Energy Performance Simulation of Hotel in Greece using the EnergyPlus software with the aim of upgrading

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Objectives

To improve energy performance of existing hotel
- by implementation of retrofit interventions supporting energy saving
- by application of renewable energy technology supporting energy production

Introduction

The contribution of tourism to GDP in Greece reaches 16.4% (SETE, 2012) with hotel sector contributing 45.3% of tourist GDP (IOBE).

However, hotels can have adverse environmental effects due to their excessive energy consumption. The annual average total energy consumption in hotels is 273 kWh/m2 in Greece, the second highest among all categories of buildings (Santamouris et al 1996).

Initiatives have been taken for sustainable development . In this direction hoteliers implement effective innovations and retrofitting systems which can have environmental and financial benefits.

Case Study

Hotel building 3* category
- constructed in 1980
- 4 floors with total area of 3900 m², 93 rooms included
- elongated shape in North-South axis with North façade
- electricity used for lighting, electrical equipment and air-conditioning for air cooling only
- located in Heraklion, Crete of Greece

Fig. 1: Daily Dry Temperature in Heraklion in DView software

Materials and Methods

Assessment tools used :
- Google SketchUp & Legacy Open Studio plugin
  - division in 27 thermal zones (T.O.T.E.E. Protocols)

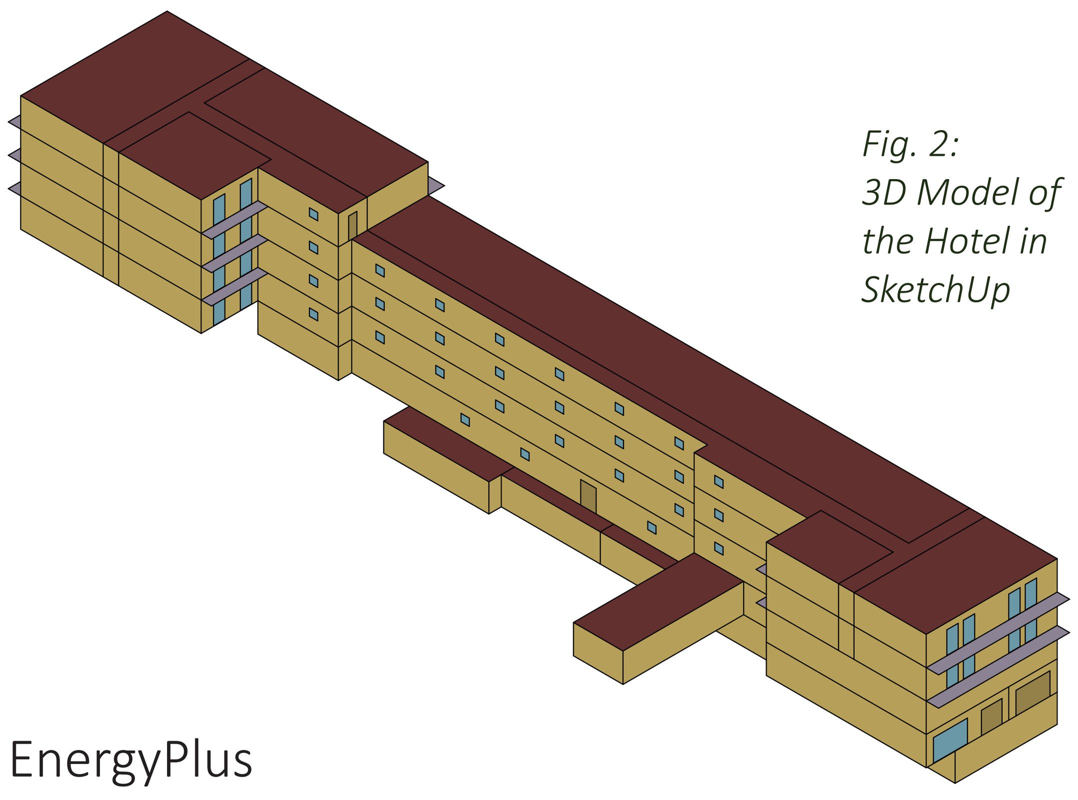

Fig. 2: 3D Model of the Hotel in SketchUp

- EnergyPlus

  Imported parameters:
  - Building materials (T.O.T.E.E. Protocols)
  - Internal gains (ASHRAE, IES), zones airflows, HVAC
  - Schedules (according to hotel management info)

Materials and Methods

Proposed scenarios:
- *Night Vevntilation*
  - decrease the value of day ventilation
  - increase the value of night ventilation
- *Low-emissivity Glazing*
  - external layer: Low-e 3mm, G-Value: 0.837→0.63
  - air cavity filling → Argon 12mm
- *External Insulation*
  - external layer → expanded polisteryne plates
  - exterior walls U-value: 1.66 → 0.47
  - exterior roof U-value: 1.94 → 0.49
- *Photovoltaic system*
  - interconnected PV system -net metering-
    94 PV monocrystalline silicon panels of 245 Watt inclination 30°

Cost viability
- research for technology systems that implement the above scenarios
- estimation of payback period for each one

Results

!!! Energy Consumption = Ideal Electrical Energy Consumption Required

Base Case
- Total Energy Consumption: 36.29 kWh/m²/year

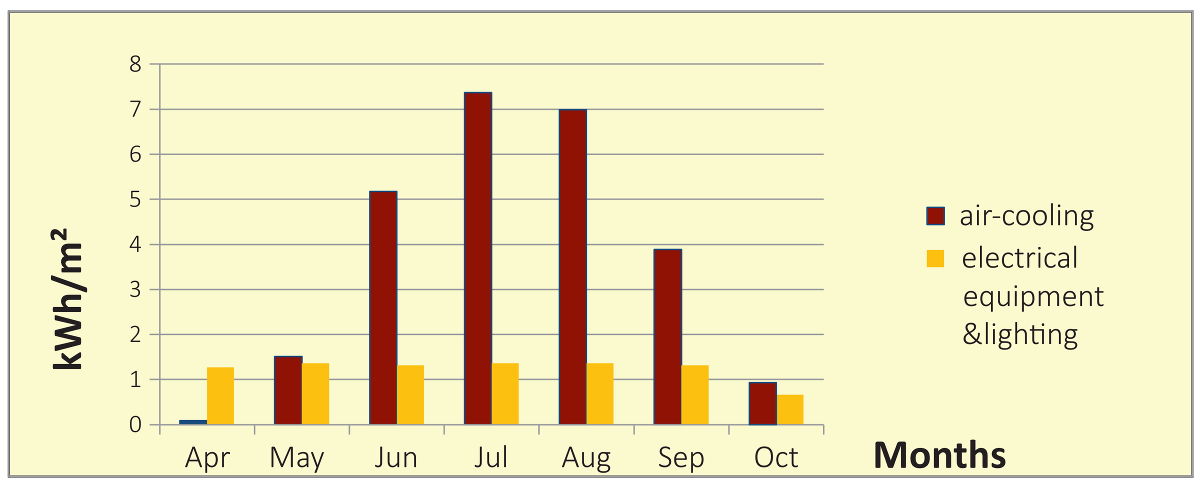

Fig. 3: Monthly Energy Consumption

Night Ventilation (Scenario 1)

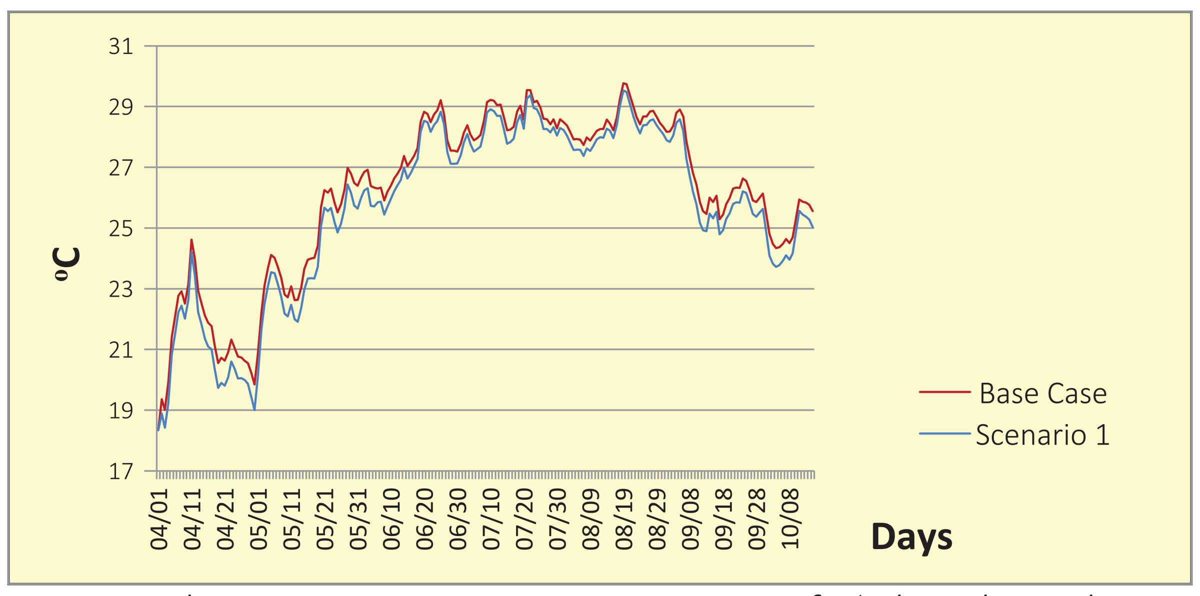

Fig. 4: Daily Mean Temperature in West Rooms of 1st Floor thermal zone

- **5% /year** reduction in Energy Consumption
- Excepted payback period: 19 years (EBMS-Window Control System)

Low-e Glazing (Scenario 2)

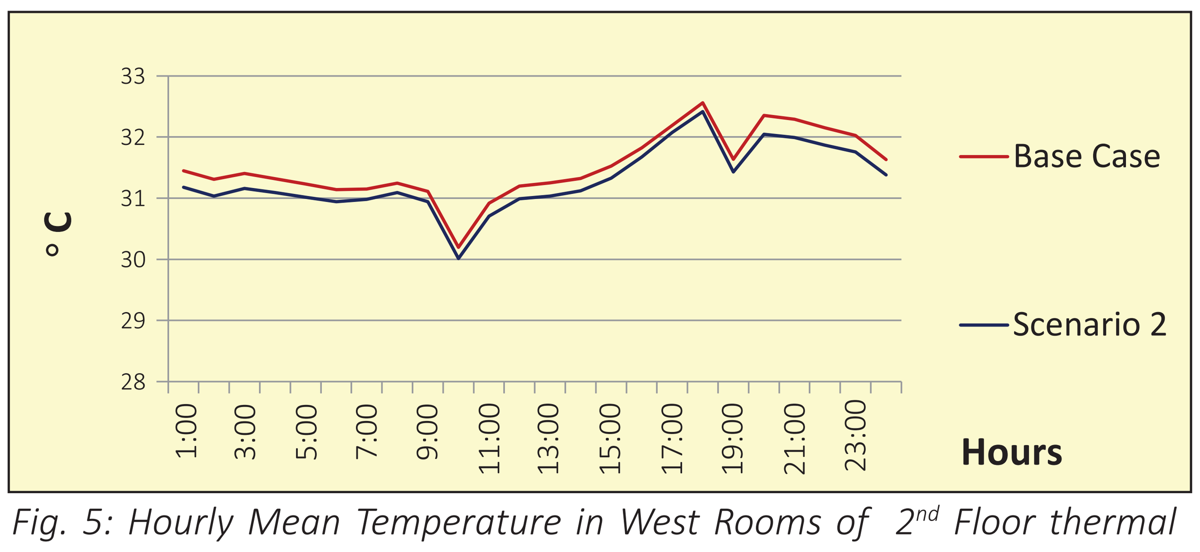

Fig. 5: Hourly Mean Temperature in West Rooms of 2nd Floor thermal zone, highest radiation day: 12/07 (Dview software)

- **3.36% /year** reduction in Energy Consumption
- Excepted payback period: 25 years

Results

External Insulation (Scenario 3)

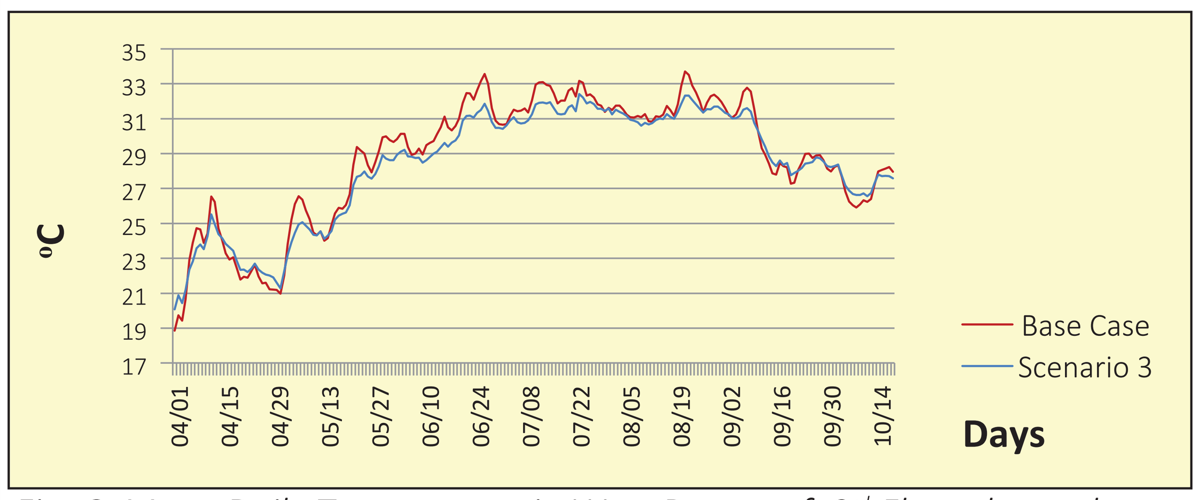

Fig. 6: Mean Daily Temperature in West Rooms of 3rd Floor thermal zone

- **18.2% /year** retduction in Energy Consumption
- Excepted payback period: 26 years

PV System (Scenario 4)
- Annual production 8.7 kWh/m² → **23.7%/year** of the Total Energy Consumption
- Excepted payback period: 16 years

All Interventions simultaneously (Scenario1&2&3&4)
- **49.9%/year** reduction in Total Energy Consumption

Months	Required Energy Consumption (kWh/m2)		Generated Energy by PV System (kWh/m2)	Final Energy Consumption Required (kWh/m2)
	Before	After		
January	0	0	0.51	
February	0	0	0.45	
March	0	0	0.67	
April	1.43	1.32	0.72	
May	3.01	1.94	0.81	
June	6.81	4.75	0.88	
July	9.16	6.85	0.93	
August	8.75	6.68	0.95	
September	5.46	4.00	0.89	
October	1.67	1.25	0.90	
November	0	0	0.49	
December	0	0	0.41	
Total	36.29	26.79	8.61	18.18

Table : Monthly Energy Consumption

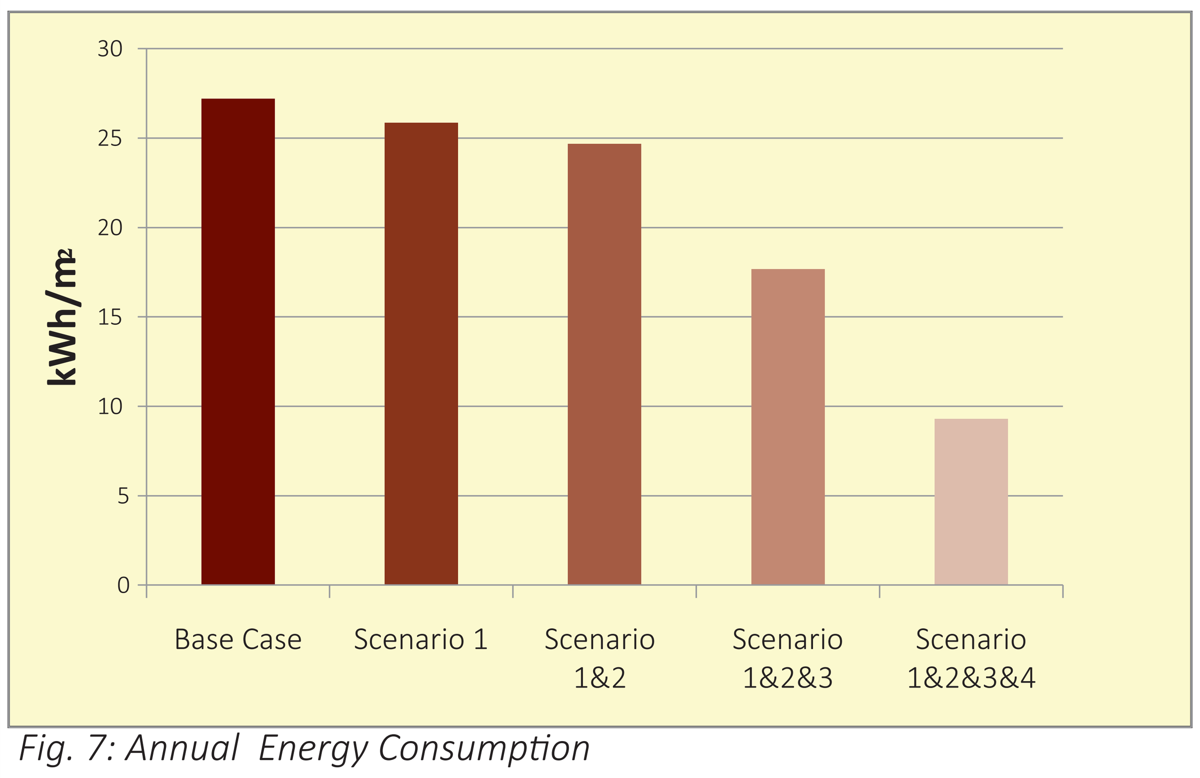

Fig. 7: Annual Energy Consumption

- Excepted payback period: 21 years

Conclusions

- Most efficient solution: Scenario 4 (23.7% energy saving)
- Cost viable solution: Scenario 4 (16 years payback period)
- Most environment friendly solution: the simultaneous implementation of all the proposed interventions (approximately 50% energy saving)

References

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