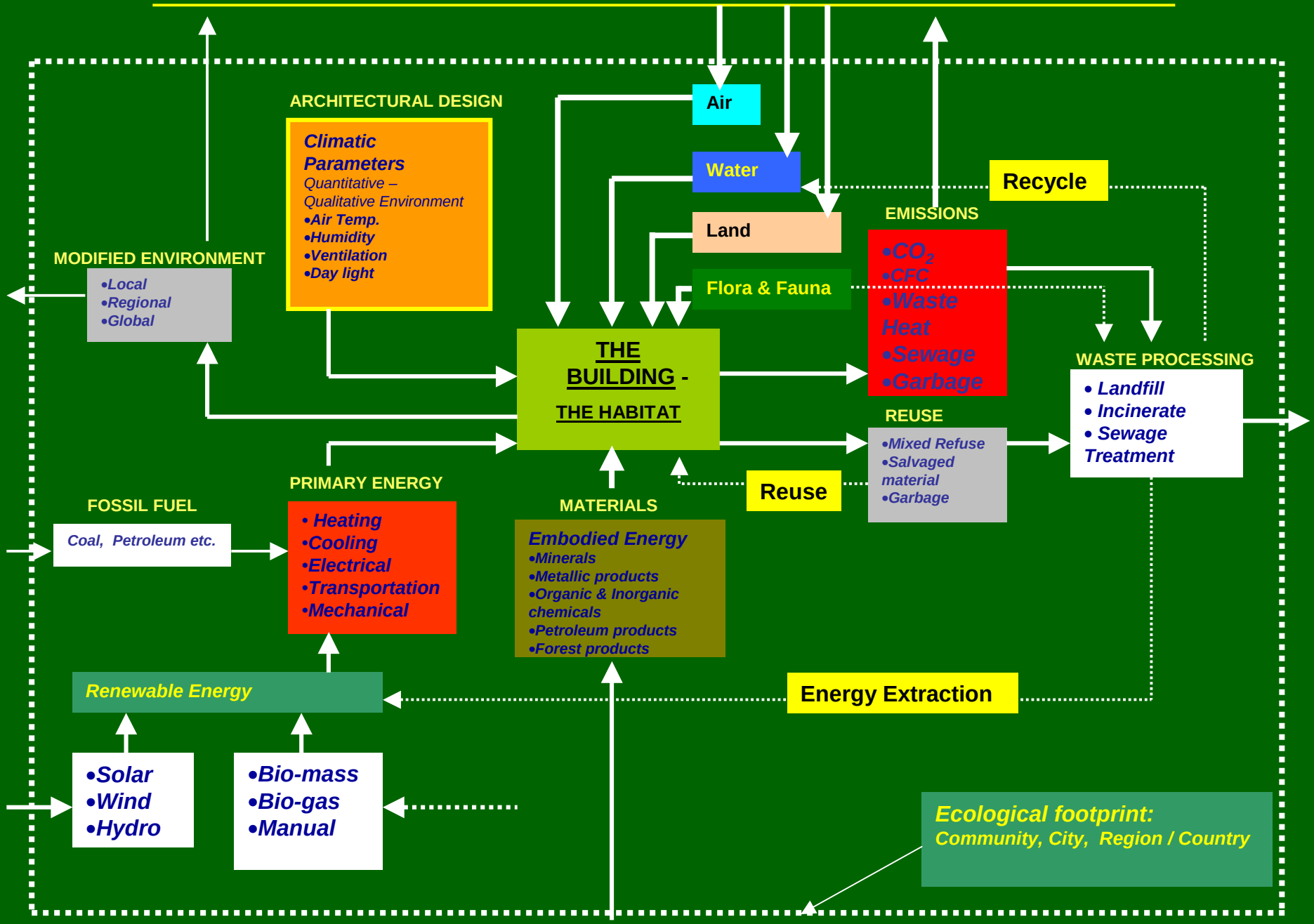
A NEW LANGUAGE OF ARCHITECTURE

IN QUEST FOR SUSTAINABLE FUTURE

PRESENTED BY

Prof. Dr. Arvind Krishan

ENERGY - RESOURCE FLOW ECOLOGICAL FOOTPRINT: MODEL



PARAMETERS FOR ENERGY 'E' OPTIMIZATION

In order to achieve an optimum ecological footprint, various parameters may be optimized as follows:

1.1 Reduction in Energy Input:

- Through Climate Responsive Design
- Appropriate technology
- Optimization of Embodied energy through Value Engineering and Life Cycle costing.

This may thus be formulated as:

Climate 'C' ↑ (Systemic strategy of Climate responsive design is critical and is the first level of priority)

App. Tech. & Embodied E. 'D' ↑ (Optimize embodied energy through Value engineering and Life Cycle costing)

User 'E' ↓ (Intelligent and participatory use through daylight optimization, active environmental control)

∴ Low E (1) α Climate 'C' ↑ + App. Tech. & Embodied E. 'D' ↑ + User 'E' ↓

1.2 Lower Environmental Impact:

Env Imp. ↔ ' F' (Optimize land use, Maximize landscape integration, Re-cycle rain water)

Tox. 'M' ↓ (Avoid Toxic materials)

Emi.'EM' ↓ (Minimize CFC, CO_2 and other environmentally degrading emissions)

∴ Low E (2) α Env. Imp. ↔ + Tox. 'M' ↓ + Emi. 'EM' ↓

1.3 Lower Waste Production:

Low 'W' ↓ (Use of re-cycled materials, increase ability of Elements and materials in building to be re-cycled.)

High 'R' ↑ (Re-cycle waste as alternative material / source For Energy, Water etc.)

∴ Low E (3) α Low 'W' ↓ + High 'R' ↑

1.4 Maximize Use of Renewable Energy:

Sol. 'SE' ↑ (Maximize use of Solar Energy through Passive (building design) and active PV integration, and Solar Thermal Means etc.)

Ren. Energy ' RE' ↑ (Maximize Alternative Energy sources of energy, i.e. Co-generation, Wind, Mini – Hydro, Bio-mass etc)

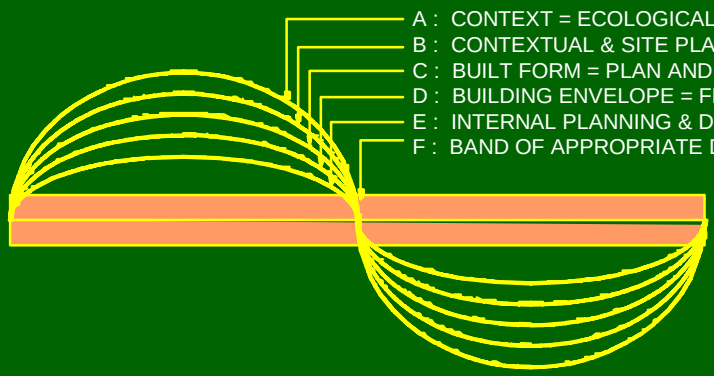
High E (4) α Sol. 'SE' ↑ + Ren. Energy ' RE' ↑

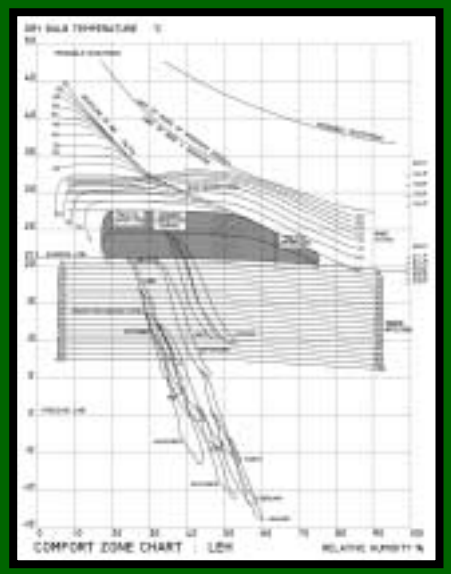
2.0 SUSTAINABILITY INDICATOR: *Sus* 'I'

Above parameters of planning and design can thus be optimized leading to a sustainability indicator.

∴ *Sus* 'I' α Low E (1) + Low E (2) + Low e (3) + High E (4)
(Renewable energy systems)

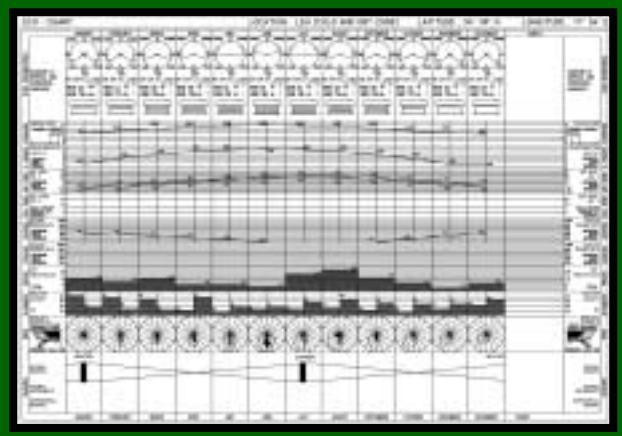
Integrated Process Of Design



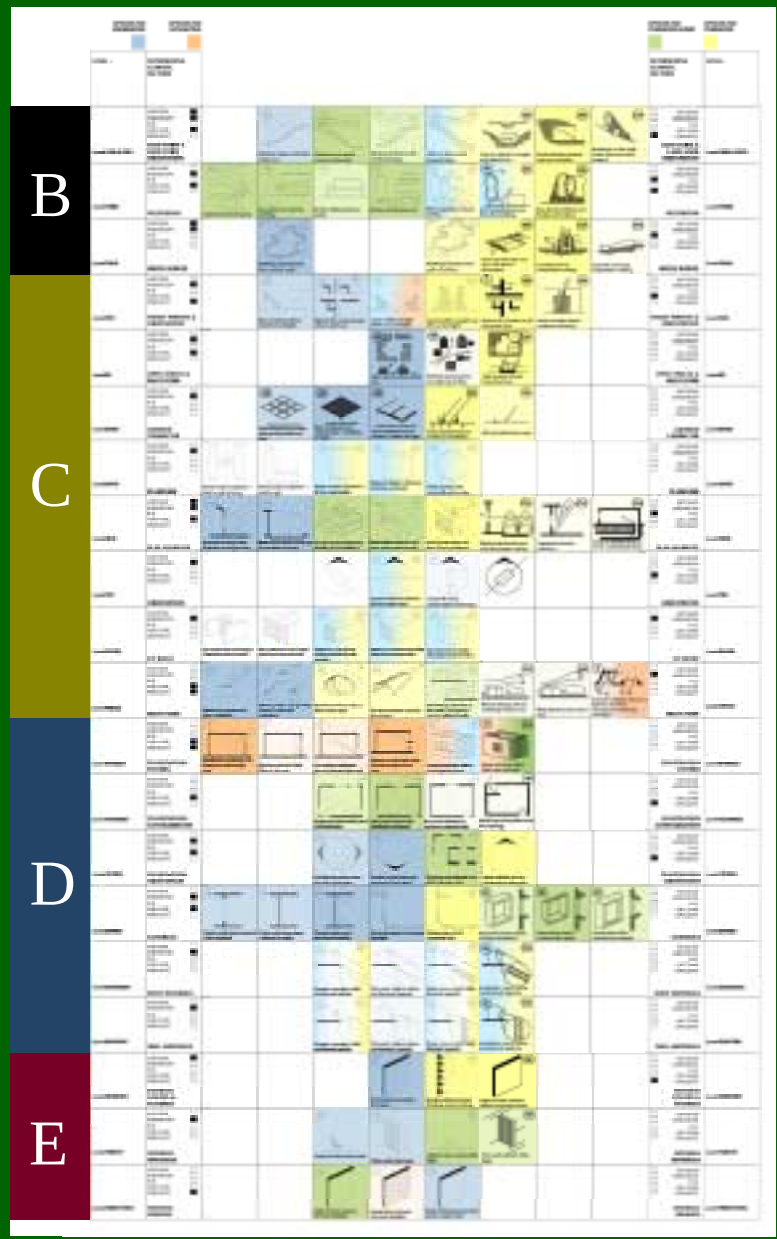


Comfort Zone Chart

A (Context)



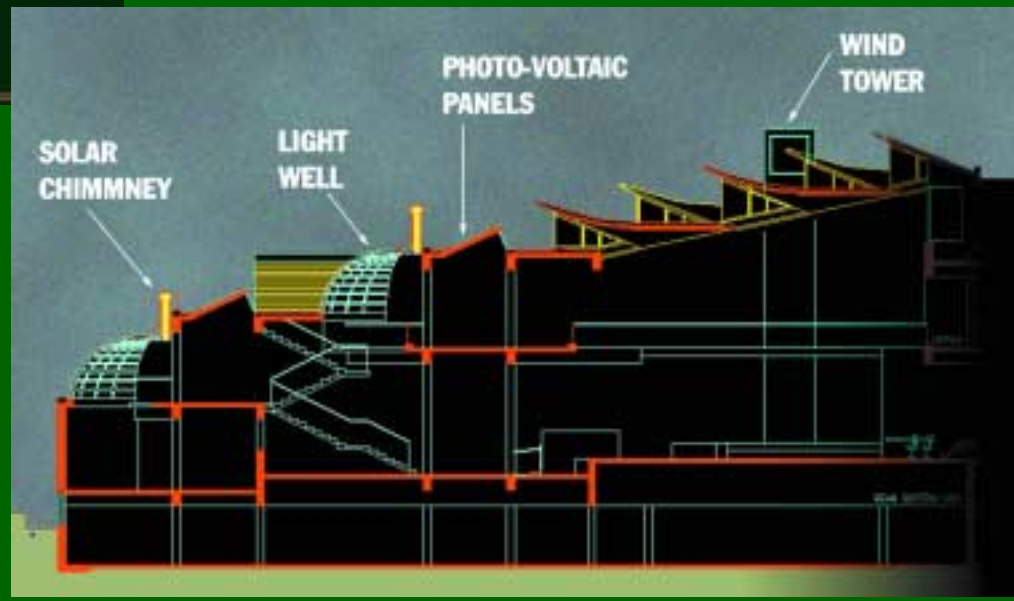
Eco Chart



CRITICAL PROJECTS IN VARIOUS CLIMATE ZONES OF INDIA

Critical Issues

- Enhanced Thermal Performance through Architectural Design
- Enhanced Daylight Distribution through Architectural Design
- Optimise Embodied Energy through judicious material use
- Cost Effectiveness through:
  - ✓Enhanced Thermal & Daylight Performance.
  - ✓Structural System Optimisation and Low Cost through Lightweight Materials



PEDA Office

PEDA Office

PEDA Office

PEDA Office

PEDA Office

PEDA Office

PEDA Office

PEDA Office

DOUBLE SKINNED BUILDING ENVELOPE

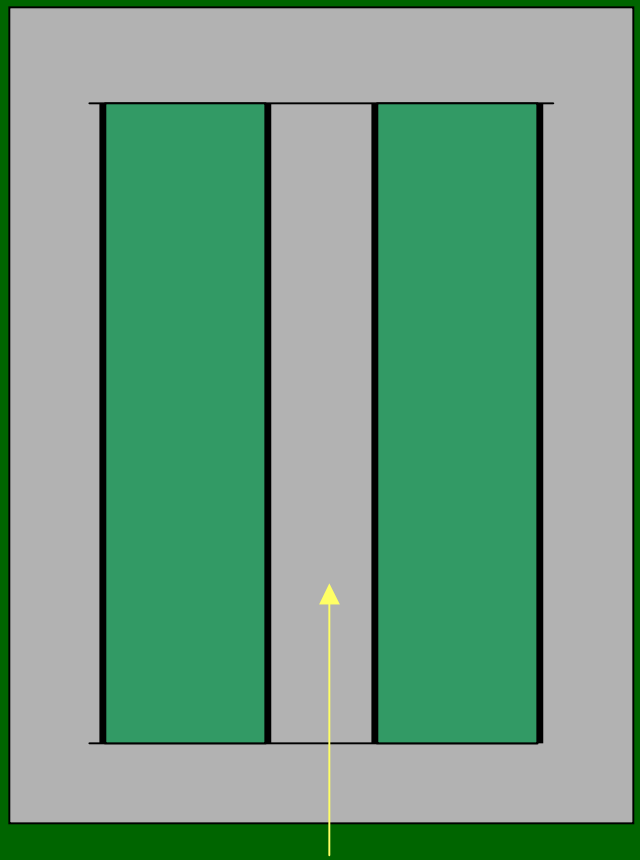
INSIDE

THERMAL INNER SKIN INTERACTS WITH INTERNAL CONDITIONS

-AIR TEMP.

-HUMIDITY

-LIGHT



OUTSIDE

STRUCTURAL OUTER SKIN INTERACTS WITH EXTERNAL CONDITIONS

-WEATHER

-RADIATION

-HUMIDITY

-AIR TEMP.

-U.V.

INTER-STITIAL SPACE

-HEAT BARRIER THROUGH INSULATION / DEAD AIR CAVITY

-MOISTURE BARRIER

-T.A.P. (THERMOSYPHON AIR PANEL)

- THROUGH SOLAR / MECHANICAL ACTIVATION

TRIBUNE : MAY 2004

Building that runs on solar power

POONAM BATTH
TRIBUNE NEWS SERVICE

CHANDIGARH, MAY 3

The city and surrounding areas can look forward to a greener tomorrow with certain government and civic agencies increasingly exploring renewable sources of energy like the solar power.

Conceived as one of its kind in North India, the state-of-the-art building with in-built solar lighting, heating and cooling systems, which become functional as Punjab Energy Development Agency (PEDA) Bhavan in Sector 33, is a case in point.

Talking to TNS about the concept, PEDA Director S.S Sekhon said: "A better building design in consonance with solar photovoltaic (SPV) principals will help utilise sun's energy not only to provide natural eco-friendly lighting, but also ensure optimal insulation, temperature control and minimal glare."

Designed by Prof Arvind Krishan of Delhi, the building is based on the solar passive theory.

"The three-dimensional form of the building has been designed in such a way that it follows the trajectory of the sun and has a solar power plant of 25 kw to run the lighting, heating and ventilation systems," said Mr Sekhon. The construction has been undertaken by PEDA at a cost of Rs 7 crore as demonstration model to promote conservation of conventional energy.

Mr Sekhon said the low energy architecture of the building would help save 40-50 per cent of electricity bills by making optimal utilisation of wind power and solar light for energy generation. "We plan to take the load of running fans, computer/light, fax machines and other systems with solar power," Mr Sekhon informed. The conventional sources of energy would be required only to run air-conditioners, that too for only 2-3 months in a year.

Spread over 1.5 acres, the building has a covered area of 70,000 sq feet. The orientation of the building is such that it brings in light from the south-east during the winters and cuts it out during the summers. In fact, two of the external walls on the south and the west have been insulted with a layer of spintex wool. This would protect it from heat in summers and from cold in winters.

The roof has been fitted with solar photovoltaic cells which would supply energy to run the lighting and cooling systems. "The inner temperature of the building would be anything between 25-30 degree celsius, both during the summers and winters," said a junior engineer.

A visit to the building shows that the North and the South blocks have been joined by a suspended bridge. The central wind tower located at the entrance of the building will suck in the light hot air from the surface and send it out through the solar chimneys atop the building so as to ensure proper ventilation.

"We would take just a 80 kw-load to run the systems against the normal load requirement of 200 kw and that too during the peak of the season," said Mr Sekhon. This would help save at least Rs 8-9 lakhs per year on energy bills, he claimed. It would also make employees work in a healthier environment.

Besides the auditorium, the building has an exhibition hall to display latest products running on non-conventional sources like wind power, solar power, biogas and fuel cells.

An inside view of the PEDA Bhavan in Sector 33, Chandigarh. A Tribune photograph

TRIBUNE : JAN 2004

PEDA builds first solar building in city

MANOJ KUMAR
TRIBUNE NEWS SERVICE

CHANDIGARH, JANUARY 13

North India's first building with in-built solar lighting and cooling systems will soon become functional in the city. Designed following the trajectory of the sun, it has a central wind tower and a solar power plant of 25 kw to run the lighting, heating and ventilation systems.

It has been constructed by the Punjab Energy Development Agency (PEDA) at a cost of Rs 7 crore as a demonstration model to promote conservation of conventional energy. The agency, engaged in the promotion of non-conventional energy sources in Punjab, plans to shift its headquarters from Sector 34 to this building in Sector 33. Besides adequate space for official staff, it will have an exhibition hall to display latest products running on non-conventional energy sources like solar power, wind power, biogas and even fuel cells.

Mr S.S. Sekhon, Director, PEDA, said, "It is the first building in North India that has been designed to show that by optimal utilisation of wind power and solar light, one can save 40 to 60 per cent of electricity bills in any building. We plan to run all lights, fans, computers, fax machines and other systems with solar power." He said if it proved to be successful, the PEDA would offer consultancy to construct such buildings in the region.

Spread over 1.5 acres, the building will have about 70,000 sq ft covered area. Some of the officials of the agency have already been shifted to this building, and by April 13, all offices will be shifted there, he said. The building has been designed by Mr Arvind Krishnan, a renowned architect from the School of Planning and Architecture, New Delhi.

Mr Balour Singh, Joint Director, PEDA, said the building had been designed in such a way that from the southern side it would receive maximum sunlight during winter and summer. The external walls have been insulated by filling a layer of spintex wool that would protect it from heat during summer and from cold in winter. The roof has been fitted with solar photovoltaic cells which would supply energy to run the lighting and cooling systems. For cloudy days, it would have two-day battery back-up to run machines.

Mr Sekhon said the inner temperature of the building would remain between 25 to 30°C during winter and summer. There will be no walls in the building except small rooms on the northern corner. The floors have been joined by a suspended bridge. In addition, the central wind tower will suck in atmospheric air for proper ventilation in the basement and other floors.

"Against the normal requirement of 200 kw power load, we will take just 80 kw connection to run the system," he said. The rest of the requirements would be met by the solar power plant. Mr Sekhon said additional power produced on weekends would be sold to the UT grid.

"We hope to save at least Rs 7 to 8 lakh per year in energy bills by following this unique design, apart from preserving a model of utilisation of natural energy available in abundance," he said.

The Punjab Energy Development Agency has constructed North India's first building with in-built solar lighting and cooling systems in Sector 33, Chandigarh. A Tribune photograph

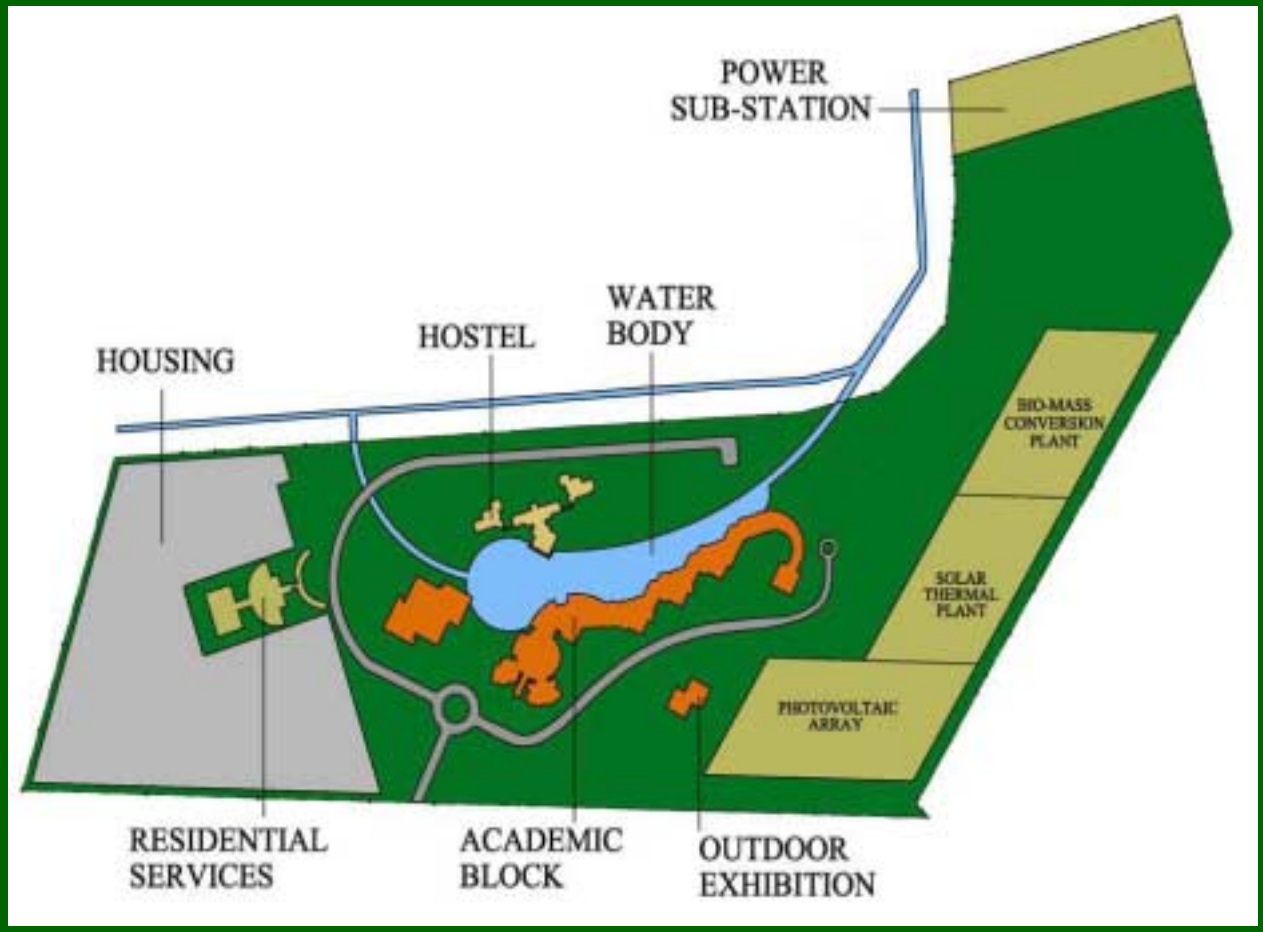
PEDA Building
Conclusions - Design for Composite Climate

- Innovative concept of design: Office Spaces designed as floor plates at various levels floating in large volume of space.
- Building envelope designed as double skinned building with Dead air cavity & Insulation.
- Integration of space, structure and thermal performance through architectural design.
- Renewable energy systems integrated into the building as a generic design.

Zoning Plan

View from the entry gate

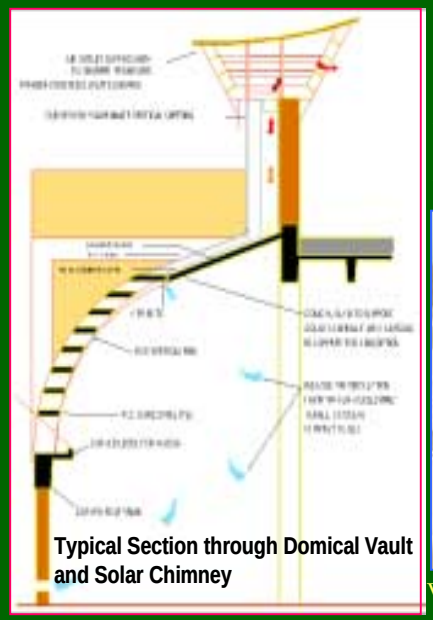
View of the canal adjoining the south edge of the site



SSS – National Institute of Renewable Energy, MNES

Perspective

R & D wing & Passive systems



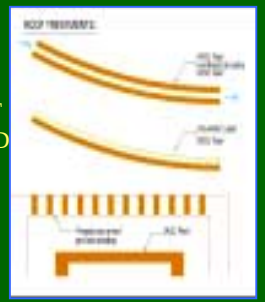
Typical Section through Domical Vault and Solar Chimney

PHOTOVOLTAIC PANELS ON SOUTH FACING GLAZING ALLOWS SOME DAYLIGHT INTO THE ATRIUM

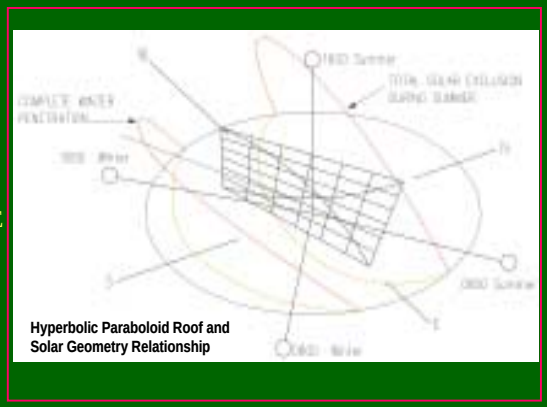
View of typical Domical vault

THE HYPERBOLIC ROOF FORM ALLOWS MAX. DAYLIGHT PENETRATION WITHIN THE COVERED SPACE DURING THE WINTER

DOMICAL LIGHT VAULT COUPLED WITH SOLAR CHIMNEY IN LABORATORIES



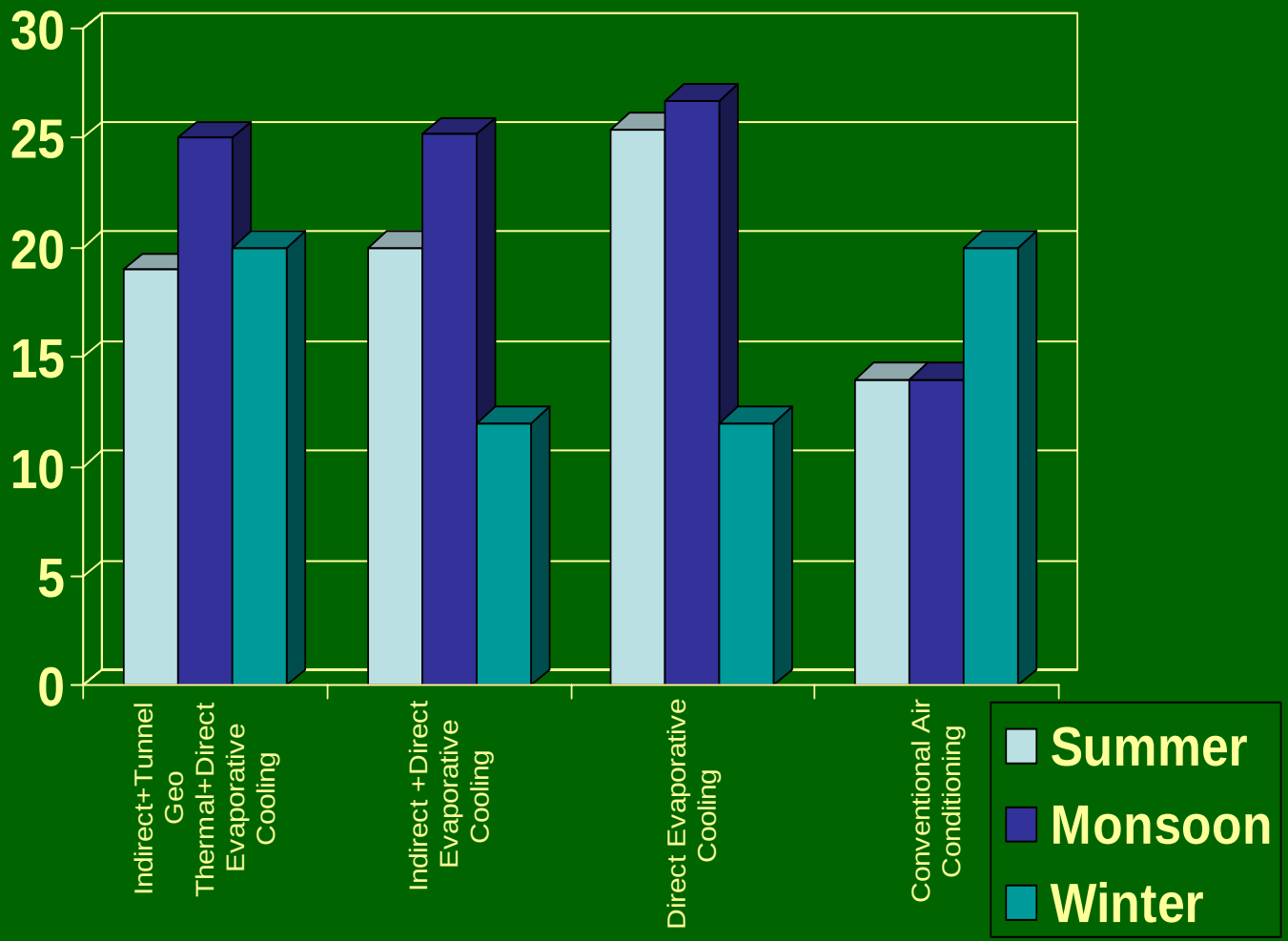
POSSIBLE ALTERNATIVES FOR DESIGN OF THE ROOF SECTION



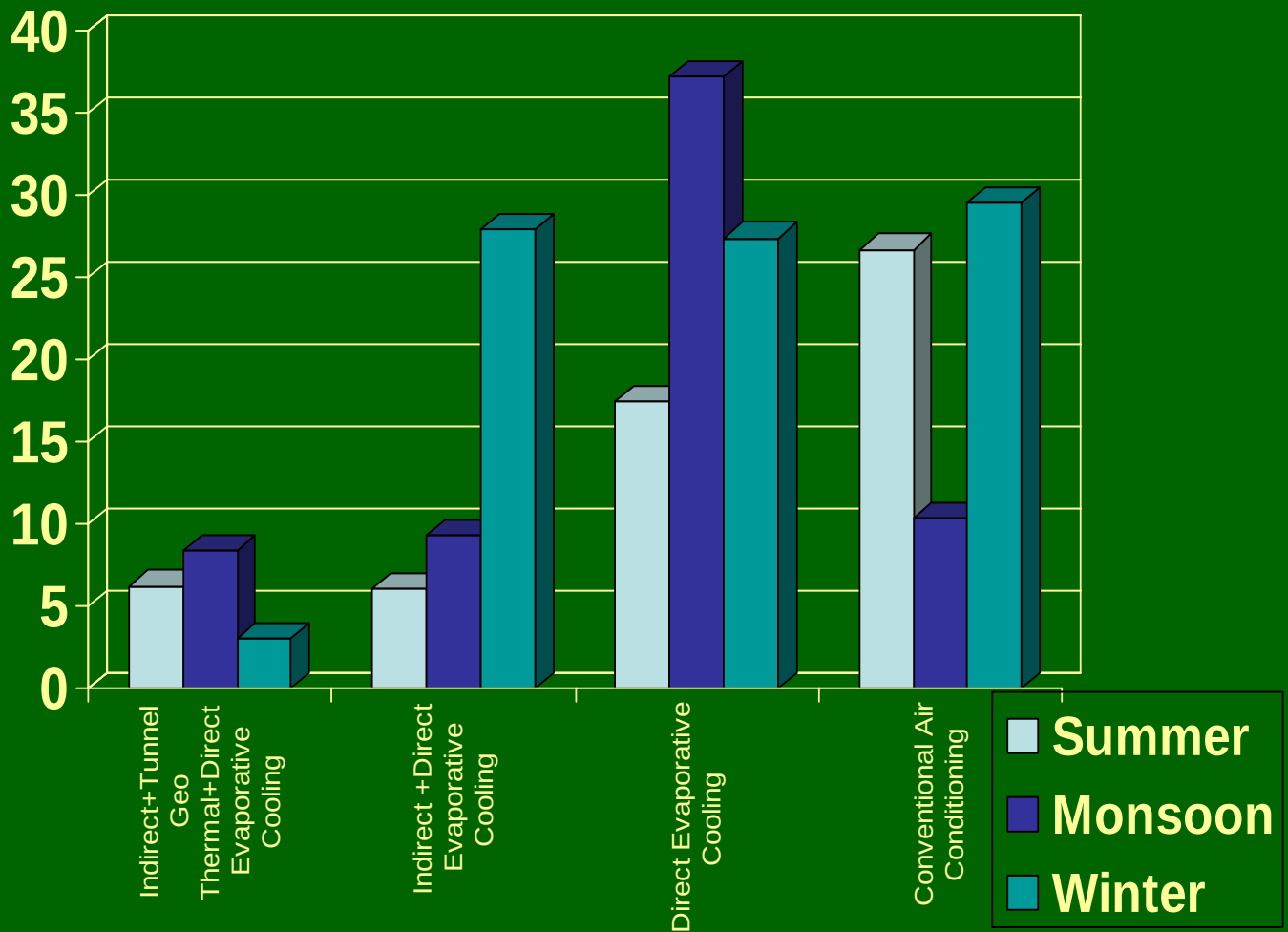
Hyperbolic Paraboloid Roof and Solar Geometry Relationship

SSS – National Institute of Renewable Energy, MNES

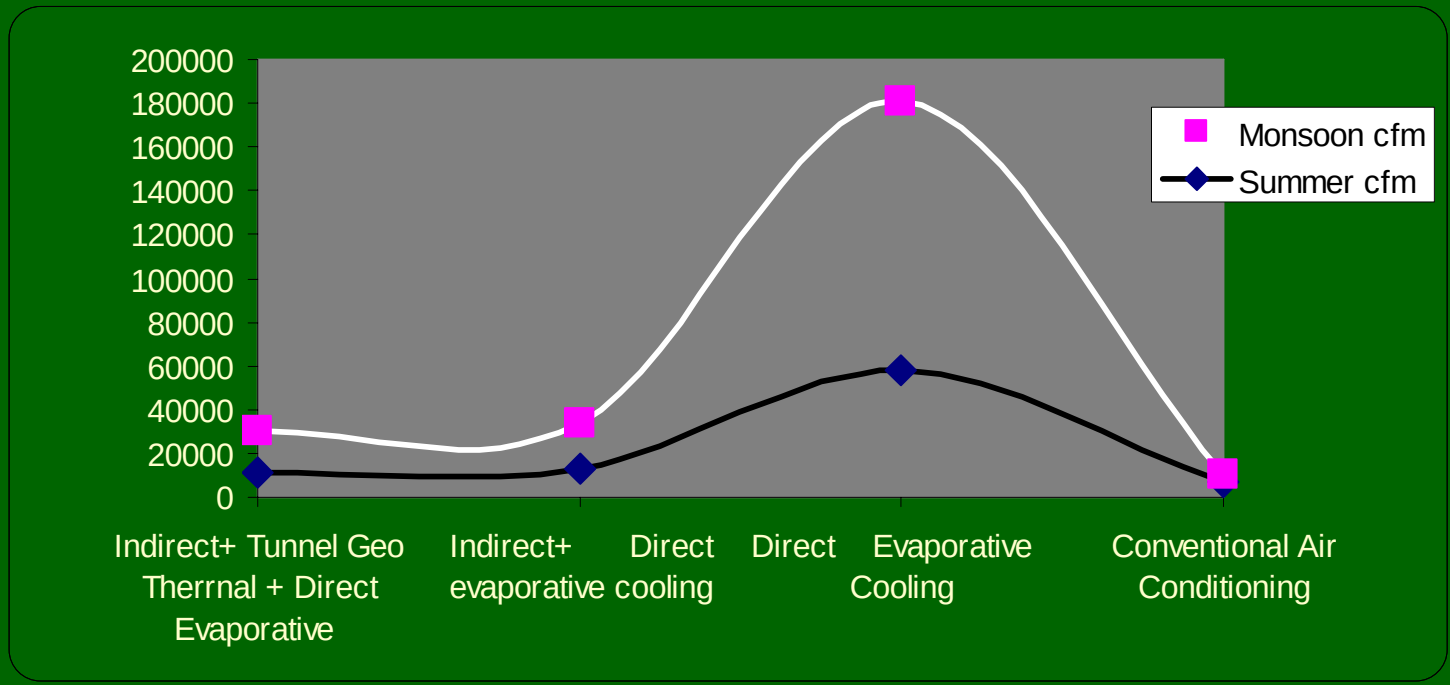
ANNUAL AIR SUPPLY TEMPERATURES



TOTAL ANNUAL POWER CONSUMPTION (KW)

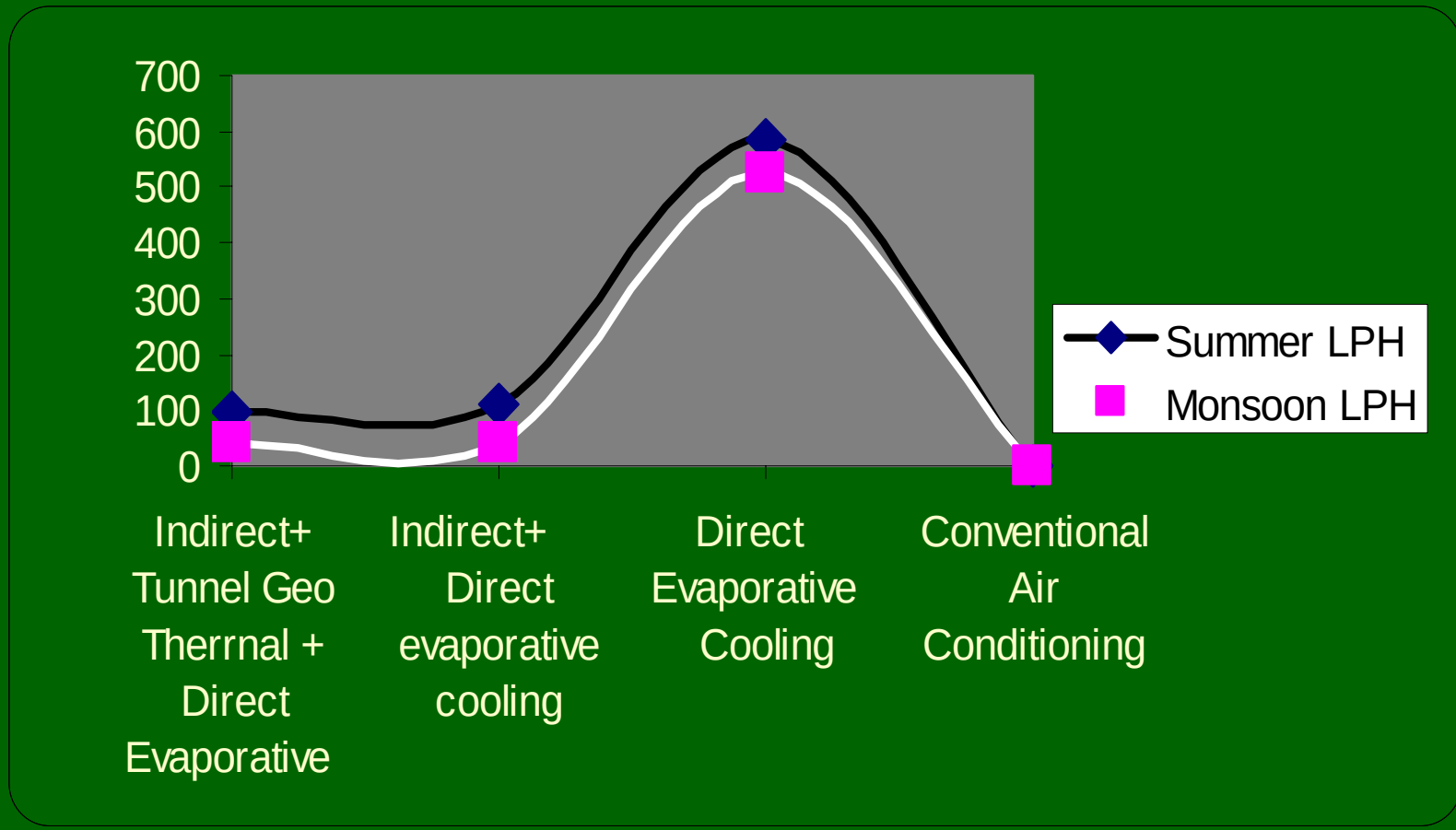


AIR QUANTITY CFM



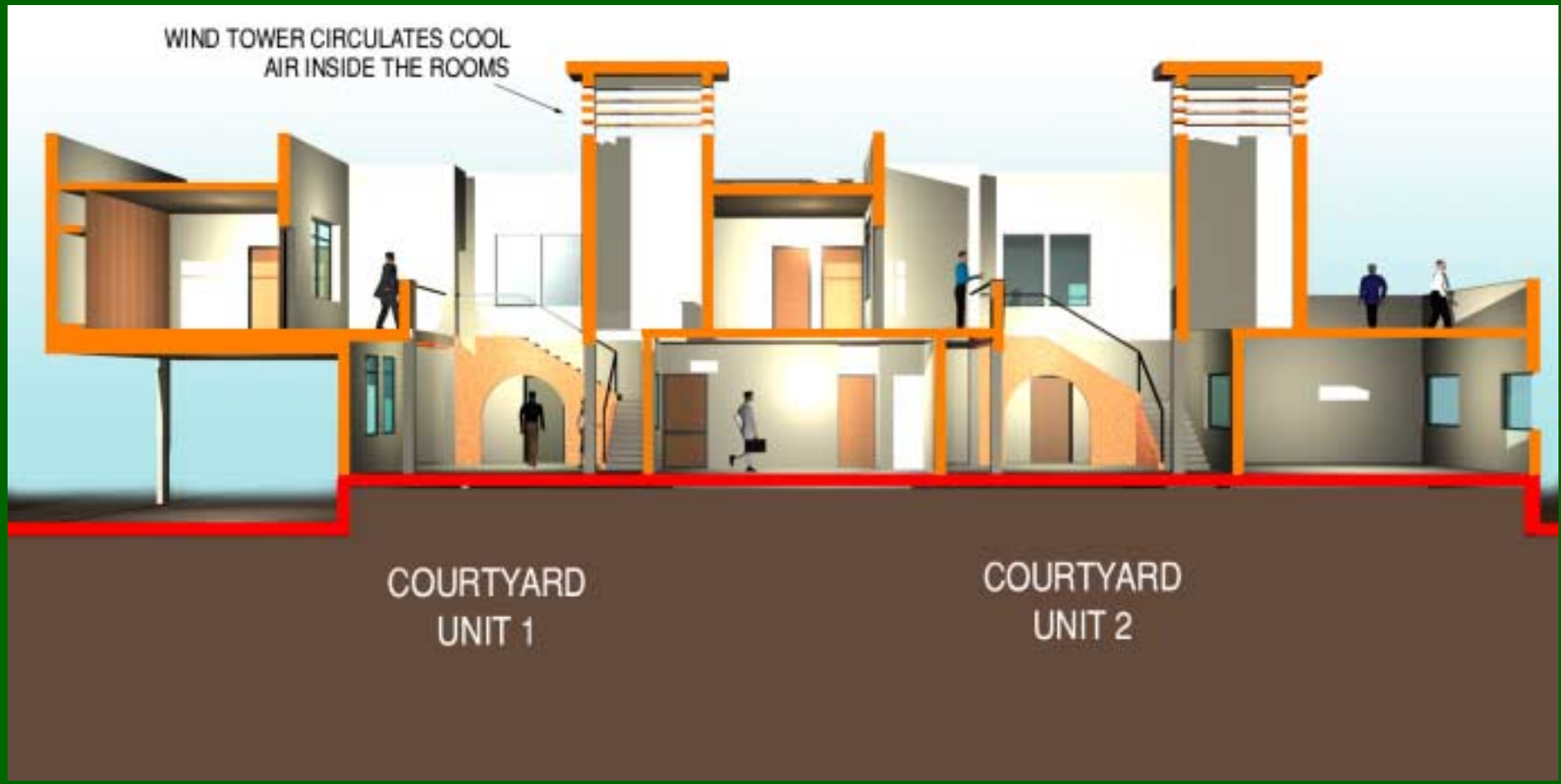
SSS – National Institute of Renewable Energy, MNES

WATER CONSUMPTION LPH



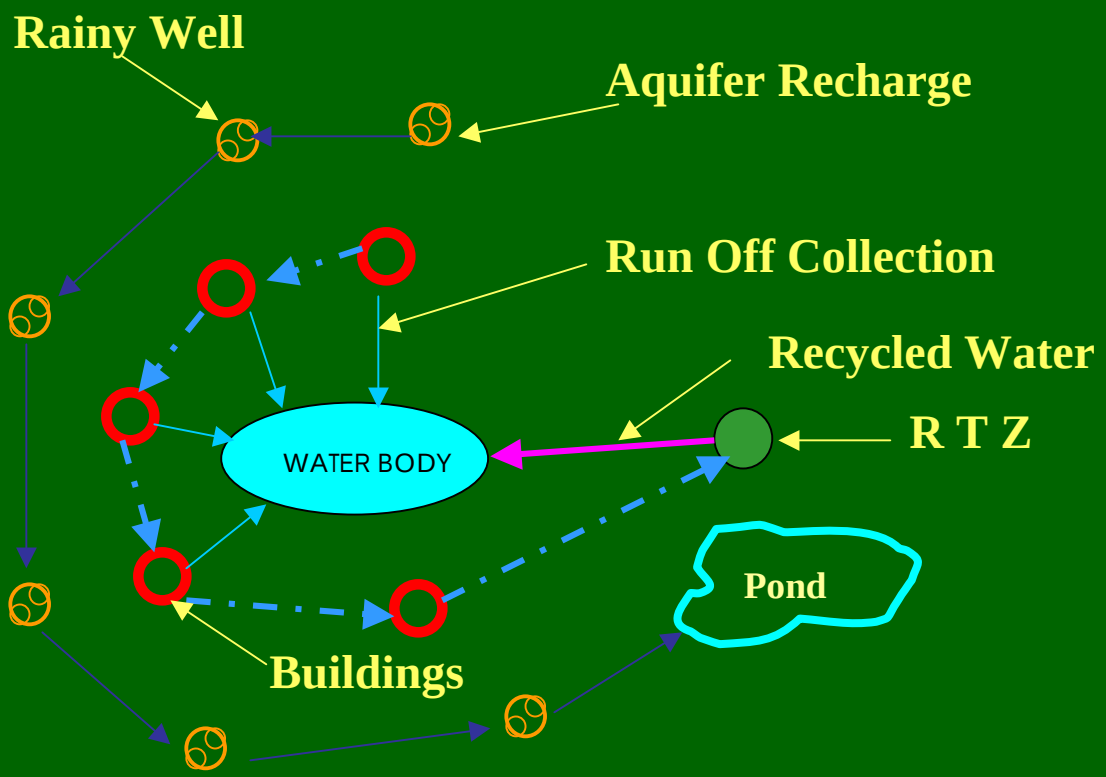
SSS – National Institute of Renewable Energy, MNES

SECTIONAL PERSPECTIVE - HOUSING



SSS – National Institute of Renewable Energy, MNES

SCHEMATIC PLAN FOR RECYCLE & CONSERVATION OF WATER



LEGEND

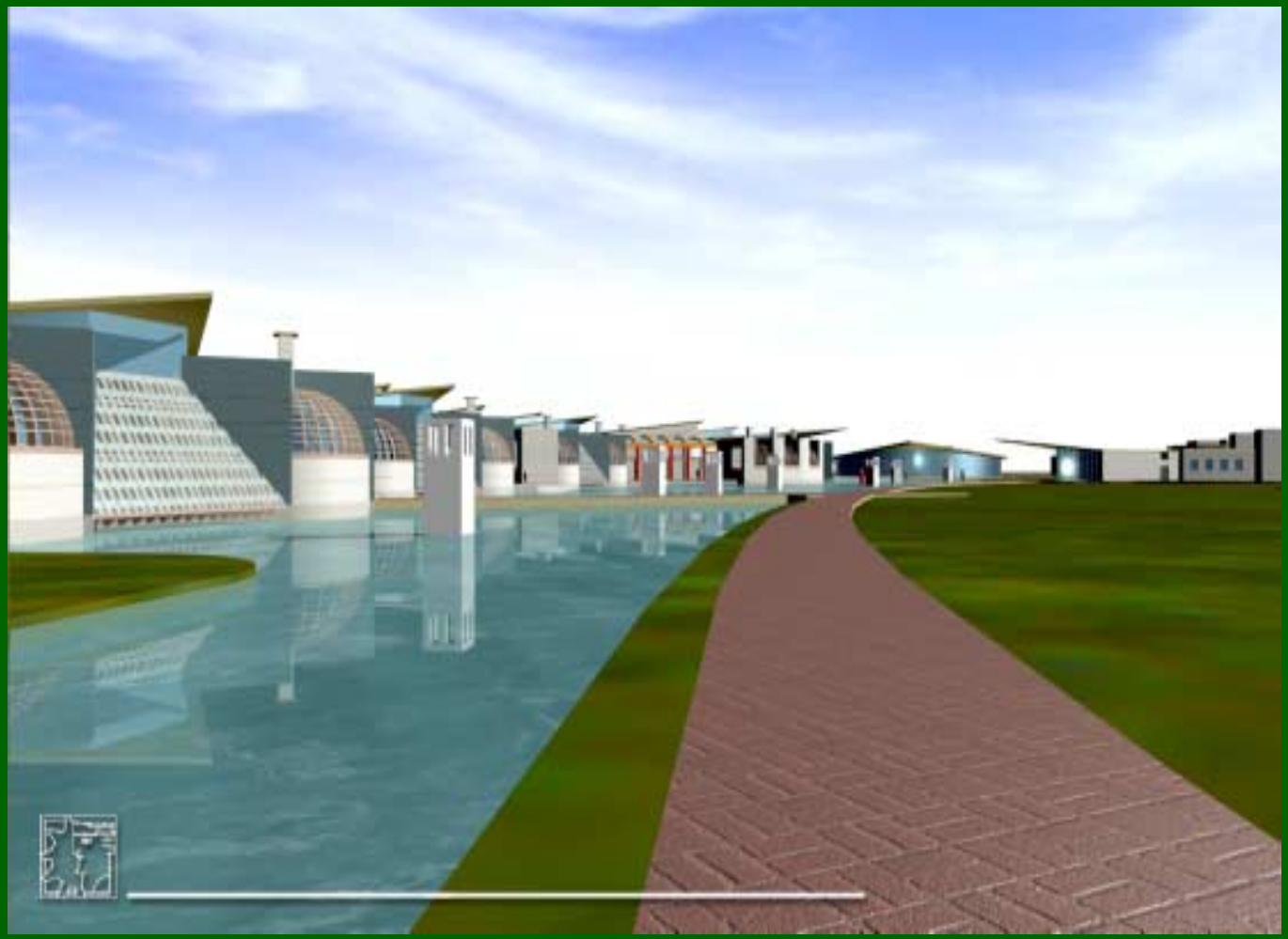
- RAINY WELL
- BUILDINGS
- SEWER LINE
- R T Z
- STORM WATER LINE
- RECYCLED WATER
- ROOFTOP RUNOFF

SSS – National Institute of Renewable Energy, MNES

Conclusions – Design for Composite Climate

- Innovative concept of design: Building in its plan and three dimensional configuration responds to solar geometry.
- Building envelope designed as double skinned building with insulation.
- Integration of space, structure and thermal performance through architectural design.
- Renewable energy systems integrated into the building as a generic design.
- Innovative natural conditioning systems integrated into building design.

3D VIEWS



View of the Academic block from the water body

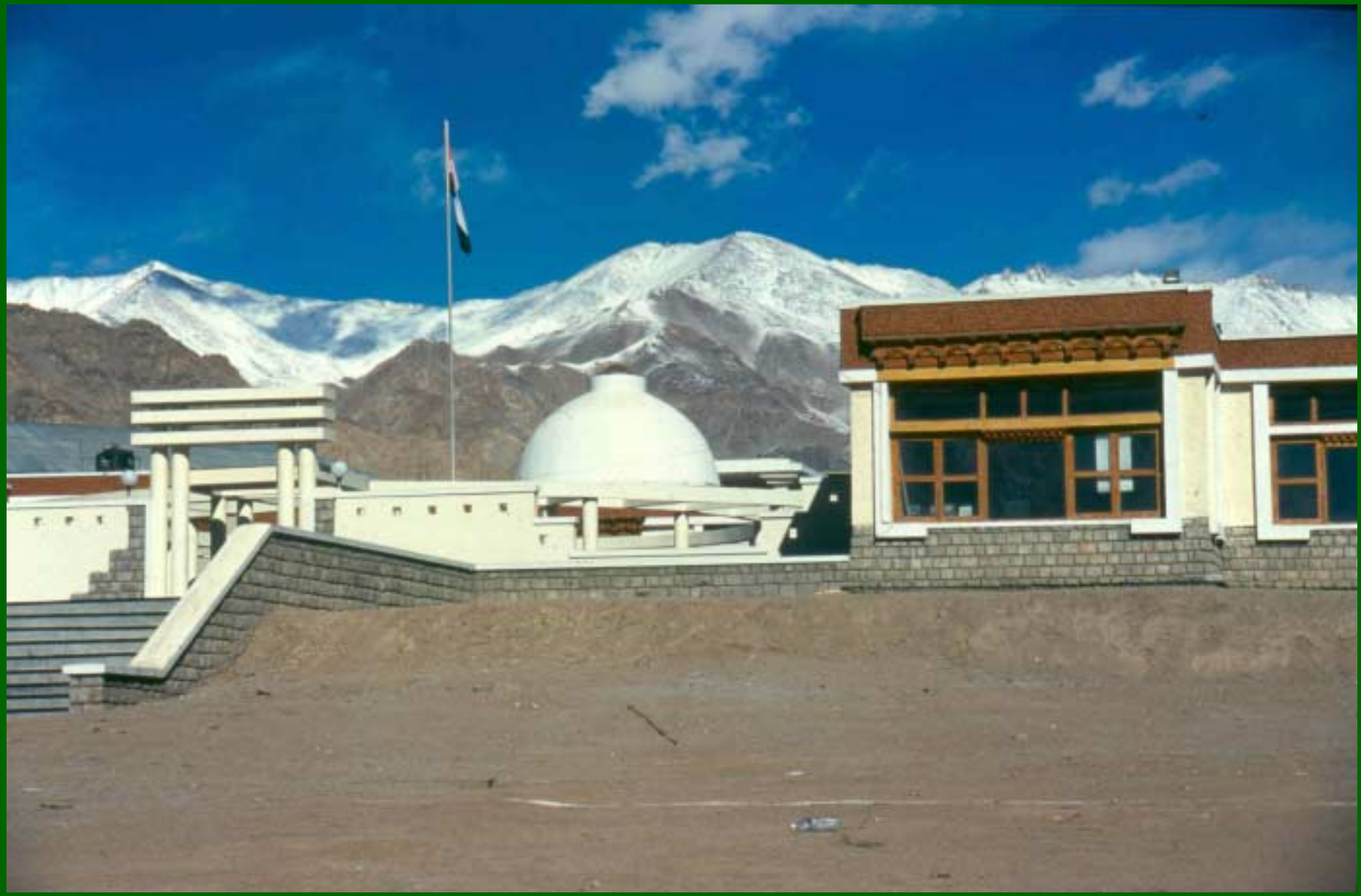
SSS – National Institute of Renewable Energy, MNES

CRITICAL PROJECTS IN VARIOUS CLIMATE ZONES OF INDIA

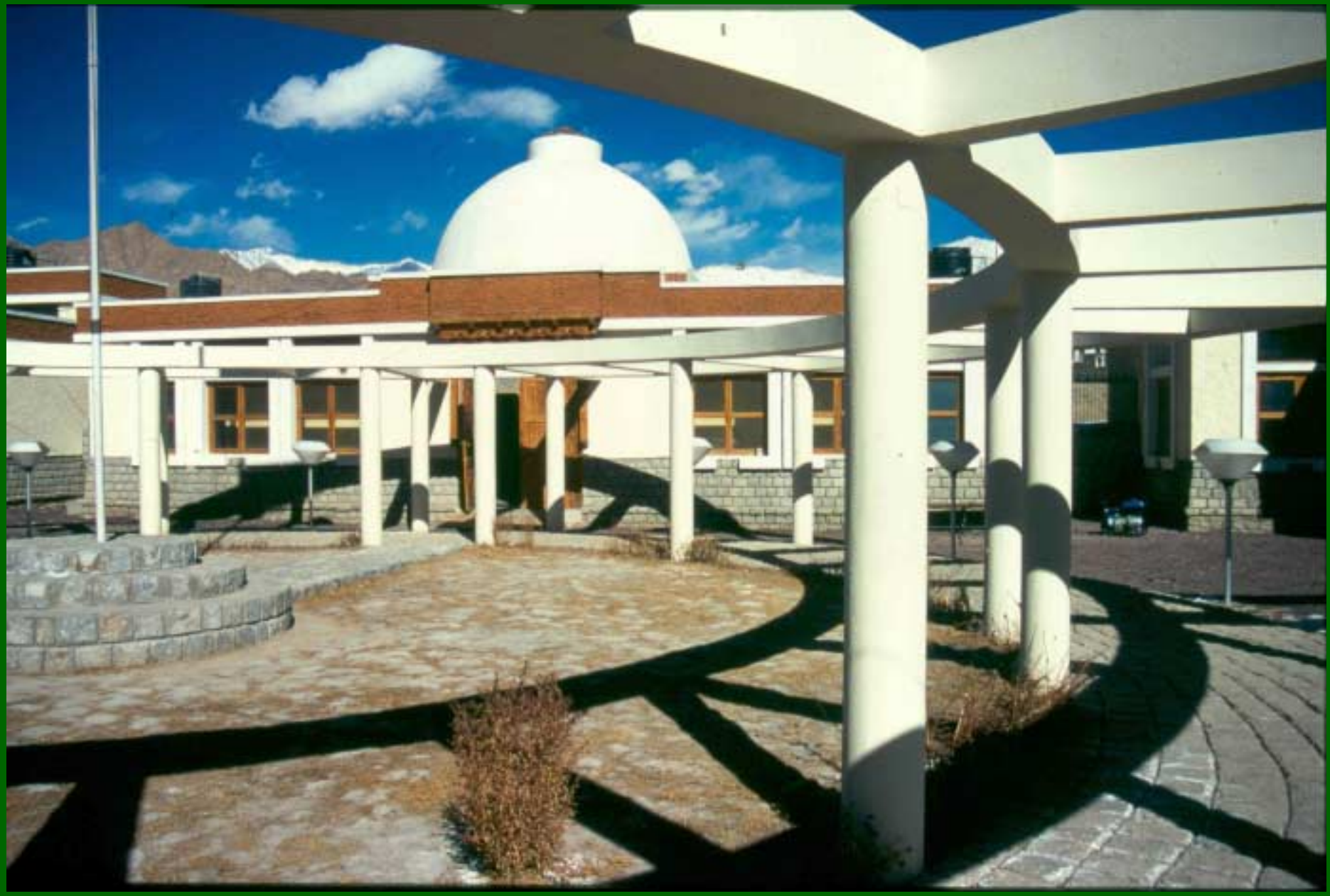
Critical Issues

- Enhanced Thermal Performance through Architectural Design
- Enhanced Daylight Distribution through Architectural Design
- Optimise Embodied Energy through judicious material use
- Cost Effectiveness through:
  - ✓Enhanced Thermal & Daylight Performance.
  - ✓Structural System Optimisation and Low Cost through Lightweight Materials

Hill Council Complex – Cold Dry Zone; Leh

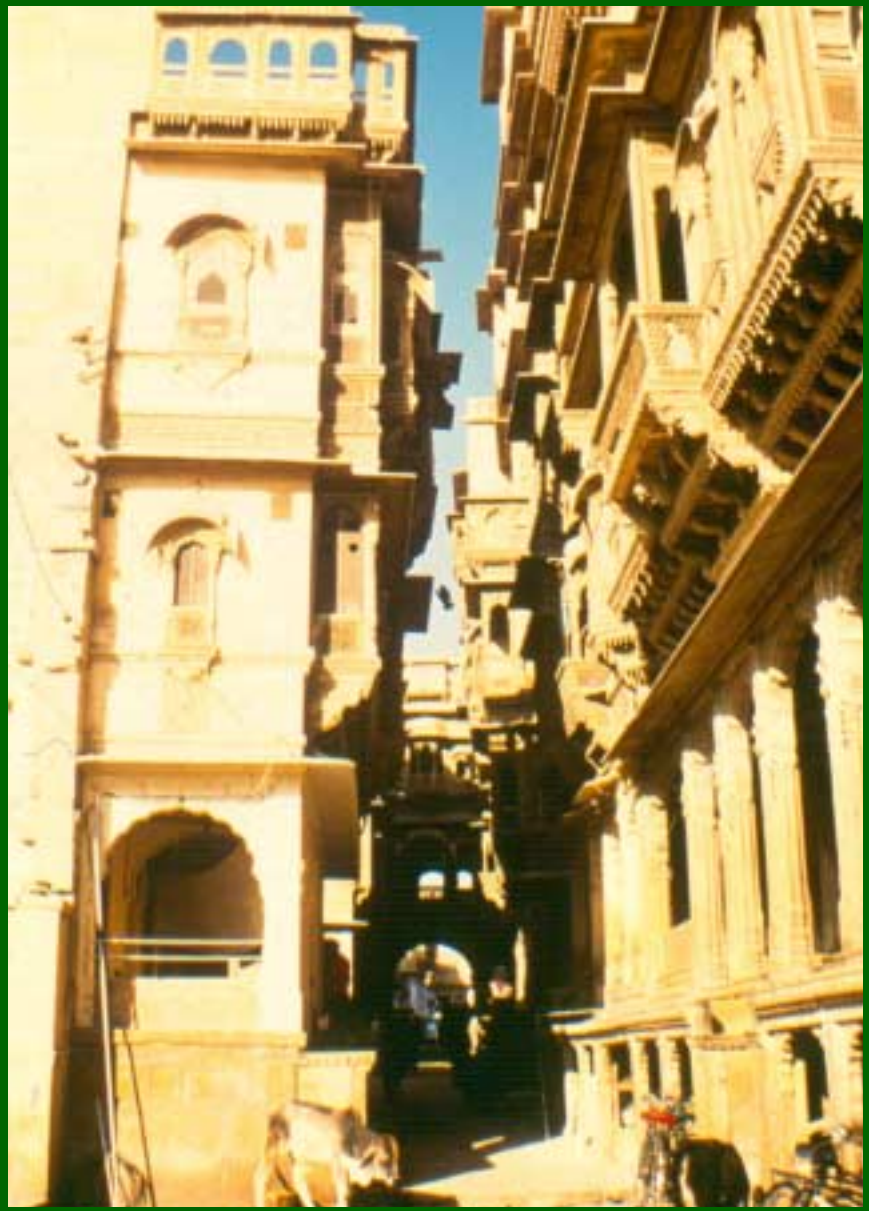


Hill Council Complex – Cold Dry Zone; Leh

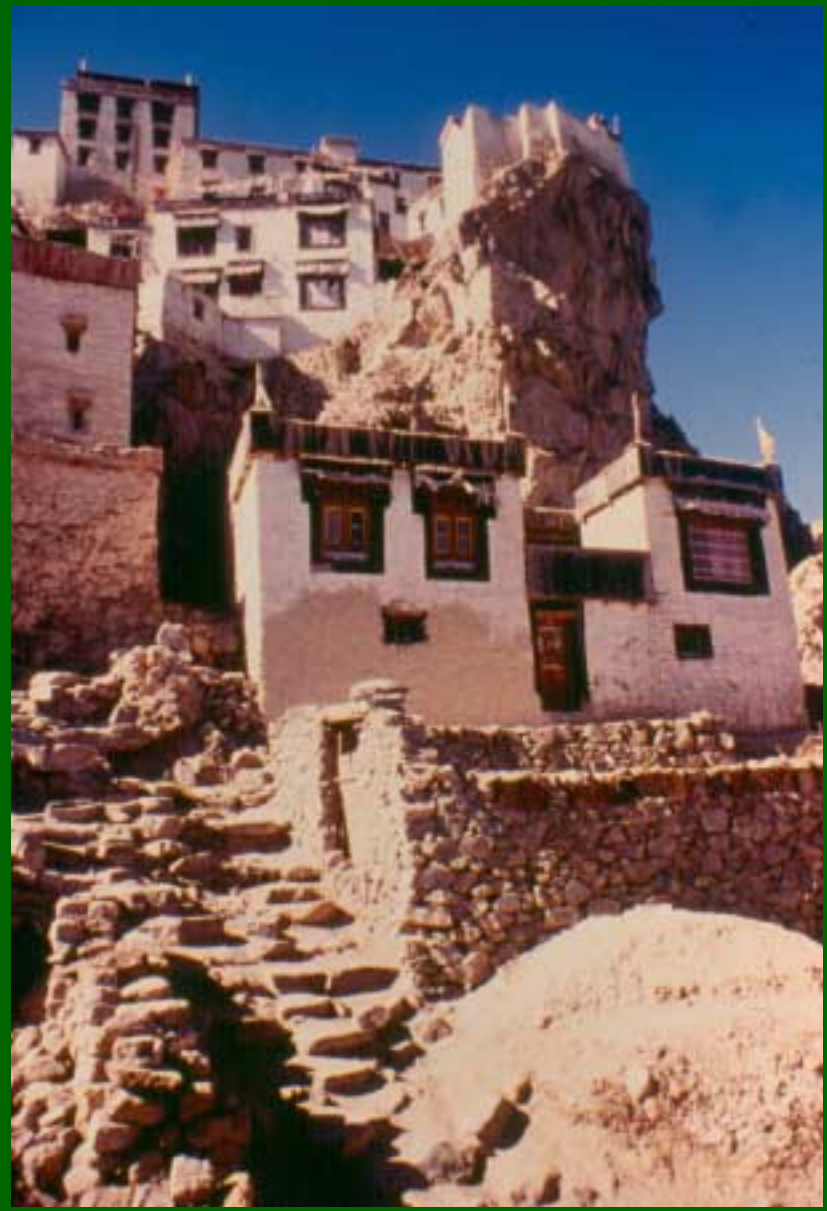


Hill Council Complex – Cold Dry Zone; Leh

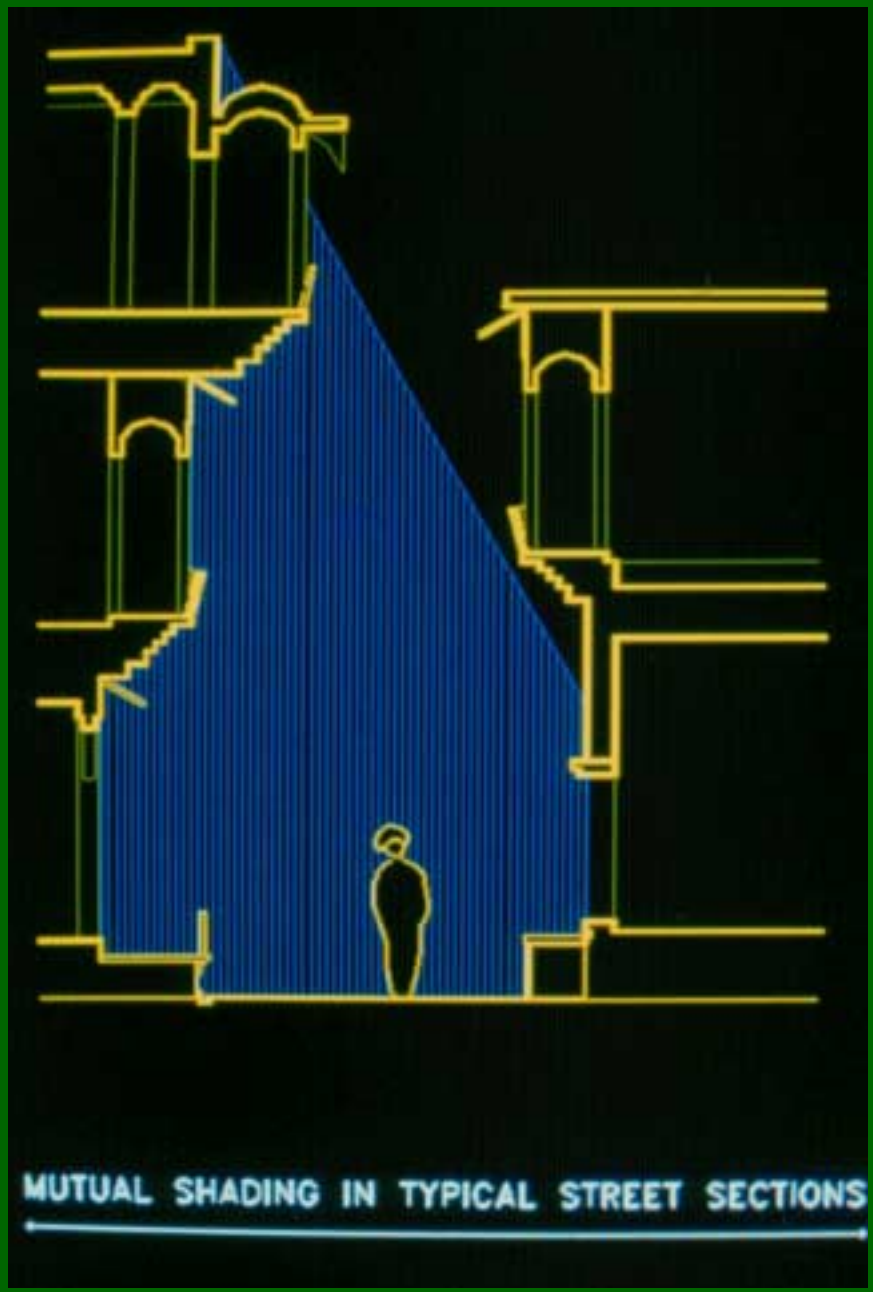
Hill Council Complex – Cold Dry Zone; Leh

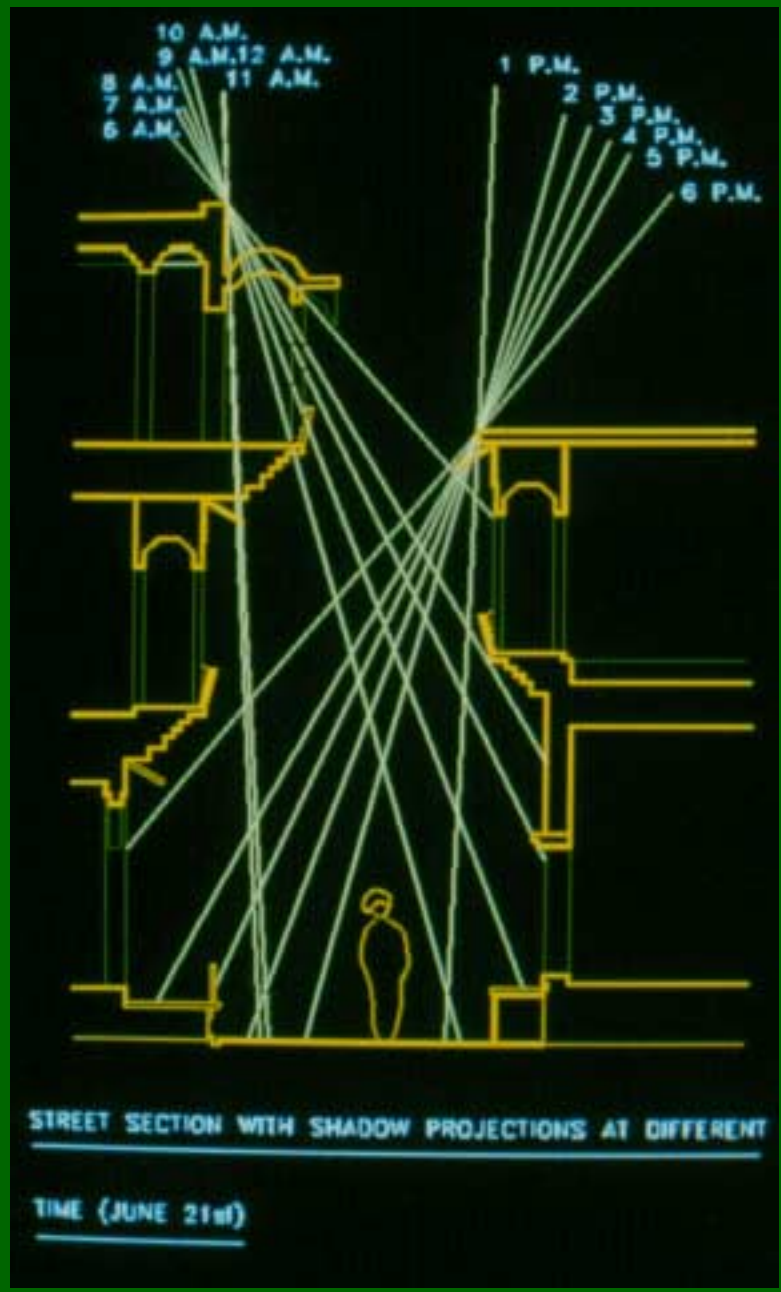


Jaiselmer



Leh

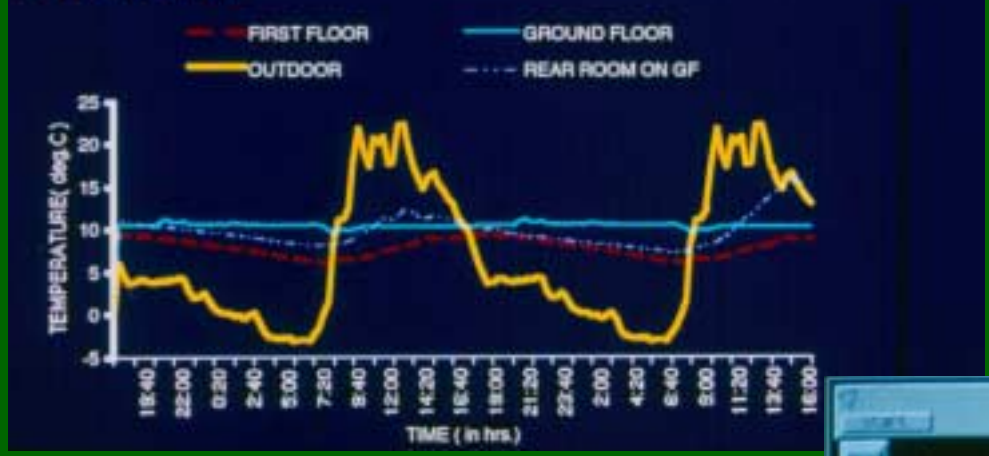

MUTUAL SHADING IN TYPICAL STREET SECTIONS

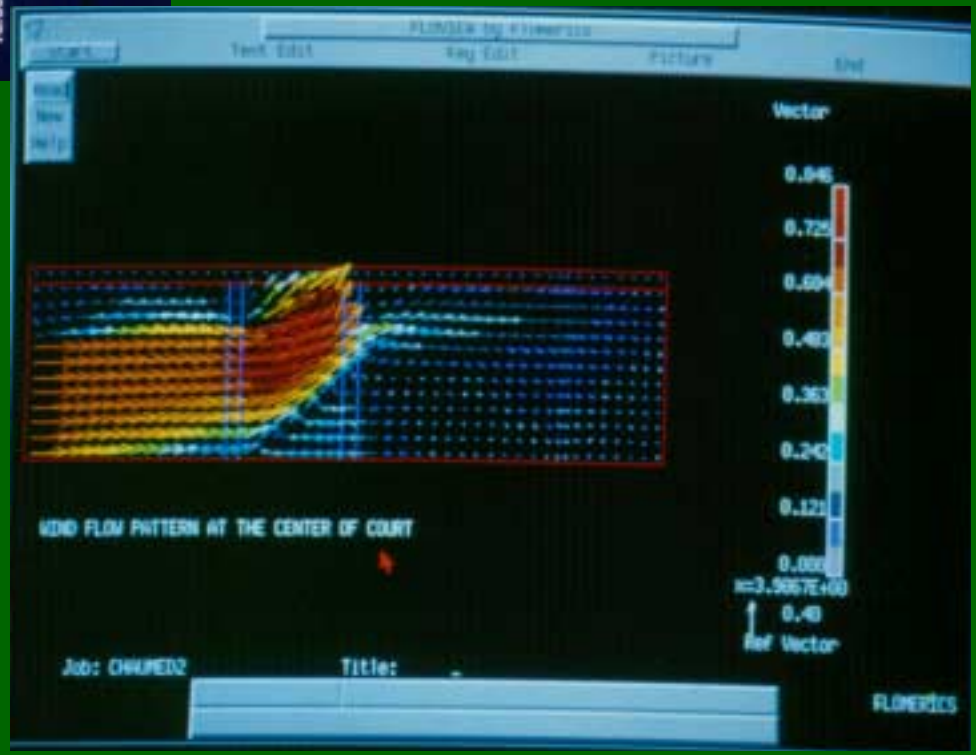

10 A.M.
9 A.M.
12 A.M.
11 A.M.
8 A.M.
7 A.M.
6 A.M.
1 P.M.
2 P.M.
3 P.M.
4 P.M.
5 P.M.
6 P.M.
STREET SECTION WITH SHADOW PROJECTIONS AT DIFFERENT
TIME (JUNE 21st)

Jaiselmer

THERMAL PERFORMANCE OF BUILDINGS

MONITORED PERFORMANCE OF A TYPICAL LEH HOUSE IN OCTOBER :





INTEGRATED, SUSTAINABLE VILLAGE DEVELOPMENT

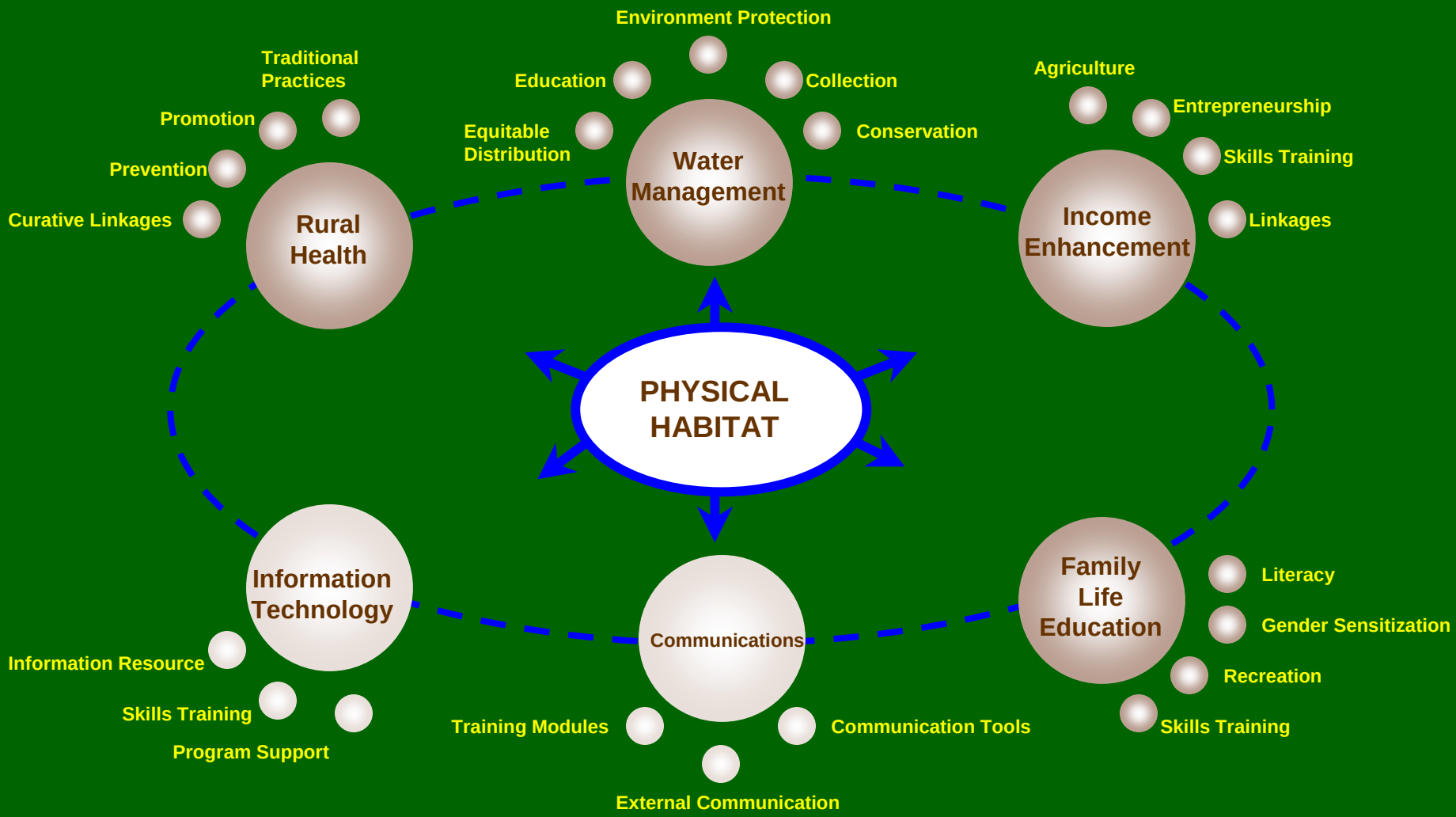


CHART 1: CURRICULUM STRUCTURE – Bachelor in Architecture

CURRICULUM STRUCTURE

STREAMS	AREAS	SEMESTER 1	SEMESTER 2	SEMESTER 3	SEMESTER 4	SEMESTER 5	SEMESTER 6	SEMESTER 7	SEMESTER 8	SEMESTER 9	SEMESTER 10
HUM & SOCIAL SCIENCES	Man and society	Hum 1 Culture and Civilization	Hum 2 Scientific thought	Hum 3 Society and Culture	Hum 4 Culture and Philosophy	EL	EL		EL	EL	
ARTS/CRAFTS	Arts/Crafts	Drawing	Drawing and Painting	Sculpture Ceramics	Print & Graphics Photography	EL	EL		EL	EL	
ARCHITECTURE	Design Synthesis	Basic Design Arch. Design Design Language	Basic Design Arch. Design Design Language	Arch. Design Space Structure, Form	Arch. Design Environment Cultural Dimensions	Arch. Design Inst. Character Landscape Architecture	Arch. Design Des. Dev. & Detail Int. Detail	Office Practice Report	Arch. Design Int. Design Urban Housing Urban Insert	Arch. Design Design Project Urban Design	Thesis Design /Research
	History, Theory & Criticism		Related Study Program 1	History & Th. 1 Early Civilization	History & Th. 2 Medieval India Related Study Program	History & Th. 3 Islamic & Comparative	History & Th. 4 Colonial & Early Industrial Related Study Program	Study Report	History & Th. 5 Contemp. 2 Arch. Related Study Program	Urban History & Urban Planning Theory	History & The Seminar (EL)
SKILLS	Media Skills	Graphic Tech.	Graphic Tech.	Computer Application	Computer Application	Computer Application	Computer Application	PROFESSIONAL OFFICE TRAINING		Research Meth. Research Paper	Computer Modeling Laboratory (EL)
TECHNOLOGY	Building Construction & Services	Building Construction Th. and Drawing	Building Construction Th. and Drawing	Building Construction Th. and Drawing	Building Construction Th. and Drawing	Bldg. Tech. Building Services	Bldg. Tech. Building Services		Adv. Building Tech. Bldg. Qty. & Costs	Construction Project Management Specific & Contract	Construction Project Management
	Principles of Structure	Structure Behaviour	Structure Behaviour	Structure Str. of Mat and El Str. Analysis	Structures Adv. Str. Analysis	Structures R. Concrete	Structures Surface Structure				Adv. Str. Systems EL
ENVIRONMENT	Environmental Science	Environmental Science Geology Hydrology	Environmental Science Geology Hydrology	Environmental Science Ecology of Habitat	Environmental Science Ecology of Habitat	Environmental Science Building Science	Topographical Systems Building Science		Environmental Science EL	Environmental Science EL	

CURRICULUM STRUCTURE

STREAMS	AREAS	SEMESTER 1	SEMESTER 2	SEMESTER 3	SEMESTER 4	SEMESTER 5	SEMESTER 6	SEMESTER 7	SEMESTER 8	SEMESTER 9	SEMESTER 10
HUM & SOCIAL SCIENCES	Man and Society	Hum 1 Culture and Civilization	Hum 2 Scientific thought	Hum 3 Society and Culture	Hum 4 Culture and Philosophy	EL	EL		EL	EL	
ARTS/CRAFTS	Arts/Crafts	Drawing	Drawing and Painting	Sculpture Ceramics	Print & Graphics Photography	EL	EL		EL	EL	
ARCHITECTURE	Design Synthesis	Basic Design Design Design Language	Basic Design Design Design Language	Arch. Design Space Form	Arch. Design Environment Dimensions	Arch. Design Inst. Character Architecture	Arch. Design Des. Int. Detail	Office Practice Report	Arch. Design Int. Design Housing Urban Insert	Arch. Design Design Project	Thesis Design
	History, Theory & Criticism		Related Study Program 1	History & Th. 1 Early Civilization	History & Th. 2 Medieval India Related Study Program	History & Th. 3 Islamic & Comparative	History & Th. 4 Colonial & Early Industrial Related Study Program	Study Report	History & Th. 5 Contemp. 2 Arch. Related Study Program	Urban History & Urban Planning Theory	History & The Seminar (EL)
SKILLS	Media Skills	Graphic Tech	Graphic Tech.	Computer Application	Computer Application	Computer Application	Computer Application			Research Meth. Research Paper Thesis Proposal	Computer Modeling Laboratory (EL)
TECHNOLOGY	Building Construction & Services	Building Construction Th. and Drawing	Building Construction Th. and Drawing	Building Construction Th. and Drawing	Building Construction Th. and Drawing	Bldg. Tech. Building Services	Bldg. Tech. Building Services		Adv. Building Tech. Bldg. Qty. & Costs	Construction Project Management Specific & Contract	Construction Project Management
	Principles of Structure	Structure Behaviour	Structure Behaviour	Structure Str. of Mat and El Str. Analysis	Structures Adv. Str. Analysis	Structures R. Concrete	Structures Surface Structure	PROFESSIONAL OFFICE TRAINING			Adv. Str. Systems EL
ENVIRONMENT	Environmental Science	Environmental Science Geology Hydrology	Environmental Science Geology Hydrology	Environmental Science Ecology of Habitat	Environmental Science Ecology of Habitat	Environmental Science Building Science	Topographical Systems Building Science		Environmental Science EL	Environmental Science EL	

This chart depicts the Conventional approach to relating various courses/ streams to architectural design as the main stream.

CURRICULUM STRUCTURE

STREAMS	AREAS	SEMESTER 1	SEMESTER 2	SEMESTER 3	SEMESTER 4	SEMESTER 5	SEMESTER 6	SEMESTER 7	SEMESTER 8	SEMESTER 9	SEMESTER 10
HUM & SOCIAL SCIENCES	Man and	Hum 1 Civilization	Hum 2 thought	Hum 3 Culture	Hum 4 Philosophy	EL	EL		EL	EL	
ARTS/CRAFTS	Arts/Crafts	Drawing	Drawing and Painting	Sculpture Ceramics	Print & Graphics Photography	EL	EL		EL	EL	
ARCHITECTURE	Design Synthesis	Basic Design	Basic Design	Arch. Design Space	Arch. Design Environment	Arch. Design Inst. Character	Arch. Design Des.	Office Practice Report	Arch. Design Int. Design	Arch. Design Design Project	Thesis Design
		Design Design Language	Design Design Language	Form	Dimensions	Architecture	Int. Detail		Housing Urban Insert		
	History, Theory & Criticism		Related Study Program 1	History & Th. 1 Early Civilization	History & Th. 2 Medieval India Related Study Program	History & Th. 3 Islamic & Comparative	History & Th. 4 Colonial & Early Industrial Related Study Program	Study Report	History & Th. 5 Contemp. 2 Arch. Related Study Program	Urban History & Urban Planning Theory	History & The Seminar (EL)
SKILLS	Media Skills	Graphic Tech.	Graphic Tech.	Computer Application	Computer Application	Computer Application	Computer Application			Research Meth. Research Paper Thesis Proposal	Computer Modeling Laboratory (EL)
TECHNOLOGY	Building Construction & Services	Building Construction Th. and Drawing	Building Construction Th. and Drawing	Building Construction Th. and Drawing	Building Construction Th. and Drawing	Bldg. Tech. Building Services	Bldg. Tech. Building Services		Adv. Building Tech. Bldg. Qty. & Costs	Construction Project Management Specific & Contract	Construction Project Management
	Principles of Structure	Structure Behaviour	Structure Behaviour	Structure Str. of Mat and El Str. Analysis	Structures Adv. Str. Analysis	Structures R. Concrete	Structures Surface Structure	PROFESSIONAL OFFICE TRAINING			Adv. Str. Systems EL
ENVIRONMENT	Environmental Science	Environmental Science Geology Hydrology	Environmental Science Geology Hydrology	Environmental Science Ecology of Habitat	Environmental Science Ecology of Habitat	Environmental Science Building Science	Topographical Systems Building Science		Environmental Science EL	Environmental Science EL	

This chart depicts the interactive relationship between Design and the various streams, enhanced through restructured studio system wherein architectural design studios can simultaneously happen in the main design stream and interrelated streams where any issue of design needs to be explored and the importance of Research and its methodology and its interrelationship with the other steams after third year.

New from Tata McGraw Hill

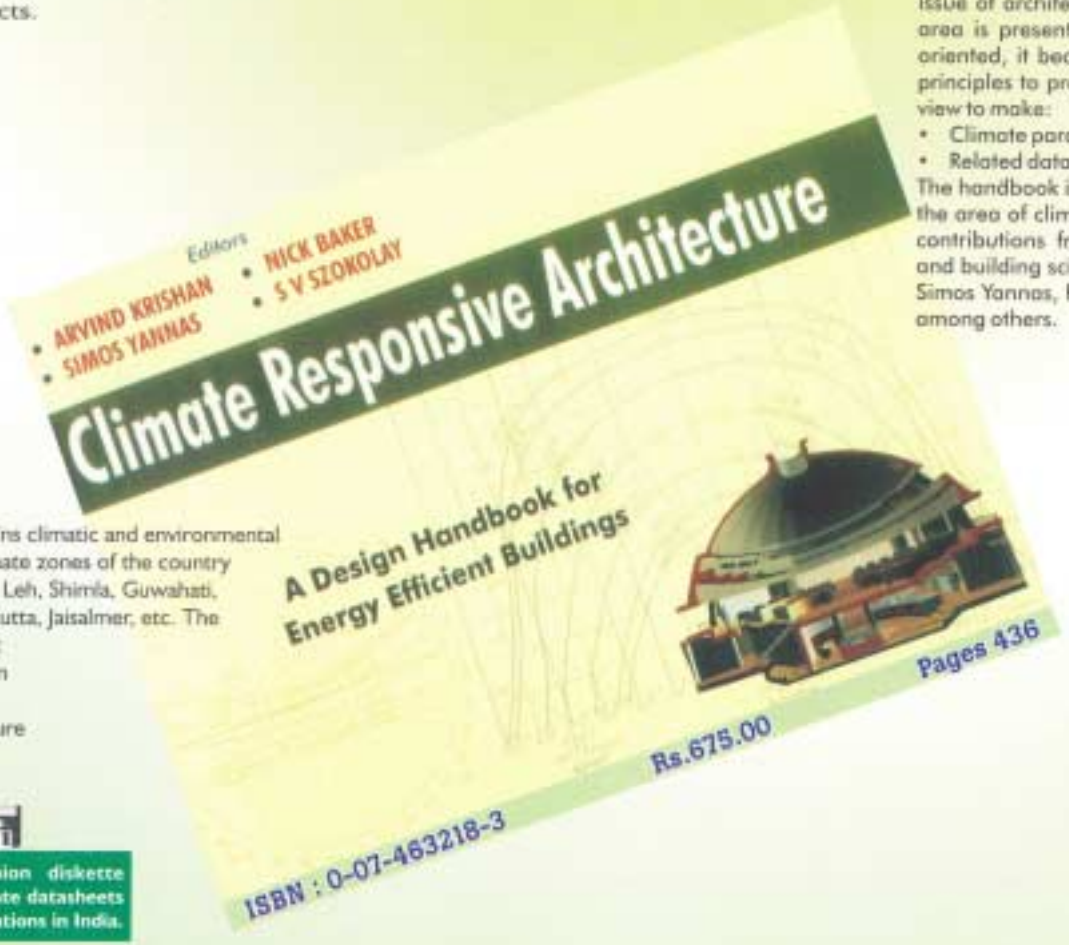
A Design Handbook for Energy Efficient Buildings

Part One discusses the methodology of design, design tools, latest developments in enegrgy efficient architecture and materials, and is suitably aided by case studies and actual projects.

Part Two contains climatic and environmental data for six climate zones of the country represented by Leh, Shimla, Guwahati, Bangalore, Calcutta, Jaisalmer, etc. The parameters are:

- Solar radiation
- Air humidity
- Air temperature
- Wind
- Precipitation

The companion diskette includes climate datasheets for various stations in India.



This book envisages to re-create the process by which buildings and entire habitats can be designed to respond to nature with climate as the basic parameter of design without sacrificing a holistic approach to design.

With the imminent threat of exhausting natural resources, architecture must respond to the ecological context and become a means of regenerating natural resources. 'Climate Responsive Architecture' is therefore a prime issue of architecture. Since most of the literature in this area is presented in a manner that it appears physics oriented, it becomes difficult for architects to apply the principles to practice. This book has been written with a view to make:

- Climate parameters the basic paradigm of design
- Related data and principles easily comprehensible

The handbook is an outcome of longstanding research in the area of climate responsive architecture and includes contributions from internationally acclaimed architects and building scientists–Dr Nick Baker, Prof Szokolay, Prof Simos Yannas, Prof Jeffrey Cook and Prof Arvind Krishan among others.

Editors

Prof Arvind Krishan is Dean, School of Planning and Architecture, New Delhi, India.

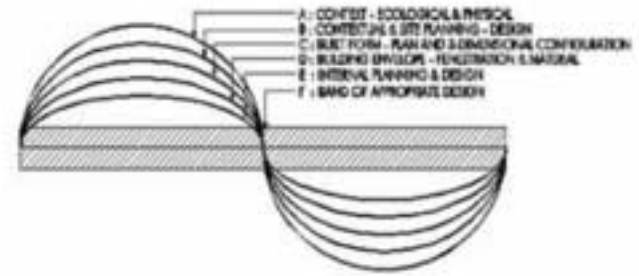
Dr. Nick Baker is Joint Director, Martin Centre for Urban Studies Cambridge Unviersity, UK.

Prof Simos Yannas is Director, Environmental & Energy Studies Program, Architectural Association, Graduate School, London, UK.

Prof S V Szokolay is with the University of Queensland, Australia.

CLIMATE RESPONSIVE ARCHITECTURE 1.0

SOFTWARE FOR A COMPUTER BASED INTEGRATED APPROACH TO ARCHITECTURAL DESIGN-A DESIGN DECISION MAKING EXPERT SYSTEM



PRESENTED BY:

PROF. DR. ARVIND KRISHAN

CASA

Thank You...