can be halved.

- Water removed from the digestate can be added to the feedstock before digestion to improve process efficiency and create a closed loop system.
- The heat involved in the DCS process is recovered and re-used up to a maximum of four cycles, resulting in a highly efficient process.
- Reduces odors and increases nutrient content by turning ammonia into ammonium sulphate.
- Unlike conventional digestate dryers – which use a lot of power to create a small amount of product – the DCS is extremely energy efficient.

### Thermal Hydrolysis for Enhanced Biogas Production

A process of continuous thermal

hydrolysis of digester sludge involves heating the sludge to 160-170 °C of the sludge and a steam explosion step can be included for extra efficiency. This heat treatment changes the cell structure of the compounds, breaking down lignin and hemi-cellulose chains to create free sugars which are easier for the bacteria to digest. Consequently, residence times in the digester can be reduced.

The design is based on a traditional shell and tube heat exchanger with scraping elements inside each interior tube. The reciprocating movement of the hydraulically operated scrapers mixes the fluid and cleans the heat exchange surface. This keeps heat transfer high and reduces downtime as cleaning in place (CIP) can be avoided. In addition, the scraping movement introduces turbulence in the fluid increasing levels of heat transfer.

### Conclusion

There are many different ways to maximise both the efficiency of biogas plants, and the usefulness and effectiveness of digestate. With the right advice and by choosing the correct technology, it is possible to make sound investment decisions which will not only increase plant efficient, but also improve the overall environmental profile of AD – and maximise its benefits in terms of mitigating climate change. ■

#### Ankit Kumar

B.Tech Final Year, Department of Mechanical Engineering, Shrinathji Institute of Technology & Engineering, Nathdwara, Rajasthan



**Now  
Subscribe / Renew  
Online**

**Cooling India**

**Just Log on to: [www.coolingindia.in](http://www.coolingindia.in)**



## Behind Machinery of Tomorrow's Smart Cities

The International Energy Agency (IEA) demonstrated that district energy systems provide efficiency gains of up to 80% -90% relative to conventional heat and electricity generation. i.e, upto nearly 35 gigatons of carbon emissions can be avoided by 2050, through the use of modern district heating and cooling. Implementation of district energy is a gateway for improving the infrastructure needed for greener solutions especially when we see a movement towards using renewable energy resources...

**U**rban areas are today responsible for nearly two thirds of India's GDP and are bound to make a bigger contribution in the future. It is with this reasoning we have seen the Government draft plans to build Smart Cities across the country.

Smart cities are defined to be smart not only because of the infrastructure it will provide but also due to the efficiency with which it utilizes resources to run it. For example, let us take into consideration air conditioning, something that a common man naturally associates with better conditions to live and work under. Setting up central air conditioning in individual buildings can cost up to 10% of the overall building costs, not to mention the increased costs in maintenance and future energy consumption. A system that efficiently manages both the heating and cooling energy requirements is known as district energy.

To build a compact and connected smart city, sustainability and awareness are keys. In fact, smart cities across the globe have moved towards district cooling i.e., a centralized cooling station that will take care of the heating, ventilation and air conditioning of buildings within its grid. Be it commercial or private structures. There are significant cost savings from building

setup and maintenance to reduced energy consumption while still efficiently delivering on cooling requirements. This system not only plays to the economy of scales (meaning it would cost lesser to buy machinery for a single large set up, than multiple machineries for individual set up in each building) but also is a much greener solution due to its sheer efficiency in managing not only air conditioning and ventilation requirements but the left over heat that can be used in district heating systems.

It is estimated that by 2050 the energy utilized for cooling requirements around the world would be much more than the energy for heating requirements. The technology needed to make sure that we limit climate change within 2-3 degree Celsius already exists. It's the implementation and management that we need to carry out. This technology is already in use in GIFT City Gujarat and has helped the management consume 65-80 per cent of the energy as compared to conventional air-conditioning.

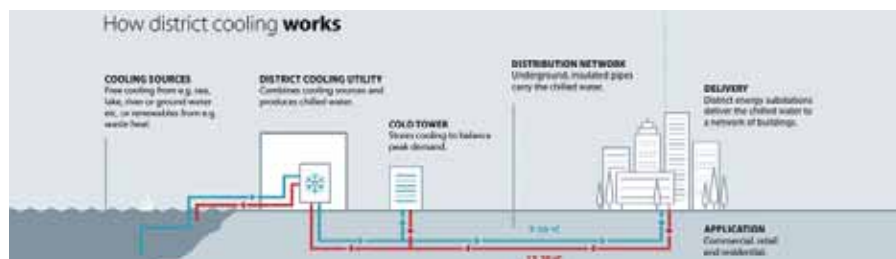
The International Energy Agency (IEA) demonstrated that district energy systems provide efficiency gains of up to 80% -90% relative to conventional heat and electricity generation. i.e, upto nearly 35 gigatons of carbon emissions can be



avoided by 2050, through the use of modern district heating and cooling. Implementation of district energy is a gateway for improving the infrastructure needed for greener solutions especially when we see a movement towards using renewable energy resources.

The Indian government supported by a technical team empaneling experts from Danfoss India has carried out assessments on five cities to understand their potential for implementing district cooling Initiatives with a view on developing bankable pilot district energy project approval. But such large scale implementation needs careful mapping and utilization to make sure the system runs at optimum efficiency to reduce wastage.

Danfoss has engineered several technology solutions that can answer these needs and we have these solutions implemented across the globe for District Energy which includes cooling and heating. We believe that processes and infrastructure that are focused on energy efficiency would provide better sustainable and economical yields. ■



Source

Danfoss



**"Implementation rigor  
& performance tracking  
holds the key to  
success of programs"**

Today, India is the third largest market for LEED (Leadership in Energy & Environmental Design) buildings outside the US and was the first to pursue a groundbreaking new LEED pilot program in partnership with US Green Building Council (USGBC) to address the unique needs of transit around the world, informs **Mili Majumdar, Managing Director, Green Business Certification Inc (GBCI)** in an interaction with **Supriya Oundhakar...**

### **How do you envisage growth of green buildings concept in India?**

Sustainability is not new to India. It has been embedded in culture, heritage and architectural styles since very early times. There has been a growing awareness and demand for green development and recognition that by improving our environmental performance we are benefiting Indians everywhere, as well as Mother Earth. As India goes through rapid urbanization, the adoption of green business practices is why the market has become a true engine of green growth. Today, India is the third largest market for LEED buildings outside the US and was the first to pursue a groundbreaking new LEED pilot program in partnership with US Green Building Council (USGBC) to address the unique needs of transit around

the world. This innovative thinking and dedication to improving quality of life guarantees that India will continue to be first-to-market in many more ways as we work to transform our built environment.

### **Kindly elaborate on the services offered by GBCI India.**

GBCI (Green Business Certification Inc.), the organization that certifies all LEED projects globally, was incorporated in India in 2015. Our local teams based in National Capital Region, Hyderabad, Mumbai, Chennai and Bangalore provides on-the-ground customer support and technical assistance for projects teams as they work to incorporate green business practices. GBCI administers project certifications and professional credentials and certificates within the framework of the LEED green building rating systems, as

well as standards addressing reliable power generation and distribution (PEER), human health and wellbeing (WELL), sustainable landscapes (SITES), sustainable parking solutions (Parksmart), resource efficient design (EDGE), resource management and waste diversion (Zero Waste), energy efficiency financing (Investor Confidence Project), and ESG performance of real assets (GRESB). As a result, we are dedicated to supporting India's efforts in raising the bar for the global market while enhancing environmental and human health benefits. The accessibility in India will not only benefit the country, but the entire Asia Pacific corridor, by deploying more local resources to support projects.

**Considering that the Indian environment and geographical**



### scenario is very different from that of the US, how do you customise your services for India?

GBCI works with experts, academia, business and government officials to help address and meet the priority needs of a rapidly urbanizing India. We are the leader in speed-to-market transformation, but we cannot do it alone. Our local presence improves India's access to resources, but strong partnerships across business and government will make market transformation a reality. We are very fortunate to have a network of partners with whom we are working to understand and uncover opportunities that benefit India. In February, we announced a new LEED pilot designed to address the unique needs of transit systems around the world and Delhi Metro Rail Corporation is the first to pursue it for their metro station in Delhi NCR and other states in India. This kind of partnership not only benefits the Indian market, but also positions the country as a leader in advancing sustainable business practices globally. With GBCI, businesses, government and project teams have a partner who will walk the entire sustainability journey with them. In addition, the technical teams are developing alternative compliance paths for various LEED credits to make them applicable for India.

### What kind of role GBCI India would like to play in smart cities project?

GBCI India has been very active in engaging with stakeholders about the smart cities project. It is important to help businesses and leaders better understand the challenges and opportunities it offers. GBCI is the leader in speed-to-market transformation and our array of rating systems are available to help businesses, communities and cities work towards their smart city goals. Our LEED for cities/communities rating system shall complement efforts of smart cities and be able to track performance and score cities based on various performance parameters.

### While developers often cite cost as a key reason for not adopting the latest green technologies, is

### there any way this technology can be incentivised? Is there a role GBCI have to play here?

There are a lot of misperceptions about the cost of green building and interestingly the public tends to overestimate the cost. A 2007 public opinion survey by the World Business Council for Sustainable Development found that respondents believed, on average, that green features added 17 percent to the cost of a building, whereas a study of 146 green buildings found an actual average marginal cost of less than 2 percent. Every day sustainable building materials are becoming more and more affordable because of increased competition and currently several states in India provide incentives towards the construction of green building.

### What are the challenges faced by you in Indian markets?

India is urbanizing on a breathtaking scale – our urban population has nearly doubled in the past 20 years. This drives tremendous economic development, but it also creates serious challenges including energy shortages, water scarcity, waste accumulation and air quality issues. The good news is that all of this can be addressed through green building; however, it must be a part of the conversation from the beginning.

Every story about a green building is a story about people. Green buildings have a direct impact on the people who eat, live, work and play in them: these high-performing buildings boost the health, productivity and happiness of millions of people across the globe. For us, we're focused on accelerating market transformation through the adoption of LEED and our other green rating systems, including standards addressing reliable power generation and distribution (PEER), human health and wellbeing (WELL), sustainable landscapes (SITES), sustainable parking solutions (Parksmart), resource efficient design (EDGE), resource management and waste diversion (Zero Waste), energy efficiency financing (Investor Confidence Project), and ESG performance of real assets (GRESB).

### What are the sustainable design considerations adopted during the construction of green buildings?

There are a number of design elements to consider during the construction phase and the best way to work through those is to refer to the LEED scorecard available online. USGBC also offers a number of educational resources to help project teams manage the process. Not to mention, GBCI works hard to establish high quality, enduring relationships with our customers and clients through our responsiveness and excellence in service.

### How would you achieve the goal of energy efficiency during the construction of buildings?

Each building is unique and the approach for addressing energy usage will be different, however, if a project is pursuing LEED certification, they can refer to the LEED credit library to better understand how energy might be addressed. For any green building project, it is important to incorporate LEED or any green rating system as early in the process as possible. Tracking energy data is also an important first step to improving energy efficiency. That is why last year, GBCI launched Arc, a state-of-the-art digital platform that benchmarks, tracks and monitors performance across five categories, including energy, waste, transportation and human experience. Project teams can use the platform even if they are not yet ready to pursue certification. Arc allows users to track performance using real-time data. The platform scores the building and each individual category from 0 to 100. When improving energy efficiency, understanding where you're starting from and how you're improving will help teams make more informed decisions with the goal of improving performance over time.

### Also, at the policy level in India, do you think we need more additions supporting the green building concept?

We have adequate number of policy initiatives. Implementation rigor and performance tracking holds key to success of these policies and programs. ■

## Boston Remains Most Energy-Efficient US City

Scorecard of 51 large cities reveals the top 10, including Boston, NYC, Seattle, Los Angeles, and Portland. Orlando, Phoenix, Los Angeles, San Diego, and Kansas City among those most improved...



As the federal government weighs budget cuts to energy efficiency programs, cities are stepping up efforts to reduce energy waste. More mayors and local lawmakers in America's largest cities are turning to energy efficiency to reduce energy costs for consumers and businesses, strengthen the resilience of their communities, and reduce pollution, according to the third edition of the City Energy Efficiency Scorecard, released by the American Council for an Energy-Efficient Economy.

The ACEEE report finds that Boston remains the top US city for energy efficiency, receiving 84.5 out of a possible 100 points, an improvement of 2.5 from its 2015 score. Following Boston, the top 10 US cities for energy efficiency are New York City (#2), Seattle (#3), Los Angeles (tied for #4), Portland (tied for #4), Austin (#6), Chicago (#7), Washington, DC (#8), Denver (tied for #9), and San Francisco (tied for #9).

Based on a 25-point jump from the last edition of the Scorecard in 2015, Los

Angeles was the most-improved city. It entered the top five—and the top 10—for the first time. San Diego, Kansas City and Phoenix are the second, third, and fourth most-improved cities, respectively. Seven other cities, including Orlando, showed double-digit improvements since the last Scorecard.

The five cities most in need of improvement on energy efficiency are Hartford (#47), Memphis (#48), Detroit (#49), Oklahoma City (#50), and Birmingham (#51).

Additional findings in the 2017 City Energy Efficiency Scorecard include the following:

Phoenix is the fourth most-improved city, with a gain of 13 points. The city increased its score in community-wide initiatives because of its adoption of the 2050 Environmental Sustainability goals, which include both energy savings and climate goals.

Orlando is another of 11 cities that improved by at least 10 points. It aims to improve efficiency in existing buildings by

benchmarking its energy use and making the data transparent and accessible. Austin, Philadelphia, Denver, Pittsburgh, Raleigh, Portland, and the four most-improved cities mentioned above round out this group.

Los Angeles is home to a new Existing Building Energy and Water Efficiency program, which requires an energy audit, retrofit, and benchmarking for many commercial and multi-family buildings, as well as water efficiency measures.

San Diego passed a Climate Action Plan that established goals to reduce energy use by 15% in select homes and to reduce community-wide greenhouse gas emissions by 15% by 2020.

"Across the nation, cities are taking steps to save energy, and they are creating more economically vibrant and resilient communities in the process," said ACEEE Senior Researcher David Ribeiro, the lead report author. "More than half, 32, of the 51 cities improved their scores from 2015 to 2017, with several making substantial point increases. More cities are requiring building owners to benchmark and report buildings' energy use, updating building energy codes, and setting community-wide goals to save energy and reduce their greenhouse gas emissions. We also see a new set of cities emerging as leaders for energy efficiency, knocking on the door of the top 10."

Boston Mayor Martin J Walsh said, "Being recognized as America's most energy-efficient city is an accomplishment that should be shared by all Bostonians. Whether you're a resident who lowered their monthly utility bill through Renew Boston or an owner of one of our city's leading green buildings, we should all be proud of our success to reduce energy and save money."

Los Angeles Mayor Eric Garcetti said,



"Building a sustainable Los Angeles is not a task for the distant future, it is a goal we are accomplishing right now with our Sustainable City pLAn, and through smart, bold investments in energy efficiency. The progress we have made on ACEEE's City Energy Efficiency Scorecard — moving up 24 places in just four years — shows just how committed we are to making our buildings greener, and creating a sustainable Los Angeles for the next generation."

San Diego Mayor Kevin Faulconer said, "This new ranking shows how far we've come in creating a more energy-efficient city in recent years. We're now the number one city for solar panel installations in the country, we are using cleaner-burning fuels in our city vehicles, and we have committed to powering our city by 100% renewable energy. With the passage of our landmark Climate Action Plan, we're setting the example for how to build a better and cleaner future for the next generation."

Phoenix Mayor Greg Stanton said, "Phoenix has made major strides toward becoming a carbon-neutral, zero-waste city with an economy built for the 21st century. Phoenix exceeded its 2015 goal for reducing greenhouse gas emissions and is offering incentives to building owners to make their properties more energy efficient, working to make its own city buildings more energy efficient, and converting all 100,000 city streetlights to LEDs. This recognition is another milestone in what has been a historic sustainability comeback for Phoenix in just the past few years. Most recently, Phoenix began rolling out its voter-approved Transportation 2050 program—the largest green infrastructure investment in city history. We've already boosted bus service and dial-a-ride for our residents and will triple light rail in the next few decades. T2050 is a game-changer for Phoenix and puts us in prime position to remain at the top of the ACEEE rankings for many years to come."

Orlando Mayor Buddy Dyer said: "Over the last year, we have made great strides to dramatically increase the energy efficiency of Orlando's buildings and transportation fleet. Through collaborations

with our business, nonprofit, and academic community, we enabled the Property Assessed Clean Energy (PACE) financing tool that unlocked more than \$500M for residential and commercial property owners and passed a historic energy and water benchmarking, transparency, and energy audit policy for the largest public- and private-sector buildings in Orlando. In addition, we've transitioned much of our city-owned fleet to alternative fuels and deployed millions of dollars to improve the efficiency of our city-owned buildings, saving taxpayers more than \$1.4M from previous years. Through these efforts and others, we will continue to save significant amounts of money, reduce public health impacts and greenhouse gas emissions, preserve natural resources, and accelerate our local clean energy economy—all things that will improve the sustainability of our city."

In the five key areas covered by the report, the key findings are:

- **Local Government Operations.** Leaders in efficiency in local government operations are Denver, New York City, Philadelphia, Portland, and Washington, DC. All have policies to increase efficiency in city government, procurement, and asset management.
- **Community-Wide Initiatives.** The top-scoring cities in community-wide initiatives are Austin, Minneapolis, Portland, and Washington, DC. They have efficiency-related goals for the entire community and strategies to mitigate urban heat islands. They also have policies or programs to plan for future combined heat and power or district energy systems.
- **Building Policies.** Leading cities in building policies include Boston, Austin, Los Angeles, and New York City. These cities have adopted or advocated for stringent building energy codes, devoted resources to building code compliance, established requirements and incentives for efficient buildings, and increased the availability of information on energy use in buildings.
- **Energy and Water Utilities.** The cities with leading energy utilities are Boston

and Providence. The energy efficiency programs of the utilities serving these cities offer high levels of savings and reach underserved markets, including low-income and multifamily households. Austin, Boston, Columbus, Denver, Los Angeles, New York City, and San Diego are the leading cities in tackling efficiency in their water systems and water uses. Utility customers in these cities have access to efficiency programs designed to save water and energy simultaneously.

- **Transportation Policies.** Cities with the top scores for transportation policies include Portland and New York City. Their initiatives include strategies to make their cities more compact and closer to transit options, shifts to efficient modes of transportation, transit investments, efficient vehicles and vehicle infrastructure, and energy-efficient freight transport.

## Methodology

ACEEE's 2017 City Energy Efficiency Scorecard includes the same 51 cities as it did in 2015. ACEEE researchers assessed the central city of each of the nation's 50 most populous metropolitan statistical areas (MSAs)—excluding San Juan, Puerto Rico—as well as El Paso and Fort Worth. The City Scorecard includes cities that have large populations within their borders (a median population of 632,309, with 124,006 in the smallest city) and are central cities in an MSA with a large population (a median of 2,384,075, and none smaller than 1,145,647). These cities alone make up 14.9% of the population of the United States.

Scoring is based on metrics that reflect the adoption and implementation by cities and utilities serving these cities of specific government policies, programs, and actions that can improve energy efficiency. The information in the Scorecard, and upon which ACEEE scored the 51 cities, reflects existing policies as of January 31, 2017. Although the policy environments in cities vary considerably, the report's metrics capture a broad range of municipal actions.

# Sustainability through Structural Cooling

Urbanization is changing patterns in our environment like climate, air, water and land. Urban areas temperature profiles become distinctly different from outskirts of urban agglomerations leading to clear delayering of temperature profiles. There are innovative techniques to reduce the heat in the structure and the effect of this heat will also reduce the heat in atmosphere. Less heated structure will use less air-conditioning system for cooling internal spaces. However, without such systems, the air conditioning systems pump the peak load plus they add 30% more heat from the compressors. This increases the ambient temperature, which requires more energy for air cooled condensers to reject the room heat. This process escalates till a heat island is formed.

## 1. Introduction

For tropical cities in warm climates or temperate climate, the Urban Heat Island (UHI) increases and the use of energy for air conditioning increases in the summer time. Increase in usage of air condition increases emissions of greenhouse gases. Higher urban temperatures lead to formation of urban smog in the atmosphere. At night when the temperature is high in

the areas, the UHI effect exacerbates heat stress. High-density compact cities on the coast like Mumbai suffers a lot with increase in humidity levels and heat stored in the buildings during day time and emit in the night time. Because humidity is in atmosphere, the transfer of heat is minimal, which creates adverse conditions for the inhabitants of the city. Area covered with concrete surfaces of urban land mass with

high thermal capacity and urban heat island intensity (Oke, 1973).

## 2. Study Area

Mumbai is a suitable study area of an Asian city in tropical climate. It has witnessed extreme urban agglomeration with one of the highest population density globally. Mumbai is the capital of Maharashtra with population above 20 million, situated at coordinates (18°58'30" N, 72°49'33" E). It is situated at the middle western coast of India and has a deep natural harbour and coast on western and southern side. The city district region is also commonly referred to as the Island City/Mumbai City or South Mumbai. The island city spans 67.79 km<sup>2</sup>. While the suburban district spans 370 km<sup>2</sup>, together accounting for 437.71 km<sup>2</sup>, under the administration of Municipal Corporation of Greater Mumbai (MCGM). The remaining area belongs to Defence, Mumbai Port Trust, Atomic Energy Commission and Borivali National Park, which are out of the jurisdiction of the BMC. Mumbai has amongst the highest population density in the world which is estimated to be about 52,209 people per Sq. Km (Census 2011).

Mumbai	2014
Latitude	18°58'30"N
Longitude	72°49'33"E
Mean Temperature (°C)	27.8
Maximum Temperature (°C)	36.0
Minimum Temperature	23.3
Wind speed (ms-1)	7.6
Relative Humidity %	88
Population (Million)	11.97

Table 1: Climatic Parameters Mumbai

## 3. Methodology

USGS/NASA Landsat-8 Enhanced Thematic Mapper Plus (ETM+) satellite data was used in this study. Landsat-8

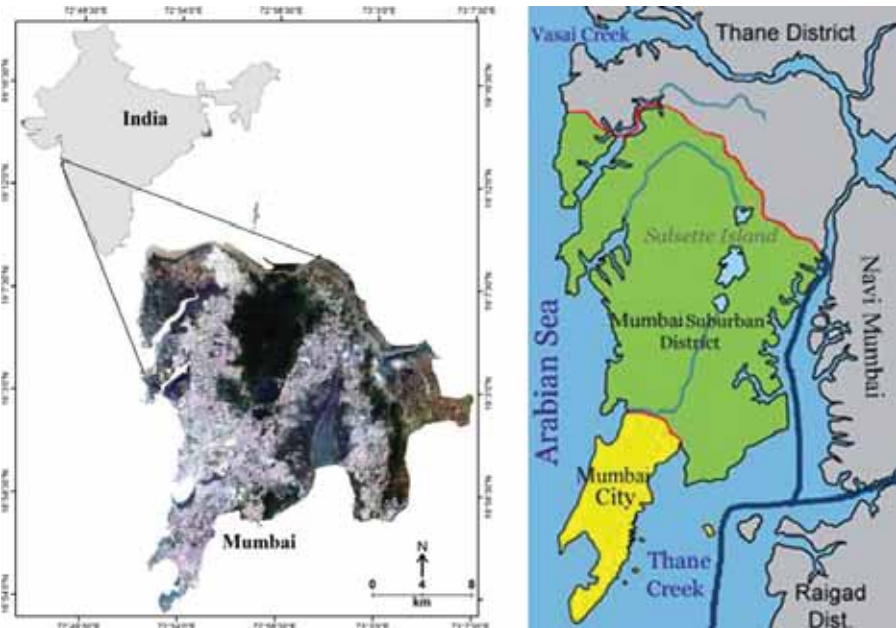


Figure 1: Study Area



Sr. No.	Date	Satellite	Sensor	Place	Scene Time	Path	Row	Season	Sun Elevation Angle
1	6.1.2014	Landsat 8	OLI_TIRS	Mumbai	11:05 AM	148	47	Winter	42.014
2	12.4.2014	Landsat 8	OLI_TIRS	Mumbai	11:02 AM	148	47	Summer	64.373

Table 2 Satellite Details Mumbai

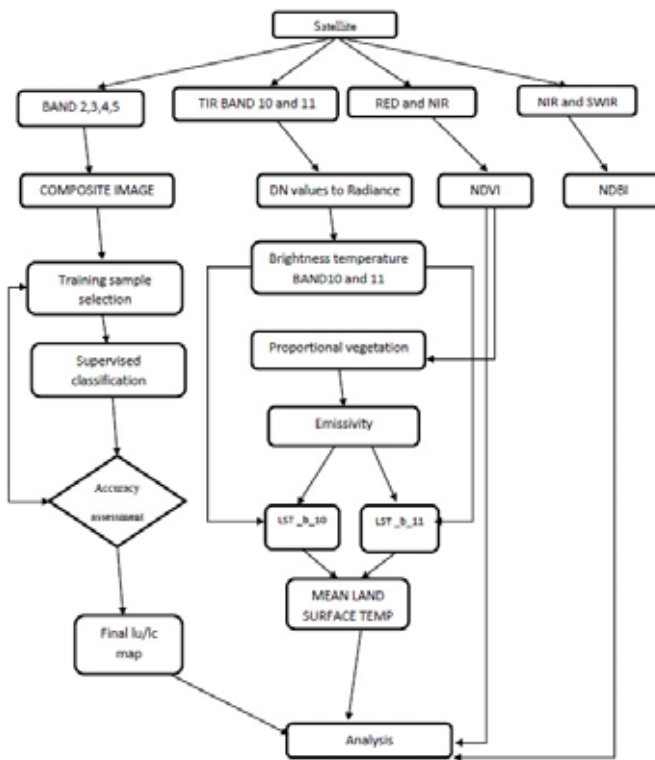


Figure 2: Methodology to get LST and LU/LC map from digital data

ETM+ images obtained on 6<sup>th</sup> January 2014 and 12<sup>th</sup> April 2014. The processed images were geo-referenced using WGS84/UTM projection system.

For the present study, the following methodology is adopted in which data collection, classification of imagery, development of land use/land cover maps, preparation of NDVI maps, preparation of NDBI map, Land surface Temperature map and correlation studies are included. Cloud free Landsat Images of 2014 for the study area has been downloaded from [www Landsatlook.usgs.gov](http://www Landsatlook.usgs.gov)

The details of satellite data is shown in Table 2. To derive land surface temperatures from the satellite image the major steps:

- 1) Conversion of DN to Radiance
- 2) Radiance to Brightness Temperature
- 3) Calculation of Emissivity
- 4) To derive LST.

From satellite Image to retrieve Land Surface Temperature the first step is

### 3.1 Conversion of DN to Radiance

$$L\lambda = \frac{LMAX - LMIN}{QCALMAX - QCALMIN} * (QCAL - QCALMIN) + LMIN$$

Where  $L\lambda$  = Spectral radiance at the sensor (watts/m<sup>2</sup>\*sr\* $\mu$ m)

QCAL = Quantized calibrated pixel value in DN

$L_{MAX}$  = Spectral radiance scaled to  $QCAL_{MAX}$  (watts/m<sup>2</sup>\*sr\* $\mu$ m)

$L_{MIN}$  Spectral radiance scaled to QCAL (watts/m<sup>2</sup>\*sr\* $\mu$ m)

$QCAL_{MIN}$  = The minimum Quantized calibrated pixel value in DN=1

$QCAL_{MAX}$  = The maximum Quantized calibrated pixel value in DN=65535

### 3.2 Radiance to Brightness Temperature

The calculated radiance values can be converted to effective at-satellite temperature in Kelvin (TB) by applying the inverse of the Planck function as shown in the Equation (Aniello et al., 1995, Chen et al. 2006, Li et al., 2012, Shahmohamadi et al., 2010, Weng et al., 2004):

$$T = K2 / \ln ((K1/L\lambda) + 1)$$

Where

T = At- satellite brightness temperature (K)

$L\lambda$  = Spectral radiance at the sensor (watts/m<sup>2</sup>\*sr\* $\mu$ m)

K1 = Calibration Constant 1 (607.76)

K2 = Calibration Constant 2 (1260.56)

### 3.3 Calculation of Emissivity

Emissivity is the properties of urban materials, in particular solar reflectance, thermal emissivity, and heat capacity, which also influence thermal conditions, as they determine how the sun's energy is reflected, emitted and absorbed (Akbari et al., 2010). The emissivity of land is significantly varies with the heterogeneity of vegetation, surface moisture, roughness, and viewing angle.

### LSE by NDVI Method

### 3.4 Normalized Difference Vegetation Index NDVI

NDVI is known as Simple Ratio (SR). SR can be calculated using the reflectance of the near infrared band (NIR) and is the reflectance of the red band (red). The Normalised Difference Vegetation Index (NDVI) is the most commonly used vegetation index. For dense vegetation, this ratio will be high, due to the inverse relationship between vegetation brightness in the red and infrared regions of the spectrum.

$$NDVI = (NIR \text{ band} - Red \text{ band}) / (NIR \text{ band} + Red \text{ band})$$

NDVI images were obtained with the help of Raster calculator in ArcGIS. The images obtained were having values ranging between -1 AND +1. Values closer to 1 represent dense vegetation whereas value closer to -1 represents water or soil.

### 3.5 Proportional Vegetation

Proportional Vegetation is represented by Pv and it deals with the association between the amount of vegetation present within a pixel and the pixel's emissivity. There have been some studies regarding the relationship between NDVI and percent vegetation cover (Valor and Caselles, 1996). Proportional vegetation was evaluated using the equation.

$$Pv = \left( \frac{NDVI - NDVI_{min}}{NDVI_{max} - NDVI_{min}} \right)^2$$

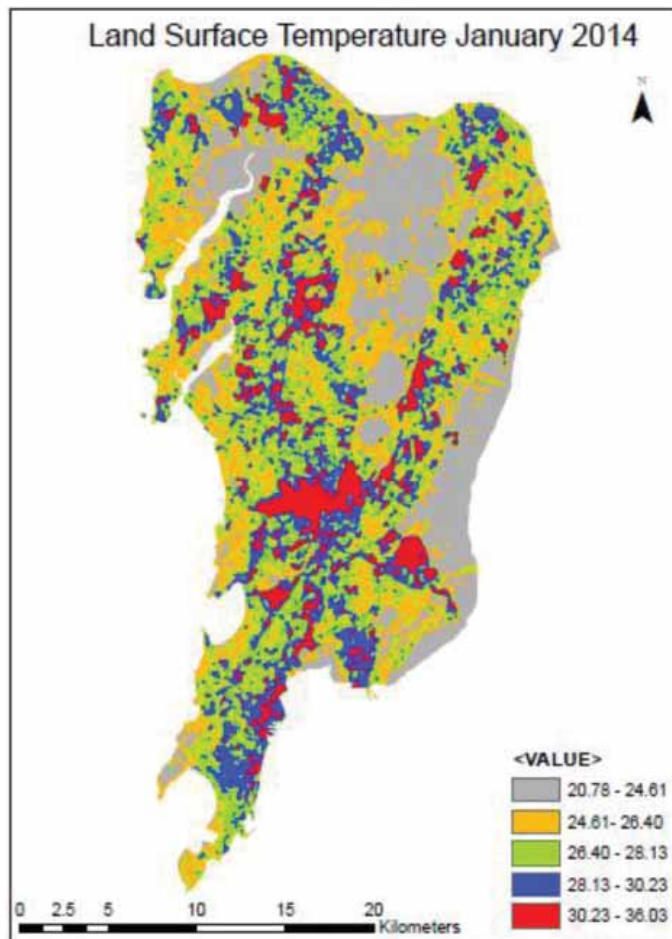


Figure 2: LST January 2014

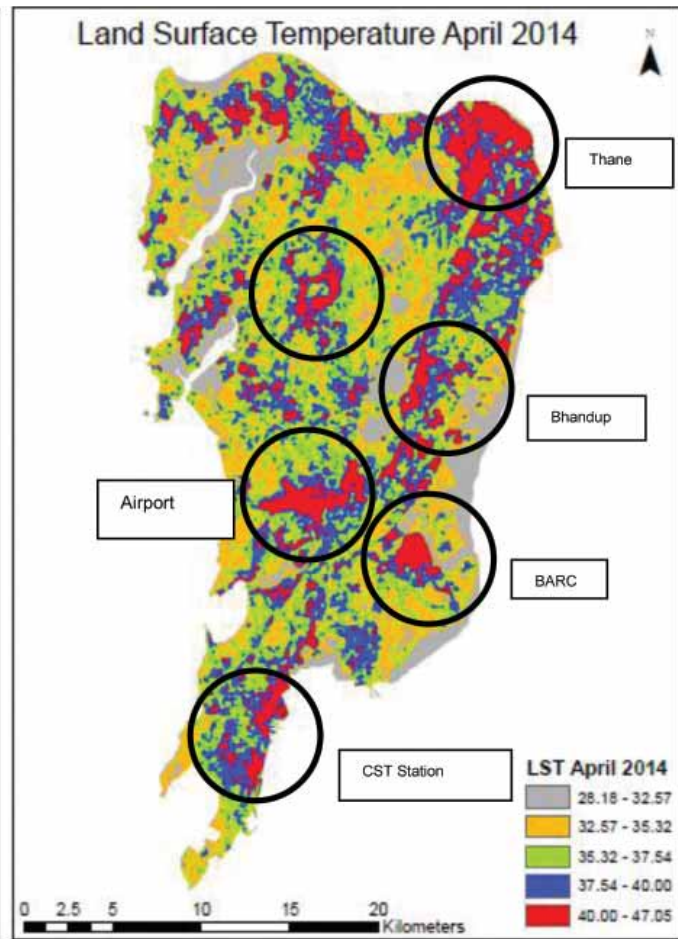


Figure 3: LST April 2014

Where  $P_v$  : Vegetation Proportion

NDVI : Normalized Difference Vegetation Index

NDVImax : Maximum value of NDVI NDVimin : Minimum value of NDVI

NDVI gives the live green vegetation presence in each pixel of raster image and thus, gives some measure of surface composition which can be applied for obtaining emissivity values.

#### Calculation of Proportional Vegetation

$P_v$  is the vegetation proportion and it deals with the relationship between the amount of vegetation present within a pixel and the pixel's emissivity.

lower values of  $P_v$  indicates built up or bare land and higher values indicate vegetation, whereas water and soil lies at the median of the range.

#### 3.6 Emissivity

Land Surface Emissivity was then evaluated using NDVI and  $P_v$ . This method was being derived by (Sobrino, 2004) which was given by the equation

$$\epsilon = 0.004 \times P_v + 0.986$$

It, thus, gives the potential of surface materials to emit radiation. This measure contributes in reducing the error of land surface temperature computation and assures the values to be closer to ground truth.

#### 3.7 Land Surface Temperature

Becker(1990) proposed a local split-window algorithm for channels 4 and 5 of AVHRR. And it was applied here to Landsat-8 TIRS band 10 and 11. The general form of the split window algorithm can be written as,

$$T_s = 1.274 + \frac{M(T_{10} + T_{11})}{2} + \frac{N(T_{10} - T_{11})}{2}$$

Where Temperature in Kelvin and the co-efficient M and N are

$$M = 1 + \frac{0.15616(1 - \epsilon)}{\epsilon} - \frac{0.486(\epsilon)}{\epsilon^2}$$

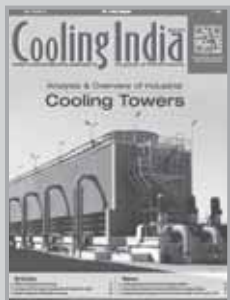
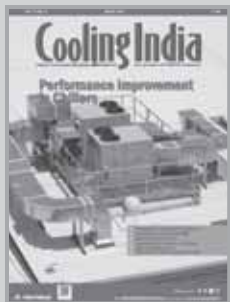
$$N = 6.26 + \frac{3.98(1 - \epsilon)}{\epsilon} - \frac{38.33(\epsilon)}{\epsilon^2}$$

$T_s$  represents the land surface temperature,  $T_{10}$  and  $T_{11}$  represent the brightness temperature for channels 10 and 11 respectively, M and N are the coefficients determined by the

Area	(Built up – Vegetation) $T_{B-V}$	(Built up – Water) $T_{B-W}$	(Barren-Vegetation) $T_{Ba-V}$	(Barren-Water) $T_{Ba-W}$
Mumbai	10 – 13.0 °C	10 – 12.0 °C	8.7 – 8.1 °C	7 – 7.4 °C

Table 3: Urban Heat Island Intensity Mumbai





The Subscription In-charge  
**Cooling India**  
 Chary Publications Pvt. Ltd.  
 906, The Corporate Park, Plot No. 14 & 15,  
 Sector - 18, Vashi, Navi Mumbai - 400 703  
 Email: sub@charypublications.in

If you are already a Subscriber,  
 Enter your  
 Subscription/Order no. \_\_\_\_\_

**SUBSCRIBE / RENEW  
 ONLINE**  
**Log on to –**  
**www.coolingindia.in**

Yes, I would like to subscribe **Cooling India** for \_\_\_\_\_ years  
 at ₹ \_\_\_\_\_ (US\$ \_\_\_\_\_ overseas subscribers)

**Payment details:**

Cheque / DD No. \_\_\_\_\_ dated \_\_\_\_\_  
 drawn on bank \_\_\_\_\_ branch \_\_\_\_\_

In favour of **CHARY PUBLICATIONS PVT. LTD.**

**Bank details for Wire Transfer**

Bank Name: **Bank of India** Branch: **Chembur, Mumbai - 400 071** Pan No.: **AABCC 6078J**  
 IFSC Code: **BKID 0000009** Bank a/c number: **000920110000322** SWIFT CODE : **BKIDINBBCHM**

Name: \_\_\_\_\_

Company: \_\_\_\_\_ Designation: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ Pin: \_\_\_\_\_

Phone: \_\_\_\_\_

Email: \_\_\_\_\_

Signature: \_\_\_\_\_

No. of Years	Amount	US \$	Tick ✓
<input type="checkbox"/> 1 (12 Issues)	1000	300	
<input type="checkbox"/> 2 (24 Issues)	1750	560	
<input type="checkbox"/> 3 (36 Issues)	2500	720	
<input type="checkbox"/> 5 (60 Issues)	4000	1000	



The Subscription In-charge  
**Medical Equipment & Automation**  
 Chary Publications Pvt. Ltd.  
 906, The Corporate Park, Plot No. 14 & 15,  
 Sector - 18, Vashi, Navi Mumbai - 400 703  
 Email: sub@charypublications.in

If you are already a Subscriber,  
 Enter your  
 Subscription/Order no. \_\_\_\_\_

Yes, I would like to subscribe **Medical Equipment & Automation** for \_\_\_\_\_ years  
 at ₹ \_\_\_\_\_ (US\$ \_\_\_\_\_ overseas subscribers)

**Payment details:**

Cheque / DD No. \_\_\_\_\_ dated \_\_\_\_\_  
 drawn on bank \_\_\_\_\_ branch \_\_\_\_\_

In favour of **CHARY PUBLICATIONS PVT. LTD.**

**Bank details for Wire Transfer**

Bank Name: **Bank of India** Branch: **Chembur, Mumbai - 400 071** Pan No.: **AABCC 6078J**  
 IFSC Code: **BKID 0000009** Bank a/c number: **000920110000322** SWIFT CODE : **BKIDINBBCHM**

Name: \_\_\_\_\_

Company: \_\_\_\_\_ Designation: \_\_\_\_\_

Address: \_\_\_\_\_

City: \_\_\_\_\_ Pin: \_\_\_\_\_

Phone: \_\_\_\_\_

Email: \_\_\_\_\_

Signature: \_\_\_\_\_

No. of Years	Amount	US \$	Tick ✓
<input type="checkbox"/> 1 (6 Issues)	750	150	
<input type="checkbox"/> 2 (12 Issues)	1350	275	
<input type="checkbox"/> 3 (18 Issues)	2000	400	
<input type="checkbox"/> 5 (30 Issues)	3000	600	

**SUBSCRIBE**

El \ June 2017

**SUBSCRIBE**

El \ June 2017

# Heating, Ventilation, Air Conditioning & Refrigeration all core subjects related to environment & life

## Who can Subscribe?

### Industries:

- Absorbers
- Air Handling Units
- Boilers
- Chemicals
- Cold Stores
- Condensers
- Contractors
- Cooling Towers & Parts
- Ducts & Accessories
- Environmental
- Exhaust
- Fans
- Freezers
- Insulated Doors
- Pumps
- Refrigerators
- Thermal Storage Systems
- Valves
- Water Treatment
- Air Distribution
- Air Conditioners
- Building Automation
- Chillers
- Compressors
- Condensing Unit
- Controls
- Dampers & Parts
- Energy Saving
- Evaporators
- Fan-Coil Units
- Fire
- Instruments
- Insulation
- Refrigerants
- Solar
- Transport Refrigeration
- Water Coolers

... and related accessories.

## Professional Readers - CI

### Industries:

- Pharmaceuticals
- Biotech
- Process Industries
- Printing & Packaging
- Hospitals
- Cold Chains
- Food Processing
- Storages
- Entertainment
- Other Allied Industries
- Institutions

### Professionals:

- Top industrialists
- Manufacturers
- Consultants
- Architects
- Interior Designers
- Process Engineers
- Importers & Exporters
- Traders

Several Others...

# Would you like to know all about the medical equipments and what they do to us...

## Who can Subscribe?

### Industries:

- Pharmaceutical Machineries
- Medical implements & implants
- Oxygen setup & Dental equipments
- Hearing aids
- Pathological equipments
- Ophthalmologic equipments, devices & solutions
- Ambulance & Air sterilization
- Surgical equipments
- Electro medical equipments / Medical technology
- Rescue & Emergency equipments
- Medical Diagnostic & hospital supplies
- Physiotherapy / Orthopedic equipments & technology
- Communication & IT
- Medical furnitures & equipments & Cardiology equipments
- Radiology & Imaging equipment technology
- Medical disposable disinfection
- Hospital utilities & supplies
- Neonatal / Pediatric equipments & patient monitoring equipments
- Electromechanical linear actuator system for hospital, beds, O.T tables, O.T lights
- Dental chairs, Blood donor coach
- Power backup systems (UPS, Inverters & SMF batteries)
- Rehabilitation aids

... and related accessories.

## Professional Readers - MEA

### Industries:

- Medical and Surgical Equipment & Supplies
- Pharmaceutical & Bulk Drugs
- Disposable Supplies
- Diagnostics & Laboratory Instruments
- Hospital Furnishing & Related computer software
- Rehab. & Therapeutic aids
- Ophthalmic Instruments
- Oral & Dental Equipment
- Optical Equipment and supplies
- Institutions & Other allied industries

### Professionals:

- Medical Professional / Doctors
- Surgeons
- Paramedical Professionals
- Hospital Administrators
- Pathologists
- Radiologists
- Physiotherapists

Several Others...



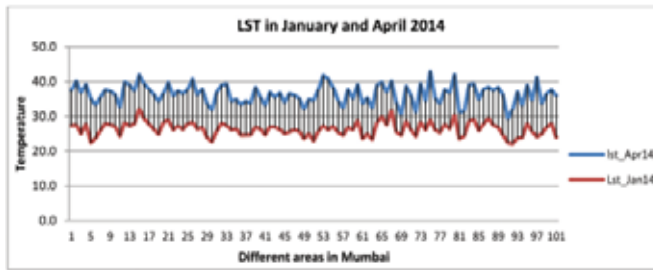


Figure 4: Temperature profile on various locations in the city

impact of atmospheric conditions and other related factors on the thermal spectral radiance, and its transmission in channels 10 & 11.

Urban heat island effect is hardly being quantified in the cities of India. In this study, Mumbai city has been selected for the quantification of UHI. The results clearly indicate the presence of UHI in Mumbai. A rise of 10-12°C is estimated in this study. The population density in densely populated areas like Kurla, Chembur, Thane shows higher temperature as compared to greener spaces like Sanjay Gandhi National Park. Temperature difference between various surfaces

Further, the effect of urbanization and concretization at local scale showing the difference in temperature in less vegetated and more vegetated land is also studied. It is found that the conventional rooftops are about 3-4°C higher as compared to green and garden roof or roof covered with vegetation. Conventional roofs absorb maximum amount of solar radiation during day time. It can be seen that the temperature of the region having more green (vegetated) area falls to lower scale as compared to the area having less green space and more concrete area. It can be said that the presence of vegetation reduces the overall temperature of the area both at regional and local scale. With the help of Thermo IMAGER TIM 160 is used for the city to map some buildings material and surrounding areas.

#### 4.0 Thermal Images and their Analysis: Mumbai region

Thermal images of structures and greenery at various locations of Mumbai like Parel area are captured. With the help of Thermo IMAGER TIM 160 software the analysis of the images is carried out to find out the effect of concretization in Mumbai, on the local temperature conditions. In this image, the temperatures

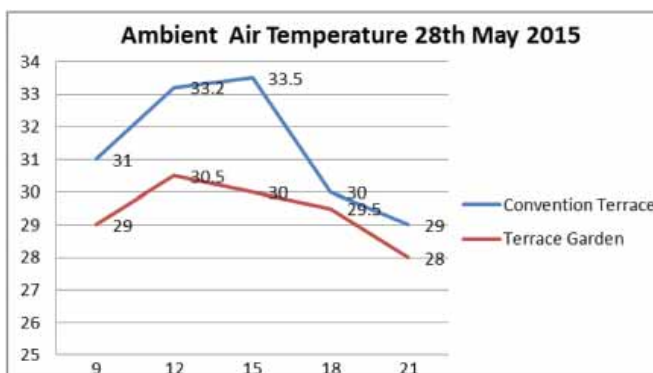


Figure 6: Comparison of the temperature of conventional and green terrace

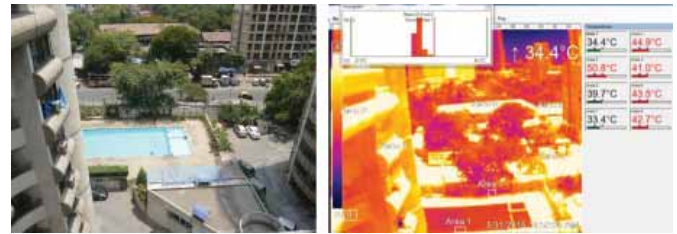


Figure 5: Thermal image of different material applied in the area in Mumbai

of horizontal surface or terraces are around 50°C and temperature of grass /vegetation 30- 34.5°C.

With the help of these images, we can also see that the greenery in the region helps in reduction of temperature and so the wind profile and other climatic factors associated with temperature.

These thermal images are very useful in analyzing the temperature difference between different surfaces in the city. In these combinations of surfaces the planners and architect can make out which material to opt in which direction to absorb less heat. The city is made up of different surfaces and the properties of these can change the micro climate of the city

It is found that the roof tops and roads are about 12-15°C higher as compared to green spaces having vegetation. Even the barren surfaces also emit the same radiation as concrete surfaces. It can be seen that the temperature of the outer region of the city having more green (vegetated) area falls to lower scale as compared to the area having less green space and more concrete area.

A model of a residential building in Mumbai is taken to demonstrate the case.

#### 4.1 Palais Royale, Mumbai

Palais Royale is a high-end residential apartment in Mumbai. Evaluation of the results of solar load from simulations was done using Energy Plus software. The data so obtained was evaluated and innovative systems for reduction in load, coupled with high efficiency refrigeration systems that cut down the energy demand were proposed and installed. The entire exercise aimed at enhancing the feeling of thermal comfort to the occupants using minimum amounts of energy or water, mostly by natural means as well as throwing the heat content is less in the atmosphere

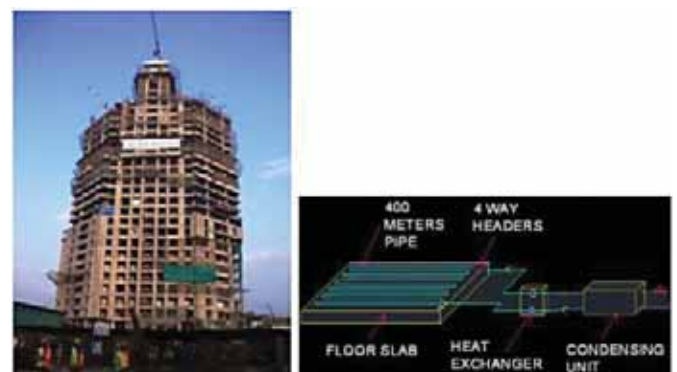


Figure 7: Palais Royale and schematic representation of installed system

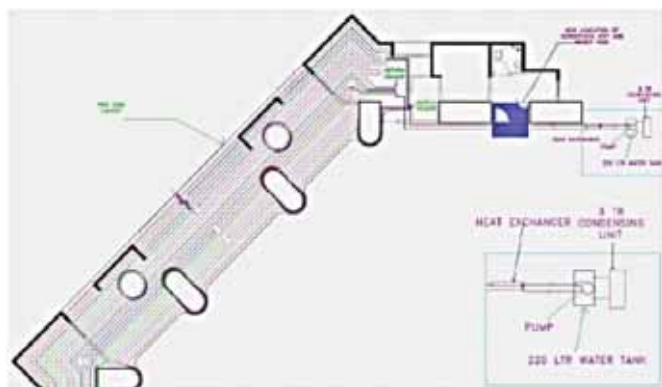
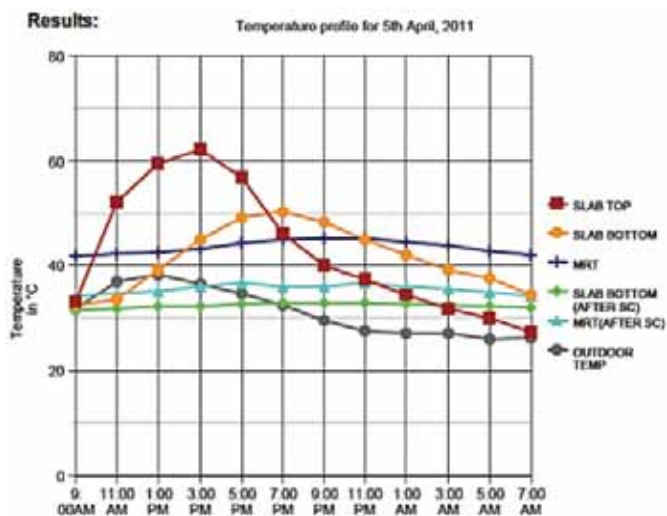


Figure 8: Piping Layout in balconies at Palais Royale



Figure 10: Completed Slab and condenser Units at Palais Royale



Graph 1: Temperature Profile of Slab (Palais Royale)

which will help in reducing the temperature.

- The current system works by pumping chilled water through a loop of plastic pipes (4 loops, each of 100 meters) embedded in the floor slab using a small pump.
- The water absorbs the structural heat (solar load) from the floor slab and rejects the same to the refrigerant of the condensing unit through a water refrigerant heat exchanger.
- After rejecting the structural load (solar load) to the condensing unit through a heat exchanger, water is re-circulated through the same loop of plastic pipes again to absorb the structural load.
- Thus, the cycle repeats, resulting in continuous extraction of the structural load.
- In order to prevent the floor top temperature from falling below



Figure 9: Laying of pipes on the roof at Palais Royale

30°C, the pump will stop, thus stopping, water from being circulated through loop of pipes encased in the bedding of floor.

Considering the thermal capacitance of the roof, which causes delay in the peak outdoor temperature to reach the inner surface, only the peak roof bottom value occurring after the peak roof top value has been taken into calculation.

- Slab Top peak– 62.26 °C @15:00:00
- Slab Bottom peak – 50.45 °C @ 17:00:00, with outside ambient

temperature peaked to 38.31°C @ 13:00:00

- Slab Bottom (After SC) peak – 40.18 °C @ 21:00:00

## Analysis of Peak Values

Table 4: Comparison of peak temperature values at Slab of Palais Royale

Temperature gain on the inside =  $(40.18 - 50.45) / 50.45 / 100$   
= 20.35; 20% less heat gain

Load reduction, if air conditioned to achieve 24°C room temperature

$$= (21.32 - 12.73) / (21.32 / 100) \\ = 40.29; 40\% \text{ savings}$$

$$Q = A \times U \times \Delta T$$

Where,

Q = heat removed

A = Area of surface = 38.84 sq. M

U = thermal transmittance = (thermal conductivity / thickness)  
=  $k/L = 0.5 / 0.2032 = 2.46 \text{ W/m}^2\text{K}$

$\Delta T$  = difference between the maximum outside & corresponding inside surface

Temperature =  $62.26 - 40.18 = 22.08^\circ\text{C}$

Total heat removed =  $38.84 \times 2.46 \times 22.08$

= 2109.66 W = 0.6 TR of savings

With this system the proposed air conditioning load of 2484 TR reduced to 1711 TR for the whole building.

## 4.2 In hot humid climates radiant slab cooling requires some special measures.

1. To prevent condensation the supply air requires

### Analysis of Peak Values

	Roof			Load Reduction		
	Slab Top	Slab Bottom	Difference	MRT	Room Design	Difference
Slab	62.26	50.45	11.81	45.32	24	21.32
Slab (After SC)	62.26	40.18	22.08	36.73	24	12.73
Effect on cooling load if air-conditioned				Reduction		8.59
				Percent Savings		40.29

Note: All temperature values are in degree celcius

dehumidification. The temperature of water for cooling coil should be reduced to about 6°C, and also dehumidification of air is required.

- Due to condensation risk natural ventilation without combined control is problematic for radiant slab cooling. The building should be air tight.
- Due to solar radiation heat gains should be kept low, specially, in glass structures so that the temperature of chilled water supplied to the radiant slab can be increased, which reduces the possibility of condensation.

Performance of radiant cooling with outdoor air system is better than conventional VAV Systems.

### Observations and Discussion

The reduction in air-conditioning load, in warm and humid climate, by structural cooling is possible. PVC Pipes laid on the terrace at 10 cm away and water is flowing at a very less speed to absorb as much heat as possible. This water can be used either in firefighting tank or cool it with the help of cooling tower. It can be seen that the temperature of the areas with different landcover like concrete, Marble, Kota stone, bricks cement tiles and Shabad (a type of stone in India) is increasing with the increase in the urban areas. Thus, use of Structure Cooling judiciously across various surfaces will directly help reduce effects of Urban Heat Island. Same effect will be there on all the horizontal surfaces in the city like footpath, pavings, parking lots, roads and concrete roads.

### 5. Conclusions

Increase or decrease in Land Surface Temperature depends on many factors such as anthropogenic heat, percentage of surfaces in the city, land cover and city layout. The UHI pattern is

highly related to land cover and land use in Mumbai and is also determined by the quantity of vegetation and impervious surface.

Landsat Images of January 2014 and April 2014 from remote sensing process derived thermal data from the Landsat TM sensor for locating large-scale structures and parks which are the contributing factors of heat in the city. The temperature patterns are seen in the city and found out the micro pattern and local pattern needs attention in planning.

Lakes, water bodies surrounded by vegetation reduce the temperature, which gradually increases as land cover changes in areas with more of impervious surface. The UHI pattern is highly related to land cover and land use in Mumbai and is also determined by the quantity of vegetation and impervious surface. Images 2014 from remote sensing process derived thermal data from the Landsat TM sensor, for locating large-scale structures and parks which are the contributing factors of heat in the city.

Our planners have to think to change the land use patterns and land cover in the city, all the terraces should have a use of Structure Cooling system to reduce the temperature of the buildings and its surroundings by reduce the usage of air conditioning systems in the buildings. A mandate/policy in this regard is the need of the time. Making different choices about this use for construction and the configuration can reduce urban heating and reduce the demand of air conditioning. With the help of these results our planners can implement mitigation techniques, which would have the greatest immediate effect at the neighborhood scale by reducing temperature of Micro Urban Heat Islands to make it sustainable for the citizens. ■

Aparna Dwivedi  
IIT, Mumbai

M V Khire  
IIT, Mumbai

B K Mohan  
IIT, Mumbai

**Cooling India is reachable  
on Social Media Platforms!!!**

 [www.facebook.com/coolingindiamagazine](http://www.facebook.com/coolingindiamagazine)  
 [www.linkedin.com/in/coolingindia](http://www.linkedin.com/in/coolingindia)  
 [www.twitter.com/coolingmagazine](http://www.twitter.com/coolingmagazine)

Chary Publications offers you  
Print + Digital version of

**Cooling India**

Follow us on Digital Social  
Platforms and get the most  
interesting updates  
and developments in the industry...



# Ground-Source Heat Pump System for Buildings Heating & Cooling

The main goal of this study is to stimulate the uptake of the GSHPs. Recent attempts to stimulate alternative energy sources for heating and cooling of buildings has emphasised the utilisation of the ambient energy from ground source and other renewable energy sources. The purpose of this study, however, is to examine the means of reduction of energy consumption in buildings, identify GSHPs as an environmental friendly technology able to provide efficient utilisation of energy in the buildings sector, promote using GSHPs applications as an optimum means of heating and cooling, and to present typical applications and recent advances of the DX GSHPs..

The earth's surface acts as a huge solar collector, absorbing radiation from the sun. In the UK, the ground maintains a constant temperature of 11-13°C several metres below the surface all the year around. Among many other alternative energy resources and new potential technologies, the ground source heat pumps (GSHPs) are receiving increasing interest because of their potential to reduce primary energy consumption and thus, reduce emissions of greenhouse gases.

Direct expansion GSHPs are well suited to space heating and cooling and can produce significant reduction in

carbon emissions. In the vast majority of systems, space cooling has not been normally considered, and this leaves ground-source heat pumps with some economic constraints, as they are not fully utilised throughout the year. The tools that are currently available for design of a GSHP system require the use of key site-specific parameters such as temperature gradient and the thermal and geotechnical properties of the local area. A main core with several channels will be able to handle heating and cooling simultaneously, provided that the channels to some extent are thermally insulated and can be operated independently as single units, but at the same time function as integral parts of the entire core. Loading of the core is done



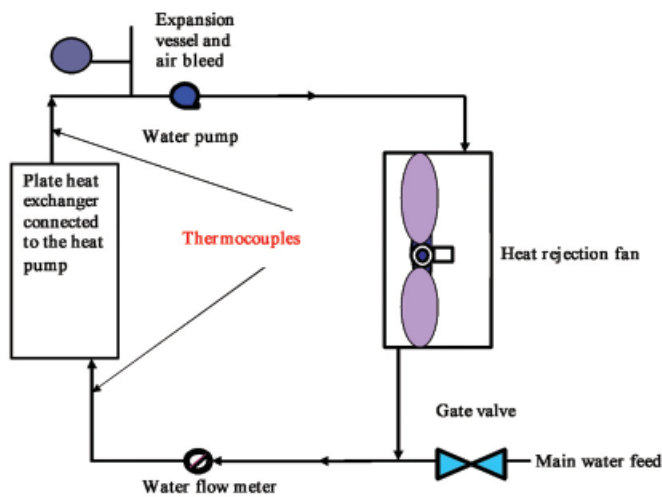


Figure 1: Sketch of installing heat pump

by diverting warm and cold air from the heat pump through the core during periods of excess capacity compared to the current needs of the building. The cold section of the core can also be loaded directly with air during the night, especially in spring and fall when night times are cooler and day times are warmer. The shapes and numbers of the internal channels and the optimum configuration will obviously depend on the operating characteristics of each installation. Efficiency of a GSHP system is generally much greater than that of the conventional air-source heat pump systems. Higher COP (coefficient of performance) is achieved by a GSHP because the source/sink earth temperature is relatively constant compared to air temperatures. Additionally, heat is absorbed and rejected through water, which is a more desirable heat transfer medium due to its relatively high heat capacity.

The GSHPs in some homes also provide:

- Radiant floor heating.
- Heating tubes in roads or footpaths to melt snow in the winter.
- Hot water for outside hot tubs and
- Energy to heat hot water.

With the improvement of people's living standards and the development of economies, heat pumps have become widely used for air conditioning. The driver to this was that environmental problems associated with the use of refrigeration equipment, the ozone layer depletion and global warming are increasingly becoming the main concerns in developed and developing countries alike. With development and enlargement of the cities in cold regions, the conventional heating methods can severely pollute the environment. In order to clean the cities, the governments drew many measures to restrict citizen heating by burning coal and oil and encourage them to use electric or gas-burning heating. New approaches are being studied and solar-assisted reversible absorption heat pump for small power applications using water-ammonia is under development.

An air-source heat pump is convenient to use and so it is a better method for electric heating. The ambient temperature in winter is comparatively high in most regions, so heat pumps with high efficiency can satisfy their heating requirement. On the other hand, a conventional heat pump is unable to meet the heating

requirement in severely cold regions anyway, because its heating capacity decreases rapidly when ambient temperature is below  $-10^{\circ}\text{C}$ . According to the weather data in cold regions, the air-source heat pump for heating applications must operate for long times with high efficiency and reliability when ambient temperature is as low as  $-15^{\circ}\text{C}$ . Hence, much researches and developments have been conducted to enable heat pumps to operate steadily with high efficiency and reliability in low temperature environments. For example, the burner of a room air conditioner, which uses kerosene, was developed to improve the performance in low outside temperature. Similarly, the packaged heat pump with variable frequency scroll compressor was developed to realise high temperature air supply and high capacity even under the low ambient temperature of  $-10$  to  $-20^{\circ}\text{C}$ . Such a heat pump systems can be conveniently used for heating in cold regions. However, the importance of targeting the low capacity range is clear if one has in mind that the air conditioning units below 10 kW cooling account for more than 90% of the total number of units installed in the EU.

## 2. Methods and Laboratory Measurements

This communication describes the details of the prototype GSHP test rig, details of the construction and installation of the heat pump, heat exchanger, heat injection fan and water supply system. It also, presents a discussion of the experimental tests being carried out.

### 2.1. Main Experimental Test Rig

The schematic of the test rig that was used to support the two ground-loop heat exchangers is shown in Figure 1. It consisted of two main loops: heat source loop and evaporation heat pump. Three boreholes were drilled each 30 meters deep to provide sufficient energy. The closed-loop systems were laid and installed in a vertical well. The ground-loop heat exchangers were connected to the heat pump.

#### 2.1.1. Direct Expansion Heat Pump Installation

The experimental work undertaken was separated into three parts. The first part dealt with drilling three boreholes each 30

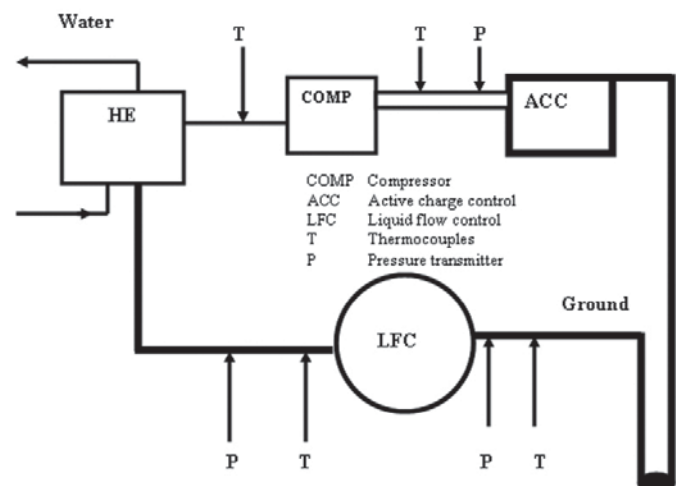


Figure 2: Shows the connections of ground loops to heat pump and heat exchanger



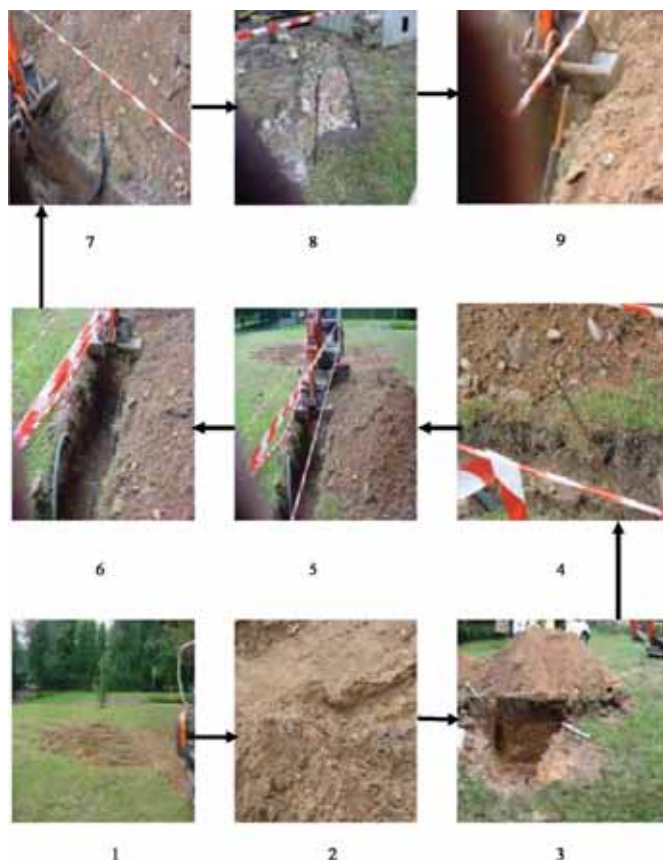


Figure 3: Showing the drilling (1-2) digging of the pit (3), connection of the manifolds (4), grouting, preparation of the coils (5-6) and the source loop, which consists of two earth loops: one for vapour and one for liquid (7-9)

meter deep, digging out the pit and connection of the manifolds and preparation of coils. Holes were grouted with bentonite and sand. The pipes were laid and tested with nitrogen. Then, the pit was backfilled and the heat pump was installed. The second part was concerned with the setting up of the main experimental rig: construction and installation of the heat injection fan, water pump, expansion valve, flow meter, electricity supply, heat exchanger and heat pump. The third part was an installation of refrigerator and measurements.

The aim of this project is to present and develop a GSHP system to provide heating and cooling for buildings (Figure 2). The heat source loop consisted of two earth loops: one for vapour and one for liquid. A refrigeration application is only concerned with the low temperature effect produced at the evaporator; while a heat pump is also concerned with the heating effect produced at the condenser.

The earth-energy systems, EESs, have two parts; a circuit of underground piping outside the house, and a heat pump unit inside the house. And unlike the air-source heat pump, where one heat exchanger (and frequently the compressor) is located outside, the entire GSHP unit for the EES is located inside the house.

The outdoor piping system can be either an open system or closed loop. An open system takes advantage of the heat retained in an underground body of water. The water is drawn up through a well directly to the heat exchanger, where its heat is extracted.

The water is discharged either to an above ground body of water, such as a stream or pond, or back to the underground water body through a separate well. Closed-loop systems, on the other hand, collect heat from the ground by means of a continuous loop of piping buried underground. An anti-freeze solution (or refrigerant in the case of a DX earth-energy system), which has been chilled by the heat pump's refrigeration system to several degrees colder than the outside soil, and circulates through the piping, absorbing heat from the surrounding soil.

The direct expansion (DX) GSHP installed for this study was designed taking into account the local meteorological and geological conditions. The site was at the School of the Built Environment, University of Nottingham, where the demonstration and performance monitoring efforts were undertaken Figures (3-4). The heat pump has been fitted and monitored for one-year period. The study involved development of a design and simulation tool for modelling the performance of the cooling system, which acts a supplemental heat rejecting system using a closed-loop GSHP system. With the help of the Jackson Refrigeration (Refrigeration and Air Conditioning engineers) the following were carried out:

- Connection of the ground loops to the heat pump
- Connection of the heat pump to the heat exchanger
- Vacuum on the system
- Charging the refrigeration loop with R407C refrigerant

## 2.1.2. Water Supply System

The water supply system consisted of water pump, boiler, water tank, expansion and valve flow metre (Figure 4). A



Figure 4: Showing preparation of coils (1-2), installation of heat pump (3-6) and connection of water supply system (water pump, flow metre, expansion valve and the boiler) (7-9)



thermostatically controlled water heater supplied warm water, which was circulated between the warm water supply tank and warm water storage tank using a pump to keep the surface temperature of the trenches at a desired level.

The ground source heat pump system, which uses a ground source with a smaller annual temperature variation for heating and cooling systems, has increasingly attracted market attention due to lower expenses to mine for installing underground heat absorption pipes and lower costs of dedicated heat pumps, supported by environmentally oriented policies. The theme undertakes an evaluation of heat absorption properties in the soil and carries out a performance test for a DX heat pump and a simulated operation test for the system. In fact, these policies are necessary for identifying operational performance suitable for heating and cooling, in order to obtain technical data on the heat pump system for its dissemination and maintain the system in an effort of electrification. In these circumstances, the study estimated the heat properties of the soil in the city of Nottingham and measured thermal conductivity for the soil at some points in this city, aimed at identifying applicable areas for ground source heat pump system.

## 2.2. Design and Installation

Installation of the heat pump system and especially, the ground heat exchanger needs to be carefully programmed so that it does not interfere with or delay any other construction activities. The time for installation depends on soil conditions, length of pipe, equipment required and weather conditions. The DX systems are most suitable for smaller domestic applications.

The most important first step in the design of a GSHP installation is accurate calculation of the building's heat loss, its related energy consumption profile and the domestic hot water requirements. This will allow accurate sizing of the heat pump system. This is, particularly, important because the capital cost of a GSHP system is generally higher than for alternative conventional systems and economies of scale are more limited. Oversizing will significantly increase the installed cost for little operational saving and will mean that the period of operation under part load is increased. Frequent cycling reduces equipment life and operating efficiency. Conversely, if the system is undersized design conditions may not be met and the use of top-up heating, usually direct acting electric heating, will reduce the overall system efficiency. In order to determine the length of heat exchanger needed to piping material. The piping material used affects life; maintenance costs, pumping energy, capital cost and heat pump performance.

## 2.3. Heat Pump Performance

The need for alternative low-cost energy resources has given rise to the development of the DX-GSHPs for space cooling and heating. The performance of the heat pump depends on the performance of the ground loop and vice versa. It is, therefore, essential to design them together. Closed-loop GSHP systems will not normally require permissions/authorisations from the environment agencies. However, the agency can provide comment

on proposed schemes with a view to reducing the risk of groundwater pollution or derogation that might result. The main concerns are:

- Risk of the underground pipes/boreholes creating undesirable hydraulic connections between different water bearing strata.
- Undesirable temperature changes in the aquifer that may result from the operation of a GSHP.
- Pollution of groundwater that might occur from leakage of additive chemicals used in the system.

Efficiencies for the GSHPs can be high because the ground maintains a relatively stable temperature allowing the heat pump to operate close to its optimal design point. Efficiencies are inherently higher than for air source heat pumps because the air temperature varies both throughout the day and seasonally such that air temperatures, and therefore efficiencies, are lowest at times of peak heating demand.

A heat pump is a device for removing heat from one place - the 'source' - and transferring it at a higher temperature to another place. The heat pumps consist of a compressor, a pressure release valve, a circuit containing fluid (refrigerant), and a pump to drive the fluid around the circuit. When the fluid passes through the compressor, it increases in temperature. This heat is then given off by the circuit while the pressure is maintained. When the fluid passes through the relief valve the rapid drop in pressure results in a cooling of the fluid. The fluid then absorbs heat from the surroundings before being re-compressed. In the case of domestic heating the pressurised circuit provides the heating within the dwelling. The depressurised component is external and, in the case of ground source heat pumps, is buried in the ground. Heat pump efficiencies improve as the temperature differential between 'source' and demand temperature decreases, and when the system can be 'optimised' for a particular situation. The relatively stable ground temperatures moderate the differential at times of peak heat demand and provide a good basis for optimisation.

The refrigerant circulated directly through the ground heat exchanger in a direct expansion (DX) system but most commonly GSHPs are indirect systems, where a water/anti-freeze solution circulates through the ground loop and energy is transferred to or from the heat pump refrigerant circuit via a heat exchanger. This application will only consider closed loop systems. The provision of cooling, however, will result in increased energy consumption and the efficiently it is supplied. The GSHPs are, particularly, suitable for new build as the technology is most efficient when used to supply low temperature distribution systems such as underfloor heating. They can also be used for retrofit especially in conjunction with measures to reduce heat demand. They can be particularly cost effective in areas where mains gas is not available or for developments where there is an advantage in simplifying the infrastructure provided.

### 2.3.1. Coefficient of Performance (COP)

Heat pump technology can be used for heating only, or for cooling only, or be 'reversible' and used for heating and cooling

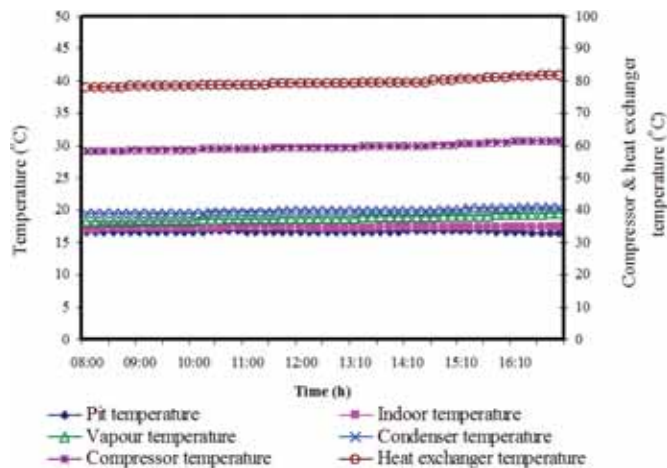


Figure 5: Variation of temperatures per day for the DX system

depending on the demand. Reversible heat pumps generally have lower COPs than heating only heat pumps. They will, therefore, result in higher running costs and emissions. Several tools are available to measure heat pump performance. The heat delivered by the heat pump is theoretically the sum of the heat extracted from the heat source and the energy needed to deliver the cycle. Figure 5 shows the variations of temperature with the system operation hours. Several tools are available to measure heat pump performance. The heat delivered by the heat pump is theoretically the sum of the heat extracted from the heat source and the energy needed to derive the cycle. For electrically driven heat pumps the steady state performance at a given set of temperatures is referred to as the coefficient of performance (COP). It is defined as the ratio of the heat delivered by the heat pump and the electricity supplied to the compressor:

$$\text{COP} = [\text{heat output (kW}_{\text{th}})] / [\text{electricity input (kW}_{\text{el}})] \quad (1)$$

For an ideal heat pump, the COP is determined solely by the condensation temperature and the temperature lift:

$$\text{COP} = [\text{condensing temperature (°C)}] / [\text{temperature lift (°C)}] \quad (2)$$

Figure 6 shows the COP of heat pump as a function of the evaporation temperature. Figure 7 shows the COP of heat pump as a function of the condensation temperature. As can be seen, the theoretical efficiency is strongly dependent on the temperature lift. It is important not only to have as high a source temperature as possible but also to keep the sink temperature (i.e., heating distribution temperature) as low as possible. The achievable heat

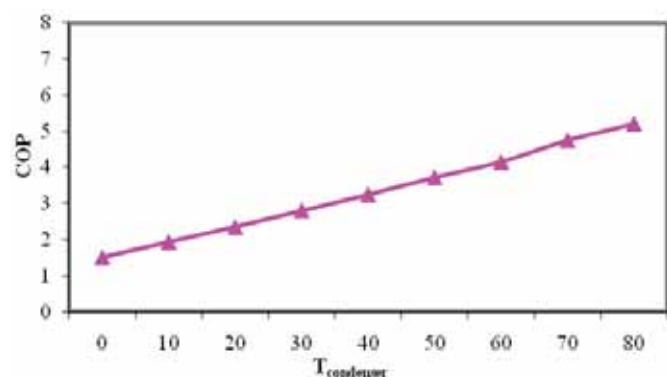


Figure 7: Heat pump performance vs condensation temperature

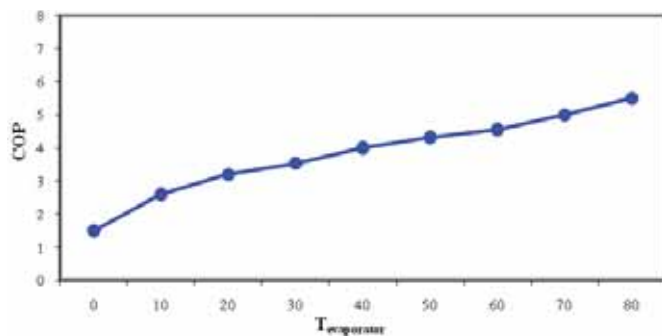


Figure 6: Heat pump performance vs evaporation temperature

pump efficiency is lower than the ideal efficiency because of losses during the transportation of heat from the source to the evaporator and from the condenser to the room and the compressor. Technological developments are steadily improving the performance of the heat pumps.

The need for alternative low-cost energy has given rise to the development of the GSHP systems for space cooling and heating in residential and commercial buildings. The GSHP systems work with the environment to provide clean, efficient and energy-saving heating and cooling the year round. The GSHP systems use less energy than alternative heating and cooling systems, helping to conserve the natural resources. The GSHP systems do not need large cooling towers and their running costs are lower than conventional heating and air-conditioning systems. As a result, GSHP systems have increasingly been used for building heating and cooling with an annual rate of increase of 10% in recent years. While in some zones such as hot summer and cold winter areas, there is a major difference between heating load in winter and cooling load in summer. Thus, the soil temperature increases gradually after yearly operation of the GSHP system because of the inefficient recovery of soil temperature as the result of imbalance loads (Figure 8). Finally, the increase of soil temperature will decrease the COP of the system.

The first law of thermodynamics is often called the law of conservation of energy. Based on the first law or the law of conservation of energy for any system, open or closed, there is an energy balance as:

$$[\text{Net amount of energy added to system}] = [\text{Net increase of stored energy in system}] \quad (3)$$

or

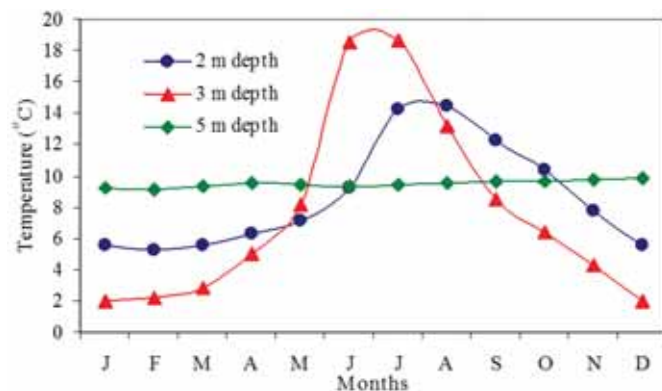


Figure 8: Seasonal temperature variations

$$[\text{Energy in}] - [\text{Energy out}] = [\text{Increased of stored energy in system}] \quad (4)$$

In a cycle, the reduction of work produced by a power cycle (or the increase in work required by a refrigeration cycle) equals the absolute ambient temperature multiplied by the sum of irreversibilities in all processes in the cycle. Thus, the difference in reversible and actual work for any refrigeration cycle, theoretical or real, operating under the same conditions becomes:

$$W_{\text{actual}} = W_{\text{reversible}} + T_o \sum I \quad (5)$$

Where:

$I$  is the irreversibility rate, kW/K.

$T_o$  is the absolute ambient temperature, K

Refrigeration cycles transfer thermal energy from a region of low temperature to one of higher temperature. Usually, the higher temperature heat sink is the ambient air or cooling water, at temperature  $T_o$ , the temperature of the surroundings. Performance of a refrigeration cycle is usually described by a coefficient of performance (COP), defined as the benefit of the cycle (amount of heat removed) divided by the required energy input to operate the cycle:

$$\text{COP} = \frac{[\text{Useful refrigeration effect}]}{[\text{Net energy supplied from external sources}]} \quad (6)$$

For a mechanical vapour compression system, the net energy supplied is usually in the form of work, mechanical or electrical and may include work to the compressor and fans or pumps. Thus,

$$\text{COP} = \frac{[Q_{\text{evap}}]}{[W_{\text{net}}]} \quad (7)$$

In an absorption refrigeration cycle, the net energy supplied is usually in the form of heat into the generator and work into the pumps and fans, or:

$$\text{COP} = \frac{(Q_{\text{evap}})}{(Q_{\text{gen}} + W_{\text{net}})} \quad (8)$$

In many cases, work supplied to an absorption system is very small compared to the amount of heat supplied to the generator, so the work term is often neglected. Applying the second law of thermodynamic to an entire refrigeration cycle shows that a completely reversible cycle operating under the same conditions has the maximum possible COP. Table 1 lists the measured and computed thermodynamic properties of the refrigerant. Departure of the actual cycle from an ideal reversible cycle is given by the refrigerating efficiency:

$$\eta_R = \text{COP} / (\text{COP})_{\text{rev}} \quad (9)$$

### 2.3.2. Seasonal Performance Factor (SPF)

There are primary two factors to describe the efficiency of

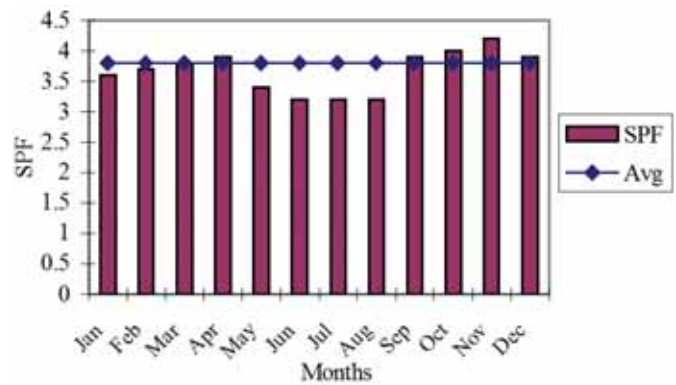


Figure 9: Seasonal performance for individual months and average for 2008

heat pumps. First, the coefficient of performance (COP) is determined in the test stand with standard conditions for a certain operating point and/or for a number of typical operating points. Second, the seasonal performance factor (SPF), describes the efficiency of the heat pump system under real conditions during a certain period, for example for one year. The SPFs in this case are the ratio of the heat energy produced by the heat pump and the back-up heater and the corresponding energy required of the heat pump. The SPF for individual months and an average value for the year 2008 for the DX GSHP are shown in Figure 9. The assessment of the 2008 measurement data for the GSHP in the buildings providing both heating and cooling reveals a seasonal performance factor (SPF) of 3.8. The SPF of the individual system was in the range of 3.0-4.6.

The preliminary results show that the GSHP are especially promising when it comes to reaching high efficiencies under real conditions. However, there is still a need for optimisation in the integration of the unit in the supply system for the house and for the control strategies of the heat pump. Thus, a poorly integrated heat source or an incorrectly designed heat sink can decrease the seasonal performance factor of the heat pump. The main point to consider is the careful layout of the system as a whole, rather than with respect to single components. High installation costs have been identified as a major barrier to wider application of the GSHPs often referred to as geothermal heat pumps. The primary reason cited for higher cost is the ground loop. Other factors may be high costs of the GSHP heat pump units and supplies, interior installation, and limited competition. The ground-source machine

Table 1. Measured and computed thermodynamic properties of R-22

Measured			Computed		
State	Pressure (kPa)	Temperature (°C)	Specific enthalpy (kJ/kg)	Specific entropy (kJ/kg°K)	Specific volume (m3/kg)
1	310	-10	402.08	1.78	0.075
2	304	-4	406.25	1.79	0.079
3	1450	82	454.20	1.81	0.021
4	1435	70	444.31	1.78	0.019
5	1410	34	241.40	1.14	0.0008
6	1405	33	240.13	1.13	0.0008
7	320	-12.8	240.13	1.15	0.0191



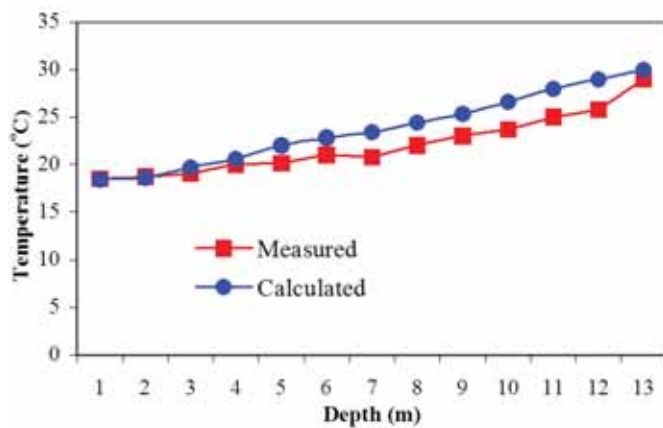


Figure 10: Comparison of calculations and experiments for saturated soil with groundwater flow (SSG)

had lower demand (summer and winter) and lower heating energy use than either of the air heat pumps. Comparisons with natural gas must be based on cost since the units for natural gas (therm = 100,000 Btu) are different than electrical energy unit (kWh).

### 3. Comparison of Numerical Simulation and Experiments

The GSHPs are generally more expensive to develop, however, they have very low operating cost, and justify the higher initial cost. Therefore, it is necessary to have an idea of the energy use and demand of these equipments. The performances are normally rated at a single fluid temperature (0°C) for heating COP and a second for cooling EER (25°C). These ratings reflect temperatures for an assumed location and ground heat exchanger type, and are not ideal indicators of energy use. This problem is compounded by the nature of ratings for conventional equipment. The complexity and many assumptions used in the procedures to calculate the seasonal efficiency for air-conditioners, furnaces, and heat pumps (SEER, AFUE, and HSPF) make it difficult to compare energy use with equipment rated under different standards. The accuracy of the results is highly uncertain, even when corrected for regional weather patterns. These values are not indicators for demand since they are seasonal averages and performance at severe conditions is not heavily weighted.

The American Society of Heating, Refrigerating, and Air-

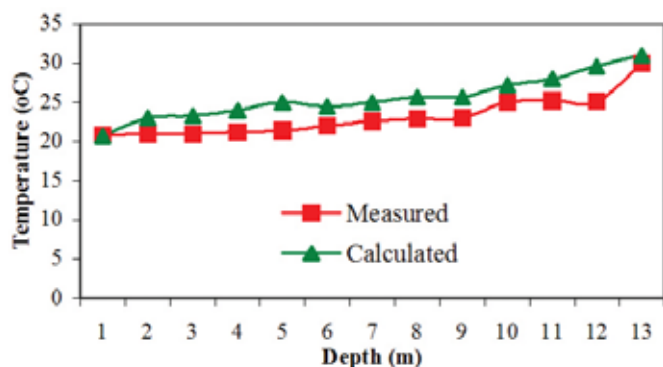


Figure 12. Comparison of calculations and experiments for unsaturated soil without groundwater flow (US).

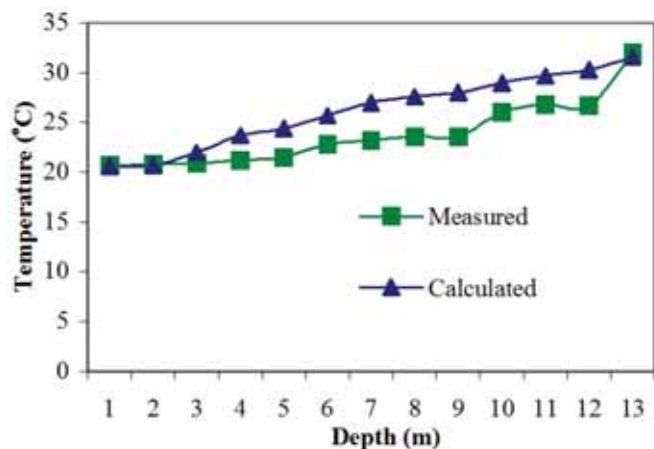


Figure 11: Comparison of calculations and experiments for saturated soil without groundwater flow (SS)

Conditioning Engineers (ASHRAE) recommends a weather driven energy calculation, like the bin method, in preference to single measure methods like seasonal energy efficiency ratio (SEER), seasonal performance factor (SPF), energy efficiency rating (EER), coefficient of performance (COP annual fuel utilisation efficiency rating (AFUE), and heating season performance factor (HSPF). The bin method permits the energy use to be calculated based on local weather data and equipment performance over a wide range of temperatures. Both solid and liquid parts co-existed in one control volume of non-isothermal groundwater flow. It was therefore necessary to integrate the two parts into one energy equation. Accordingly, the governing equation describing non-isothermal groundwater flow in a saturated porous medium was as follows:

$$T(\Delta v) + (\delta T / \delta t) \sigma = \alpha_t \Delta^2 T + q_t / (\rho C_p)_f \quad (10)$$

$$(\rho C_p)_t = \psi (\rho C_p)_f + (1 - \psi) (\rho C_p)_s \quad (11)$$

Latent heat during phase changes between freezing soil and thawing soil was regarded as an inner heat source described as follows:

$$WH(\sigma_d) \delta f_s / \delta t_s = q_s \quad (12)$$

$$(\delta T / \delta t) \sigma + U_x \delta T_f / \delta x = \alpha_t \Delta^2 T + q_t / (\rho C_p)_f \quad (13)$$

Where:

$C_p$  is the specific heat ( $J kg^{-1} K^{-1}$ );  $q$  is the internal heat source ( $W m^{-3}$ ).

$W$  is the water content in soil (%);  $T$  is the temperature ( $^{\circ}C$ ).

$H$  is the condensation latent heat of water ( $J kg^{-1}$ ).

$t$  is the times (s);  $U$  is the velocity ( $ms^{-1}$ ).

$f_s$  is the solid phase ratio.

$s$  is the soil;  $f$  is the groundwater.

$\Psi$  is the porosity.

$\alpha$  is the convective heat transfer coefficient ( $W m^{-2} K^{-1}$ ).

$\delta$  is volumetric specific heat ratio.

$\rho$  is the density ( $kg m^{-3}$ ).

The experiments and calculations are conducted for unsaturated soil without groundwater flow (US), saturated soil without groundwater flow (SS) and saturated soil with groundwater flow (SSG) under same conditions and their results are compared with each other in Figures 10-12. The temperature in vertical boreholes used, as heat source for GSHPs will slowly drop with

time, the more so the more energy is extracted. This can be mitigated either by a deeper borehole (in a new installation) or a system to replenish the energy extracted from the hole (in both new and existing installations). Raising the brine temperature from -5°C to 0°C may improve the COP by 10-50% depending on the type of heat pump.

## Conclusion

The direct expansion (DX) ground source heat pump (GSHP) systems have been identified as one of the best sustainable energy technologies for space heating and cooling in residential and commercial buildings. The GSHPs for building heating and cooling are extendable to more comprehensive applications and can be combined with the ground heat exchanger in foundation piles as well as seasonal thermal energy storage from solar thermal collectors. Heat pump technology can be used for heating only, or for cooling only, or be 'reversible' and used for heating and cooling depending on the demand. Reversible heat pumps generally have lower COPs than heating only heat pumps. They will, therefore, result in higher running costs and emissions and are not recommended as an energy-efficient heating option. The GSHP system can provide 91.7% of the total heating requirement of the building and 55.3% of the domestic water-heating requirement, although only sized to meet half the design-heating load. The heat pump can operate reliably and its performance

appears to be at least as good as its specification. The system has a measured annual performance factor of 3.16. The heat pump system for domestic applications could be mounted in a cupboard under the stairs and does not reduce the useful space in the house, and there are no visible signs of the installation externally (no flue, vents, etc.).

The performance of the heat pump system could also be improved by eliminating unnecessary running of the integral distribution pump. It is estimated that reducing the running time of the pump, which currently runs virtually continuously, would increase the overall performance factor to 3.43. This would improve both the economics and the environmental performance of the system. More generally, there is still potential for improvement in the performance of heat pumps, and seasonal efficiencies for ground source heat pumps of 4.0 are being achieved. It is also likely the unit costs will fall as production volumes increase. By comparison, there is little scope to further improve the efficiency of gas- or oil-fired boilers. ■

Abdeen Mustafa Omer  
Energy Research Institute (ERI)  
Nottingham  
United Kingdom



## Shirish Adi Appointed as Vice President & Managing Director, India, for Emerson's Commercial & Residential Solutions

In his new role Shirish Adi, Vice President & Managing Director, India, for Emerson's Commercial & Residential Solutions will be responsible for the entire business and operations in the country. He will be directing and leading the organization to drive growth and profitability in line with Emerson's strategic direction and business ethics. Shirish takes over from Sridar Narayanswami who has been promoted as President, Middle East & Africa, for Emerson's Commercial & Residential Solutions. Shirish will be based at the company's India headquarters at Pune and will report to Hakan Erdamar, President, Asia and Middle East & Africa, for Emerson's Commercial & Residential Solutions.

Speaking on the occasion Hakan Erdamar said "I am delighted to announce the appointment of Shirish to this key position. It is an exciting time for us as we

continue to provide innovative products and solutions for the Heating, Ventilation, Air Conditioning and Refrigeration (HVACR) industry, additionally products for commercial & residential solutions."

Shirish Adi has over 27 years of stellar experience at Emerson progressing through various management roles from the time he joined Daniel India operations. He rose to become the General Manager/Managing Director of Daniel Measurement as well as its Entity leader. In 2013, Shirish moved as the Business Director for Rosemount in



India, with complete Profit & Loss (P&L) responsibility. Prior to joining Emerson, Shirish has worked with Advanced Spectra-Tek and DDE ORG Systems. ■

# International Ranking of Top 10 Countries for LEED

The full ranking is as follows:

Rank	Country Name	Gross Square Meters*	Number of Projects
1	China	34.62	931
2	Canada	34.39	2,586
3	India	15.90	644
4	Brazil	7.43	380
5	Republic of Korea	5.95	97
6	Taiwan	5.66	99
7	Germany	5.03	215
8	Turkey	4.78	191
9	Sweden	3.88	210
10	United Arab Emirates	3.64	180
	United States**	336.84	27,699

\*Gross square meters are reported in millions. Data reported as of December 2016.

Source: [www.usgbc.org](http://www.usgbc.org)

## Carrier China Wins Contract for Chengdu Capital and Century Mansion

Carrier China was selected to supply a series of variable refrigerant flow (VRF) units to Chengdu CapitalLand Century Mansion, a high-end residential building developed by CapitalLand Limited in Southwestern China. This latest win demonstrates Carrier China's commitment to developing high-performing, energy efficient and innovative building solutions. Carrier China, which includes Carrier Air Conditioning Sales Service (Shanghai) Co., Ltd., is a part of Carrier, a world leader in high-technology heating, air-conditioning and refrigeration solutions, a part of UTC Climate, Controls & Security, a unit of United Technologies Corp.

Chengdu CapitalLand Century Mansion is located in the central area of Chengdu Hi-Tech Industrial Development Zone and will house approximately 2,000 apartments once completed in 2018. Carrier's mini VRF products fit perfectly with CapitalLand's demands to minimize the environmental impact of its cooling solutions and offer a superior living experience by providing units that are reliable, high-efficiency and ultra-low noise. The VRF units



have an Integrated Part Load Value (IPLV) of 6.2, which is 70% higher than the national energy efficiency standard.

"Our VRF portfolio has proven its quality and performance in a range of demanding applications in key segments from large shopping malls to upscale residential buildings. More importantly, its remarkable energy efficiency makes it a great environmentally responsible choice for our customers," said Yinghua

Zhu, light commercial sales director, Carrier China.

As one of Asia's largest real estate companies headquartered and listed in Singapore, CapitalLand Limited covers a wide spectrum of expertise comprising integrated developments, shopping malls, serviced residences, offices, homes, real estate investment trusts and funds. For its efforts in sustainability, CapitalLand was listed in the Global 100 Most Sustainable Corporations in the World 2015, Sustainability Yearbook 2015, Dow Jones Sustainability World Index and Dow Jones Sustainability Asia Pacific Index. ■



## Dwyer SMART Air Hood Balancing Instrument

The Series SAH SMART Air Hood Balancing Instrument is the most accurate and easy to operate air hood flow available in the market. By using the included hood stand and wireless communications to the



handheld, a single operator can balance a branch in less time than traditional balancing teams. Besides being lighter than most traditional capture hood, the ergonomic design makes the Series SAH easy to manoeuvre with less physical stress.

The rugged polypropylene base hood features patented Quad Flow Design Technology for controlling air flow and minimizing back pressure which yields superior measurement accuracy. The Wi-Fi direct communications gives reliable communication with a distance of up to 200 yards between the hood and the handheld test instrument.

The SMART hood balancing instrument includes the PredictAir Application Software which reduces the number of steps in the air flow balancing process using Predictive Balancing's Express Balance mode. Predictive balancing is a method of predicting the optimal flow set point for each register and the other in which they should be adjusted.

### Features/Benefits

Patent pending Quad Flow Design Technology directs the circulating air patterns to provide a more even air flow that minimizes backpressure enabling accurate readings.

Predictive balancing is a process that

guides the balancing technician on setting the optimal flow set point for each sequential terminal. With the PredictAir Application Software, the balancing process takes much less time than traditional air balancing methods.

The ergonomic design is much lighter and easier to work with than the existing bulky air hoods, providing better manoeuvrability and less physical strain. One technician can complete the air balancing.

Wi-Fi directs wireless communication provides a range up to 200 yards.

### Application

Commissioning, testing, adjusting and balancing volumetric air flow from diffusers, grilles and registers in HVAC systems.

ALM Engineering and Instrumentation Pvt Ltd is a brand ambassador for Smart Hood in India. ■

Email: [info@alмонтazar.com](mailto:info@alмонтazar.com)

## Solar Roofing System from CertainTeed

The Apollo II system is the pinnacle of roof-integrated energy production using high-efficiency monocrystalline silicon solar cells to capture the most energy per square foot of any solar shingle. Apollo II also functions as your roof, generating clean power while protecting your home from water intrusion.

### Features & Benefits

The Apollo II system is a versatile solution for power and aesthetics when installed directly on a new or existing asphalt shingle roof.

**Beauty:** An all-black solar shingle with a low profile visually blends into your roof and provides a clean look which a standard rack-mounted system

cannot match.

**Efficiency:** 14 high-efficiency monocrystalline silicon solar cells provide a power rating of 60 watts per solar shingle.

**Simplicity:** No need to find rafters. Apollo II solar shingles are installed directly



into the roof sheathing using standard deck screws.

**Lightweight:** No need for structural reinforcements or analysis. The Apollo II system weighs about as many pounds per

square foot as a typical asphalt shingle.

**Durable:** Even though Apollo II shingles are lightweight, they are designed to be strong. The solar shingles have been tested and rated to withstand 250 pounds per square foot.

**Wind resistant:** The Apollo II system achieves the highest wind rating available for roofing materials and can be installed in wind zones of up to 150 miles per hour.

**Watertight:** Water channels and raised fastener locations provide added protection against water intrusion. With over 110 years in the roofing industry, you can be assured that CertainTeed knows how to keep water out of your home. ■

## Daikin Applied Launches Navigator Water-Cooled Screw Chiller

**D**aikin Applied has launched Navigator, a screw compressor water-cooled chiller engineered with award-winning Variable Volume Ratio (VVR) technology. Built on Daikin Applied innovation—VVR technology and water-cooled technology—Navigator gives you the power of efficiencies that meet or exceed ASHRAE 90.1-2016 levels and IPLV as low as 0.36. Navigator's single VFD-driven screw compressor brings new levels of performance to applications that aren't suited to traditional centrifugal chillers or magnetic bearing solutions.

No two buildings are alike and no



two days serve up the same climate conditions, so engineers need technology with the flexibility and intelligence to help them design an HVAC solution optimized for any day or hour. Daikin's portfolio

addresses that customer need whether the system design calls for a water-cooled (Navigator) or air-cooled (Pathfinder) chiller.

Recognized with Frost and Sullivan's Manufacturing Leadership Award, VVR compression technology senses the precise amount of lift needed and adjusts the compression ratio on the fly to deliver optimal efficiency, regardless of ambient temperature or time of day. With VVR technology, customers don't pay for over-compression, and get exactly the lift needed. ■

## Air-Conditioning Unit from Trane

**D**esigned to fit space constrained areas, the XR16 Low Profile, side discharge home air conditioning unit gives the reliability you expect from Trane and the energy efficiency.

Every Trane home air conditioning system is packed with high-quality components. Each helps ensure that time after time, your unit will provide total comfort your family can rely on. The XR16 Low Profile includes:

- Small footprint for tight spaces
- Climatuff Compressor
- Duratuff Plate Fin coil
- Weatherguard Zinc Coated Fasteners

- Integrated fan system with leading edge swept blade design
- Super Durable Power-Paint finish
- Assembled in U.S.A.
- Efficient performance

The XR16 Low Profile home air conditioning system has a SEER rating of up to 17.00, making it an excellent choice for home comfort and for earning energy-efficiency tax credits.

### Unique Design

Designed with limited space in mind, the XR16 Low Profile home air conditioner



will meet the needs of difficult-to-install or tight space required homes such as zero lot line, condos, or under decks.

**Cleaner, healthier indoor air**

Add Trane CleanEffects™ to air conditioning system for advanced air filtration that removes more dust, pollen and other irritants from conditioned air for a cleaner, healthier, more comfortable home. ■

For more info: [www.trane.com](http://www.trane.com)

## Explosion Proof Portacool Portable Evaporative Cooler

**T**he EPF-AC-30-GLVD Class I Division 1 Portable Evaporative Cooling System is rated for use in hazardous location work environments. This explosion proof galvanized air chiller combines a non-sparking fan and dry mist technology to cool Class I Division 1 work areas that do not have access to traditional air conditioning. This portable cooling is equipped with a



34 gallon tank and 2 separate water filters to cool the work environment for up to 8 hours.

This Larson Electronics evaporative cooling unit is rated Class I Division 1 & 2, Group D and Class II Divisions 1 & 2, Groups E, F & G explosion proof environments. At 36" wide by 39" deep by 66" tall, this evaporative cooling unit can reach an evaporation zone of 5'-10'. With a 30" inch fan and eight spray nozzles, this unit is

applicable to work areas with smaller access ways. This portable cooling system will automatically shut off once the water reservoir is empty, so operators don't need to worry about burning out the pumps. The EPF-AC-30-GLVD has an ambient temperature rating of 10° to 40°C. With a fan unit running at 8723 RPM, this galvanized portable misting unit can chill down any industrial or commercial space in need of a cool down. ■

For more info: [www.trane.com](http://www.trane.com)

# Forthcoming Events At A Glance

## All India Cold Chain Seminar 2017

**Venue:** Hotel Clark Shiraj, Agra  
**Date:** 5<sup>th</sup> to 7<sup>th</sup> July 2017  
**Website:** www.fcaoi.org

## DairyTech India 2017

**Venue:** BIEC, Bengaluru  
**Date:** 2<sup>th</sup> to 30<sup>th</sup> August 2017  
**Website:** www.dairytechindia.in

## FoodPro 2017

**Venue:** Chennai Trade Centre, Chennai  
**Date:** 7<sup>th</sup> to 9<sup>th</sup> September 2017  
**Website:** www.ciifoodpro.in

## India Cold Chain Show 2017

**Venue:** Bombay Exhibition Centre, Goregaon, Mumbai  
**Date:** 12<sup>th</sup> to 14<sup>th</sup> December 2017  
**Website:** www.indiacoldchainshow.com

## 2018 AHR Expo

**Venue:** Chicago  
**Date:** 22<sup>nd</sup> to 24<sup>th</sup> January 2018  
**Website:** ashrae.org/AHRExpo2018

## ACREX 2018

**Venue:** BIEC, Bengaluru  
**Date:** 22<sup>nd</sup> to 24<sup>th</sup> February 2018  
**Website:** www.acrex.in

If you feel that the industry need to know your experiences and that will help conserve a lot of efforts and time, its time you write us and our team will guide you on the various topics we cover in each and every issue.

**Think no further just e-mail your interest to [editorial@charypublications.in](mailto:editorial@charypublications.in)**

We would love your involvement in your favourite magazine!



Cooling India invites HVACR professionals and industry experts to write articles on their area of expertise and interest.

## index to advertisers

Company Name	Page No.
Air Master Fire Safety Equipments	11
ALM Engineering & Instrumentation Pvt. Ltd.	IFC
Calpeda Pumps India Pvt. Ltd.	19
DairyTech India 2017	37
Embraco	25
Emerson Electric Co. (India) Pvt. Ltd.	21
Bangkok RHVAC 2017 and Bangkok E&E 2017	7
GAPS Engineering & Consultancy	15
Hira Technologies Pvt. Ltd.	9
Lubi Industries Llp	3
Mist Resonance Engineering Pvt. Ltd.	5
Russ Air	33
Siemens	BC
Schaefer Systems International Pvt. Ltd.	17
Success Forever	IBC
Trane - Ingersoll -Rand International (India) Ltd.	13



## One Airport Square with Natural Ventilation

One Airport Square is a world-class development situated in Accra's newest commercial and retail area. The building comprises nine floors of office space and 2,000 sq m of retail space. This ultra-modern, eco-friendly building is Ghana's most advanced development. It will be the first green commercial building in West Africa.

### Design Features of the building are:

- First environmentally certified commercial building in Ghana
- Target Four Green Star Environmental certification
- Between 30-40 % reductions in energy use
- Use of natural light and natural ventilation
- Sun pattern driven building orientation to minimize solar exposure and energy requirements for cooling
- Automatic presence detectors and high efficiency lighting
- Overhangs optimized to provide shading from intensive solar

radiation, reducing energy requirements for cooling

- High level of indoor air quality via increased ventilation rates
- Heat recovery through the centralized fresh air supply system

A high performance façade combined with an efficient system of cooling ensures that the design parameters are achieved and that comfort maintained with efficient use of energy. ■



## New Energy-Efficient San Diego Central Courthouse

The new San Diego Central Courthouse will officially open for business on July 17. Located at 1100 Union Street, the 704,000 square-foot courthouse includes 71 courtrooms and is energy efficient. Designed to achieve LEED Silver Certification by the US Green Building Council, the building uses natural sunlight to optimize interior day-lighting. It will consume approximately 15% less energy than a code-minimum facility.

Other sustainability features include water-saving fixtures, energy-efficient lighting, drought-tolerant plants, and drip irrigation. The building is



funded from fines and fees, not from taxpayers. It is ranked as a critical need in the judicial branch's capital-outlay plan; the \$555.5 million project was funded by Senate Bill 1407, enacted in 2008 to provide bond funding for new and renovated courthouses using court fees, penalties, and assessments rather than taxpayer revenues from the state's General Fund.

The project also underwent cost reduction now required of all SB 1407 projects, with \$78.4 million or 13% pared from the project's total cost. ■

## Eco-friendly Plastic Bottle Building in Taipei

The amazing EcoARK in Taipei, Taiwan is one fantastic example of plastic bottle architecture. Built from 1.5 million recycled plastic bottles, this massive pavilion is surprisingly strong enough to withstand the forces of nature—including fires and earthquakes. The building designed by architect Arthur Huang is powered by solar energy and was built to the mantra of 'Reduce, Reuse, and Recycle.'

Use of recycled plastic bottles isn't the only eco-friendly feature of the EcoARK. The pavilion was



built with low-carbon building techniques to maintain a zero-carbon footprint during operation. The building stays cool without air conditioning thanks to natural ventilation. The air inside the polli-bricks also provides insulation from heat and rainwater is collected and reused to cool the building. The polli-bricks' transparency allows natural light to illuminate the interior during the day. Solar- and wind-powered systems generate the electricity needed to power 40,000

LEDs that light the building up at night. ■

# LIVING THE LAWS OF LEADERSHIP WORKSHOP

Live Out the Laws of Leadership  
for Maximum Improvement,  
Influence and Impact

## *Live (and Lead) With Purpose!*

Based on John C. Maxwell's book, *The 21 Irrefutable Laws of Leadership*, this workshop will provide you with the practical tools you need to address the leadership challenges you encounter daily within your profession. During this two-day immersive workshop, you will:

- » Understand the four leadership disciplines and behaviors.
- » Assess your leadership strengths and weaknesses.
- » Develop and practice the behaviors required to effectively lead yourself and others.
- » Identify ways to incorporate and apply the laws in your daily life.



September 25 - 26, 2017  
(Full Day - 8 am to 6 pm)  
Venue: Toronto, Canada

Phone 416-473-5243 • Email: [info@successforever.ca](mailto:info@successforever.ca)  
[www.successforever.ca](http://www.successforever.ca)

## TWO-DAY WORKSHOP SCHEDULE

### DAY 1

#### Session 1: Welcome

Focus: Welcome/Introduction

#### Session 2: I'm a Guide

Focus: Influence, Respect, Process

#### Session 3: I'm a Partner

Focus: Solid Ground, Buy-In, Connection

### DAY 2

#### Session 4: I'm a Results Champion

Focus: Momentum, Priorities, Law of the Lid

#### Session 5: I'm a Leader Maker

Focus: Equipping, Replication, Inner Circle

#### Session 6: Wrap Up

Focus: Creating a Leadership Legacy

Upon completion of this training, participants will have the knowledge and skills to effectively use the Maxwell Method of Leadership to cultivate daily leadership habits.



**US\$1997.00**

**Early Bird Pricing**

**US\$1,597.00**

**before July 15, 2017**

Includes Hotel, Breakfast, Lunch  
and Dinner on both days.



**SIEMENS**

*Ingenuity for life*



## SINAMICS V20 Smart Access

from commissioning to maintenance –  
quite simply at your fingertips

Wirelessly connect your mobile device to your converter using the SINAMICS V20 Smart Access web server module. With the Wi-Fi connection, your mobile device is transformed into a virtual operator panel, which makes it even simpler to operate your SINAMICS V20 – from commissioning through operation and diagnostics up to maintenance. The module is set up in just a few steps – and you don't have to download or install special software. Your HTML5-capable standard web browser is sufficient. Make a smart move, and simply access your SINAMICS V20!

For more information call us on 1800 209 1800

[siemens.com/sinamics-v20](http://siemens.com/sinamics-v20)