
Contents

Preface	xi
Nikos KAMPELIS	

List of Acronyms	xv
Nikos KAMPELIS	

Chapter 1. The Role of Smart Grids in the Building Sector	1
Denia KOLOKOTSA	

1.1. Smart and zero-energy buildings	2
1.1.1. Smart metering	3
1.1.2. Demand response (DR)	4
1.1.3. Distributed systems	6
1.2. Smart and zero-energy communities	6
1.3. Conclusion and future prospects	10

Chapter 2. Integrated Design (ID) Towards Smart Zero-energy Buildings and Smart Grids	13
--	----

Theoni KARLESSI, Pietro MURATORE, Luca VENEZIA, Laura STANDARDI,
Klemens LEUTGÖB and Anne Sigrid NORDBY

2.1. Introduction	15
2.2. Methodology	16
2.3. Integrated design in smart and zero-energy buildings	17
2.4. ID process principles and guidelines	19
2.4.1. Benefits	22
2.4.2. Barriers	23

2.5. Scope of services	24
2.6. Remuneration models	26
2.7. Application of evaluation tools	28
2.8. Sustainability certification	29
2.9. Consultancy and quality assurance	30
2.10. Measurement of design quality criteria.	31
2.11. Defining a client's objectives	33
2.11.1. Capital cost reduction.	34
2.11.2. Delivery risk reduction	35
2.12. Defining the tenant's objectives	35
2.12.1. Operational cost reduction	36
2.12.2. Building unsuitability risk reduction	36
2.13. Best practice sites	37
2.13.1. Alexandros N. Tombazis and Associates Architects S.A. office building	37
2.13.2. APIVITA Commercial and Industrial S.A.	42
2.13.3. Stavros Niarchos Foundation Cultural Center	46
2.13.4. Karelas Office Park	50
Chapter 3. Data Analysis and Energy Modeling in Smart and Zero-energy Buildings and Communities	55
Nikos KAMPELIS, Konstantinos GOBAKIS, Vagias VAGIAS, Denia KOLOKOTSA, Laura STANDARDI, Daniela ISIDORI, Cristina CRISTALLI, Fabio Maria MONTAGNINO, Filippo PAREDES, Pietro MURATORE, Luca VENEZIA, Marina Kyprianou DRACOU, Alaric MONTENON, Andri PYRGOU, Theoni KARLESSI and Mat SANTAMOURIS	
3.1. Energy signature for the NTL of Cyprus Institute	55
3.2. Athalassa Campus and the NTL building	57
3.2.1. Methodology	61
3.2.2. Description of the Novel Technology case study	63
3.2.3. Data exploration	68
3.2.4. Correlation matrix	71
3.2.5. Regression model	72
3.3. Linear Fresnel solar collector at the NTL building, Cyprus Institute . .	85
3.3.1. Development of the NTL model	90
3.3.2. Energy performance analysis in the NTL	92
3.3.3. Discussion	100
3.4. Conclusion	101

Chapter 4. On the Comparison of Occupancy in Relation to Energy Consumption and Indoor Environmental Quality: A Case Study	103
Margarita Niki ASSIMAKOPOULOS, Nikolaos BARMPARESOS, Alexandros PANTAZARAS, Theoni KARLESSI and Siew Eang LEE	
4.1. Introduction	103
4.2. Methodology	104
4.3. Description of the case building.	105
4.4. Description of the experimental procedure	105
4.5. Results.	106
4.5.1. Investigation of energy consumption and indoor air quality.	106
4.5.2. Days of special interest – high occupancy	110
4.5.3. Days of special interest – increased energy consumption	112
4.6. Discussion and concluding remarks	112
 Chapter 5. Indoor Environmental Quality and Energy Consumption Assessment and ANN Predictions for an Integrated Internet-based Energy Management System Towards a Zero-energy Building	115
Denia KOLOKOTSA	
5.1. Introduction.	115
5.2. Description of the SDE buildings.	116
5.2.1. General information	116
5.2.2. Monitoring activities for SDE 3	118
5.3. The power loads and hourly energy consumption	118
5.4. Indoor environmental quality	118
5.4.1. Thermal comfort assessment – time series analysis.	127
5.4.2. Indoor air quality	129
5.4.3. The indoor illuminance levels	129
5.5. Cross correlation.	135
5.6. Prediction using artificial neural networks (ANN).	136
5.6.1. Prediction of outdoor temperature	137
5.6.2. Prediction of relative humidity	138
5.6.3. Prediction of power loads	139
5.7. Specifications for an integrated internet-based energy management system toward a zero-energy building.	141
5.7.1. The phases of the internet-based energy management system for SDE	142
5.7.2. Integration of software and prediction algorithms.	149
5.8. Conclusion	149

Chapter 6. Objective and Subjective Evaluation of Thermal Comfort in the Loccioni Leaf Lab, Italy	151
Marina LASKARI, Francesco CARDUCCI, Daniela ISIDORI, Martina SENZACQUA, Laura STANDARDI and Cristina CRISTALLI	
6.1. Introduction	151
6.2. Background information	152
6.3. Methodology	153
6.3.1. Subjective measurements	154
6.3.2. Objective measurements	154
6.3.3. Combined analysis of objective and subjective measurements	155
6.3.4. User preferences and satisfaction with internal conditions	157
6.4. Collection of building background data	157
6.5. Collection of monitored data	160
6.6. Right-Now questionnaire survey	162
6.7. Results	166
6.7.1. Analysis of MyLeaf measurements	167
6.7.2. Analysis of Comfort Meter measurements	173
6.7.3. Analysis of Right-Now survey responses	176
6.7.4. Respondent characteristics and thermal comfort	184
6.7.5. Combined analysis of objective and subjective measurements	187
6.7.6. Correlation analysis for MyLeaf and Right-Now survey measurements	190
6.7.7. Correlation analysis for objective and subjective measurements (Research for Innovation office space)	191
6.7.8. Comparison between objective and subjective thermal sensation measurements	195
6.7.9. Determination of acceptable and unacceptable conditions	196
6.8. Conclusion	197
 Chapter 7. Smart Meters and User Engagement in the Leaf House	199
Niki GAITANI	
7.1. Introduction	199
7.2. Methodology	200
7.3. Analysis of user engagement	201
7.3.1. Development of the questionnaire	201
7.3.2. Leaf House case study	203
7.4. Results	210
7.4.1. Demographics, socioeconomics	210
7.4.2. Physiological, social and behavioral aspects	212

7.4.3. Information level	214
7.4.4. Health and comfort	215
7.4.5. Living situation	217
7.5. Conclusion	218
Chapter 8. Integration of Energy Storage in Smart Communities and Smart Grids	221
Denia KOLOKOTSA, Nikos KAMPELIS, Angeliki MAVRIGIANNAKI, Marco GENTILOZZI, Filippo PAREDES, Fabio Maria MONTAGNINO and Luca VENEZIA	
8.1. Energy storage systems in smart grids	223
8.1.1. Electrical and electrochemical energy storage in smart grids	223
8.1.2. Mechanical energy storage in smart grids	228
8.1.3. Thermal energy storage in smart grids	231
8.2. Energy storage and smart grids: case studies	234
8.2.1. Case study 1: the Leaf Community smart grid energy storage system	234
8.2.2. Case study 2: energy storage of CSP and integration with smart grids.	244
8.3. Conclusion and future prospects	261
Conclusion and Recommendations	263
Nikos KAMPELIS	
References	267
List of Authors	283
Index	287