

# Energy Efficient & Eco -friendly Cooling Technologies

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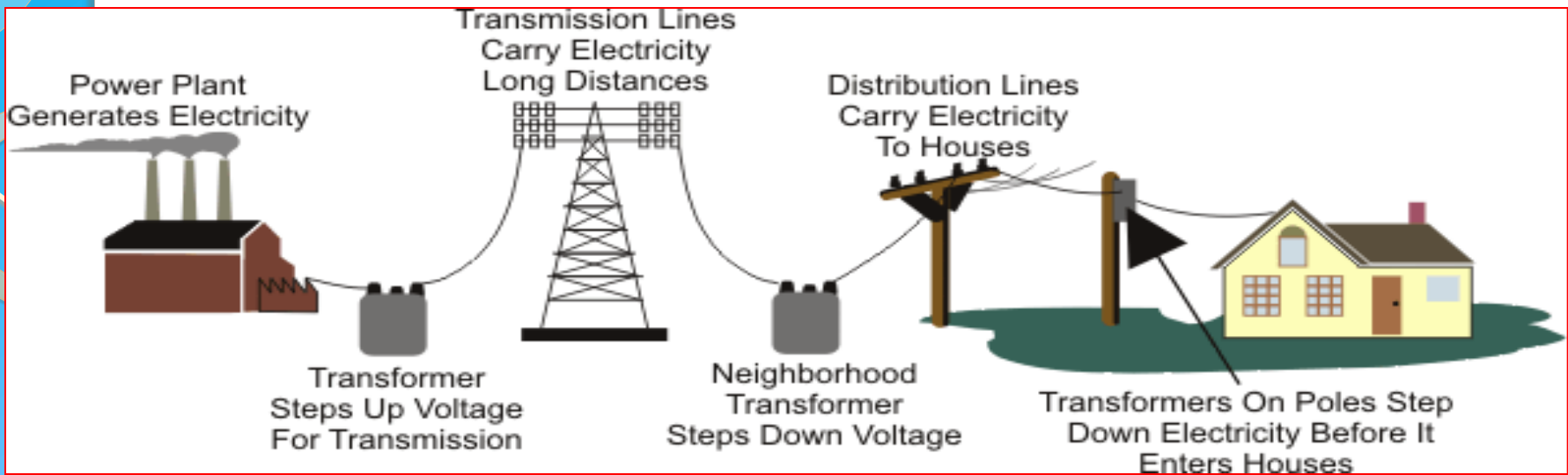
Bangalore 560 092

# Objective

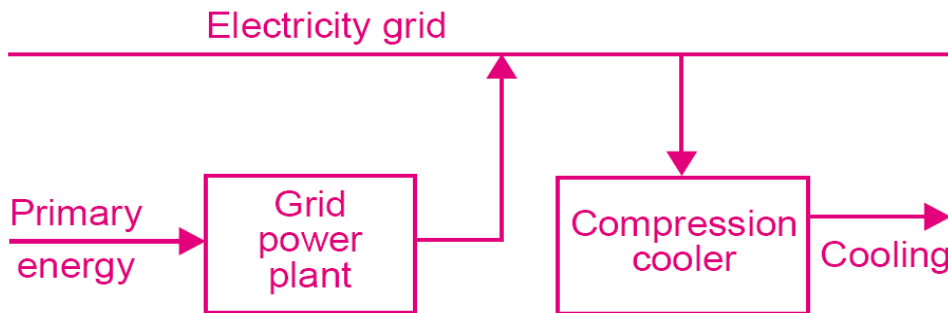
- The objective of this document is to share a few thoughts on...
  - ❖ Connect between HVAC – Environment – Energy
  - ❖ Indian perspective
  - ❖ Product & Technologies
    - ❖ Energy and Environment friendly technologies
      - Non CFC technologies
        - Indirect evaporative cooling
        - Newer technologies
        - Hybrid air conditioners
      - Solar Thermal Technologies
      - Other technologies –contemporary developments
  - ❖ Design Optimization
    - ❖ Approach
    - ❖ Opportunities
- Each is addressed in the following sections

# HVAC.. Environment.. Energy

- We do not have to go very far to link HVAC and Energy
  - ❖ Organizations spend between 40 to 70% of the total building energy costs in HVAC
- As regards environment, there is both direct and indirect impact
  - ❖ Direct – in terms of CFC, ODP
  - ❖ Indirect – total energy, GWP of power generation, Carbon emissions etc.,
- How can we go about this??
  - ❖ To have a meaningful discussion, we need to go back to the core issue that HVAC industry caters to.... 'thermal comfort'



### Electrical compression cooling system



- Power plant loss : 70 %
- Generator Loss : 5 %
- T & D Loss : 30 %
- End Equipment loss: 10 %

25 kWh – 7.5 kWh --- 6.75 kWh --- 4.75 kWh – 4.25 kWh

**Source – Site Factor : 0.17**

**Dr. Saravanan AU**

## Water requirement in power generation

- Thermal power station - 140 LP/kWh
- Atomic power station - 210 LP/kWh

Source: Environment Canada, 2008, [online]

<[http://www.ec.gc.ca/WATER/en/manage/use/e\\_therm.htm](http://www.ec.gc.ca/WATER/en/manage/use/e_therm.htm)>

# About Refrigerants

**15%**

- of world's primary energy generated is consumed by HVAC Equipment used in buildings

**30,000**

km drive of 2lt engine car emissions equivalent to 1 kg R404A refrigerant leakage

# Standards...

- ASHRAE 55 / ISO 7730 are the reference standards for design
- These standards are based on static model
  - ❖ “One size fits all” approach
- Thermally bored syndrome
- These do not take cognizance of ‘thermal adaptation’ by the occupants.
  - ❖ Adaptation due to various factors
    - Profile
    - Occupational
    - Personal
    - Other reasons
- Currently there is a lot of deliberation on need to address a dynamic model for thermal comfort

# Adaptive comfort

This has brought a new paradigm in inside design conditions.

ASHRAE 55 -2010 has a specific mention about ACS

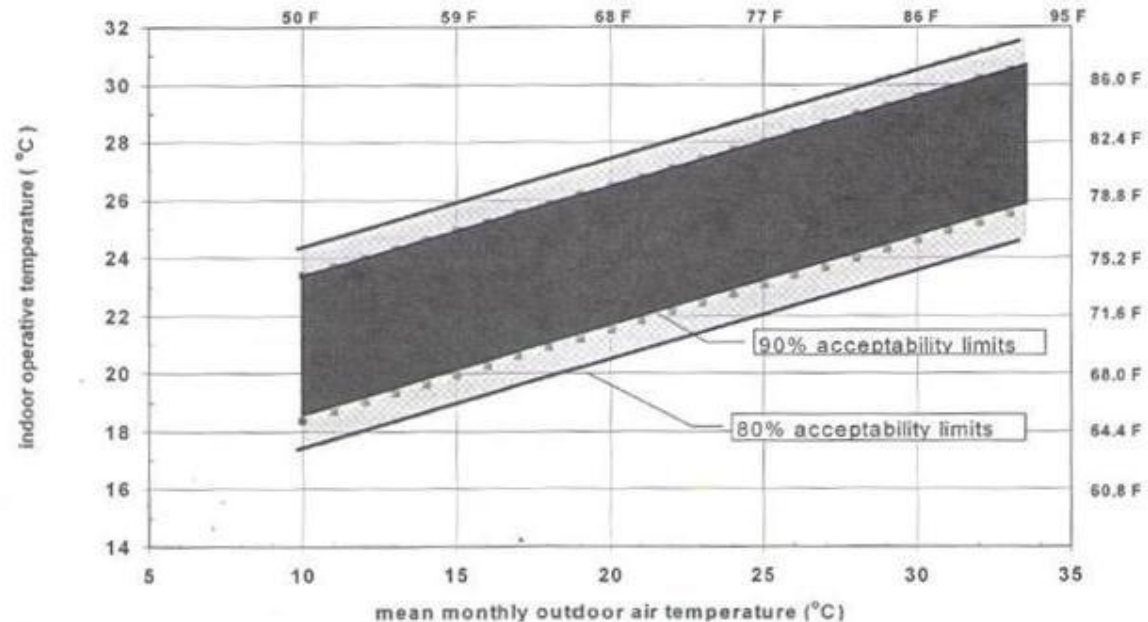
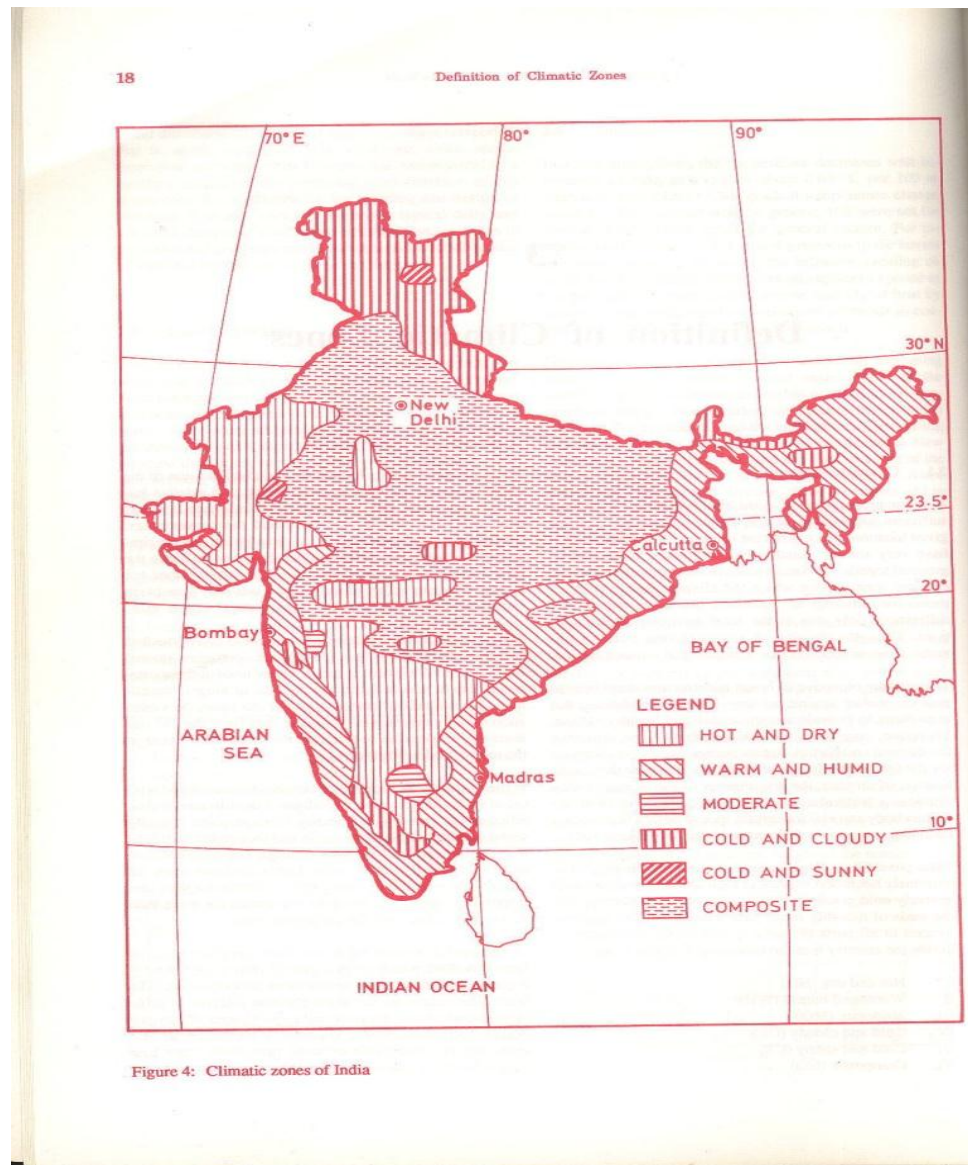


Figure 5.3 Acceptable operative temperature ranges for naturally conditioned spaces.



- We can address the connect between the three by integrating:
  - ❖ Climatology
    - Ambient weather
  - ❖ Energy
    - Choice of technology
  - ❖ Indoor Environment
    - Thermal comfort



# Non compressor based cooling

- Free Cooling
- Night Ventilation
- Earth Cooling / Hydronic cooling
  - ❖ Earth air tunnel
- Geothermal
- Evaporative Cooling
  - ❖ Direct Evaporative cooling
  - ❖ Indirect Evaporative cooling
  - ❖ Two stage evaporative cooling

..... Lawrence Berkeley Lab, USA

## ■ Night Ventilation

- ❖ Night air is always cooler.
  - Bangalore in this season is about 14 to 17 deg. C
- ❖ Use this cool air to cool the thermal mass of the building.
- ❖ This will translate to about 7 to 10% energy saving advantage

## ■ Earth Air tunnel

- ❖ Earth temperature is cooler than ambient environment
- ❖ A tunnel (pipe) is laid few meters beneath ground
- ❖ Ambient air flowing through this gets cooled naturally
- ❖ Extensive writing on this subject recently

## Natural Cooling / Earth Tunnel

- CII Institute of Quality
  - Stack effect / reverse chimney / downdraft cooling
- CII – GBC
- Torrent labs
- TERI New Delhi
  - Earth Tunnel

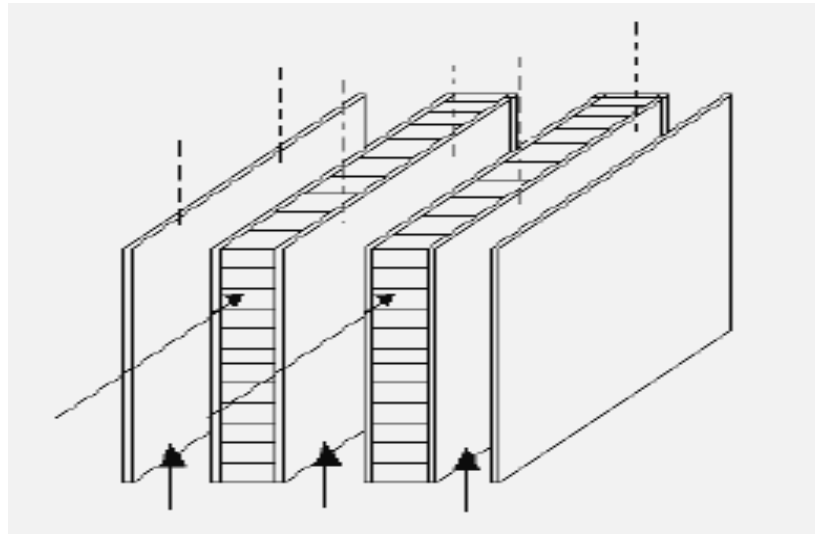
<http://bookstore.teriin.org/docs/books/booklet-%20energy%20eff%20buildings.pdf>

- Free cooling / Hydronic cooling
  - Wipro
    - Ambiator / Two stage evaporative cooling
    - Free cooling
  - Infosys
    - Hydronic cooling Hyderabad
  - Torrent laboratories
    - Passive downdraft cooling

## Indirect evaporative cooling

### Introduction:

- Achieved through an air-air heat exchanger.
- Secondary air vapourizes moisture to cool primary air
- 100 % fresh air system
- It takes less energy consumption and easy maintenance.



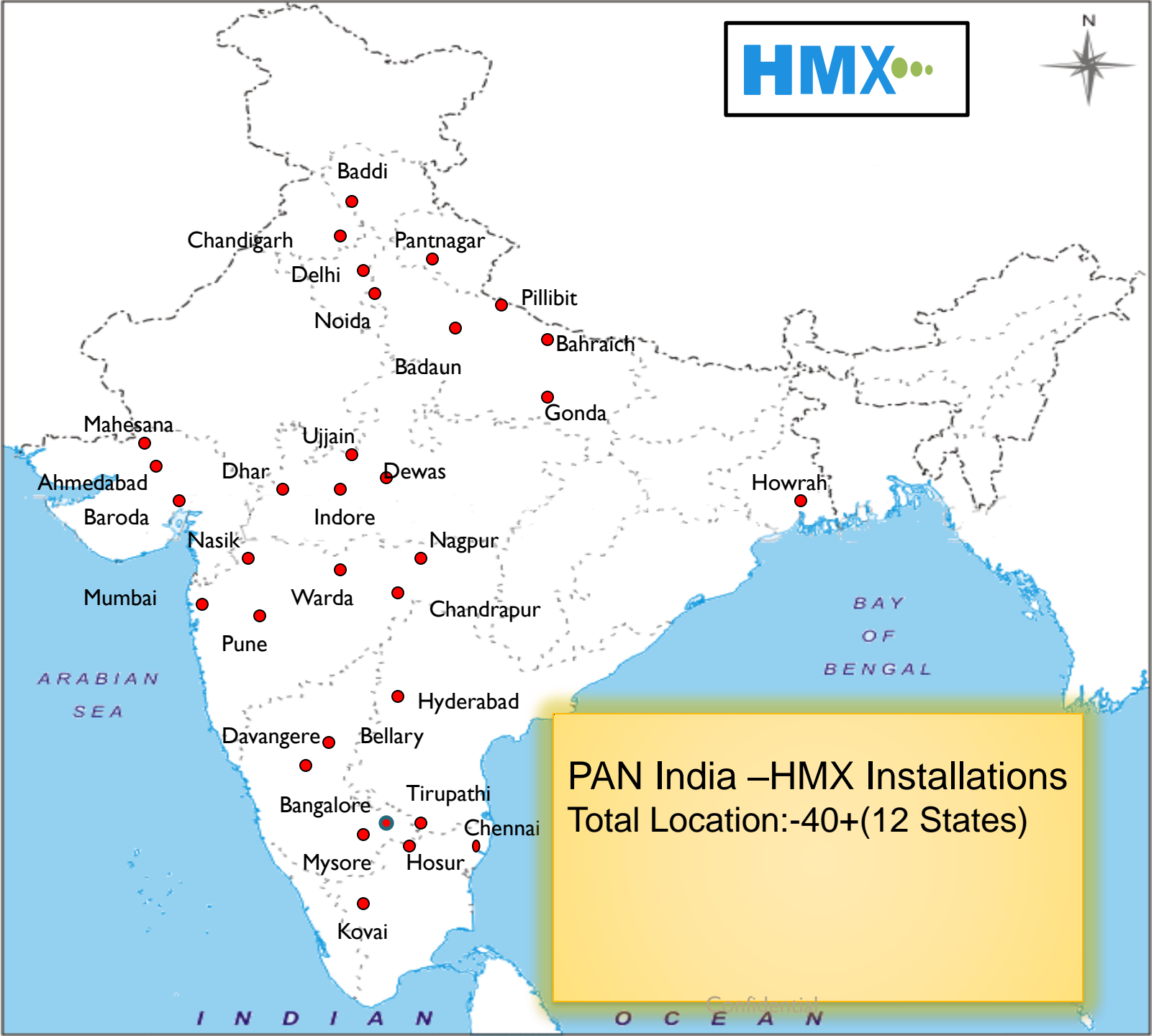
## Principle of working of IDEC / Ambiators

- Ambient air is drawn across filters (5/10/20 microns depending upon requirement) and passed through two heat exchangers:
  - ❖ **Sensible Heat Exchanger:** Air is cooled sensibly without adding any water. This works on the principle of indirect evaporative cooling of air.
  - ❖ **Adiabatic Heat Exchanger:** Air from HE I, is passed through an adiabatic heat exchanger for evaporative cooling of air. In this heat exchanger, sensible heat is converted into latent heat.



# HMX Customers





**PAN India –HMX Installations**  
**Total Location:-40+(12 States)**



## Alternatives to Vapour compression technology

- Popular technologies
  - Vapour absorption
  - Desiccant based cooling
- Hybrid solutions
  - Desiccant & evaporative cooling
  - Sensible cooling with Vapour compression cycle
  - Solar with VAM

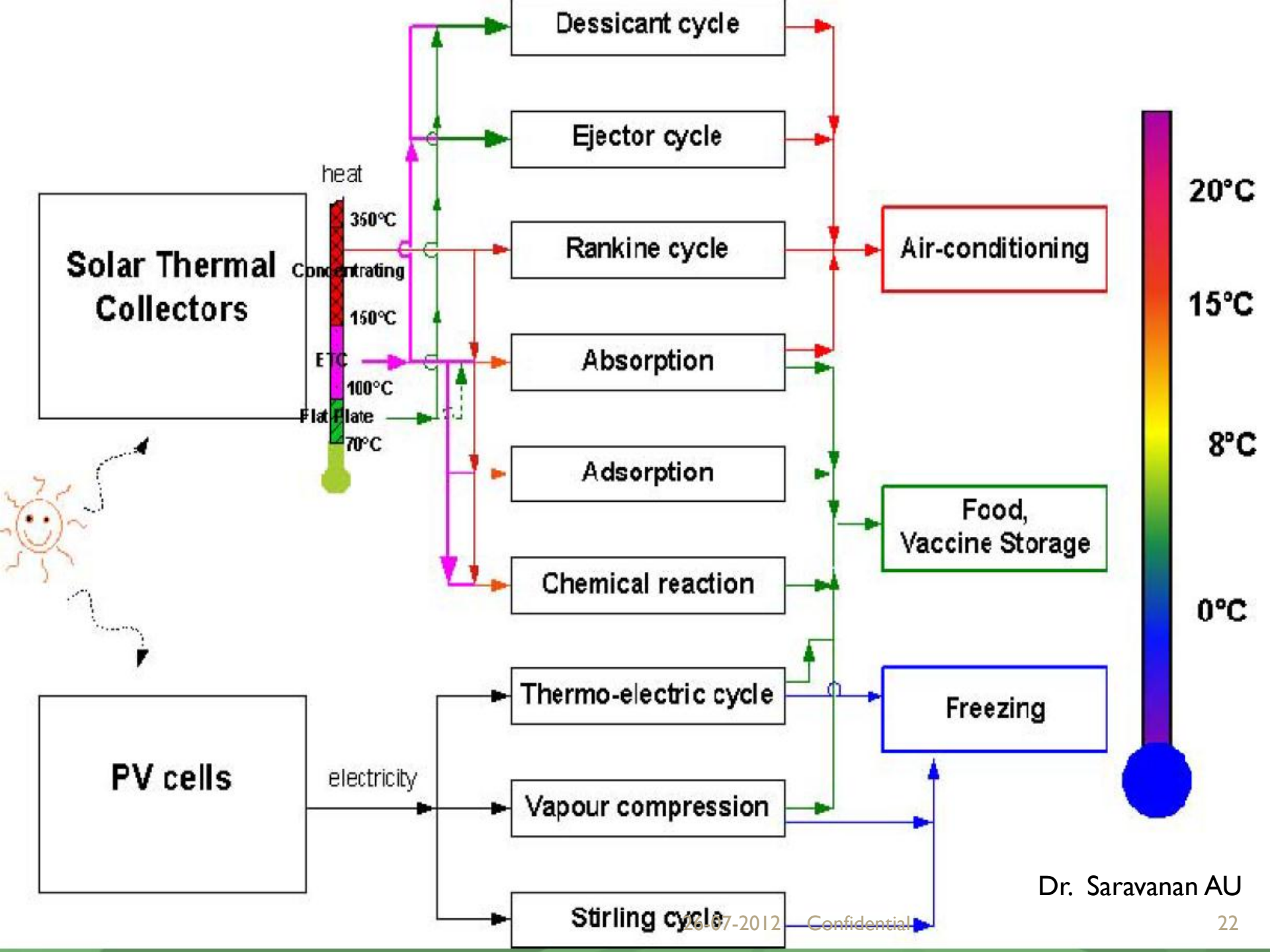
# Hybrid installations

Hybridization can be done in several ways:

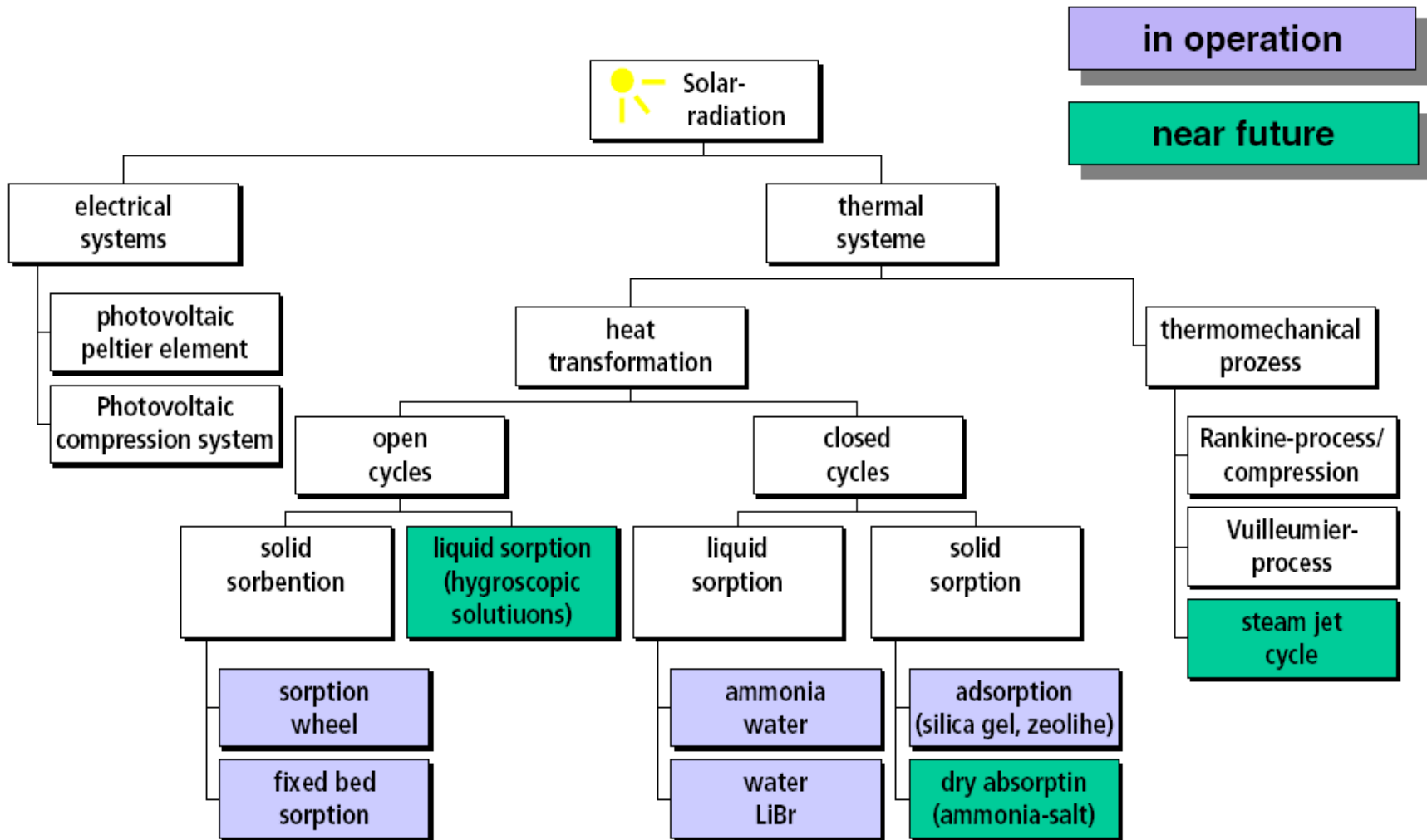
- Sensible cooling & CW / DX coil
  - ITC
  - Wipro
- Project hybridizing – combination of technologies
  - BIEC
  - DNA
  - Wipro
  - Infosys

# Solar Energy

- India receives over 5000 Tn kWh/year – more than its total annual energy requirement
- Solar energy could be harnessed for:
  - Solar heating / power generation / cooling
- In this document we will address Solar cooling



# Process - Overview



## Other technologies (PNNL – DOE)

Technology	Theroretical Max. Carnot eff / Achieved	Prospects for competing with Vapour compression	Status
Thermoelectric	30% / 15%	Fair	Many players
Thermionic	30% / < 10%	Poor	Few players (experimental)
Thermo-tunneling	80% / -	Average	Few players (experimental)
Thermo-acoustic	100% / 20%	Good	Many players
Magetic	60% / 20%	Good	Many players



# Design Optimization

- Product developments have been led by OECD countries
  - Design standards as per respective country requirements or industry standards
  - Guided by local conditions
- Attempt to have “a standard” for the world
  - Manufacture
  - Use
  - Post Sales Service

# “A Standard”

- ‘A Standard’ – has a one size fits all approach
- This “A Standard” - Universal designs become redundant. The trends are:
  - Localization /Globalization
    - Most visible in FMCG
      - McDonalds / Frito lays
    - Consumer Durables / Capital goods
      - Wet grinders / geysers
      - TV’s / Refrigerators
  - Radical new approach / design
    - Motorbikes

# Design optimization

- Tropicalizing / customization presents unique opportunities
  - New design
    - Grounds up approach
    - Customize
  - Re-design
    - Integrate contemporary development
    - Tropicalize
- Design optimization invariably results in an energy efficient and eco friendly product design, as it is a 'tailor made fit'

# About us....

- A Specialized boutique firm
  - Innovative product design
  - Sustainable business practices
- Innovative product designs:
  - New designs
  - Product re-design / retrofits
- Few cases:
  - A 60 Bn US MNC – new design, patent applied for
  - Food & equipment design customization for India

## Contact details

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