

# SPACE HEATING AND COOLING

**A.M. NARAYANAN**

24, March 2010

**Energy Management Center**  
Department of Power, Government of Kerala  
Thiruvananthapuram, INDIA



# Structure and objective

- Space Heating
- Efficient options- relevant to Afghanistan
  
- Space cooling
- Efficient option – relevant to Afghanistan
  
- Solar Passive Architecture options for space heating

# SPACE HEATING AND COOLING

## Heating Systems

- most homes use either a furnace or a boiler
- other approaches range from:-
  - wood stoves to active solar heating systems.

## Cooling Systems

- ➡ Cooling home (space) can be as simple as opening a window or
- ➡ as complex as using a central air conditioning unit
- ➡ A wide variety of cooling technologies are available.

## Heat Pump Systems

- provide both heating and cooling
- offer the benefit of delivering more useful energy than they consume.

## Supporting Equipment for Heating and Cooling Systems

- Thermostats and ducts provide opportunities for saving energy.
- Dehumidifying heat pipes allow central air conditioners and heat pumps to deliver drier air.
- Electric and gas meters allow to track your energy use closely.

# District heating

- distributing heat generated in a **centralized location** for residential and commercial heating requirements such as space heating and water heating.
- District heating plants can provide **higher efficiencies** and **better pollution control** than localized boilers.

# Afghanistan

- ❑ very cold, snowy winters

Intense cold (from  $-24^{\circ}\text{C}$  to  $8^{\circ}\text{C}$ ) can last several days during winter

- ❑ dry, hot summer; temperature

exceedingly high especially in the Oxus regions

*[boundary between Afghanistan and eastern Turkistan]* (from  $45^{\circ}\text{C}$  to  $50^{\circ}\text{C}$ )

# "Badakshan" region in the Himalayas

- remote high mountain region, old traditionally built houses have an open hole in the roof, allowing smoke from the central cooking fire to escape. The roof and walls are inevitably blackened with soot. As soon as the fire has died down, cold air, snow and rain once more seep into the room.
- heat generated from the cooking pit in the central room is retained, keeping the floor and room warm.
- During the long winters in such high altitude areas (2000 - 4000 m), family members usually live in the same room, preferably in the smallest, to economize firewood.

## Cooking and room heating



Once the meal has been cooked and the bread baked, the **heated fire pit** and remaining provide sufficient heat to warm kettles of water and everyone's legs as well. The family spends many hours in this position **to relish the remaining heat**

- massive amount of firewood required to heat the fire pits to baking temperature contributes to **alarming rate of deforestation, vegetation loss and desertification.**
- High population growth, combined with overgrazing, further **aggravates** the situation
- These issues **have been recognized** by a number of international development organizations.

# Firewood

- used simultaneously for cooking and room heating purposes
- In winter, the fire burns for many hours and cooking time **is not based on time efficiency**; hence slow-cooking dishes are common
- **When a house is well insulated, the room will quickly warm up and retain the heat, thereby eliminating the need for keeping the fire burning for long hours.** Cooking periods can then be shorter, thus traditional dishes need to be adjusted for fast preparation (less than an hour).

# Improved cooking stoves (ICS) and thermal insulation

- ↗ The correlation between the above needs to be emphasized.
- ↗ An ICS such as the Rocket model emits little heat into the room and a chimney or hood is required to evacuate the smoke
- ↗ People will not use such a stove for cooking during the winter because it does not provide sufficient room heating and consequently go back to using their **traditional cooking equipment**.
- ↗ **With room insulation, the ICS can be used all year round, but cooking methods must be adjusted. One option is the use of pressure cookers.**

For the situation in Afghanistan mountain areas, discuss the following **energy saving** sequence:

(1) **Thermal insulation of houses:** 50% less space heating required.

(2) **Improved cooking stoves:** 40% less firewood used (of the remaining amount).

(3) **Changing cooking methods:** 30% less firewood used.

(4) **Use of solar energy** (direct sunshine) for room heating, water heating and cooking: 20% less firewood used

# thermal insulation

- ✦ many and new materials in the market reducing the thickness and installation cost.
- ✦ Attention to ventilation and humidity control.
- ✦ Post-fitting of roofs and walls with thermal insulation must assure it does not affect their strength or earthquake resistance.
- ✦ **Local expertise** needs to be developed in these matters.
- ✦ One of the biggest benefits of thermal insulation is **increased comfort in the house and eventually better health for the occupants.**

# floor cooking pits



- ▀ firewood efficient methods, such as a metal or chimney stove.
- ▀ some of the solutions do already exist in the region.
- ▀ The metal stove pictured left, found in neighboring Tajikistan, bakes three pizza-size breads simultaneously.
- ▀ to turn the breads several times to avoid burn on one side.
- ▀ Lower size bread(about 30 cm)
- ▀ Improving this metal oven design is an option, but the.

## chimney bread oven

❑ more firewood efficient than the metal box oven

❑ Here waste heat from the very large chimney is used, being conducted through a double-walled box.

❑ The bread is maximum 30 cm in diameter and thicker than the traditional *naan flatbread*. The house owner confirmed that she **could only use this type of oven with her insulated house**



# fire pit in a shed outside

- richer families do so to avoid smoke inside the house.
- This use enormous amount of firewood, and radiating heat is not being utilized to warm the house in the winter.
- these families were using between 10 and 14 tonnes of firewood per season, while a third of the biomass needed to be bought because their farms were not large enough.
- they shall consider thermal insulation and ICS

# The traditional domestic heating system of Afghanistan

■ three popular heating methods throughout the country: *(mainly developed from the availability of fuel and construction materials)*

**Tabakhana** : under-floor heating system with hot air being connected through a series of subfloor channels.

**Sandali**: a low table covered by a large blanket and with a container of charcoal fire underneath.

**Stove**: made of black iron.

# Wood stoves are for space heating

A wood stove is defined as a space heater and space heaters are intended to heat a space directly, unlike a central heating furnace, which supplies its heat to the house through a system of ducts.

- ❖ If you want to heat most or all of your house with a wood stove, try to meet these FIVE objectives:
  - ✚ the heater should be located in the area where the family spends most of its time.
  - ✚ there should be ways for the heat to flow to other parts of the house.
  - ✚ Indoor air quality
  - ✚ Energy Efficiency of the Stove
  - ✚ Room insulation.

# Solar powered air-conditioning systems

- Solar home space cooling systems
- part of Thermally Activated Cooling Systems (TACS)
- environmentally-friendly technique with a promising future.

# Technologies available for solar-driven cooling

- 1) advanced absorption systems
- 2) desiccant cooling systems.

# Solar absorption technology

- Absorption technology demands high temperatures and collectors capable of producing them
- evacuated-tube and concentrating type solar collectors
- energy from these solar collectors is used to separate a tank liquid mixture that includes an
- absorbent (lithium bromide salt, for instance) and a refrigerant fluid (often the water).
- The refrigerant (water vapor) is then condensed and eventually evaporated to produce the desired cooling effect.

# Solar desiccant technology

- ▶ Solar desiccant technologies use desiccants - substances like silica gel, calcium sulfate, etc. to absorb the air humidity and to cool it.
- ▶ Desiccants are commonly solids, but may also be liquids. Both technologies are very similar in their implementation.
- ▶ In the case of the solid desiccant system, as the air passes through the desiccant (usually located on a wheel rotating into the air stream going into the rooms) the moisture is removed from the air, causing the humidity level and the temperature of the air to drop.
- ▶ At the same time the thermal energy from the solar collectors is used to dry the desiccant, driving off the absorbed water (as it rotates out of the air stream).

# district cooling

- ❖ defined as centralized production and distribution of cooling energy from the cooling plant to the industrial, commercial and residential buildings to cool the indoor climate.
- ❖ District cooling substations are used in the process of distributing cooling energy into buildings.
  - Energy efficient solution
  - Reduced air pollution
  - Decreased emissions of ozone-depleting refrigerants
  - Combats global warming
  - Easy and comfortable for the end-user

U.S. Army Natick Research, Development and Engineering Center (NRDEC) solar Radiation Tests on special Shielding.

Several of these covers (tarpaulins) were very effective at reducing the effects of solar radiation and temperature

### Published information

improve energy performance of shelters in several ways. First, by protecting the shelter against the extreme environmental conditions, the heating and cooling costs can be lowered. Natick is working with industry to develop solar covers constructed from highly porous fabric, which block the harsh solar loading found in the desert and provide good air flow, reduce heat buildup and allow wind penetration. Shelters can also be augmented with a series of internal liners that reduce the HVAC requirements.

# BIOCLIMATIC designs

- “for public buildings (schools and clinics), including SOLAR ARCHITECTURE and THERMAL INSULATION in order to reduce fuel consumption *in clinics* by about 60% and improve teaching conditions in schools”
- “Solar Architecture has the double advantage of maximizing sun penetration during winter while at the same time limiting it during summer.”

# SOLAR ARCHITECTURE

- ❖ **Large South face with large windows to collect sun energy during winter.**
- ❖ **The South face is in fact tilted  $15^\circ$  towards the East to benefit of the sun energy early in the morning.**
- ❖ **On the North side windows are smaller while providing sufficient day light.**
- ❖ **Very limited East and West windows to avoid overheating during summer.**
- ❖ **50 cm roof overhang to create shading during summer on the South face.**
- ❖ **In very cold areas, this roof overhang is limited to 30 cm only.**

# materials for insulation

❑ various materials for insulation of roof and wall, such as expanded polystyrene (EPS), glass fiber, straw and saw dust.

❑ EPS proved so far to be the best choice regarding cost, water resistance, thermal performances, quality and ease of installation.



**Save Energy Save our Planet**



*Thank You!*