



# Energy Savings in Buildings by using Solar Architecture

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## Presentation Themes

- ⊙ Introduction
- ⊙ Solar architecture as energy saver
- ⊙ Energy diagnosis tools are essential for energy optimisation

An impressive 630 kW solar-collecting building that boasts over 5,000 solar panels and kicks off over 500,000 kWh of energy per year by Sanyo in Gifu, Japan





## Why energy conservation has utmost importance

- ⊙ India generates ~ 1 50 000 MW with current growth rate of 7.6 %
- ⊙ There is a **linkage between growth and energy inputs**
- ⊙ The growth rate for energy inputs is required @ 14–16% to achieve the targets of the Integrated Energy Policy Forecast
- ⊙ **Actual growth rate is 5–6%, hence there is a deficit**
- ⊙ We do not have infrastructure to increase energy input rate required – but want at least to sustain the present growth rate
- ⊙ **We do not have an alternative but to conserve**
- ⊙ Studies show that we have potential to conserve 45 000 MW in India
- ⊙ **So is role of BEE and Energy Conservation Act**



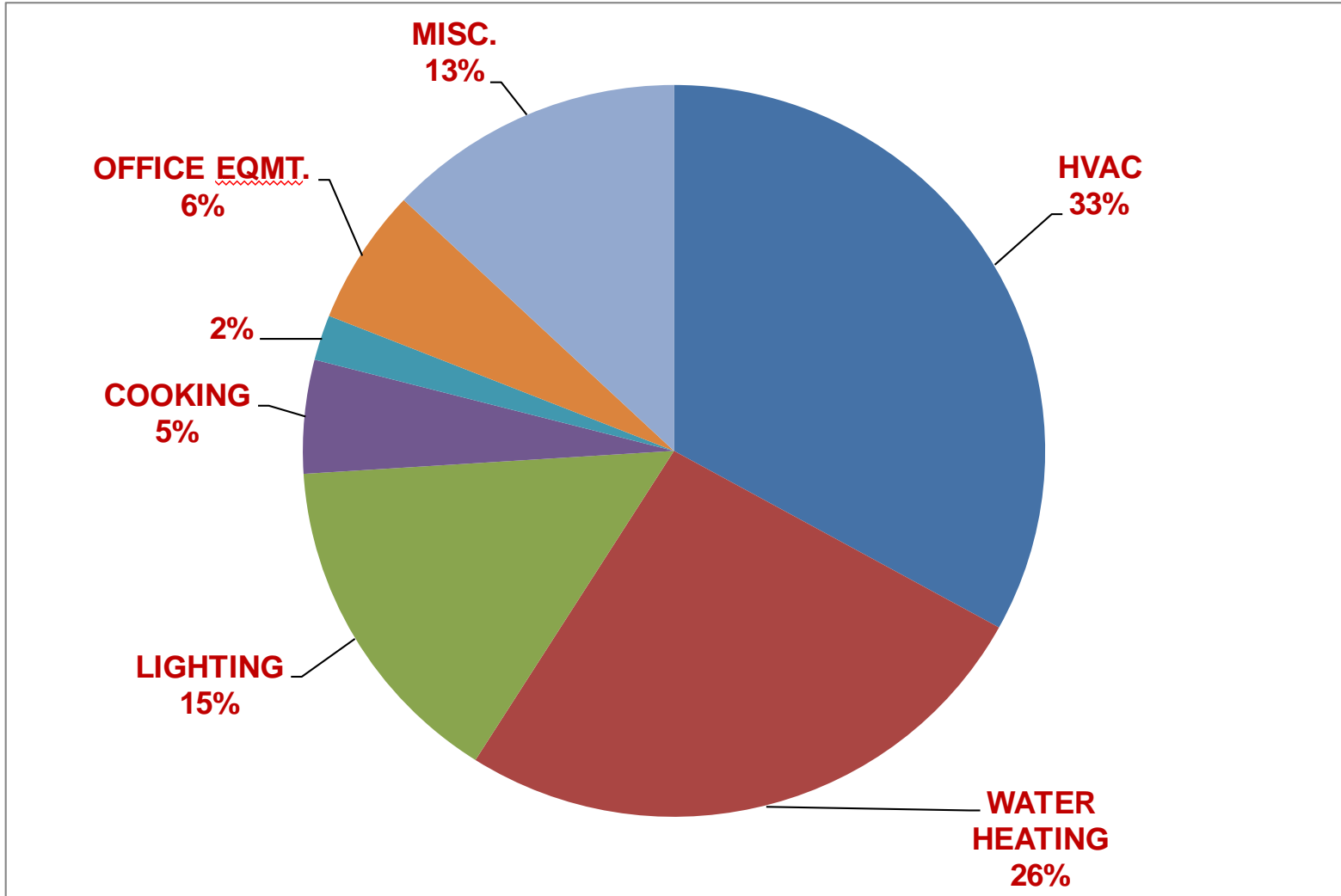
# Sectoral Energy Consumption

Category	Electricity Consumption	
	% of total	Increase over last year
Domestic	21.10%	4.63%
Commercial	7.58%	14.61%
Industry	45.13%	7.36%
Public Lighting	1.09%	4.22%
Transport	2.10%	4.72%
Agriculture	19.03%	1.96%
Public Water Works	2.16%	6.65%

- ⊙ The power consumption in domestic, commercial lighting and building construction is 30% (~45 000 MW)
- ⊙ Present power system is inadequate to supply existing demands - **shortage in average and peak demands**
- ⊙ So conserve by efficiency improvement in buildings



# Energy Requirement in Buildings





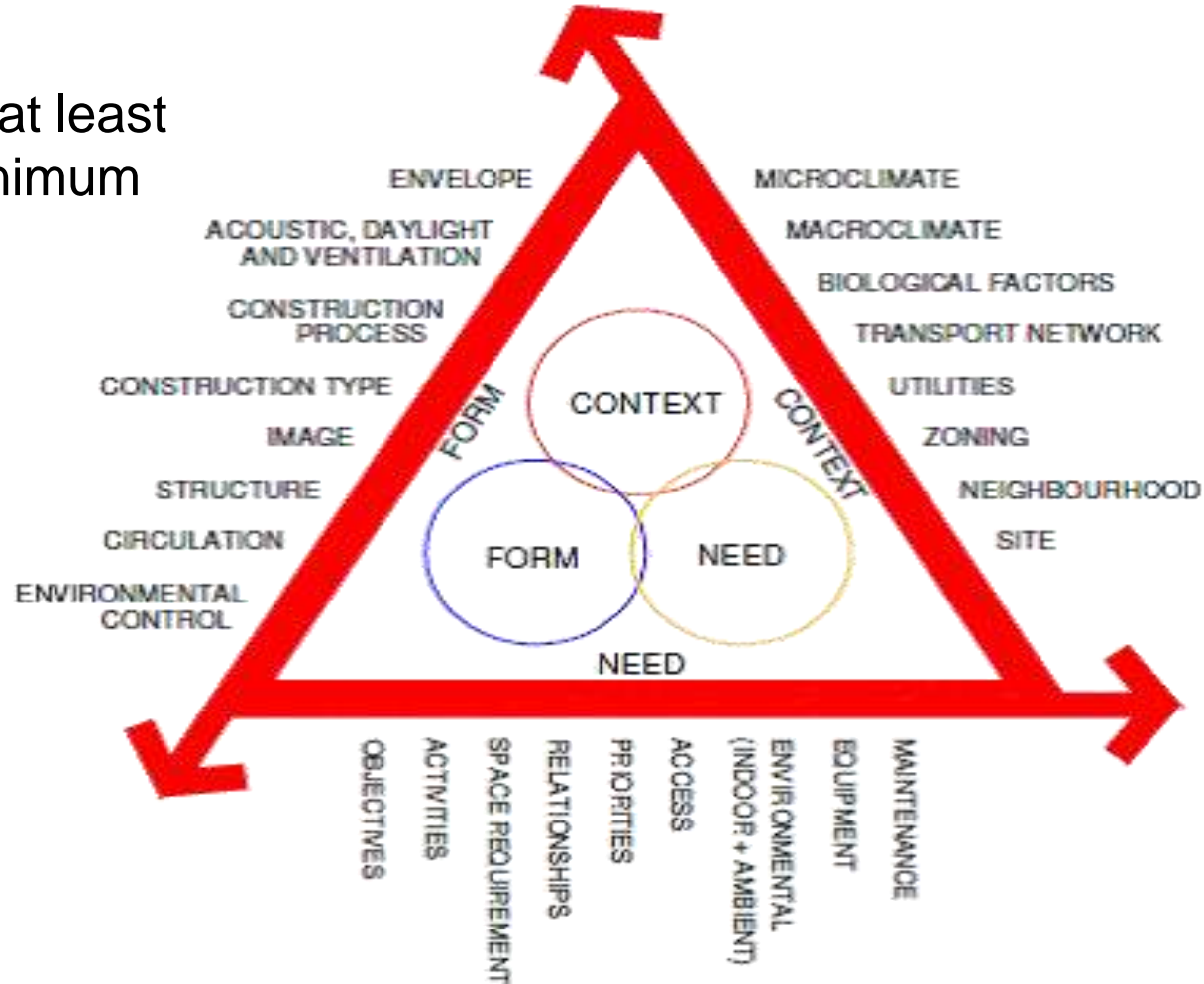
## Energy Conservation Building Code (ECBC)

- ⊙ Scope: Commercial buildings or building complexes with
  - Connected load in excess of 500 kW or contract demand in excess of 600 kW
  - All buildings with a conditioned floor are of 1000 m<sup>2</sup>
- ⊙ Building Components addressed:  
Building envelope (walls, roofs, windows); HVAC system; Service water heating and pumping; Lighting (indoor and outdoor); Electrical power (PF, Transformers)
- ⊙ ECBC sets minimum energy efficiency standards for design and construction
- ⊙ ECBC ensures the construction on energy efficient buildings with a concomitant reduced electrical demand.
- ⊙ The Code helps address the goals of state energy plans and climate change plans through the use of higher efficient mechanical and lighting systems that reduce environmental emissions and the demand of electric and gas infrastructure



# Role of Architect

Aim:  
To achieve comfort levels at least cost; least energy with minimum environmental effects





## Solar Architecture in Building Design

- ⊙ Solar buildings aim to maintain interior thermal comfort throughout the sun's daily and annual cycles
- ⊙ They reduce the requirement for active heating and cooling systems
- ⊙ Solar building design is one part of green building design
- ⊙ Green building design includes active systems such as mechanical ventilation or solar photovoltaics (PV) systems
- ⊙ Solar photovoltaics enable Architects to create buildings which produce their own low carbon energy, whilst creating unique and visually stunning designs.

The City of Dezhou in China has successfully bid to host the 4<sup>th</sup> of a biannual series of world solar conferences, and will do so in the largest building ever to be almost entirely powered by solar in the world. It has over 800,000 square feet of space inside.



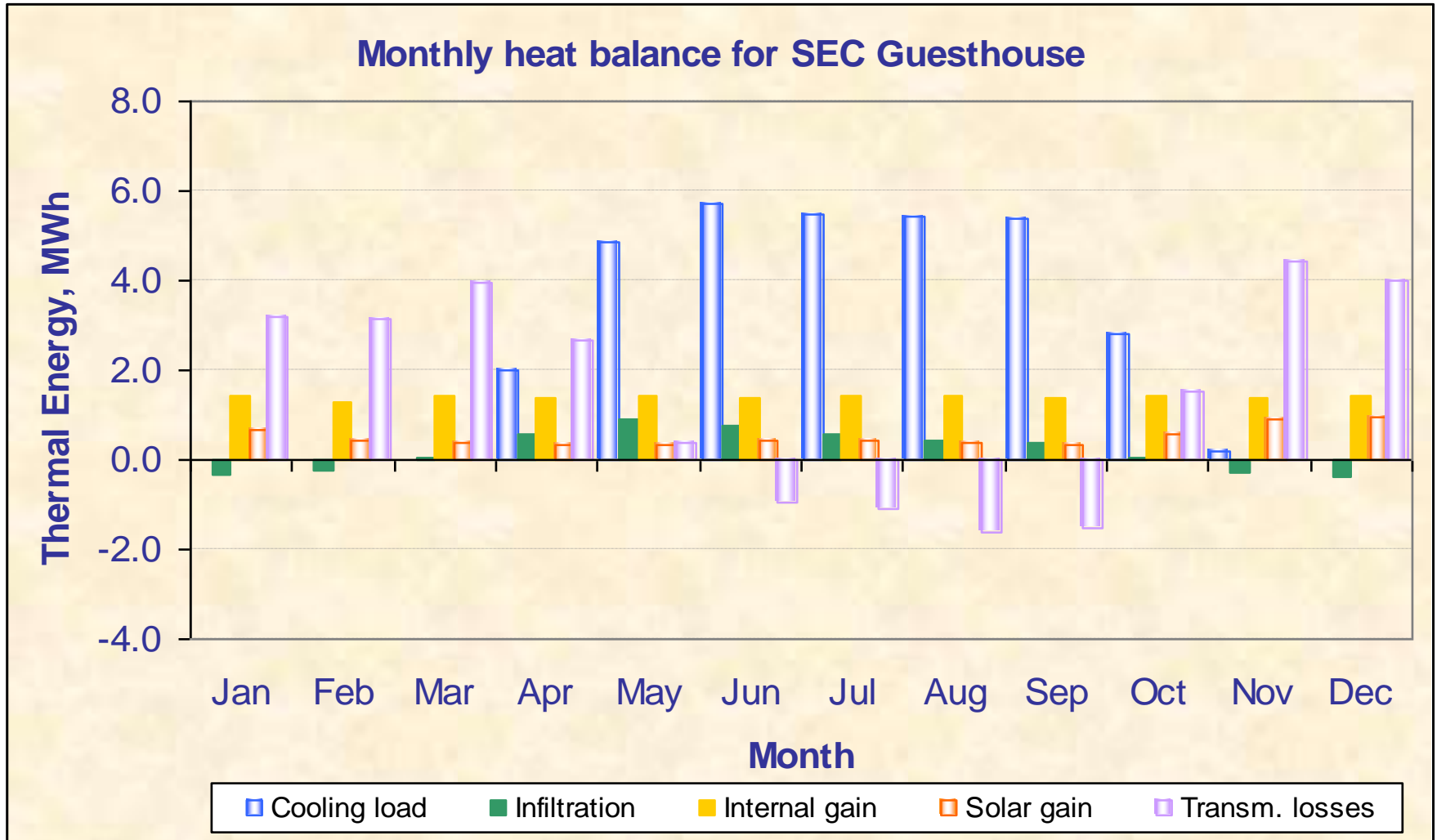


# Case study of a Guesthouse at Solar Energy Centre



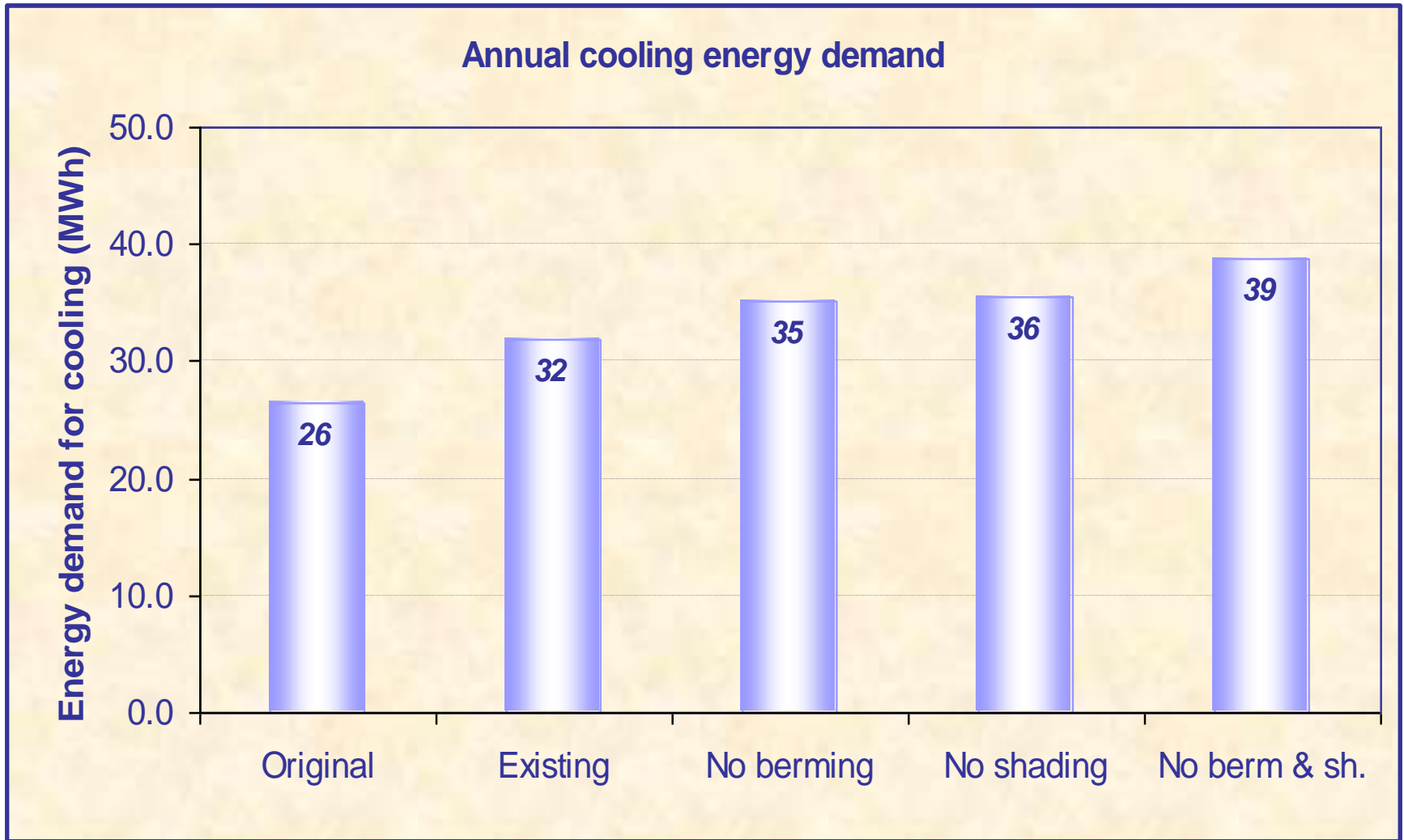


# Energy Analysis of the SEC Guesthouse - 1



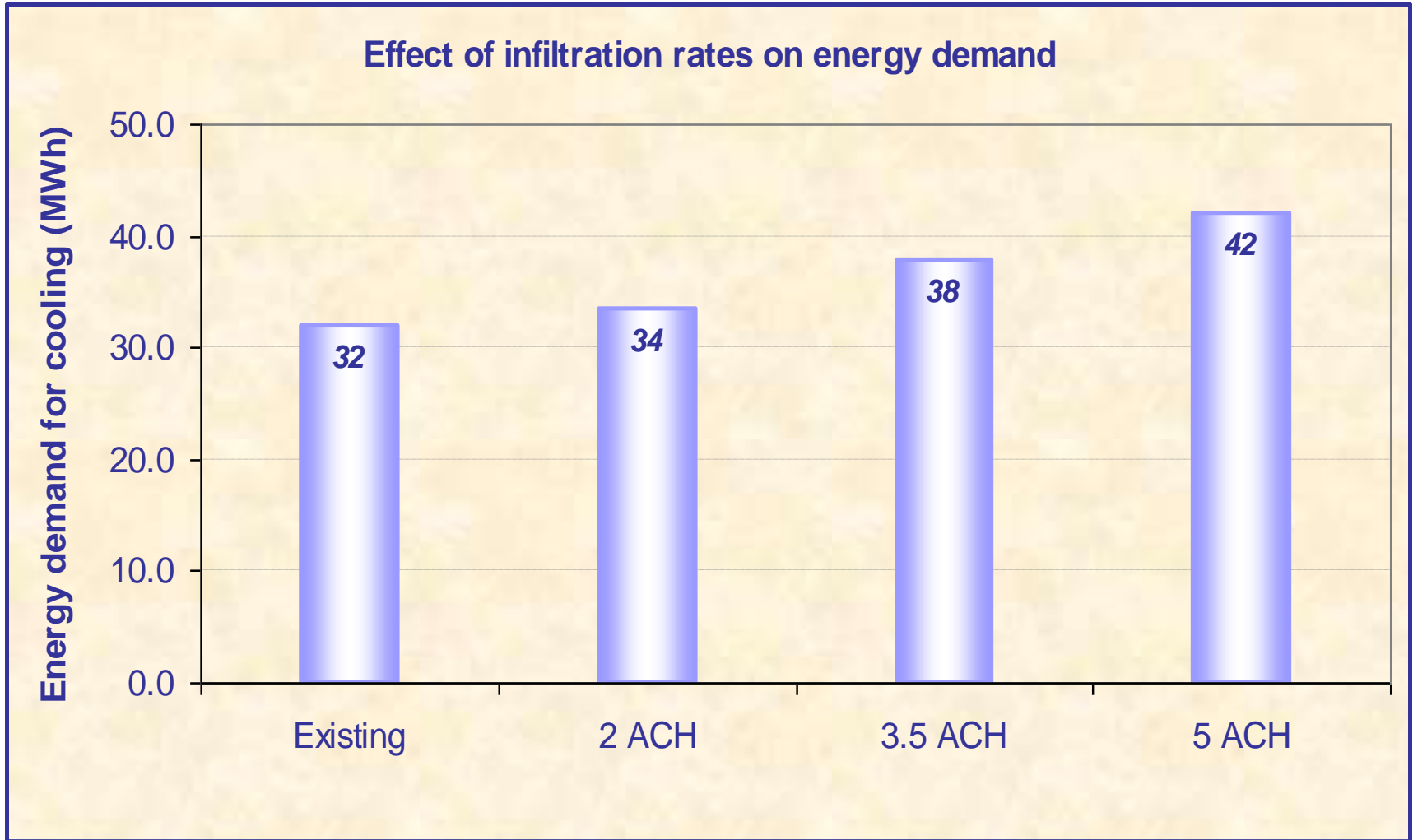


## Energy Analysis of the SEC Guesthouse - 2



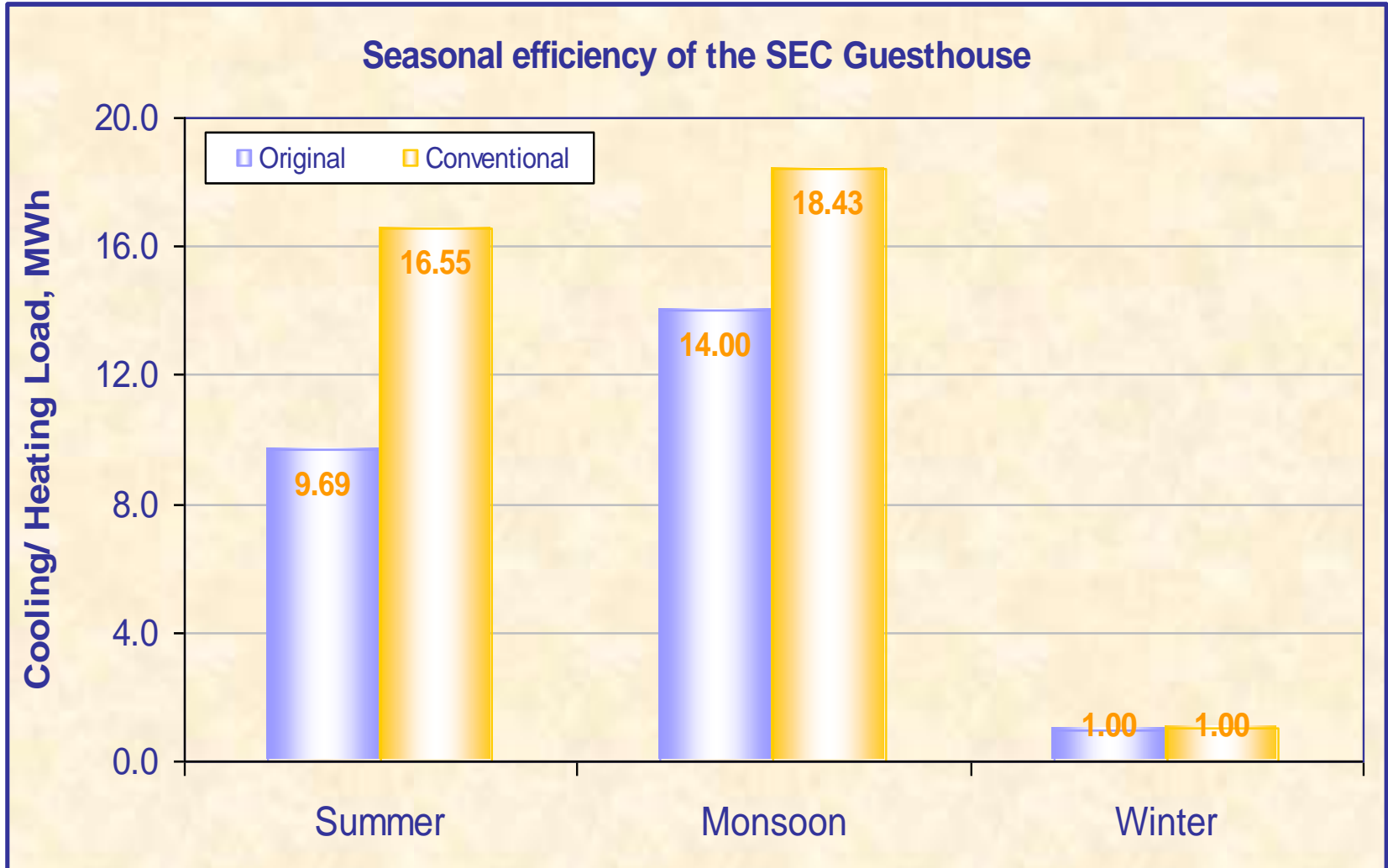


## Energy Analysis of the SEC Guesthouse - 3





# Energy Analysis of the SEC Guesthouse - 4



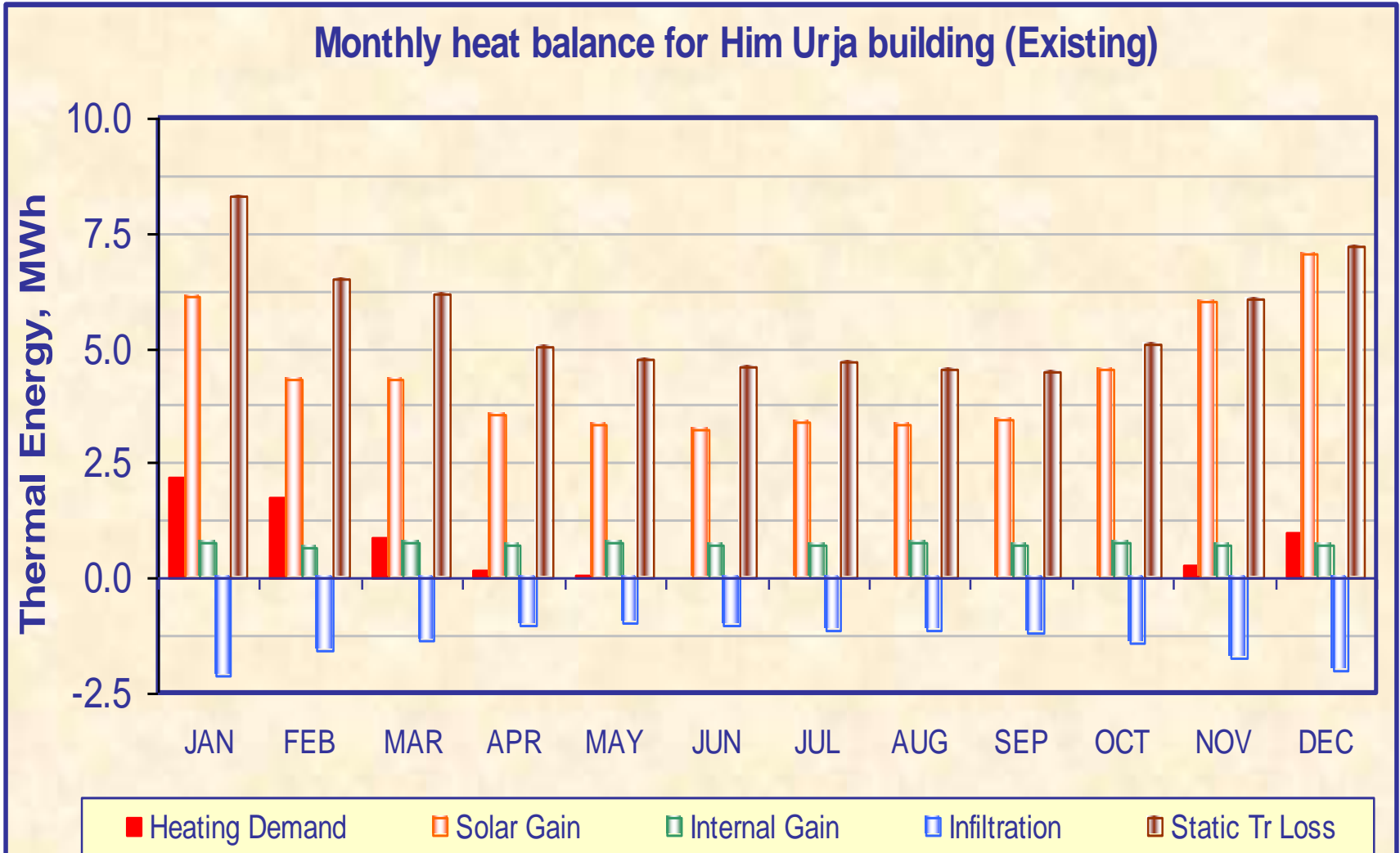


## Case study of Himurja office in Shimla



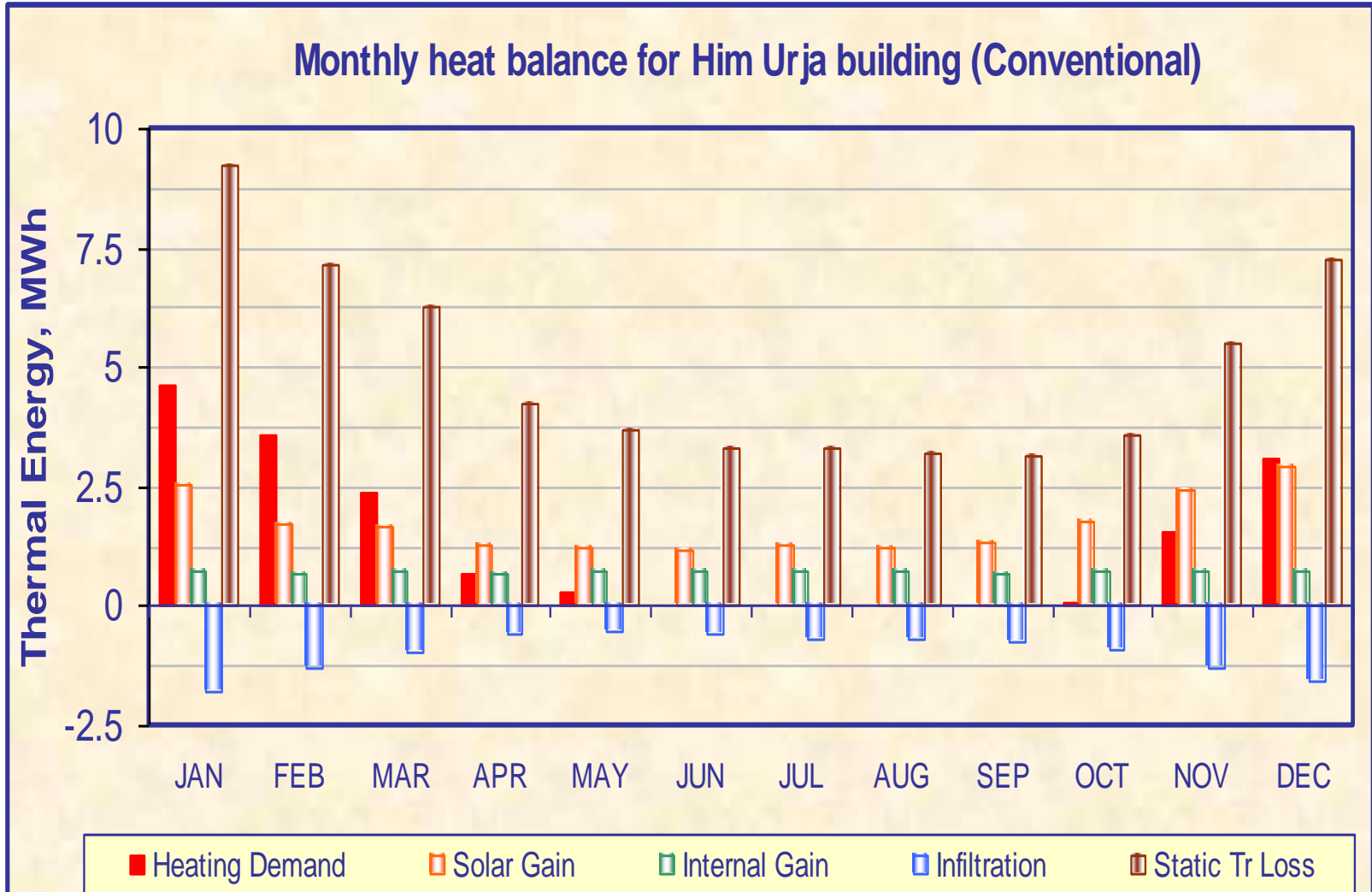


# Case study of Him Urja office in Shimla - 1



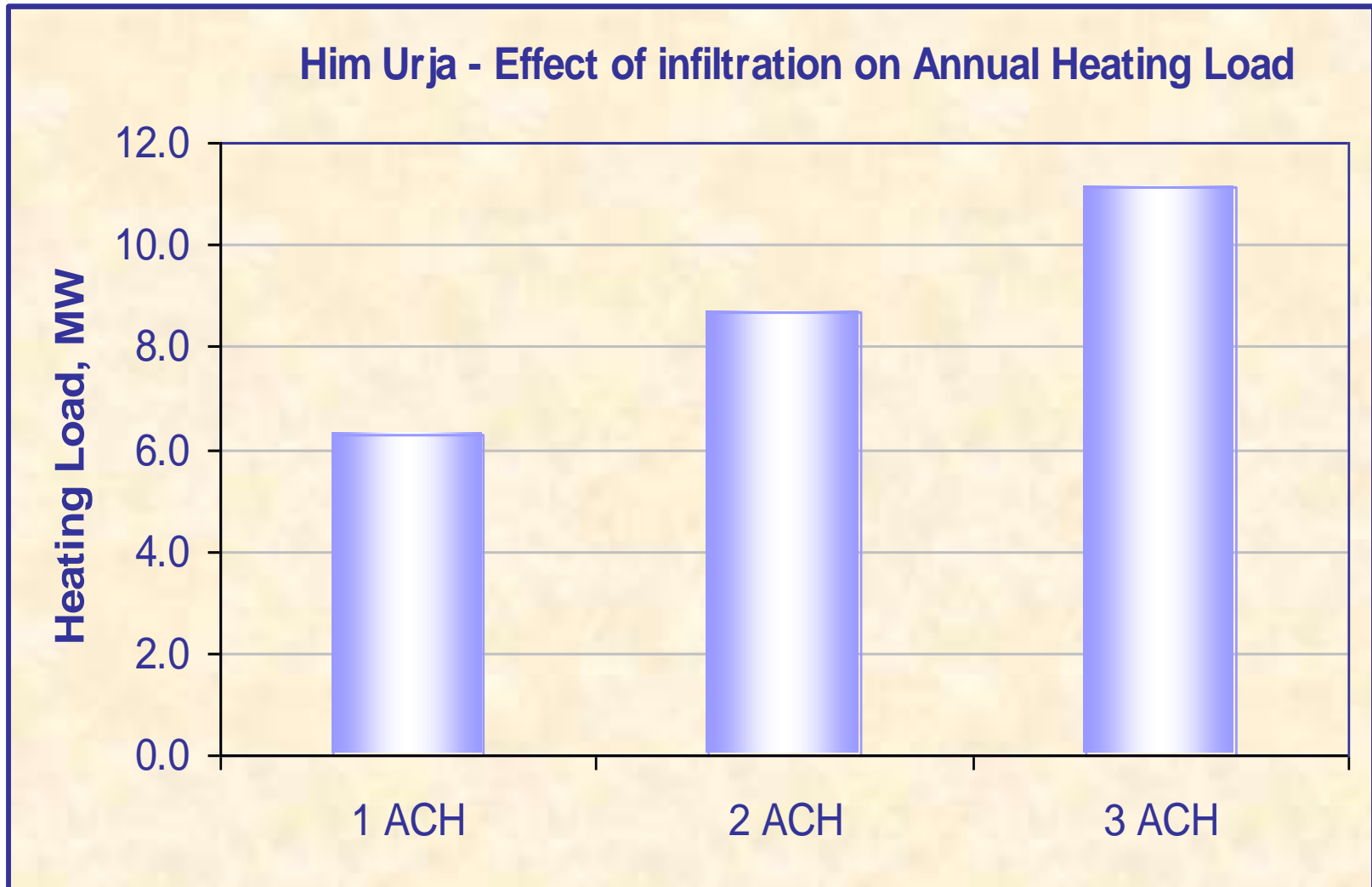


# Case study of Him Urja office in Shimla - 2



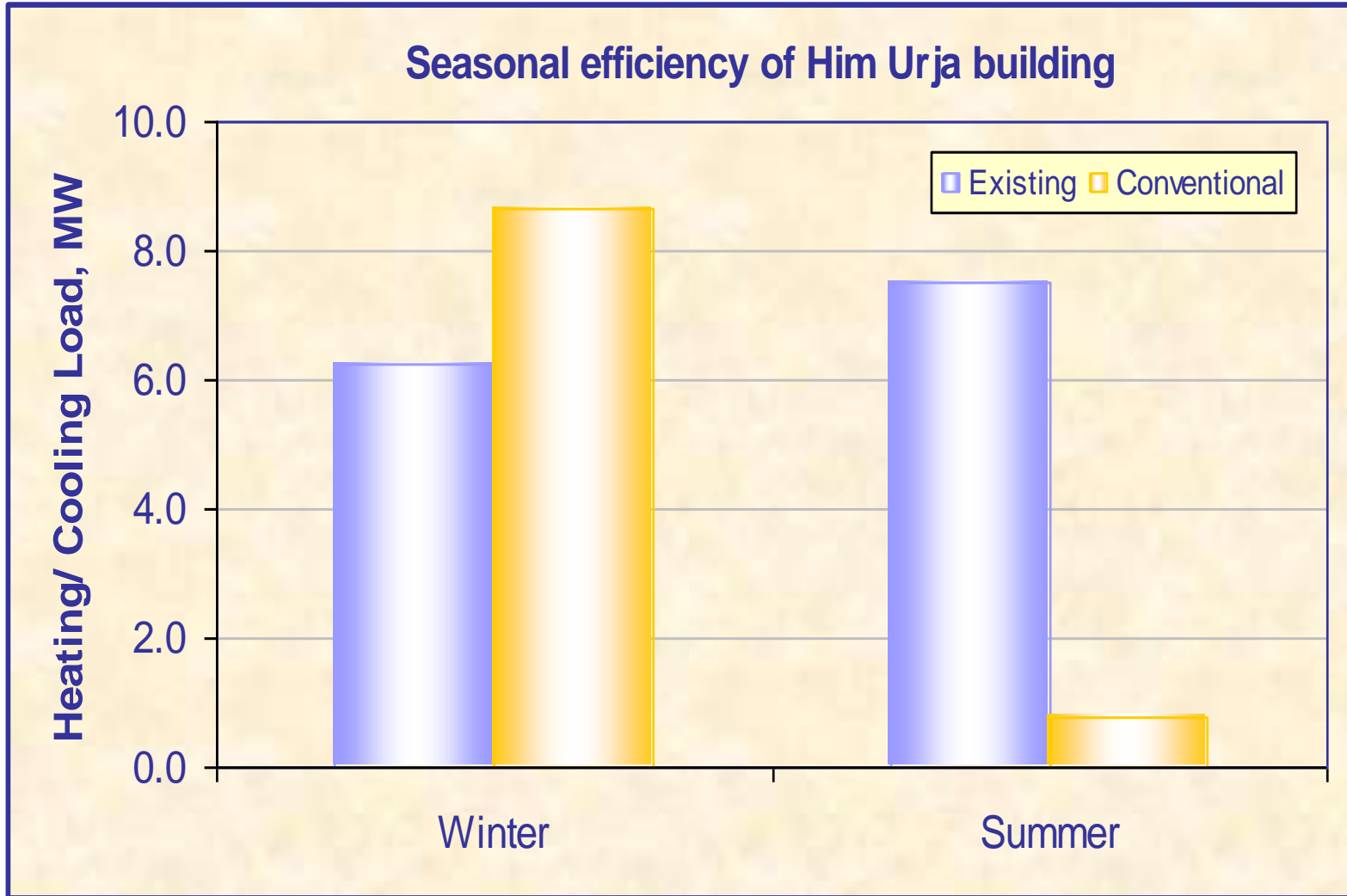


## Case study of Him Urja office in Shimla - 3





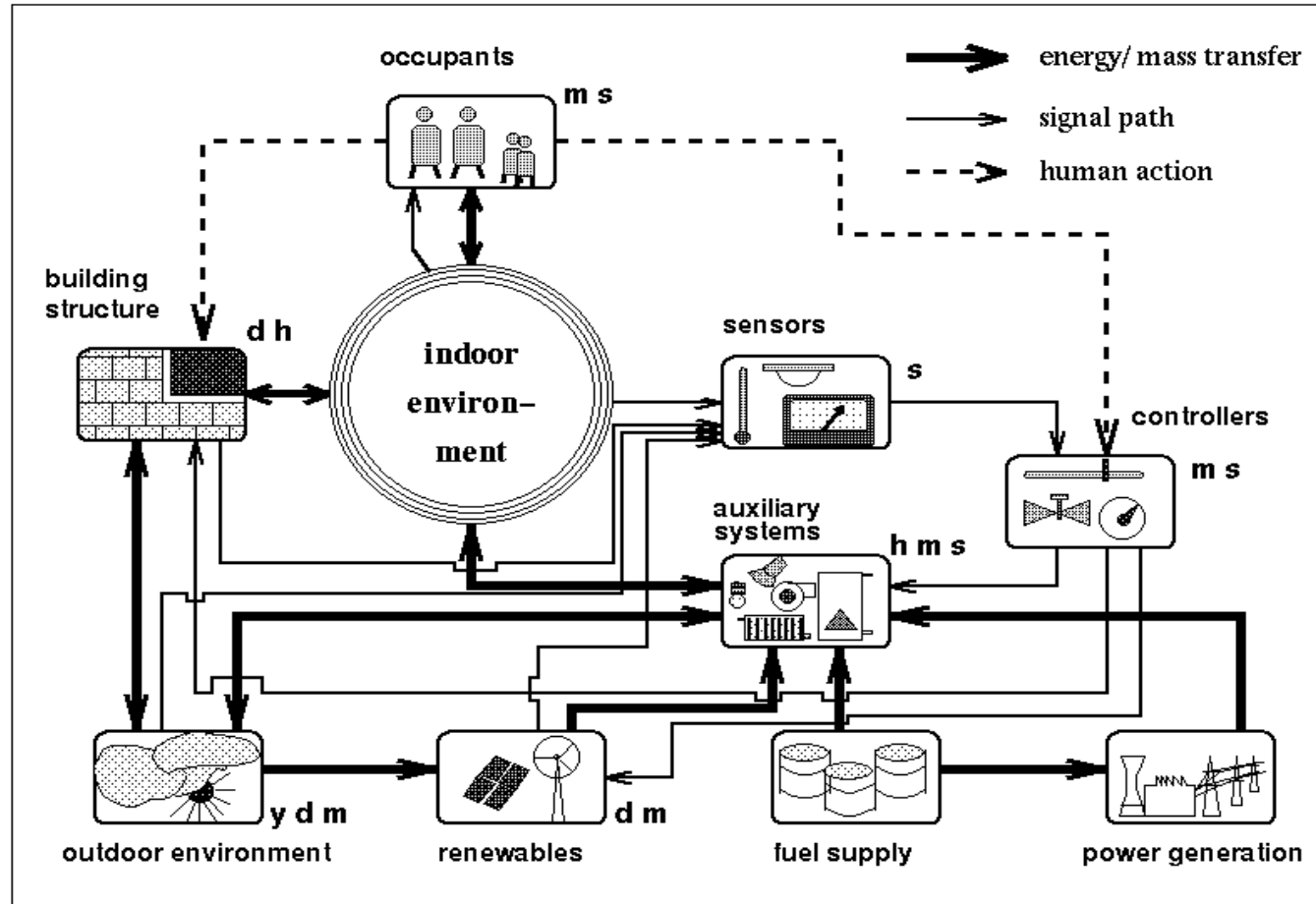
# Case study of Him Urja office in Shimla - 4





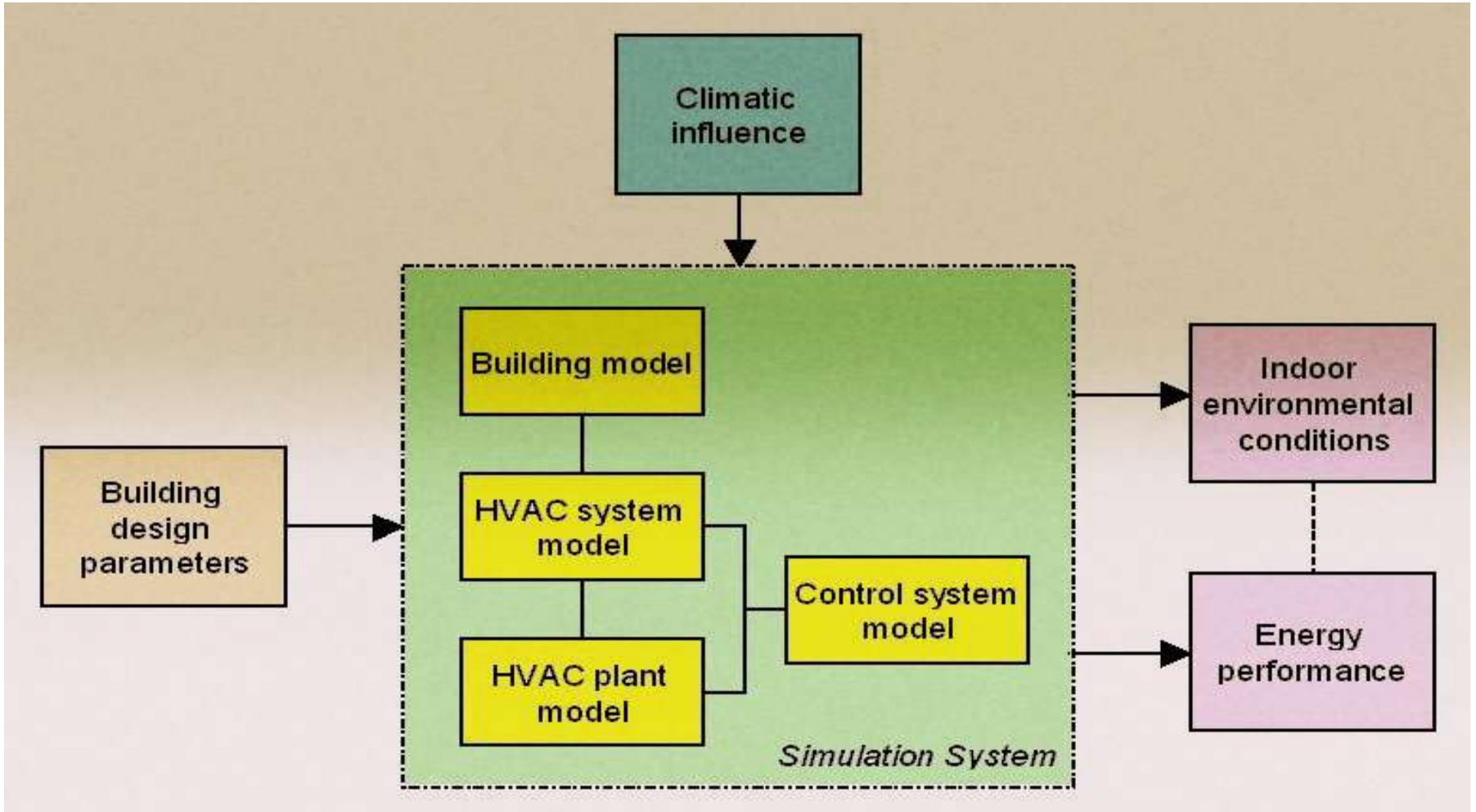
# Energy Modelling for Buildings and its Complexities

- ⊙ Overall design optimisation
- ⊙ Building energy performance analysis for energy optimisation
- ⊙ Cost analysis
- ⊙ Building energy management and control strategy





# Elements of Building Energy Simulation





## How does a Simulation Tool helps Save Energy

- ⊙ Building thermal simulation allows one to model a building before it is built or before renovations are started
- ⊙ Simulation allows various energy alternatives to be investigated and options compared to one another
- ⊙ Simulation can lead to an energy-optimized building or inform the design process
- ⊙ Simulation is much less expensive and less time consuming than experimentation (every building is different)



## Popular Simulation Tools

- ⊙ Energy - 10
- ⊙ HAP 4.1 (Hourly Analysis Programme)
- ⊙ TRACE 700 (Trane Air Conditioning Economics)
- ⊙ DOE 2.1E, 2.2 (Department of Energy)
- ⊙ Energy Plus
- ⊙ TRNSYS 17 (Transient System Simulation)



# Simulation Tool Capabilities - 1

	Energy-10	HAP	Trace	DOE-2	Energy Plus	TRNSYS
<b>Simplified Inputs</b>	●			○		
<b>CAD Interface</b>				○	●	●
<b>Interoperability</b>					●	○
<b>Lighting Design</b>				○	○	
<b>Daylighting</b>	●		●	●	●	
<b>High Performance Glass</b>	○	○	○	●	●	○
<b>Ventilated Façade</b>						
<b>Exterior Shading</b>	○	○	○	●	●	○
<b>“Cool” Roofs</b>	○	○	○	●	●	●

● indicates robust capability

○ indicates partial capability

blank indicates issue not addressed by program



## Simulation Tool Capabilities - 2

	Energy-10	HAP	Trace	DOE-2	Energy Plus	TRNSYS
Moisture Adsorption					●	○
Passive Solar Heat	○	○	○	●	●	●
Transpired Solar Walls						
Photovoltaics					●	●
Thermal Comfort				○	●	●
Radiant Cool / Heat					●	○
Displacement Ventilation						
IAQ			○			●
Desiccant Dehumidification				●	●	●
Duct Leakage	●	○	○	●		●
Heat Recovery Systems		○	○	●	●	

● indicates robust capability

○ indicates partial capability

blank indicates issue not addressed by program



## Simulation Tool Capabilities - 3

	Energy-10	HAP	Trace	DOE-2	Energy Plus	TRNSYS
Economizers/Advanced Control	○	○	○	●	●	○
Improved Unitary Equipment		○	○	●	●	●
VVT Systems				●	○	
VS Pumping		○	○	●	●	
Cooling Towers / Fluid Coolers		○	○	●	●	○
100% OA / Dual Path Systems					●	○
Combined Systems				○	○	●
Refrigeration				●		
System Sizing	○	●	●	●	●	
Code Compliance				●		

● indicates robust capability

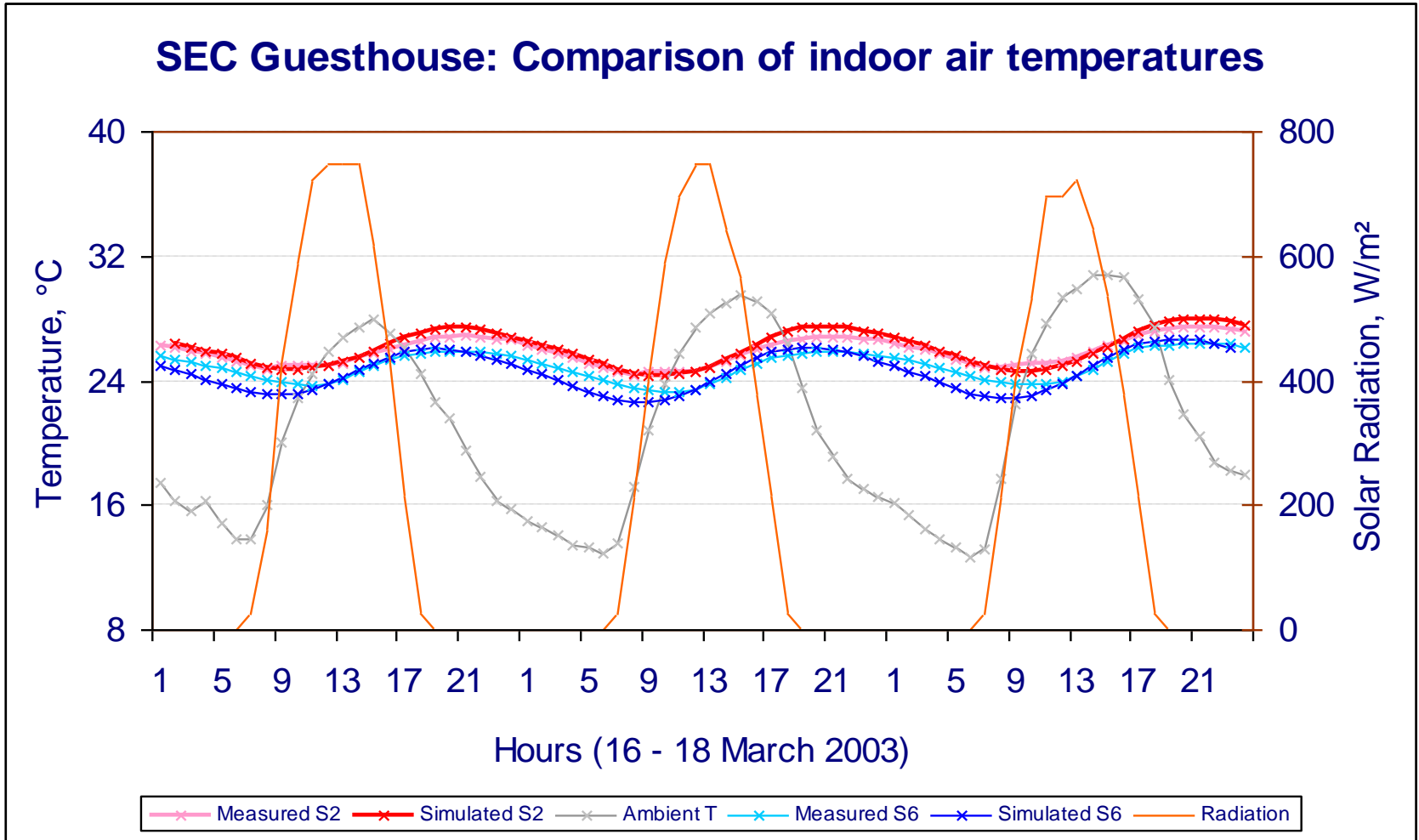
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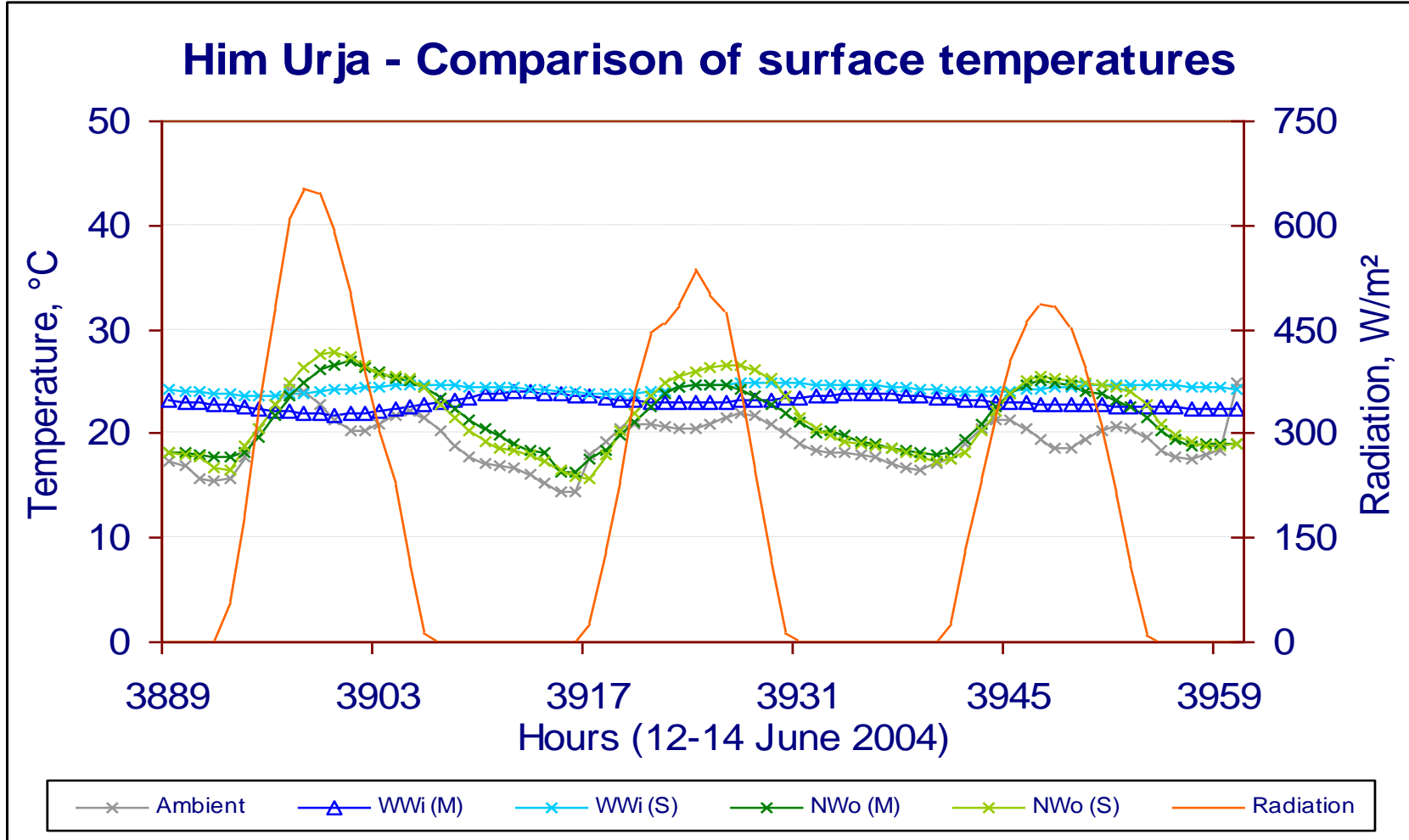


# Comparison of Simulated and Measured Indoor Temps.



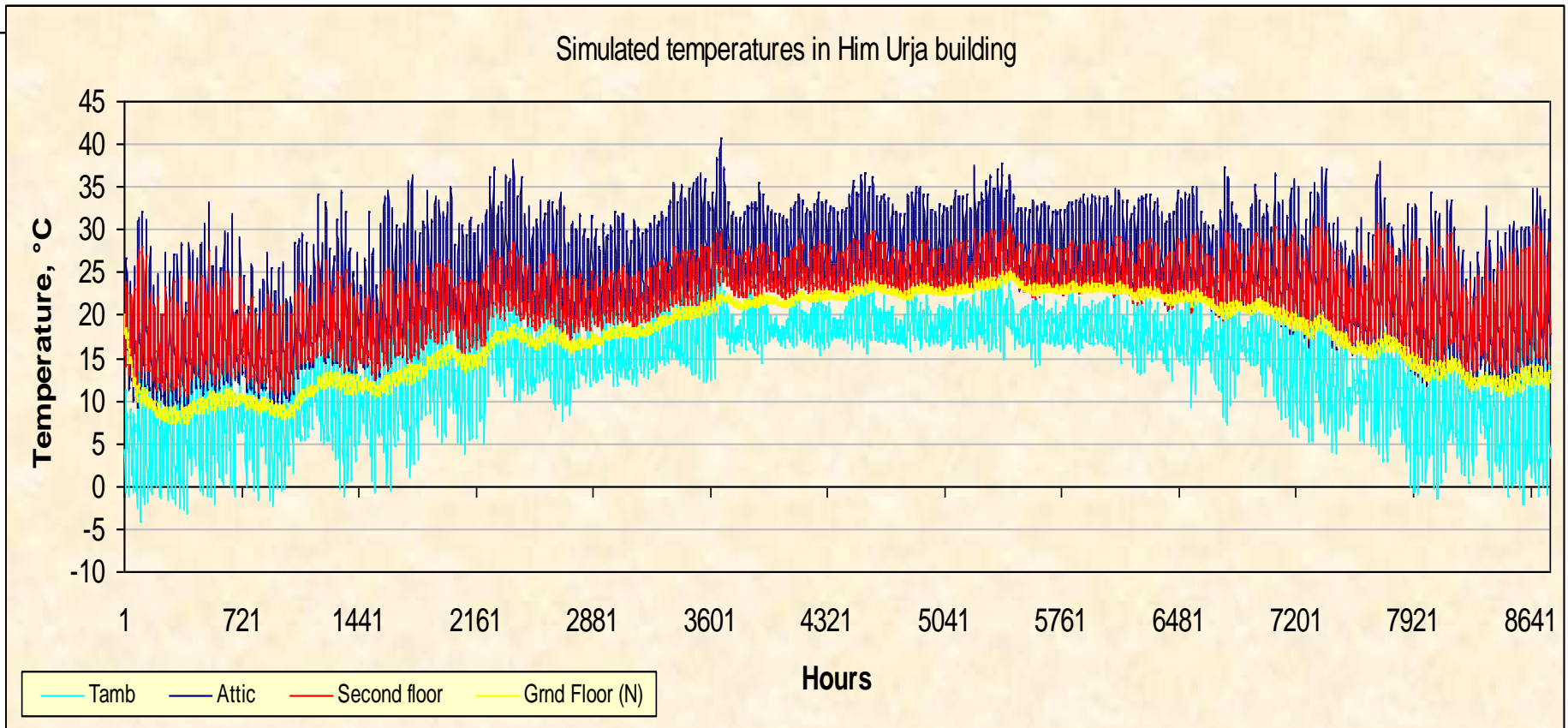


# Comparison of Simulated and Measured Indoor Temps.





# Hourly Simulation of Ambient and Indoor Temperatures





Solar building automatically shades itself from the Sun in Devonshire.  
The building has solar modules on it's roof that generate 25 kW of power





## Conclusions

- ⊙ There is a huge potential of energy saving in buildings. Utilising this potential will reduce the gap between energy demand and supply
- ⊙ Solar architecture helps create environment-friendly buildings with low energy demand
- ⊙ A building is a very complicated dynamic system, but it can be studied by using a suitable 'simple' or 'comprehensive' simulation model
- ⊙ Building thermal simulation is an excellent tool to optimise the energy efficiency of a building
- ⊙ A variety of simulation programmes are available in the market and a majority of them have matured over the years
- ⊙ It is recommended to employ a comprehensive building energy simulation model in the context of design support



**Thank you**