

CALIFORNIA COMMERCIAL END-USE SURVEY

Chapter 10

CONSULTANT REPORT

Prepared For:
California Energy Commission

CALMAC Study ID: CEC0023.06

Prepared By:
Itron, Inc.



This report is dedicated to the memory of Alan Fields, who served as the project manager until his death on February 3, 2004. Alan was a valued colleague and dear friend. He will be missed by his associates at Itron, the California Energy Commission, and the energy industry.

Prepared By:

Itron, Inc.

Subcontractors:

KEMA

ADM Associates

James J. Hirsch & Associates

Contract No. 300-00-002

Prepared For:

California Energy Commission

Peg A. Pigeon-Bergmann

Contract Manager

Mohsen Abrishami

Mark Ciminelli

Project Managers

Sylvia Bender

Manager

Demand Analysis Office

Valerie Hall

Deputy Director

Energy Efficiency & Demand Analysis Division

B.B. Blevins

Executive Director

DISCLAIMER

This report was prepared as the result of work sponsored by the California Energy Commission. It does not necessarily represent the views of the Energy Commission, its employees or the State of California. The Energy Commission, the State of California, its employees, contractors and subcontractors make no warrant, express or implied, and assume no legal liability for the information in this report; nor does any party represent that the uses of this information will not infringe upon privately owned rights. This report has not been approved or disapproved by the California Energy Commission nor has the California Energy Commission passed upon the accuracy or adequacy of the information in this report.

TABLE OF CONTENTS

Executive Summary	1
E.1 Introduction	1
Overview	1
Background	1
Project Objectives	1
E.2 Summary of the Project Scope and Methods	2
Survey Design	2
Collection of On-Site Survey Data	2
Collection of Information on Energy Usage for Sampled Sites	2
Development of Demand Analysis System	3
Analysis of Hourly End-Use Energy Consumption at the Premise Level	3
Analysis of Segment-Level End-Use Energy Consumption	4
E.3 Overview of Statewide Energy Usage	5
Definitions	5
Results	7
E.4 Recommendations	14
Lessons Learned	14
Recommendations for Additional Commercial Sector Research	15
Chapter 1: Introduction	17
1.1 Overview	17
1.2 Background	17
1.3 Project Objectives	17
1.4 Summary of the Study	18
Survey Design	18
Collection of On-Site Survey Data	18
Development of Energy Consumption Data for Sampled Sites	19
Development of Demand Analysis System	19
Analysis of Premise-Level End-Use Energy Consumption	20
Analysis of Segment-Level End-Use Energy Consumption	21
1.5 Organization of the Report	22
CEUS Report Structure	22
CEUS Report Appendices	22
Affiliated Reports from the CEUS Project	23
Chapter 2: Sample Design	25
2.1 Overview	25
2.2 Sampling Unit	25
2.3 Sample Frame for IOU Survey	26
2.4 Sample Frame Stratification	28
2.5 Sample Size and Sample Allocation	31
Sample Size	31

Sample Allocation	31
2.6 Development of Final Sample Design for IOU Survey	33
Allocation Methods	33
Alternative Stratification Approaches	34
Final Sample Design.....	36
2.7 SMUD Sample Design	41
Sample Frame	41
SMUD Sample Design.....	42
Chapter 3: Survey Design and Implementation.....	45
3.1 Overview	45
3.2 Survey Instrument Design	45
Non-HVAC Equipment End-use Mapping	46
Energy Efficiency Measure Detail	46
eQUEST Design Development Wizard Features	47
3.3 Customer Recruitment Protocols	48
Introduction	48
Recruitment Letter	49
Recruitment Phone Calls	49
Recruitment Disposition Report Requirements	51
3.4 Survey Protocols	54
Introduction	54
Premise as the Unit of Analysis	55
Protocols for Linking Meters to Premises.....	55
Defining Component Survey Areas.....	55
Protocols for Determining Business Type	57
Protocols for Dealing with Large Sites and Limited Access	57
Describing HVAC Zoning, Mechanical Systems and Equipment for HVAC and non HVAC End Uses	60
Site Physical Characteristics.....	61
Recording Technical Information	62
Supplemental Information	63
Key Elements of Business Operations.....	63
Interview Techniques.....	64
Quality-Control Procedures for Field Surveyors.....	65
3.5 Short-Term Metering Protocols.....	66
Overall STM Objectives	66
STM Targets	66
General Issues/Protocols.....	70
3.6 Surveyor Training.....	71
Day 1	71
Day 2-3	72
Day 4	72
3.7 Survey Pretests	72
3.8 Survey Implementation Process	73
Overall Process	73

Initial Sample	74
Recruiting Protocol	75
Site Information Sheets.....	75
Weekly Disposition Reports	75
Quality Control Procedures.....	76
Data Entry.....	76
Data Cleaning	79
On-Site Survey Form Delivery	79
Inventory Reports	79
3.9 Completed Samples	79
On-Site Survey Sample Targets and Actual Counts	80
Premises with Interval-Metered Data Available	81
Premises with Short-Term Metering Data	82
Chapter 4: Electric and Natural Gas Consumption Data	85
4.1 Overview	85
4.2 Validation and Analysis of Billing Data	86
4.3 Calendarization of Consumption Data.....	87
4.4 Developing Sample Recruitment Pools.....	88
4.5 Gas Consumption for SCE and SMUD Premises.....	89
4.6 Customer Information Sheet (CIS).....	90
4.7 Meter Reconciliation Issues	92
4.8 Mapping Interval-Metered Data to Premises	92
4.9 Post-Survey Meter Reconciliation	93
Chapter 5: Simulation Modeling Software	95
5.1 Introduction	95
5.2 DrCEUS System Design Overview.....	95
5.3 Site Processing Mode	97
Site Processor Structure	97
Site Processor Results.....	98
Energy Efficiency Measure Analysis in the Site Processor	101
Utility Billing Analysis in the Site Processor	103
5.4 Segment Processing Mode.....	104
5.5 Applications of the CEUS Database and DrCEUS	106
Chapter 6: The DRCEUS Energy Simulation And Calibration Process	109
6.1 Overview	109
6.2 Simulation Weather Data	109
6.3 Calibration Data Sources.....	111
Electric and Gas Consumption Data.....	111
Interval-Metered Electricity Data	112
Short-Term Metered (STM) Data	112
6.4 DrCEUS Simulation and Calibration Process	114
Overview of the Simulation/Calibration Process	114

Figure 6-4: Overview of the DrCEUS Simulation/Calibration Process 114

6.5 Judgmental Calibration.....115

6.6 Calibration Special Issues120

 Complex Building Systems 120

 Billed Demand Data 121

 Interval-Metered Data 122

 Short-Term Metered (STM) Data 122

 Propane and Non-IOU Commercial Natural Gas 123

Chapter 7: Analysis of Commercial Segments—Key Concepts 125

7.1 Overview 125

7.2 Expansion (Case) Weights 125

7.3 Definitions and Concepts 140

7.4 Presentation of Results 145

Chapter 8: Statewide Results by Segment 149

8.1 Introduction 149

8.2 Overview of Statewide Energy Usage 149

8.3 Segment-Level Fuel Shares, EUIs, and Energy Intensities..... 156

 All Commercial..... 156

 Small Offices..... 157

 Large Offices 158

 Restaurants 159

 Retail..... 160

 Food Stores 161

 Refrigerated Warehouses 162

 Unrefrigerated Warehouses..... 163

 Schools 164

 Colleges..... 165

 Health 166

 Lodging 167

 Miscellaneous 168

8.4 Segment-Level Hourly End-Use Electric Shapes 169

Chapter 9: PG&E Results by Segment..... 183

9.1 Introduction 183

9.2 Overview of Energy Usage in the PG&E Electric Service Area 183

9.3 Segment-Level Fuel Shares, EUIs, and Energy Intensities..... 190

 All Commercial..... 190

 Small Offices..... 191

 Large Offices 192

 Restaurants 193

 Retail..... 194

 Food Stores 195

 Refrigerated Warehouses 196

Unrefrigerated Warehouses	197
Schools	198
Colleges	199
Health	200
Lodging	201
Miscellaneous	202
9.4 Segment-Level Hourly End-Use Electric Shapes	203
Chapter 10: SCE Results by Segment.....	217
10.1 Introduction	217
10.2 Overview of Energy Usage in the SCE Electric Service Area.....	217
10.3 Segment-Level Fuel Shares, EUIs, and Energy Intensities.....	224
All Commercial.....	224
Small Offices.....	225
Large Offices	226
Restaurants	227
Retail.....	228
Food Stores	229
Refrigerated Warehouses	230
Unrefrigerated Warehouses.....	231
Schools	232
Colleges.....	233
Health	234
Lodging	235
Miscellaneous	236
10.4 Segment-Level Hourly End-Use Electric Shapes	237
Chapter 11: SDG&E Results by Segment	251
11.1 Introduction	251
11.2 Overview of Energy Usage in the SDG&E Electric Service Area	251
11.3 Segment-Level Fuel Shares, EUIs, and Energy Intensities.....	258
All Commercial.....	258
Small Offices.....	259
Large Offices	260
Restaurants	261
Retail.....	262
Food Stores	263
Refrigerated Warehouses	264
Unrefrigerated Warehouses.....	265
Schools	266
Colleges.....	267
Health	268
Lodging	269
Miscellaneous	270
11.4 Segment-Level Hourly End-Use Electric Shapes	271

Chapter 12: SMUD Results by Segment	285
12.1 Introduction	285
12.2 Overview of Energy Usage in the SMUD Electric Service Area.....	285
12.3 Segment-Level Fuel Shares, EUIs, and Energy Intensities.....	292
All Commercial.....	292
Small Offices.....	293
Large Offices	294
Restaurants	295
Retail.....	296
Food Stores	297
Refrigerated Warehouses	298
Unrefrigerated Warehouses.....	299
Schools	300
Colleges.....	301
Health	302
Lodging	303
Miscellaneous	304
12.4 Segment-Level Hourly End Use Electric Shapes.....	305
Chapter 13: Summary and Recommendations.....	319
13.1 Summary of Project Scope and Methods.....	319
Survey Design	319
Collection of On-Site Survey Data	319
Collection of Information on Energy Usage for Sampled Sites	320
Development of Demand Analysis System	320
Analysis of Premise-Level Hourly End-Use Energy	320
Analysis of Segment-Level End-Use Energy Consumption	321
13.2 Recommendations	322
Lessons Learned	322
Recommendations for Additional Commercial Sector Research	324

Publication CEC-400-2006-005APA contains the following 10 appendices that accompany this report:

- Appendix A: Basic Survey Instrument**
- Appendix B: Annotated Survey Instrument**
- Appendix C: End-Use Mappings**
- Appendix D: Recruitment Letter**
- Appendix E: Recruitment Script**
- Appendix F: Short-Term Metering Protocols**
- Appendix G: Survey Database Layout**
- Appendix H: Non-HVAC End-Use Algorithms**
- Appendix I: Description of Forecasting Climate Zone Results Database**
- Appendix J: SIC Code to CEUS Building Type Mapping Table**

CHAPTER 10: SCE RESULTS BY SEGMENT

10.1 Introduction

This chapter summarizes the results of the CEUS analysis for the SCE service area. As noted in Chapter 7, *gas estimates relate to gas provided to these customers by other gas utilities*. Section 10.2 provides an overview of the composition of energy usage in the SCE service area by building type. Section 10.3 presents electric and gas fuel shares, energy-use indices (EUIs) and energy intensities at the end-use level by building type. Section 10.4 provides 16-day hourly end-use electric shapes by building type. For all results presented in this chapter, the end uses and building types are as described in Chapter 7 of this report.

Additional results for the California Energy Commission Forecasting Climate Zones within the SCE service area (7 through 10) were also generated. The database containing these results is described in Appendix I.

10.2 Overview of Energy Usage in the SCE Electric Service Area

Table 10-1, Figure 10-1, and Figure 10-2 depict the estimates of floor stock, whole-building energy intensities, and energy usage by building type for the SCE service area. Energy intensities and annual usage were generated using normalized weather data and 2002 as the base year. As noted in Chapter 7, these estimates represent total customer consumption rather than just purchases from utilities or other vendors.

Total commercial floor stock in the SCE electric service area is estimated to be just over 2.1 billion square feet. The building types accounting for the largest percentage of total commercial floor stock are Miscellaneous (with approximately 22% of the total), Unrefrigerated Warehouses (17%), and Retail (14%).

Total commercial electric consumption is 29,321 GWh annually. The building types accounting for the largest percentage of total electricity consumption are Miscellaneous (16%), Large Offices (14%), and Retail (16%). Natural gas usage is roughly 499 million therms (Mtherms) per year. Three building types account for over 54% of natural gas usage: Restaurants (31%), Miscellaneous (23%) and Health (15%).

Figure 10-3 and Figure 10-4 depict estimates of SCE service area electric and gas usage percentages by end use. The primary electric end uses are interior lighting (28%), cooling (16%), and refrigeration (12%). The primary natural gas end uses are space heating (29%) and water heating (34%).

Electric and gas usage and energy intensities by end use and building type are presented in Table 10-2 through Table 10-5. As indicated in Table 10-3, for the SCE commercial sector the highest overall electric end-use energy intensities are interior lighting (3.97 kWh per square foot), followed by cooling (2.31), refrigeration (1.77), and ventilation (1.55). According to Table 10-5, the highest natural gas end-use energy intensities are water heating (8.0 kBtu per square foot), space heating (6.7), and cooking (6.3).

EUIs by building type and end use are presented in Section 9-3.

Table 10-1: Overview of Energy Usage in the SCE Service Area

Building Type	Floor Stock (kft ²)	Annual Energy Intensities			Total Annual Usage	
		Electricity (kWh/ft ²)	Natural Gas (therms/ft ²)	Natural Gas (kBtu/ft ²)	Electricity (GWh)	Natural Gas (Mtherms)
All Commercial	2,142,359	13.69	0.23	23.30	29,321	499.20
Small Office (<30k ft2)	157,884	13.25	0.08	8.05	2,091	12.70
Large Office (>=30k ft2)	227,225	17.91	0.13	12.98	4,071	29.50
Restaurant	61,623	46.19	2.49	249.14	2,846	153.50
Retail	309,601	15.36	0.02	2.46	4,755	7.60
Food Store	63,820	41.71	0.22	21.81	2,662	13.90
Refrigerated Warehouse	30,031	22.41	0.08	8.08	673	2.40
Unrefrigerated Warehouse	353,765	4.29	0.02	2.46	1,517	8.70
School	176,999	8.22	0.12	12.13	1,454	21.50
College	64,809	13.62	0.24	24.01	883	15.60
Health	106,471	20.30	0.68	68.32	2,161	72.70
Lodging	112,405	13.28	0.41	40.95	1,493	46.00
Miscellaneous	477,725	9.87	0.24	24.07	4,714	115.00
All Offices	385,110	16.00	0.11	10.96	6,162	42.20
All Warehouses	383,796	5.71	0.03	2.90	2,190	11.10

Figure 10-1: Electricity Use by Building Type

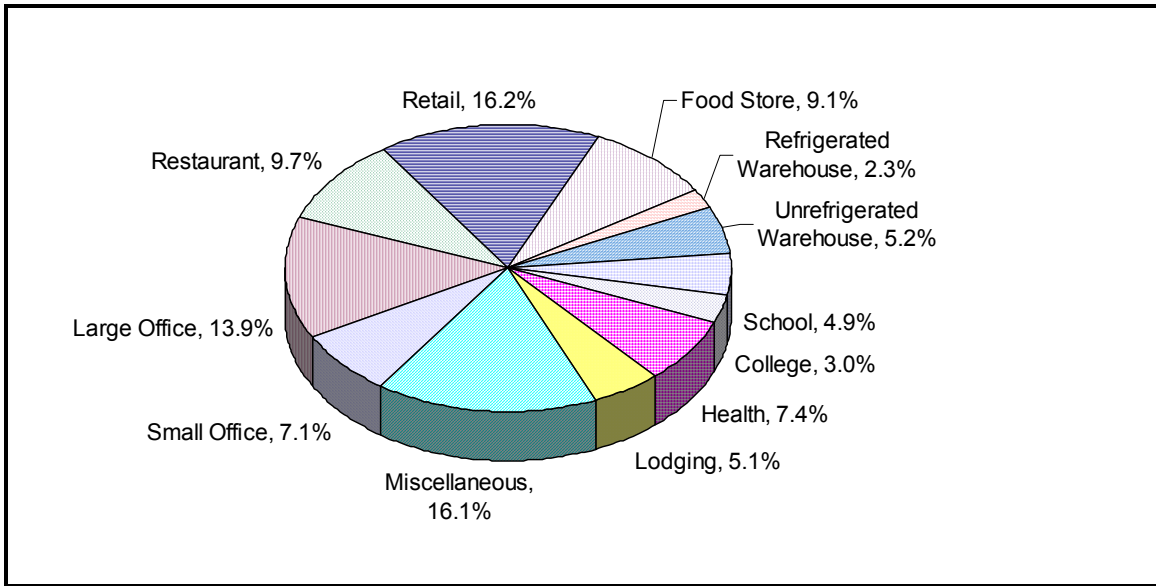


Figure 10-2: Natural Gas Usage by Building Type

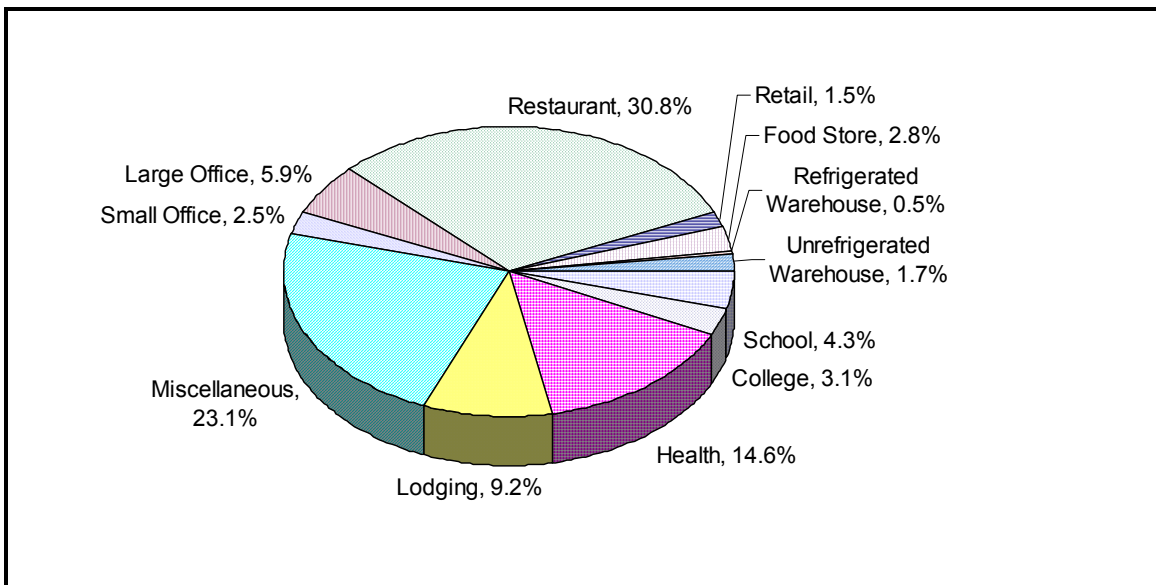


Figure 10-3: Electric Usage by End Use

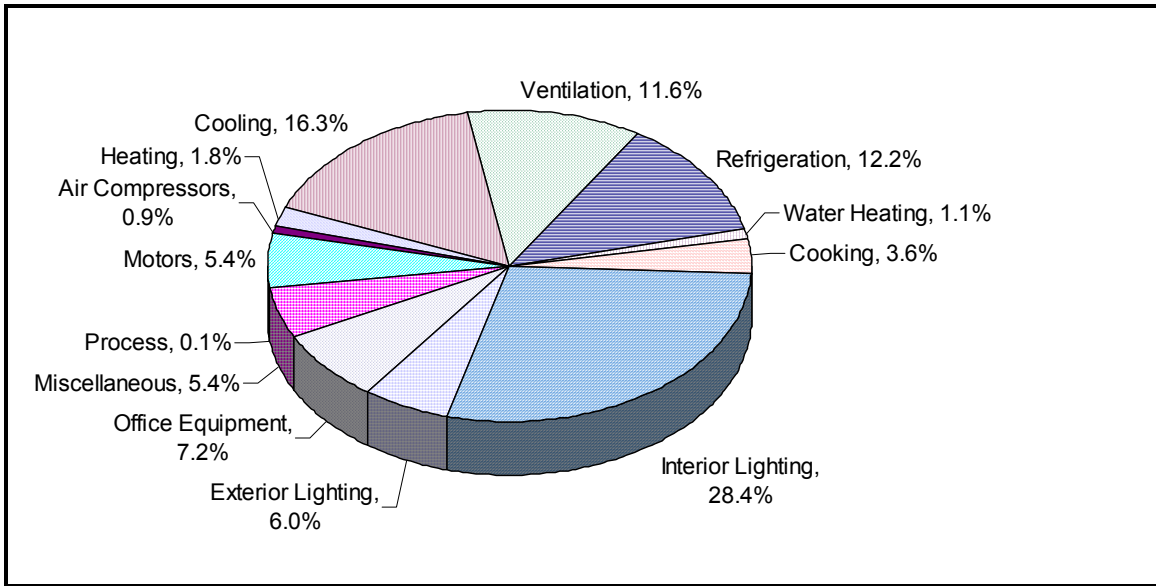
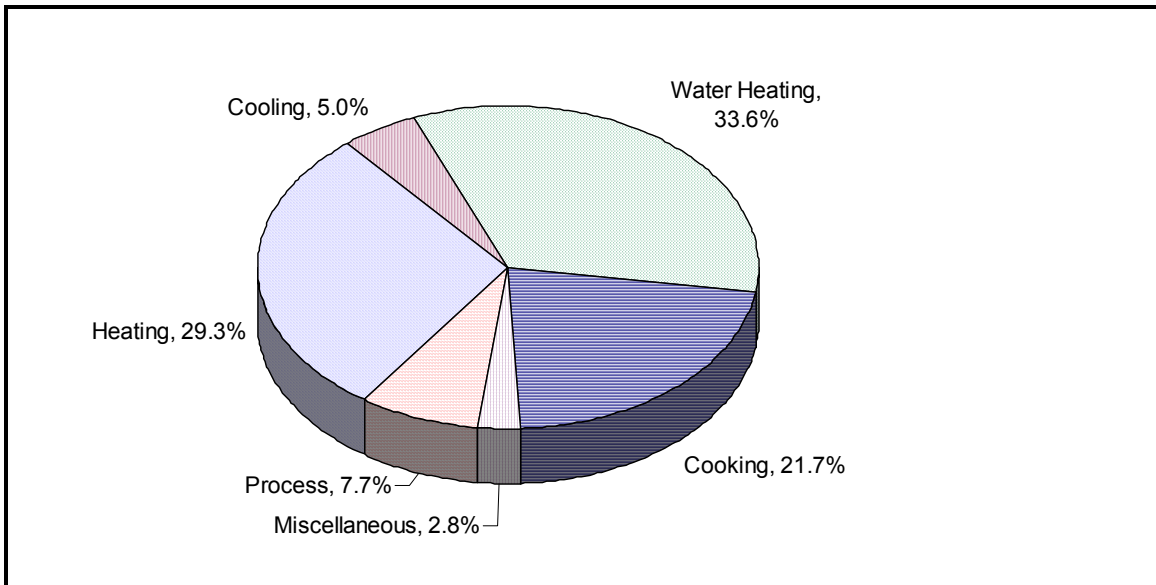


Figure 10-4: Natural Gas Usage by End Use



California Commercial Energy Use Survey

Table 10-2: Electric Usage (GWh) by Building Type and End Use

Building Type	Heat	Cool	Vent.	Refrig.	WH	Cook	Int. Ltg.	Ext. Ltg.	Office Equip.	Misc.	Air Comp.	Motors	Proc.	Total
All Commercial	356.80	4,938.70	3,328.50	3,793.50	267.30	1,199.40	8,504.20	1,825.20	1,747.10	1,718.20	120.90	1,214.30	306.60	29,320.70
Small Office	16.10	459.60	193.90	90.60	37.60	18.70	611.60	193.60	257.40	135.20	0.00	58.00	19.10	2,091.30
Large Office	58.90	898.80	684.80	88.10	25.40	22.30	1,069.10	159.20	766.60	115.70	14.80	145.00	21.90	4,070.60
Restaurant	1.80	482.70	252.70	641.80	27.50	693.50	438.70	168.60	43.90	69.70	0.00	24.20	1.20	2,846.30
Retail	11.90	863.40	598.30	310.30	39.40	68.40	2,039.50	331.00	148.80	197.50	24.90	93.00	29.10	4,755.50
Food Store	9.90	228.60	177.10	1,387.30	9.50	108.00	574.60	65.80	23.50	57.60	1.10	16.00	2.80	2,661.80
Refrigerated Warehouse	0.30	15.00	4.50	452.80	0.40	1.10	97.10	9.00	3.80	20.80	0.00	64.00	4.30	673.10
Unrefrigerated Warehouse	12.90	121.50	113.80	92.90	16.00	5.10	746.30	73.90	80.00	140.90	7.60	87.90	17.90	1,516.70
School	15.80	279.20	180.40	94.50	24.70	29.10	545.40	131.00	87.50	49.30	0.00	14.30	3.10	1,454.30
College	76.60	138.20	128.90	19.80	9.10	10.10	292.50	43.90	73.50	33.50	1.90	40.20	14.70	882.70
Health	80.50	454.30	446.90	77.90	9.50	43.60	522.40	71.40	96.30	273.00	0.60	60.60	24.20	2,161.10
Lodging	38.50	338.50	195.90	109.70	0.00	79.80	410.10	78.20	27.10	152.30	0.00	61.60	1.60	1,493.20
Miscellaneous	33.70	658.90	351.50	427.90	68.30	119.60	1,157.00	499.40	138.70	472.60	70.00	549.50	166.80	4,713.90
All Offices	75.00	1,358.40	878.70	178.70	63.00	40.90	1,680.60	352.80	1,024.00	251.00	14.80	203.00	41.00	6,162.00
All Warehouses	13.10	136.60	118.30	545.60	16.40	6.20	843.30	82.90	83.80	161.80	7.60	151.90	22.10	2,189.80

California Commercial Energy Use Survey

Table 10-3: Electric Energy Intensities (kWh/ft²-yr) by Building Type and End Use

Building Type	Total	Heat	Cool	Vent.	Refrig.	WH	Cook	Int. Ltg.	Ext. Ltg.	Office Equip.	Misc.	Air Comp.	Motors	Proc.
All Commercial	13.69	0.17	2.31	1.55	1.77	0.12	0.56	3.97	0.85	0.82	0.80	0.06	0.57	0.14
Small Office	13.25	0.10	2.91	1.23	0.57	0.24	0.12	3.87	1.23	1.63	0.86	0.00	0.37	0.12
Large Office	17.91	0.26	3.96	3.01	0.39	0.11	0.10	4.70	0.70	3.37	0.51	0.07	0.64	0.10
Restaurant	46.19	0.03	7.83	4.10	10.41	0.45	11.25	7.12	2.74	0.71	1.13	0.00	0.39	0.02
Retail	15.36	0.04	2.79	1.93	1.00	0.13	0.22	6.59	1.07	0.48	0.64	0.08	0.30	0.09
Food Store	41.71	0.15	3.58	2.77	21.74	0.15	1.69	9.00	1.03	0.37	0.90	0.02	0.25	0.04
Refrigerated Warehouse	22.41	0.01	0.50	0.15	15.08	0.01	0.04	3.23	0.30	0.13	0.69	0.00	2.13	0.14
Unrefrigerated Warehouse	4.29	0.04	0.34	0.32	0.26	0.05	0.01	2.11	0.21	0.23	0.40	0.02	0.25	0.05
School	8.22	0.09	1.58	1.02	0.53	0.14	0.16	3.08	0.74	0.49	0.28	0.00	0.08	0.02
College	13.62	1.18	2.13	1.99	0.31	0.14	0.16	4.51	0.68	1.13	0.52	0.03	0.62	0.23
Health	20.30	0.76	4.27	4.20	0.73	0.09	0.41	4.91	0.67	0.90	2.56	0.01	0.57	0.23
Lodging	13.28	0.34	3.01	1.74	0.98	0.00	0.71	3.65	0.70	0.24	1.35	0.00	0.55	0.01
Miscellaneous	9.87	0.07	1.38	0.74	0.90	0.14	0.25	2.42	1.05	0.29	0.99	0.15	1.15	0.35
All Offices	16.00	0.19	3.53	2.28	0.46	0.16	0.11	4.36	0.92	2.66	0.65	0.04	0.53	0.11
All Warehouses	5.71	0.03	0.36	0.31	1.42	0.04	0.02	2.20	0.22	0.22	0.42	0.02	0.40	0.06

Table 10-4: Natural Gas Usage (Mtherms) by Building Type and End Use

Building Type	Heat	Cool	WH	Cook	Misc.	Proc.	Total
All Commercial	144.10	6.60	171.50	134.00	12.50	30.50	499.20
Small Office	8.50	0.00	3.70	0.40	0.10	0.00	12.70
Large Office	22.50	1.20	4.60	0.90	0.30	0.00	29.50
Restaurant	5.20	0.00	37.30	110.70	0.00	0.30	153.50
Retail	3.40	0.00	2.10	1.90	0.20	0.10	7.60
Food Store	3.90	0.00	3.80	6.20	0.00	0.10	13.90
Refrigerated Warehouse	0.20	0.00	0.30	0.00	0.00	2.00	2.40
Unrefrigerated Warehouse	7.90	0.00	0.60	0.10	0.10	0.00	8.70
School	10.80	0.00	8.60	1.70	0.10	0.30	21.50
College	8.60	1.30	4.10	0.50	1.10	0.00	15.60
Health	37.00	1.70	25.50	3.50	2.30	2.70	72.70
Lodging	12.10	0.00	28.60	3.80	1.30	0.20	46.00
Miscellaneous	24.20	2.40	52.30	4.20	7.00	24.80	115.00
All Offices	31.00	1.20	8.30	1.30	0.40	0.00	42.20
All Warehouses	8.10	0.00	0.90	0.10	0.10	2.00	11.10

Table 10-5: Natural Gas Usage Intensities (kBtu/ft²-yr) by Building Type and End Use

Building Type	Total	Heat	Cool	WH	Cook	Misc.	Proc.
All Commercial	23.30	6.70	0.30	8.00	6.30	0.60	1.40
Small Office	8.00	5.40	0.00	2.30	0.30	0.10	0.00
Large Office	13.00	9.90	0.50	2.00	0.40	0.20	0.00
Restaurant	249.10	8.40	0.00	60.50	179.70	0.00	0.50
Retail	2.50	1.10	0.00	0.70	0.60	0.10	0.00
Food Store	21.80	6.10	0.00	5.90	9.60	0.00	0.20
Refrigerated Warehouse	8.10	0.60	0.00	0.90	0.00	0.00	6.50
Unrefrigerated Warehouse	2.50	2.20	0.00	0.20	0.00	0.00	0.00
School	12.10	6.10	0.00	4.90	1.00	0.10	0.20
College	24.00	13.20	2.00	6.30	0.80	1.70	0.00
Health	68.30	34.80	1.60	24.00	3.30	2.20	2.50
Lodging	40.90	10.80	0.00	25.50	3.40	1.20	0.20
Miscellaneous	24.10	5.10	0.50	10.90	0.90	1.50	5.20
All Offices	11.00	8.00	0.30	2.20	0.30	0.10	0.00
All Warehouses	2.90	2.10	0.00	0.20	0.00	0.00	0.50

10.3 Segment-Level Fuel Shares, EUIs, and Energy Intensities

This section provides EUIs, fuel shares, and energy intensities for the building types and end uses defined in Chapter 7. Results are not presented in this section for the “All Offices” and “All Warehouses” building types.

All Commercial

Estimated total floor stock for all commercial buildings in the SCE service area is just over 2.1 million square feet. Electric and natural gas EUIs, fuel shares and energy intensities for the overall SCE commercial sector are presented in Table 10-6 and Table 10-7.

Table 10-6: All Commercial Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft ²)	Electric Fuel Share	Electric EI (kWh/ft ²)
Heating	0.44	37.60	0.17
Cooling	3.49	66.10	2.31
Ventilation	2.22	69.90	1.55
Water Heating	0.27	46.80	0.12
Cooking	0.60	93.70	0.56
Refrigeration	1.84	96.50	1.77
Interior Lighting	3.97	100.00	3.97
Office Equipment	0.82	98.90	0.82
Exterior Lighting	0.97	87.50	0.85
Miscellaneous	0.84	95.40	0.80
Process	3.01	1.90	0.06
Motors	0.97	58.20	0.57
Air Compressors	0.39	36.80	0.14
All End Uses			13.69

Table 10-7: All Commercial Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft ²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft ²)
Heating	13.49	49.90	6.73
Cooling	33.15	0.90	0.31
Water Heating	13.87	57.70	8.00
Cooking	22.06	28.40	6.25
Miscellaneous	4.56	12.80	0.59
Process	58.34	2.40	1.42
All End Uses			23.30

Small Offices

Estimated total floor stock in small office buildings (defined as premises with total floor area less than 30,000 square feet) is just over 157 million square feet. Based on the electric intensities shown in the last column of Table 10-8, the largest electric end uses in this building type are interior lighting, cooling, and refrigeration. As shown in Table 10-9, gas usage is fairly evenly split among water heating, space heating and cooking.

Table 10-8: Small Office Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft ²)	Electric Fuel Share	Electric EI (kWh/ft ²)
Heating	0.23	44.50	0.10
Cooling	3.12	93.30	2.91
Ventilation	1.31	93.90	1.23
Water Heating	0.46	51.40	0.24
Cooking	0.13	92.30	0.12
Refrigeration	0.60	95.50	0.57
Interior Lighting	3.87	100.00	3.87
Office Equipment	1.63	99.90	1.63
Exterior Lighting	1.69	72.70	1.23
Miscellaneous	0.93	92.50	0.86
Process	0.00	0.00	0.00
Motors	1.32	27.80	0.37
Air Compressors	0.74	16.30	0.12
All End Uses			13.25

Table 10-9: Small Office Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft ²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft ²)
Heating	10.46	51.50	5.39
Cooling	0.00	0.00	0.00
Water Heating	5.71	40.70	2.32
Cooking	3.91	7.20	0.28
Miscellaneous	2.47	2.40	0.06
Process	0.00	0.00	0.00
All End Uses			8.00

Large Offices

Estimated total floor stock in large office buildings (defined as premises with total floor area of 30,000 square feet or more) is just over 227 million square feet. As shown in Table 10-10, the largest electric end uses in this building type are interior lighting, cooling, office equipment, and ventilation. Table 10-11 shows that space heating is the major gas end use.

Table 10-10: Large Office Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft ²)	Electric Fuel Share	Electric EI (kWh/ft ²)
Heating	0.33	78.10	0.26
Cooling	4.26	92.80	3.96
Ventilation	3.21	93.90	3.01
Water Heating	0.24	47.00	0.11
Cooking	0.10	97.50	0.10
Refrigeration	0.39	98.50	0.39
Interior Lighting	4.70	100.00	4.70
Office Equipment	3.37	100.00	3.37
Exterior Lighting	0.71	98.70	0.70
Miscellaneous	0.54	95.20	0.51
Process	7.12	0.90	0.07
Motors	0.72	88.10	0.64
Air Compressors	0.16	58.70	0.10
All End Uses			17.91

Table 10-11: Large Office Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft ²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft ²)
Heating	13.88	71.30	9.89
Cooling	14.13	3.70	0.53
Water Heating	3.44	59.20	2.04
Cooking	1.95	19.30	0.38
Miscellaneous	2.49	6.20	0.15
Process	0.00	0.00	0.00
All End Uses			13.00

Restaurants

Estimated total floor stock for this building type is just over 61 million square feet. Table 10-12 shows that cooking, refrigeration, and cooling are the largest electric end uses in this building type. Table 10-13 shows that the most important natural gas end uses are cooking and water heating.

Table 10-12: Restaurant Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft ²)	Electric Fuel Share	Electric EI (kWh/ft ²)
Heating	0.18	16.40	0.03
Cooling	10.10	77.60	7.83
Ventilation	5.24	78.20	4.10
Water Heating	2.50	17.80	0.45
Cooking	11.25	100.00	11.25
Refrigeration	10.41	100.00	10.41
Interior Lighting	7.12	100.00	7.12
Office Equipment	0.72	99.50	0.71
Exterior Lighting	3.13	87.50	2.74
Miscellaneous	1.30	86.70	1.13
Process	0.00	0.00	0.00
Motors	1.47	26.70	0.39
Air Compressors	0.78	2.60	0.02
All End Uses			46.19

Table 10-13: Restaurant Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft ²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft ²)
Heating	14.55	57.50	8.36
Cooling	0.00	0.00	0.00
Water Heating	71.28	84.90	60.55
Cooking	195.69	91.80	179.71
Miscellaneous	0.00	0.00	0.00
Process	71.01	0.70	0.52
All End Uses			249.10

Retail

Estimated total floor stock for this building type is just over 309 million square feet. As shown in Table 10-14, the predominant electric end use in this building type is interior lighting, although cooling and ventilation account for a substantial portion of usage. Table 10-15 shows that gas usage is fairly evenly split among space heating, water heating and cooking.

Table 10-14: Retail Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft ²)	Electric Fuel Share	Electric EI (kWh/ft ²)
Heating	0.15	25.00	0.04
Cooling	3.97	70.20	2.79
Ventilation	2.69	71.90	1.93
Water Heating	0.23	55.60	0.13
Cooking	0.24	93.60	0.22
Refrigeration	1.06	94.30	1.00
Interior Lighting	6.59	100.00	6.59
Office Equipment	0.48	100.00	0.48
Exterior Lighting	1.34	79.90	1.07
Miscellaneous	0.70	91.40	0.64
Process	4.69	1.70	0.08
Motors	0.66	45.30	0.30
Air Compressors	0.43	22.00	0.09
All End Uses			15.36

Table 10-15: Retail Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft ²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft ²)
Heating	3.24	33.50	1.09
Cooling	0.00	0.00	0.00
Water Heating	2.16	30.90	0.67
Cooking	8.20	7.60	0.62
Miscellaneous	1.31	4.40	0.06
Process	2.99	0.80	0.02
All End Uses			2.50

Food Stores

Estimated total floor stock for this building type is approximately 64 million square feet. According to Table 10-16, the largest electric end use in this building type is refrigeration, with interior lighting comprising about half of remaining usage. Cooking, space heating, and water heating all account for significant shares of gas consumption, as seen in Table 10-17.

Table 10-16: Food Store Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft ²)	Electric Fuel Share	Electric EI (kWh/ft ²)
Heating	0.91	17.00	0.15
Cooling	6.02	59.50	3.58
Ventilation	4.50	61.70	2.77
Water Heating	0.38	39.50	0.15
Cooking	2.01	84.10	1.69
Refrigeration	21.74	100.00	21.74
Interior Lighting	9.00	100.00	9.00
Office Equipment	0.38	97.80	0.37
Exterior Lighting	1.21	85.40	1.03
Miscellaneous	0.98	92.20	0.90
Process	1.14	1.50	0.02
Motors	0.53	47.00	0.25
Air Compressors	0.50	8.70	0.04
All End Uses			41.71

Table 10-17: Food Store Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft ²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft ²)
Heating	16.24	37.40	6.08
Cooling	0.00	0.00	0.00
Water Heating	9.36	62.90	5.89
Cooking	21.46	45.00	9.65
Miscellaneous	26.41	0.10	0.03
Process	9.83	1.60	0.16
All End Uses			21.80

Refrigerated Warehouses

Estimated total floor stock for this building type is approximately 30 million square feet. Table 10-18 shows that refrigeration is the largest electric end use in this building type, accounting for roughly two thirds of total electric usage. As seen in Table 10-19, the largest gas end use is water heating, although the overall gas intensity is low.

Table 10-18: Refrigerated Warehouse Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft ²)	Electric Fuel Share	Electric EI (kWh/ft ²)
Heating	0.31	2.80	0.01
Cooling	2.95	17.00	0.50
Ventilation	0.88	17.00	0.15
Water Heating	0.03	41.30	0.01
Cooking	0.04	96.60	0.04
Refrigeration	15.08	100.00	15.08
Interior Lighting	3.23	100.00	3.23
Office Equipment	0.13	100.00	0.13
Exterior Lighting	0.33	91.60	0.30
Miscellaneous	0.72	96.60	0.69
Process	0.25	0.60	0.00
Motors	2.83	75.40	2.13
Air Compressors	0.24	58.50	0.14
All End Uses			22.41

Table 10-19: Refrigerated Warehouse Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft ²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft ²)
Heating	5.86	10.60	0.62
Cooling	0.00	0.00	0.00
Water Heating	1.52	59.90	0.91
Cooking	0.96	3.30	0.03
Miscellaneous	0.24	9.30	0.02
Process	46.66	13.90	6.50
All End Uses			8.10

Unrefrigerated Warehouses

Estimated total floor stock for this building type is over 353 million square feet. Table 10-20 shows that the overall electric energy intensity in this building type is low, with interior lighting accounting for almost half of electric usage. As seen in Table 10-21, the gas energy intensity is also low, with space heating being the predominant gas end.

Table 10-20: Unrefrigerated Warehouse Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft²)	Electric Fuel Share	Electric EI (kWh/ft²)
Heating	0.34	10.80	0.04
Cooling	1.96	17.50	0.34
Ventilation	1.66	19.40	0.32
Water Heating	0.06	75.10	0.05
Cooking	0.02	92.60	0.01
Refrigeration	0.28	94.50	0.26
Interior Lighting	2.11	100.00	2.11
Office Equipment	0.23	100.00	0.23
Exterior Lighting	0.22	95.70	0.21
Miscellaneous	0.41	98.00	0.40
Process	1.17	1.80	0.02
Motors	0.55	45.30	0.25
Air Compressors	0.14	36.10	0.05
All End Uses			4.29

Table 10-21: Unrefrigerated Warehouse Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft²)
Heating	18.48	12.10	2.24
Cooling	0.00	0.00	0.00
Water Heating	0.50	35.00	0.17
Cooking	0.64	3.10	0.02
Miscellaneous	0.49	4.40	0.02
Process	0.00	0.00	0.00
All End Uses			2.50

Schools

Estimated total floor stock for this building type is just over 176 million square feet. As shown in Table 10-22, the largest electric end uses in this building type are interior lighting, cooling, and ventilation. Table 10-23 shows that space heating and water heating are the major gas end uses.

Table 10-22: School Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft ²)	Electric Fuel Share	Electric EI (kWh/ft ²)
Heating	0.18	49.30	0.09
Cooling	1.97	80.10	1.58
Ventilation	1.09	93.30	1.02
Water Heating	0.30	47.30	0.14
Cooking	0.17	94.90	0.16
Refrigeration	0.54	98.80	0.53
Interior Lighting	3.08	100.00	3.08
Office Equipment	0.49	100.00	0.49
Exterior Lighting	0.75	98.40	0.74
Miscellaneous	0.29	95.30	0.28
Process	0.00	0.00	0.00
Motors	0.21	38.20	0.08
Air Compressors	0.08	22.90	0.02
All End Uses			8.22

Table 10-23: School Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft ²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft ²)
Heating	6.99	87.00	6.08
Cooling	0.00	0.00	0.00
Water Heating	5.25	92.40	4.85
Cooking	1.46	66.90	0.97
Miscellaneous	0.38	16.10	0.06
Process	6.88	2.30	0.16
All End Uses			12.10

Colleges

Estimated total floor stock for colleges in the SCE service area is approximately 65 million square feet. Table 10-24 shows that interior lighting, cooling, and ventilation, are the largest electric end uses in this building type. As shown in Table 10-25, space heating accounts for most of the gas usage in this sector.

Table 10-24: College Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft ²)	Electric Fuel Share	Electric EI (kWh/ft ²)
Heating	1.43	82.80	1.18
Cooling	2.37	89.90	2.13
Ventilation	2.16	92.20	1.99
Water Heating	0.31	45.80	0.14
Cooking	0.21	75.90	0.16
Refrigeration	0.31	99.40	0.31
Interior Lighting	4.51	100.00	4.51
Office Equipment	1.13	100.00	1.13
Exterior Lighting	0.70	96.70	0.68
Miscellaneous	0.55	94.00	0.52
Process	0.40	7.20	0.03
Motors	0.71	87.50	0.62
Air Compressors	0.31	74.10	0.23
All End Uses			13.62

Table 10-25: College Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft ²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft ²)
Heating	16.65	79.30	13.20
Cooling	20.75	9.90	2.05
Water Heating	10.28	61.40	6.31
Cooking	2.37	33.80	0.80
Miscellaneous	4.00	41.50	1.66
Process	0.00	0.00	0.00
All End Uses			24.00

Health

Estimated total floor stock for this building type is approximately 106 million square feet. Table 10-26 shows that the largest electric end uses in this building type are interior lighting, cooling, and ventilation. Heating and water heating account for the major shares of gas usage, as shown in Table 10-27.

Table 10-26: Health Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft ²)	Electric Fuel Share	Electric EI (kWh/ft ²)
Heating	1.11	68.30	0.76
Cooling	4.65	91.70	4.27
Ventilation	4.41	95.20	4.20
Water Heating	0.47	18.80	0.09
Cooking	0.42	97.90	0.41
Refrigeration	0.74	99.50	0.73
Interior Lighting	4.91	100.00	4.91
Office Equipment	0.91	99.80	0.90
Exterior Lighting	0.69	97.70	0.67
Miscellaneous	2.56	100.00	2.56
Process	1.10	0.50	0.01
Motors	0.84	67.70	0.57
Air Compressors	0.50	45.80	0.23
All End Uses			20.30

Table 10-27: Health Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft ²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft ²)
Heating	42.29	82.20	34.78
Cooling	51.17	3.00	1.55
Water Heating	28.29	84.80	23.98
Cooking	4.57	72.20	3.30
Miscellaneous	4.40	49.10	2.16
Process	13.12	19.40	2.54
All End Uses			68.30

Lodging

Estimated total floor stock for this building type is approximately 112 million square feet. According to Table 10-28, the biggest single end use in this sector is interior lighting, followed by cooling and ventilation. Table 10-29 shows that water heating accounts for most of the gas consumption.

Table 10-28: Lodging Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft ²)	Electric Fuel Share	Electric EI (kWh/ft ²)
Heating	0.42	81.70	0.34
Cooling	3.44	87.60	3.01
Ventilation	1.89	92.30	1.74
Water Heating	0.00	0.00	0.00
Cooking	0.75	94.80	0.71
Refrigeration	0.98	99.40	0.98
Interior Lighting	3.65	100.00	3.65
Office Equipment	0.24	99.00	0.24
Exterior Lighting	0.73	94.80	0.70
Miscellaneous	1.39	97.70	1.35
Process	0.00	0.00	0.00
Motors	0.59	93.20	0.55
Air Compressors	0.04	38.90	0.01
All End Uses			13.28

Table 10-29: Lodging Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft ²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft ²)
Heating	19.95	54.00	10.77
Cooling	0.00	0.00	0.00
Water Heating	26.87	94.80	25.48
Cooking	5.73	58.70	3.36
Miscellaneous	1.77	65.00	1.15
Process	4.03	4.60	0.18
All End Uses			40.90

Miscellaneous

Estimated total floor stock for this building type is approximately 478 million square feet. As shown in Table 10-30, the largest electric end use in this building type is interior lighting, with remaining electric usage spread out over several other end uses. Table 10-31 shows that space heating, process and water heating account for almost all of the gas consumption in this diverse building type.

Table 10-30: Miscellaneous Electric EUIs, Fuel Shares, and EIs

End Use	Electric EUI (kWh/End-Use ft ²)	Electric Fuel Share	Electric EI (kWh/ft ²)
Heating	0.29	24.10	0.07
Cooling	2.26	61.00	1.38
Ventilation	1.09	67.40	0.74
Water Heating	0.35	40.80	0.14
Cooking	0.27	94.20	0.25
Refrigeration	0.94	94.90	0.90
Interior Lighting	2.42	100.00	2.42
Office Equipment	0.30	95.90	0.29
Exterior Lighting	1.36	76.90	1.05
Miscellaneous	1.02	97.20	0.99
Process	3.51	4.20	0.15
Motors	1.66	69.30	1.15
Air Compressors	0.73	47.80	0.35
All End Uses			9.87

Table 10-31: Miscellaneous Natural Gas EUIs, Fuel Shares, and EIs

End Use	Natural Gas EUI (kBtu/End-Use ft ²)	Natural Gas Fuel Share	Natural Gas EI (kBtu/ft ²)
Heating	9.22	54.90	5.06
Cooling	134.83	0.40	0.50
Water Heating	17.03	64.30	10.95
Cooking	2.85	31.10	0.89
Miscellaneous	15.91	9.30	1.47
Process	173.05	3.00	5.19
All End Uses			24.10

10.4 Segment-Level Hourly End-Use Electric Shapes

This section presents 16-day hourly stacked end-use graphs from DrCEUS for the basic set of building types (that is, excluding “All Offices” and “All Warehouses”). The 16-day type basis (4 day types X 4 seasons), as defined in Chapter 7, are as follows:

- **Four Day Types.** Typical Day (weekday), Hot Day (weekday), Cold Day (weekday) and Weekend (Saturday, Sunday, and holidays). Note that the Hot and Cold day types are the hottest\coldest¹ *single* days during a season, whereas the Typical and Weekend day types are an *average* of all days of those respective types during the season.
- **Four Seasons.** Winter (December through February), Spring (March through May), Summer (June through September), Fall (October through November).

Only electric hourly end-use shapes are presented here, although gas end-use hourly shapes are also available from DrCEUS.

¹ The hottest/coldest days are determined as the first weekday during a season that has the highest or lowest hourly temperature.

Figure 10-5: All Commercial 16-Day Hourly End-Use Shapes

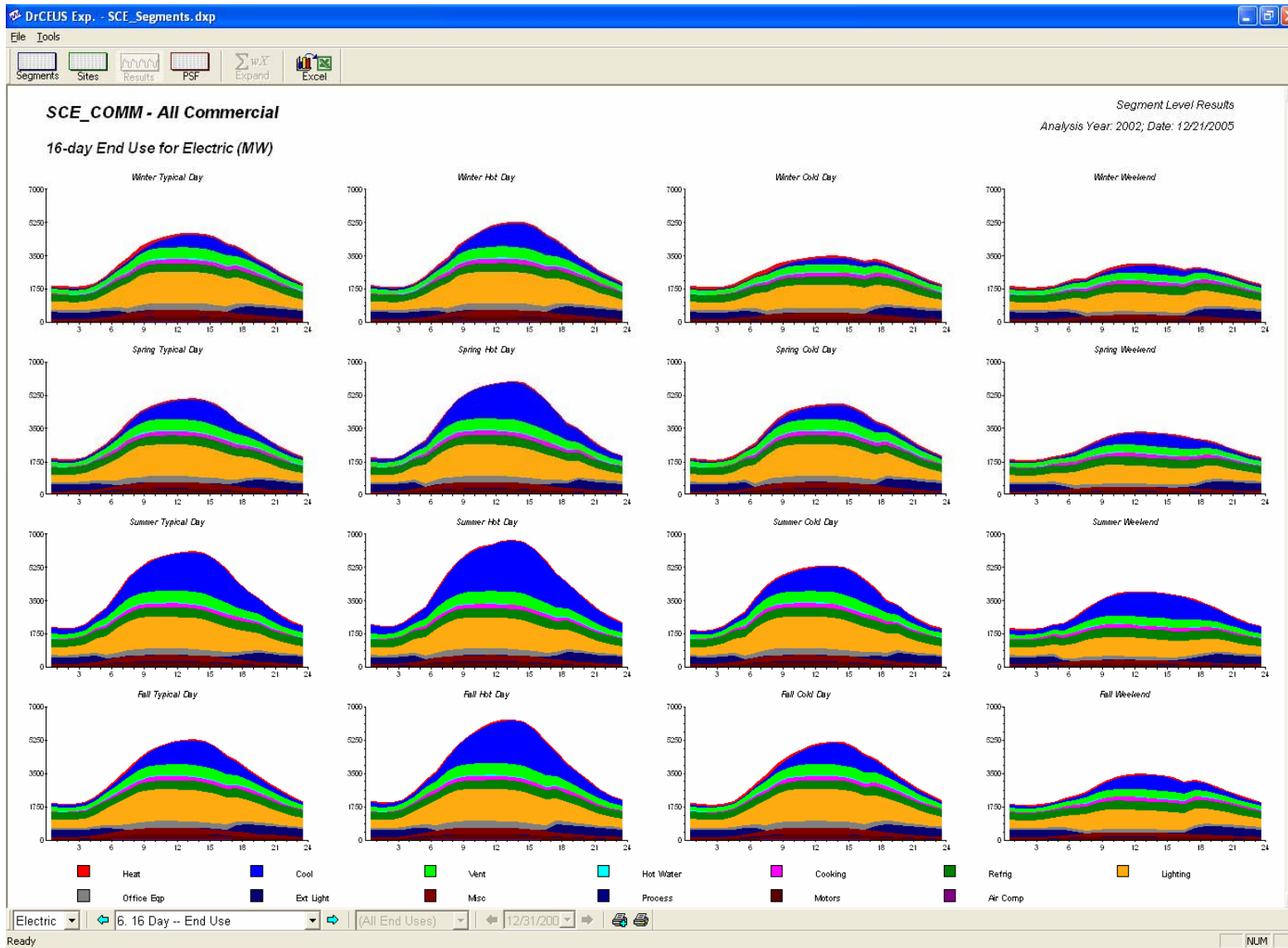


Figure 10-6: Small Office 16-Day Hourly End-Use Shapes

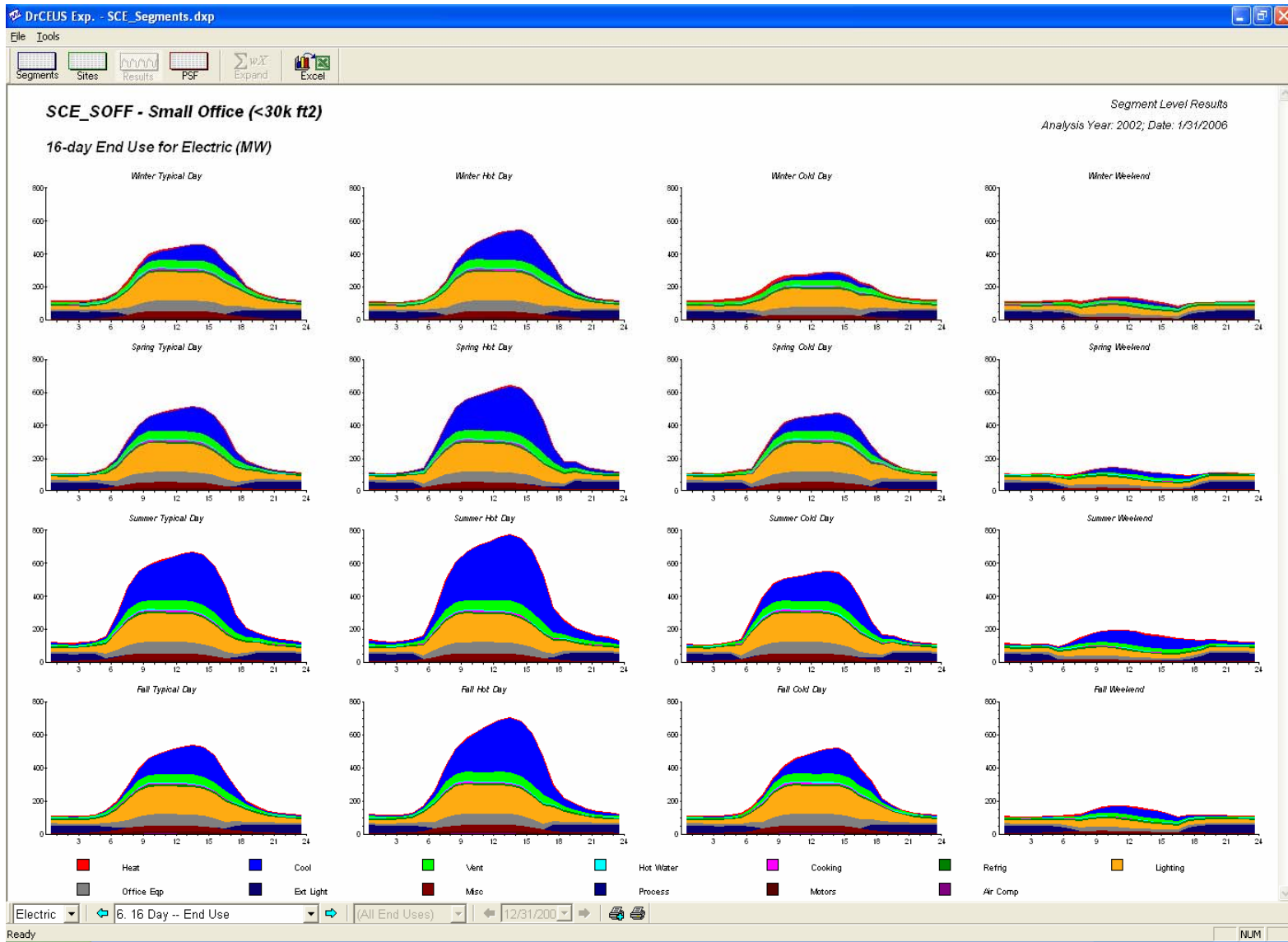


Figure 10-7: Large Office 16-Day Hourly End-Use Shapes

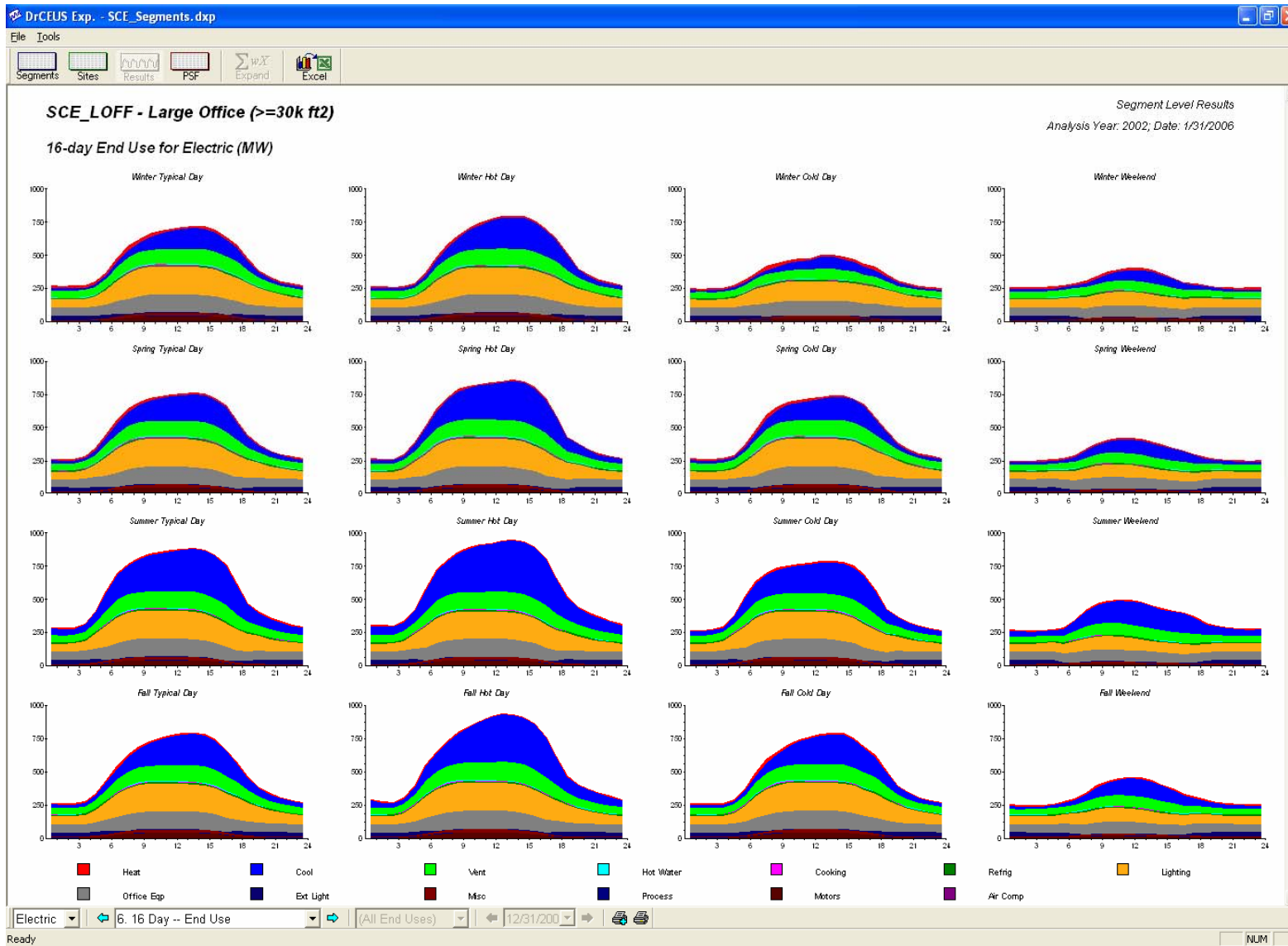


Figure 10-8: Restaurant 16-Day Hourly End-Use Shapes

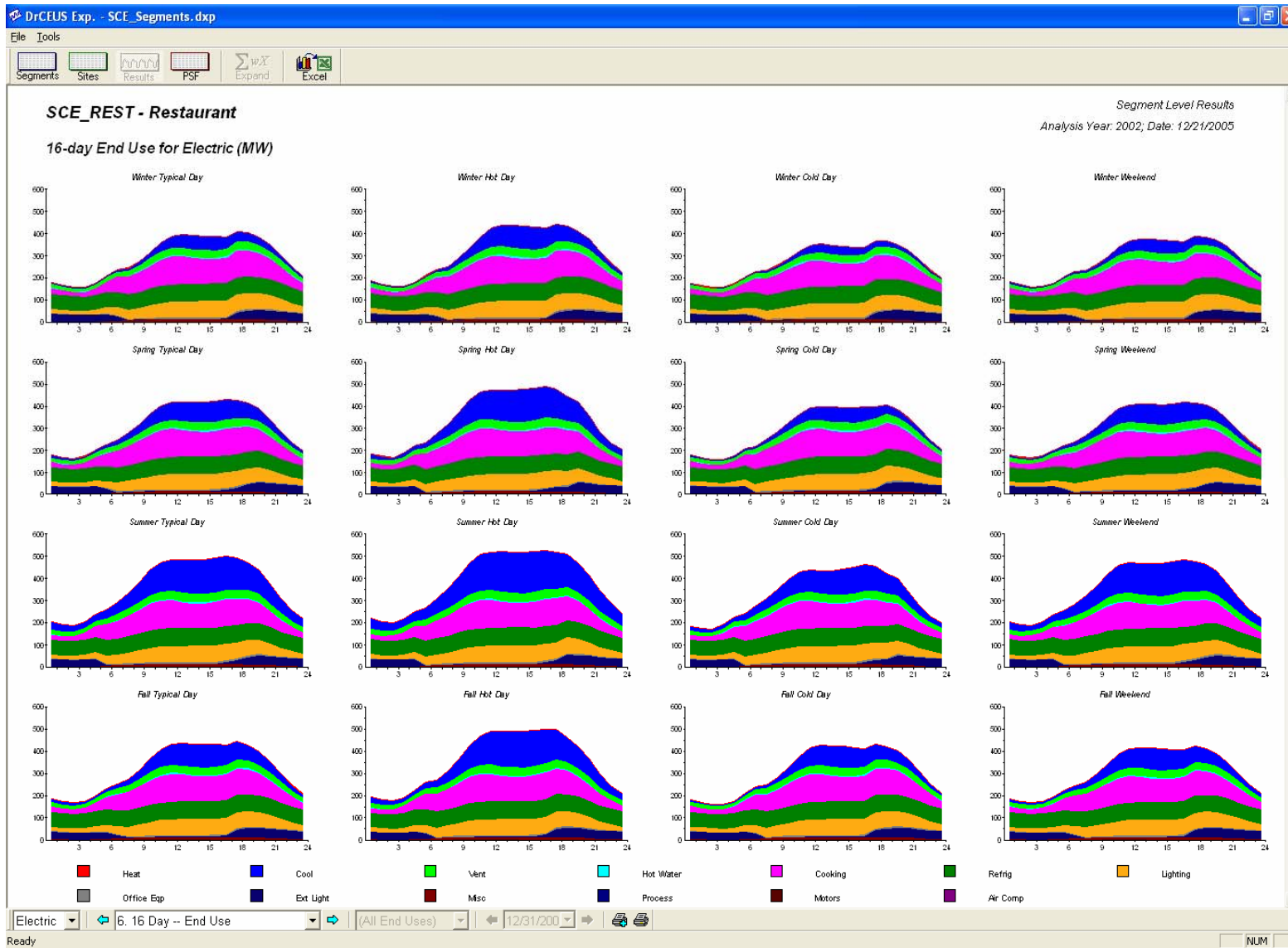


Figure 10-9: Retail 16-Day Hourly End-Use Shapes

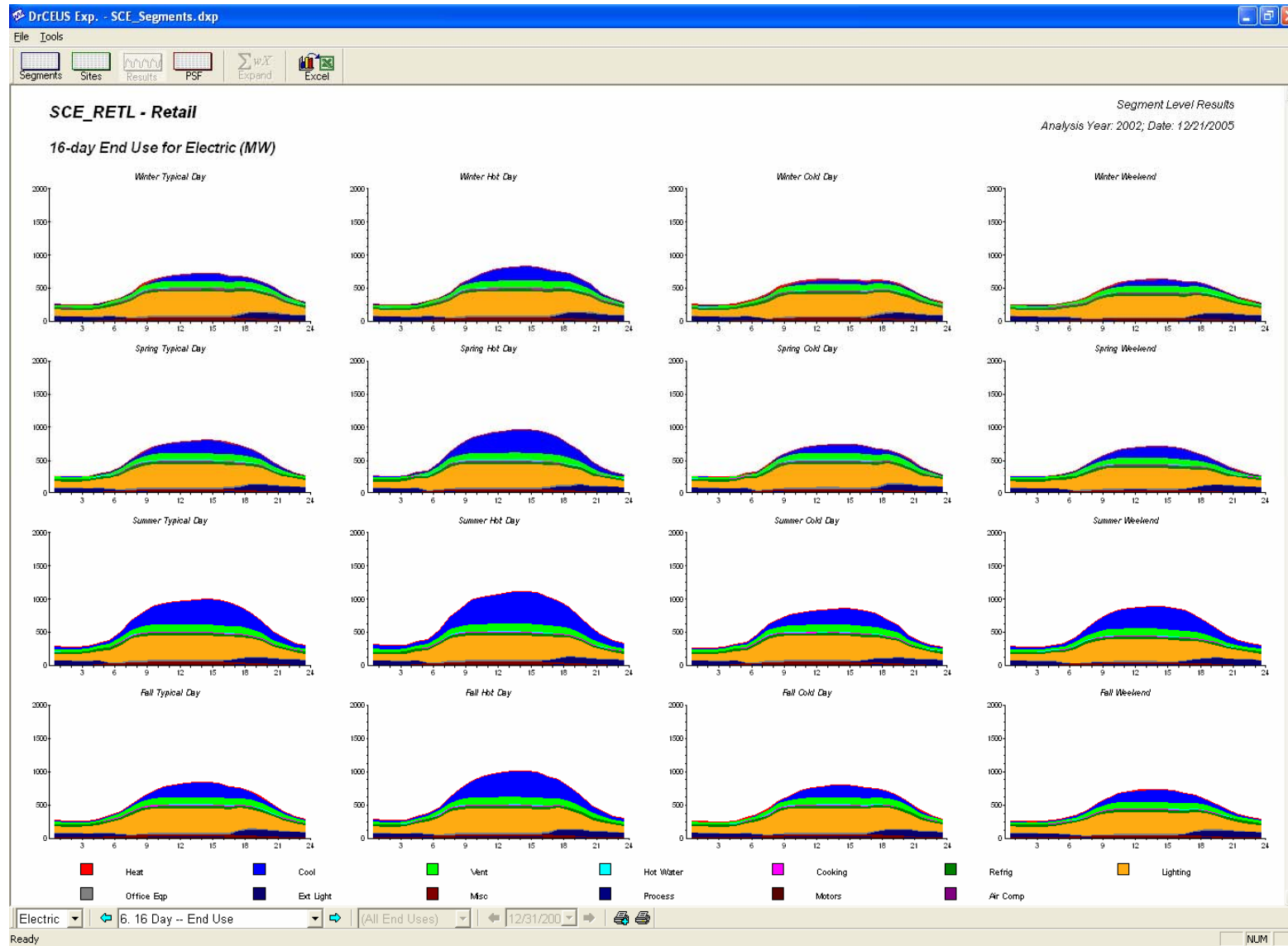


Figure 10-10: Food Store 16-Day Hourly End-Use Shapes

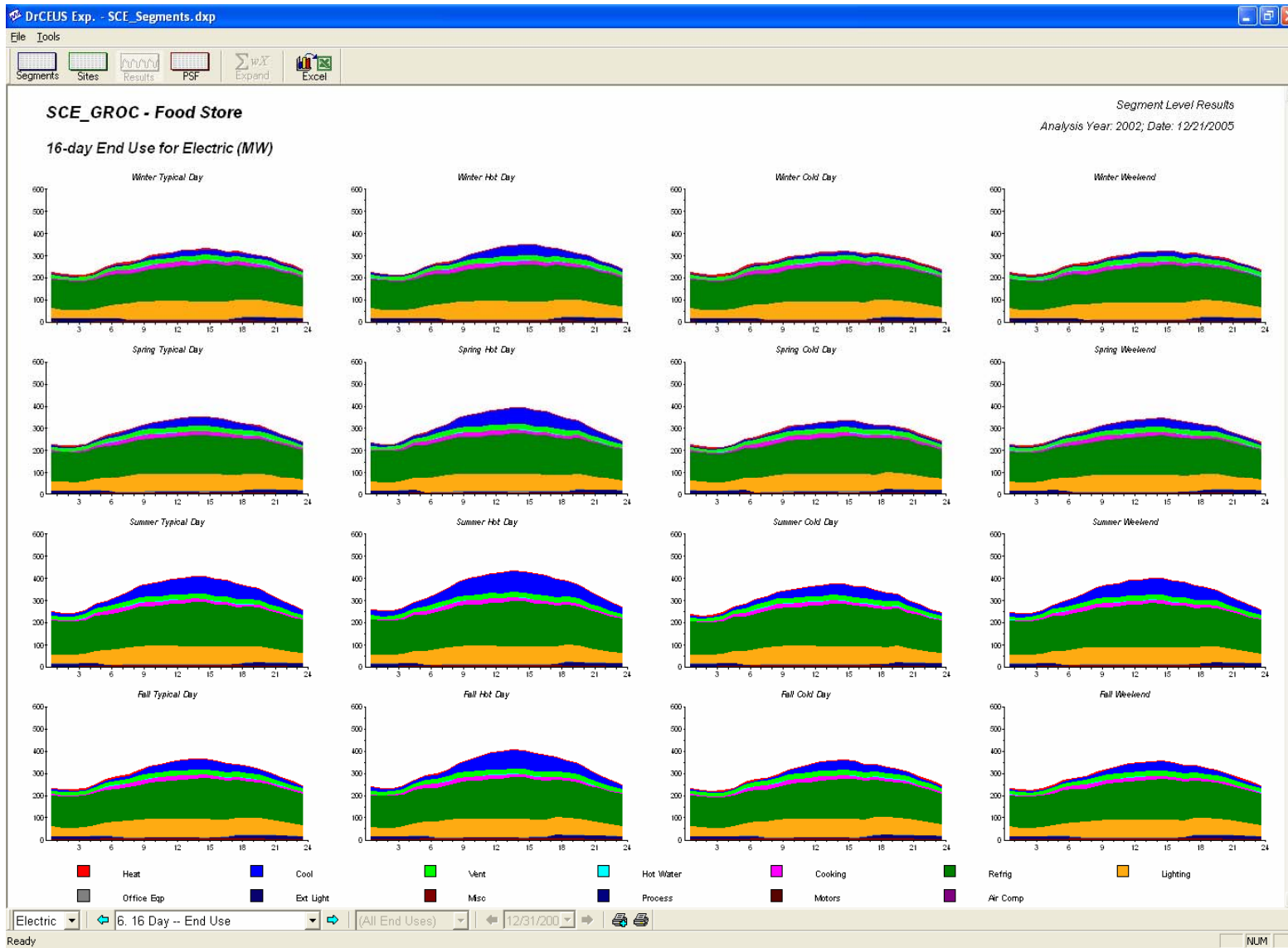


Figure 10-11: Refrigerated Warehouse 16-Day Hourly End-Use Shapes

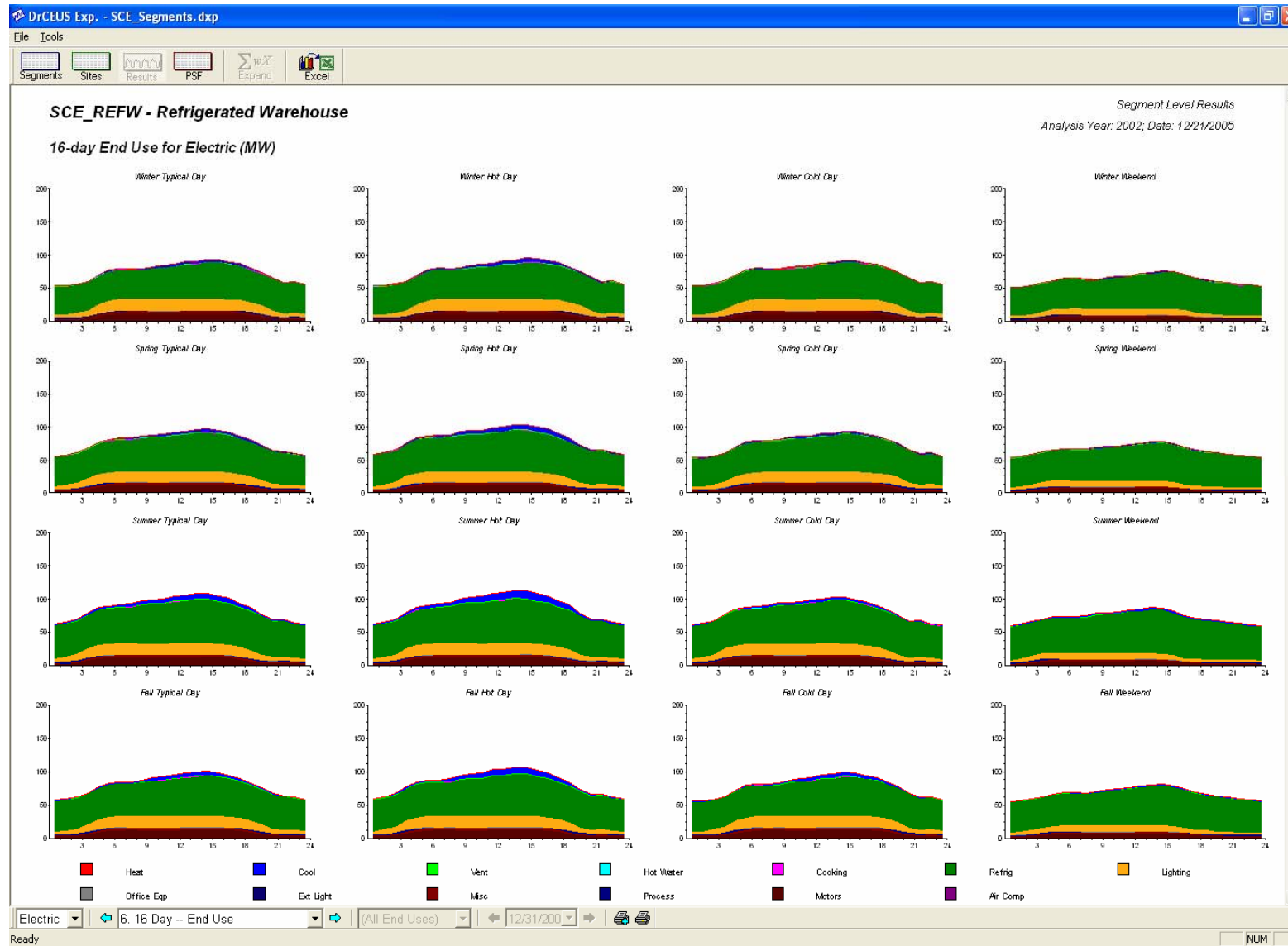


Figure 10-12: Unrefrigerated Warehouse 16-Day Hourly End-Use Shapes

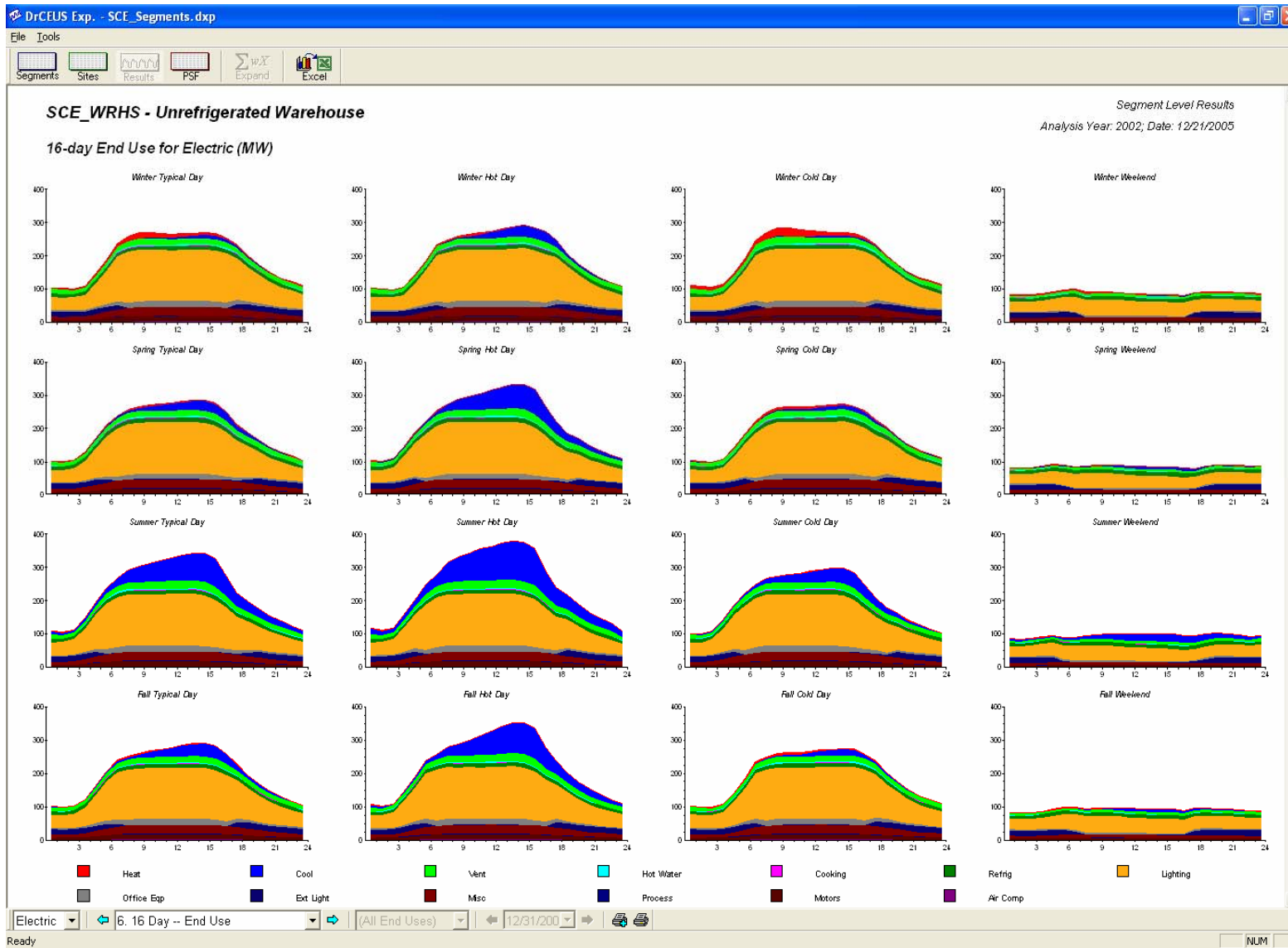


Figure 10-13: School 16-Day Hourly End-Use Shapes

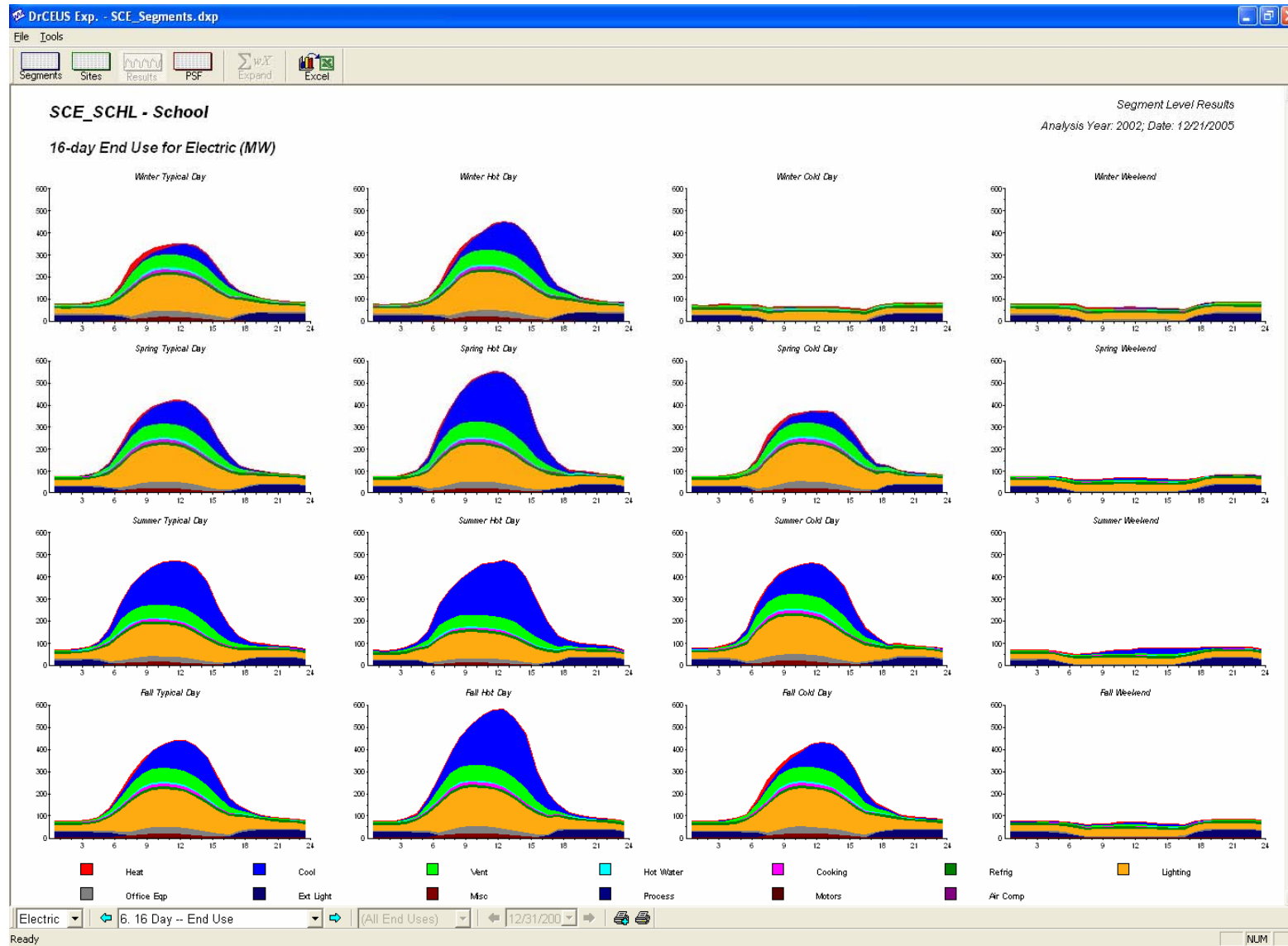


Figure 10-14: College 16-Day Hourly End-Use Shapes

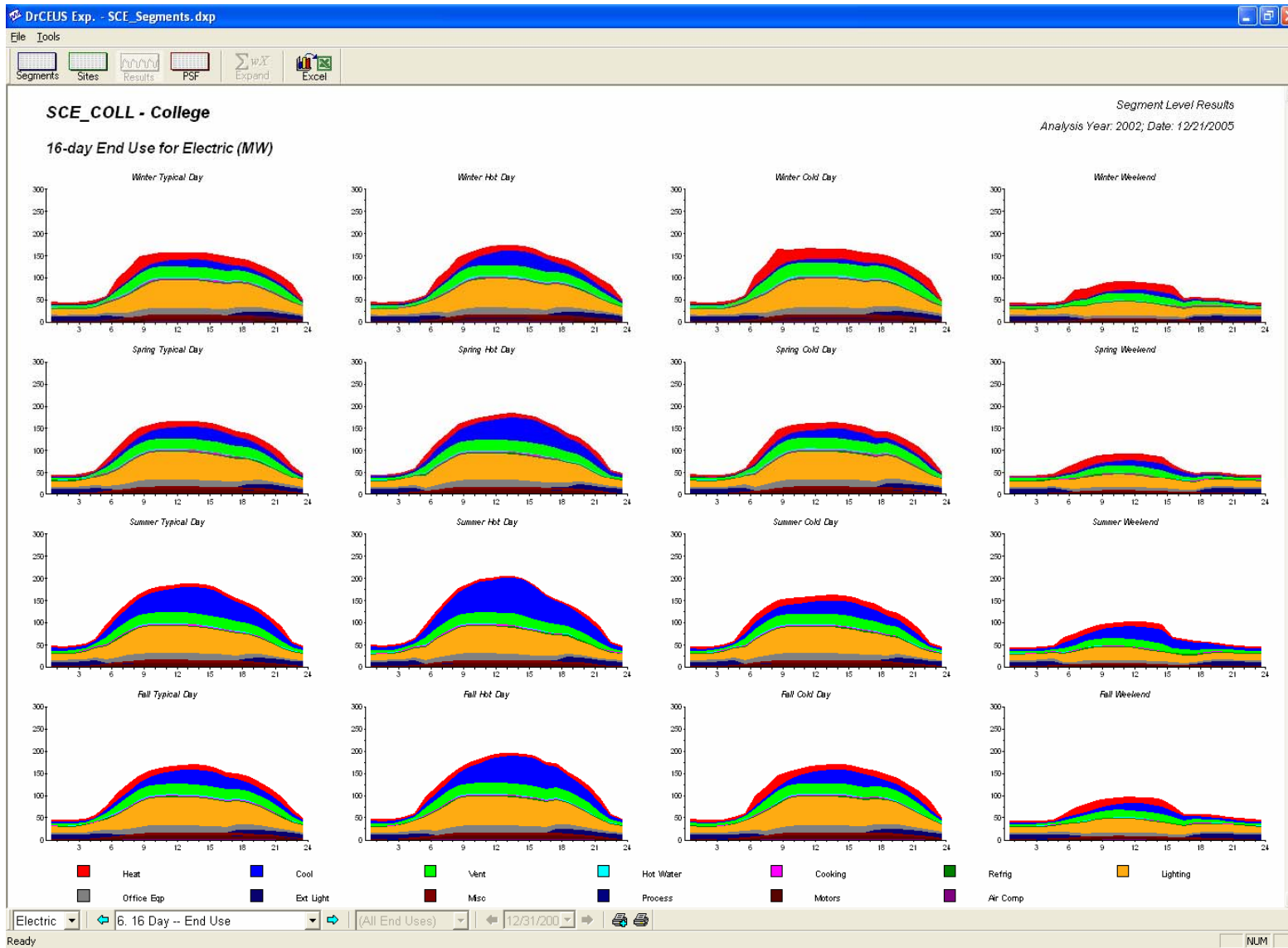


Figure 10-15: Health 16-Day Hourly End-Use Shapes

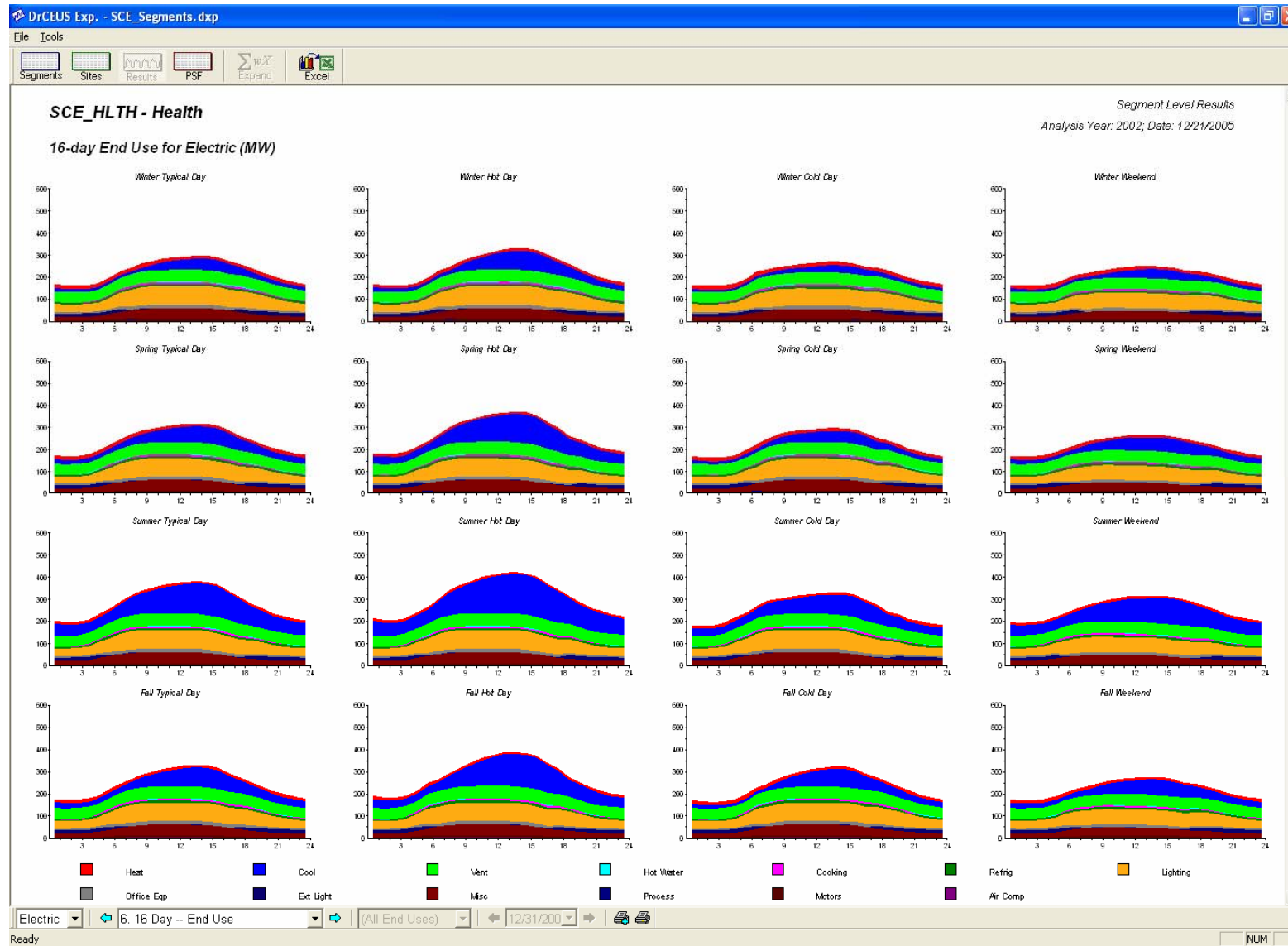


Figure 10-16: Lodging 16-Day Hourly End-Use Shapes

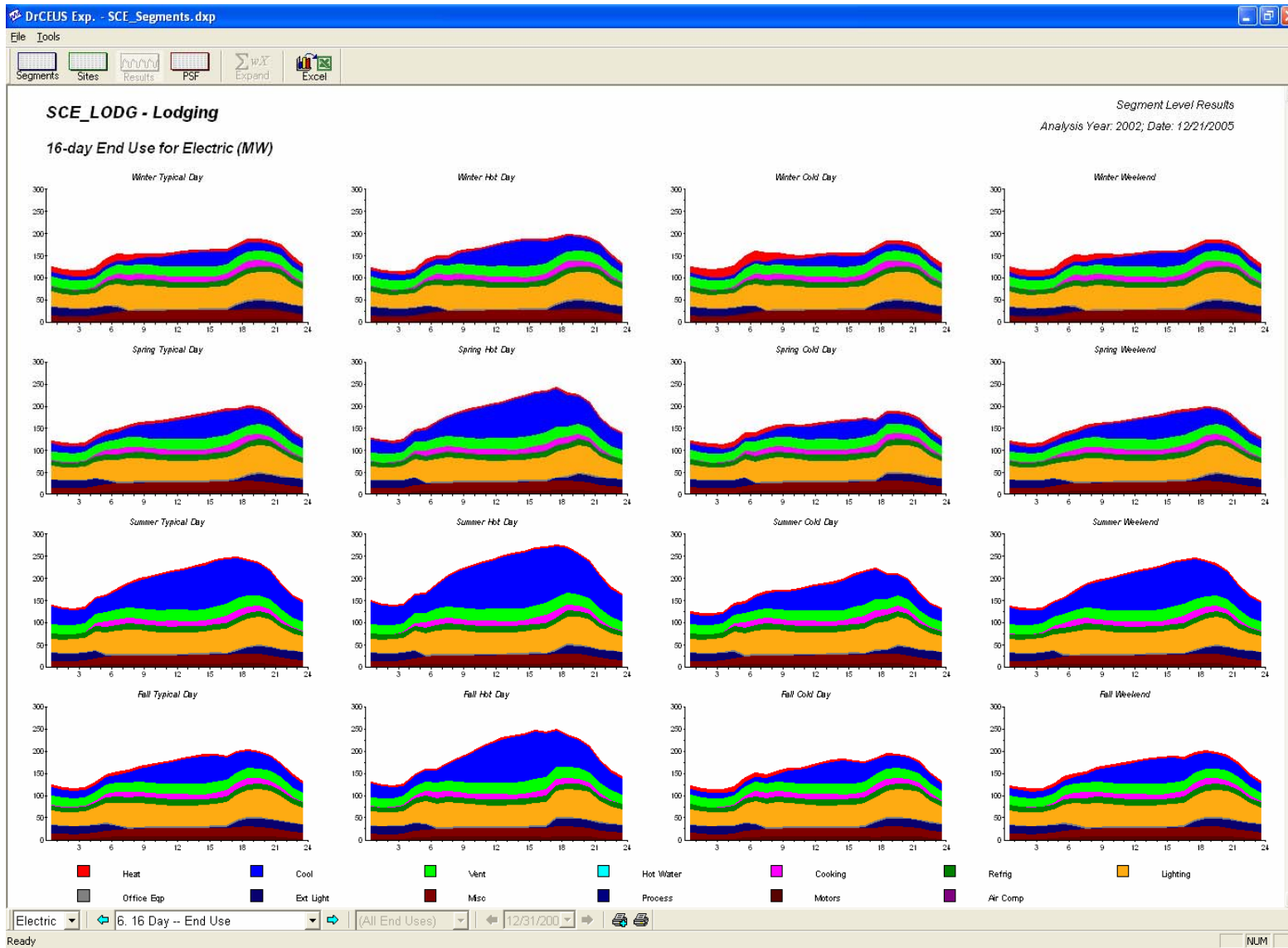


Figure 10-17: Miscellaneous 16-Day Hourly End-Use Shapes

