BOC Level I

Project Workbook

FACILITATOR EDITION

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Edition 3.1

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BOC Level I Project

Purpose. The purpose of the BOC Level I project is to enable participants to demonstrate their ability to apply skills developed in the BOC classes. The assignments require participants to gather information about their facility, provide documentation, and make recommendations for particular building systems. Taken as a whole, the project should provide the participant a useful overview of the facility's operational characteristics, energy consumption, and maintenance status. Completion of the Level I Project Workbook is REQUIRED for BOC Level I certification.

Organization and Instructions. The project consists of five assignments given during the class and should be completed and returned to the training coordinator for review at the start of the following class. Instructors and training coordinators can call the NEEC office at (206) 292-4793 for questions related to the project workbook.

Grading and Recording Scores. The BOC coordinator uses the assignment rubric to check each item to be completed and calculates the score. If a participant scores below 70%, advise them on how to correct and resubmit the assignment. Following the review of each assignment, the coordinator records the assignment scores in three places 1) assignment rubric, 2) Project Score Card 3) BOC student database. The reviewer should initial and date the rubric and score card in the Office-Use sections and include comments, if needed.

Project Assignment Description

By Class	Due
BOC 1001: Draw a simple floor plan of the facility. Identify primary heating and cooling plants, distribution lines and control points.	the following class
BOC 1002: Create an energy benchmark for your building using Energy Star ® Portfolio Manager**.**	the following class
BOC 1003: Perform a simplified lighting survey including watt densities and lighting levels. Research utility	the following class
BOC 1004: Review facility heating, cooling and ventilation operations and maintenance measures. Provide a control system overview identifying strategies by system and running time comparisons.	the following class
BOC 1005: Develop an Occupancy Schedule. Profile the occupancy of the facility by week, month and year	the following class

SAMPLE Project Score Card

Name: John Doe Company: Acme Building Services Participant ID #: 00000000000

********** OFFICE USE ONLY **********

Date	Assignment	Score	Comments (and Reviewer's Initials)
9/5/13	**Assignment 1: Building Floor Plan**	91	Requested additional time to complete the project. G.H.
10/10/13	**Assignment 2: Benchmark a Building**	85	G.H.
11/10/13	**Assignment 3: Lighting Survey**	100	G.H.
1/10/14	**Assignment 4: Control System Review**	85	G.H.
2/10/14	**Assignment 5: Occupancy Schedule**	100	G.H.

Assignment 1: Building Floor Plan

Implementation Instructions

At the beginning of class on the second day of BOC 1001, the instructor should refer participants to the project rubric and explain that it will be used to grade the assignment. Review each item and the project instructions. Discuss potential challenges and solutions such as access to systems & system identification. Suggest people in their organization participants can talk to in order gain access and/or get assistance in system identification. Fire escape floor-plans can be used as a starting point in lieu of as-built drawings. During class, demonstrate how to draw an air handler and other complex HVAC system components. Ask participants if they feel confident in their ability to complete the project. Answer questions.

Grading

Refer to the rubric, floor plan symbols, and project samples found in the appendix workbook to aid in grading. Place a check marked beside each item that was completed. 11 out of 11 check marks equal a score of 100%. 10 out of 11 correct = 91%, etc.

Grading FAQ

The FAQ, below, can be a used as a general guide for commonly asked questions about scoring all the assignments.

Q - What if it's not readily clear whether an assignment item was completed?

A - Offer to meet with the participant and instructor during a break or after class to discuss the project item in question. Depending on the total score, determine if the participant will need to correct the item.

Q - Does the project score affect certification?

A - No.

Q - What if a participant says s/he is unemployed and does not have access to a commercial facility?

A - In order to receive the BOC credential the participant must complete and turn in all of the projects. Suggest that the participant network with another participant in the class to schedule a walk-through of their facility or use information from a previous employer. Alternatively, you can assist the participant in making contact with the facility manager of the building where classes are being hosted. The use of a single-family residential building should NOT be suggested.

Assignment 2A: Benchmark a Building

Debriefing on the Previous Assignment

At the start of class, participants turn in Assignment 1 for grading. The coordinator and instructor should review the assignment objectives, instructions, project examples, and answer keys ahead of time. At the start of class, the instructor should lead a 5 minute discussion by asking general questions such as: What went well? What didn't go well? How did you address challenges? Why did things happen? What will you do differently/better next time? How will you use this?

Suggested questions: How is your floor plan organized? How did you arrive at the square footage? How did you access information on your building?

Implementation Instructions

Participants will be benchmarking the building from assignment 1 in Portfolio Manager. During the demo of Portfolio Manager, the instructor should reference the PM Quick Start Guide in the participant handbook appendix and point out that it will be helpful for completing the 1002 project assignment when participants prepare to enter their building data for benchmarking. Discuss the importance of entering data correctly e.g. use erroneous data sets to demonstrate how participants can spot data entry problems. Allow participants to practice EUI calculations during class.

At the beginning of class, refer participants to the project rubric A and explain that the rubric will be used to grade the assignment. Review each item and the project instructions. Discuss potential challenges such as finding accurate data and suggest solutions such as making contact with a utility rep as a resource for data and suggest ways to build a relationship with them. Ask participants if they feel confident in their ability to complete the project. Answer questions.

NOTE: Some participants may not be able to use Portfolio Manager if they lack access to a computer/internet, needed data or a facility that is too small or not supported by the tool. If this is the case, then the participant should be referred to the alternative Energy Accounting assignment in appendix B-3 of their workbook and complete Parts 1 - 4. If they lack needed data, then they should be referred to the sample data and the PM Assignment and rubric A.

Grading version 2-A

To receive full credit for the assignment, participants should complete/ print and turn in the three documents enumerated below:

1. Portfolio Manager Data Collection Worksheet
2. Statement of Energy Performance (SEP)
3. Benchmark Analysis Worksheet on pp 21 in the workbook

To score the assignment, use the rubrics provided in the project workbook. In the office-use section, initial, date, and score the project. The project grade should be recorded in participant record along with the exam score.

Rubric A has 11 items to be graded. Count up the correct answers and round to the nearest whole number. 11 out of 11 correct answers equal a score of 100% (10 out of 11 = 91%, etc.).

Grading version 2-B

To receive full credit for the assignment, participants should complete/ print and turn in the three documents enumerated below:

1. Energy Accounting Report Parts 1-4. See keys for parts 1, 2, and 3, below.
2. Benchmark Analysis Worksheet on pp 21 (part 4) in the workbook

Rubric B has 20 items to be graded.

2B KEY PART 1: HOSPITAL

Building Name: Palomar Medical
Building Square Footage: 572,444 sq ft
Building Type (e.g., school, office bldg., hospital, etc.): Hospital

Year	Electricity			Natural Gas		
Month	Consumed kWh	Electric MMBTU kWh x 0.003413	Electric Cost	Consumed Therms	Gas MMBTU Therms x 0.10	Gas Cost
January	1129648	3855.48	112965	906	90.6	906
February	1200382	4096.90	120038	933	93.3	933
March	1164066	3972.95	116407	1030	103.3	1030
April	1169832	3992.63	116983	952	95.2	952
May	1290330	4403.89	129033	980	98.0	980
June	1315080	4488.36	131508	866	86.6	866
July	1398754	4773.97	139875	927	92.7	927
August	1369504	4674.11	136950	748	74.8	748
September	1214870	4146.35	121487	625	62.5	625
October	1201550	4100.89	120155	1471	147.1	1471
November	1164890	3975.77	116489	936	93.6	936
December	1165976	3979.47	116598	1022	102.2	1022
Annual Totals	14784882	50460.8	1478488	11396	1139.6	11396

1. Enter monthly electrical kWh and cost from utility bill.
2. Convert monthly kWh to MMBTU.
3. Enter monthly natural gas Therms and cost from utility bill.
4. Convert monthly Therms to MMBTU.
5. Total all columns

2B KEY PART 2: HOSPITAL

Use the annual totals from the previous page for the following calculations:

1. Calculate Energy Use Index (BTU / Square Foot / Year)

50460.8	+	1139.6	=	51600.4	÷	572,444	X	1,000	=	90.1
Annual Electric MMBTU		Annual Gas MMBTU		Annual Total MMBTU		Square Footage		Conversion Factor		Energy Use Index 1,000 BTU/FT^2

2. Calculate Annual Cost per Square Foot (Dollars / Square Foot)

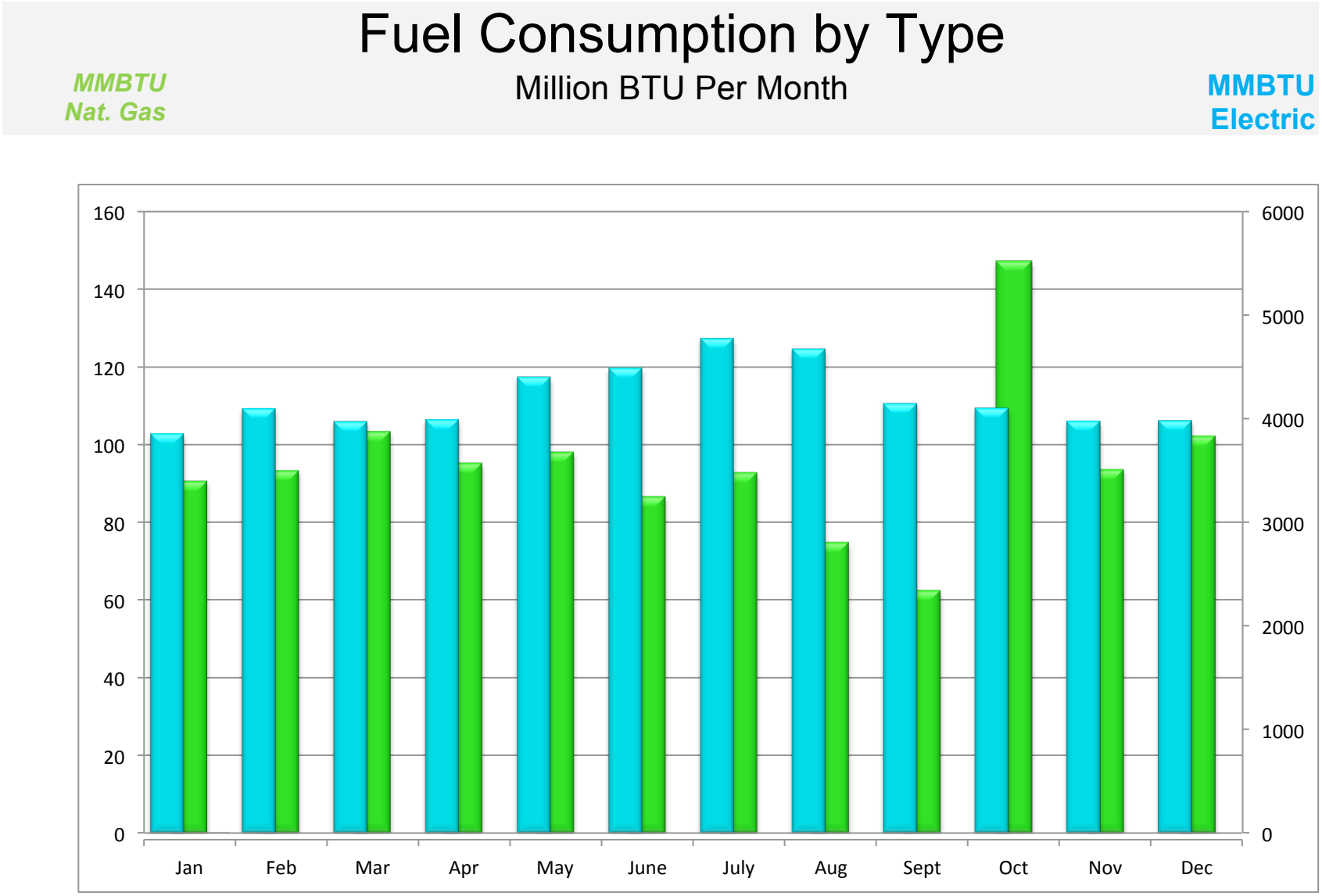
1478488	+	11396	=	1489884	÷	572,444	=	2.60
Annual Electric Cost		Annual Gas Cost		Annual Energy Cost		Square Footage		Annual Cost Per Ft^2

3. Calculate Annual Electric Benchmark (kWh / Square Foot / Year)

14784882	÷	572,444	=	25.8	(For Base Year)
Annual Electric kWh		Square Footage		Annual Electric Benchmark	

4. Complete the Benchmark Analysis Worksheet found on page 21 in your BOC Project Workbook.

2B KEY PART 4: HOSPITAL



2B KEY PART 1: K-12

Building Name: Tacoma Power
Building Square Footage: 45,000 sq ft
Building Type (e.g., school, office bldg., hospital, etc.): K-12 School

Year	Electricity			Natural Gas		
Month	Consumed kWh	Electric MMBTU kWh x 0.003413	Electric Cost	Consumed Therms	Gas MMBTU Therms x 0.10	Gas Cost
January	24000	81.91	1200	3500	350	3500
February	20000	68.26	1000	3600	360	3600
March	24000	81.91	1200	3600	360	3600
April	22000	75.08	1100	1000	100	1000
May	20000	68.26	1000	1100	110	1100
June	18990	64.81	1000	1000	100	1000
July	18000	61.43	900	1000	100	1000
August	16000	54.60	800	1000	100	1000
September	18000	61.43	900	1000	100	1000
October	20000	68.26	1000	2000	200	2000
November	22000	75.08	1100	4000	400	4000
December	22000	75.08	1100	4000	400	4000
Annual Totals	244990	836.15	12300	26800	2680	26800

1. Enter monthly electrical kWh and cost from utility bill.
2. Convert monthly kWh to MMBTU.
3. Enter monthly natural gas Therms and cost from utility bill.
4. Convert monthly Therms to MMBTU.
5. Total all columns

2B KEY PART 2: K-12

Use the annual totals from the previous page for the following calculations:

1. Calculate Energy Use Index (BTU / Square Foot / Year)

836.15	+	2680	=	3516.15	÷	45000	X	1,000	=	78.1
Annual Electric MMBTU		Annual Gas MMBTU		Annual Total MMBTU		Square Footage		Conversion Factor		Energy Use Index 1,000 BTU/FT^2

2. Calculate Annual Cost per Square Foot (Dollars / Square Foot)

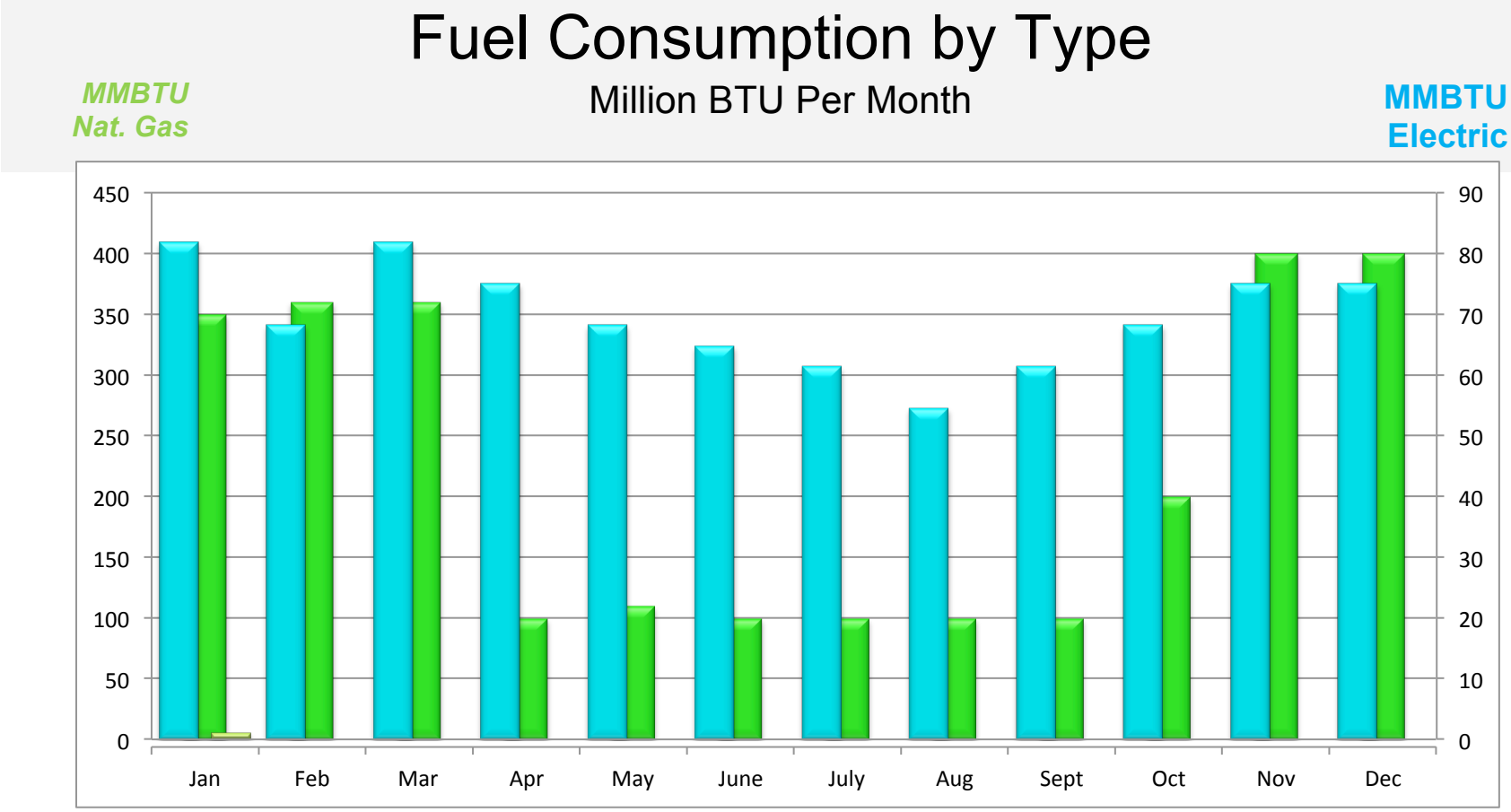
12300	+	26800	=	39100	÷	45000	=	.86
Annual Electric Cost		Annual Gas Cost		Annual Energy Cost		Square Footage		Annual Cost Per Ft^2

3. Calculate Annual Electric Benchmark (kWh / Square Foot / Year)

244990	÷	45000	=	5.44	(For Base Year)
Annual Electric kWh		Square Footage		Annual Electric Benchmark	

4. Complete the Benchmark Analysis Worksheet found on page 21 in your BOC Project Workbook.

2B KEY PART 4: K-12



2B KEY PART 1: Multifamily

Building Name: Mixed Use: 2900 1st
Building Square Footage: 188,715 sq ft
Building Type (e.g., school, office bldg., hospital, etc.): Multifamily

Year	Electricity			Natural Gas		
Month	Consumed kWh	Electric MMBTU kWh x 0.003413	Electric Cost	Consumed Therms	Gas MMBTU Therms x 0.10	Gas Cost
January	178955	610.77	15977	196	19.6	196
February	161617	551.59	13930	191	19.1	191
March	156131	532.87	11953	228	22.8	228
April	140217	478.56	10615	368	36.8	368
May	124316	424.29	11073	292	29.2	292
June	114162	389.63	11311	356	35.6	356
July	113108	386.03	11416	479	47.9	479
August	110726	377.90	12432	264	26.4	264
September	106151	362.29	14022	363	36.3	363
October	119535	407.97	15613	417	41.7	417
November	139297	475.42	16162	446	44.6	446
December	159765	545.277	17896	445	44.5	445
Annual Totals	1623980	5542.597	162400	4045	404.5	4045

1. Enter monthly electrical kWh and cost from utility bill.
2. Convert monthly kWh to MMBTU.
3. Enter monthly natural gas Therms and cost from utility bill.
4. Convert monthly Therms to MMBTU.
5. Total all columns

2B KEY PART 2: Multifamily

Use the annual totals from the previous page for the following calculations:

1. Calculate Energy Use Index (BTU / Square Foot / Year)

5542.597	+	404.5	=	5947.09	÷	188,715	X	1,000	=	31.51
Annual Electric MMBTU		Annual Gas MMBTU		Annual Total MMBTU		Square Footage		Conversion Factor		Energy Use Index 1,000 BTU/FT^2

2. Calculate Annual Cost per Square Foot (Dollars / Square Foot)

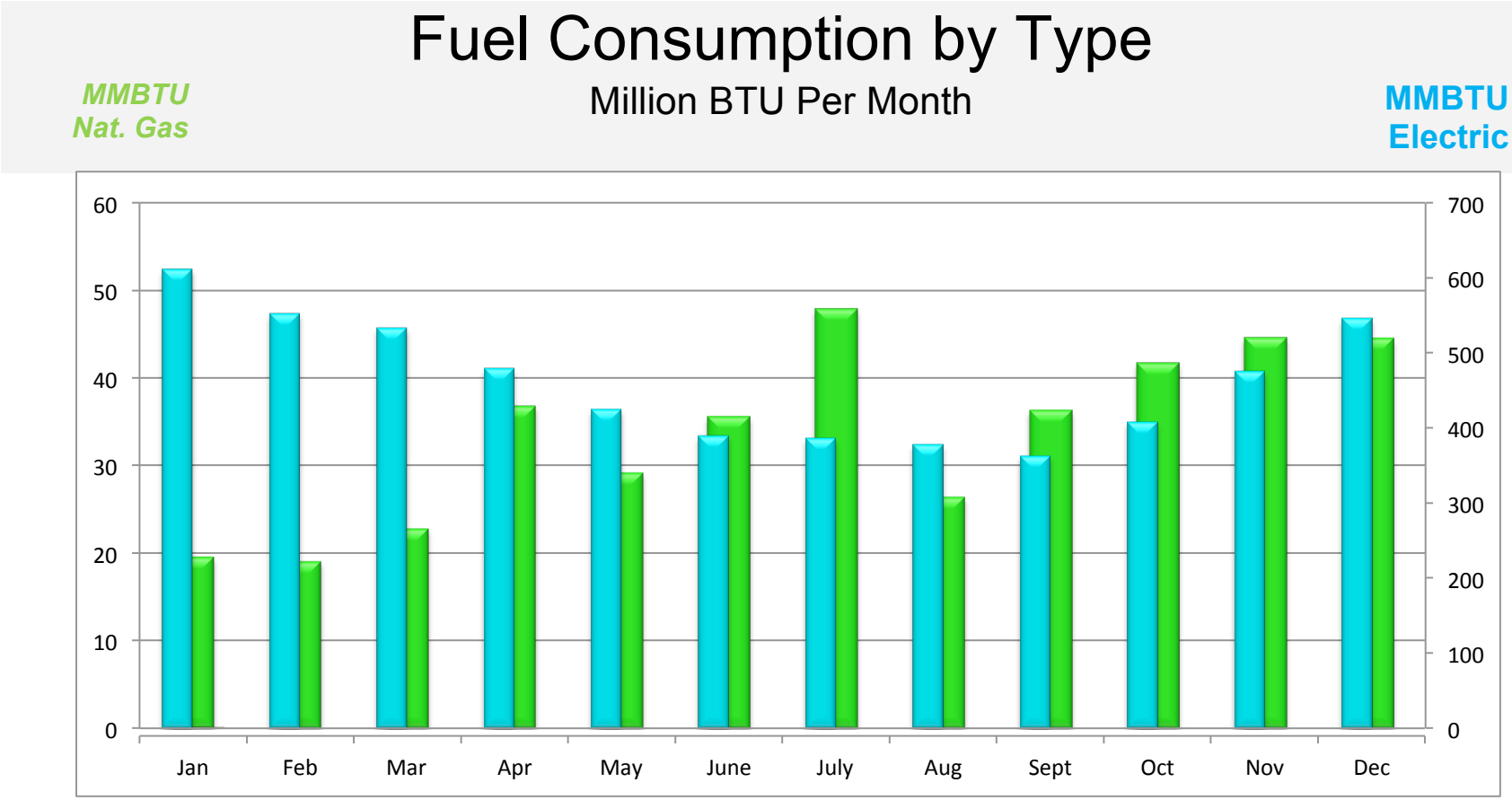
162,400	+	4045	=	166,445	÷	188,715	=	0.88
Annual Electric Cost		Annual Gas Cost		Annual Energy Cost		Square Footage		Annual Cost Per Ft^2

3. Calculate Annual Electric Benchmark (kWh / Square Foot / Year)

1623980	÷	188715	=	8.6	(For Base Year)
Annual Electric kWh		Square Footage		Annual Electric Benchmark	

4. Complete the Benchmark Analysis Worksheet found on page 21 in your BOC Project Workbook.

2B KEY PART 4: Multifamily



2B KEY PART 1: Office/Mixed Use

Building Name: Main Street Building
Building Square Footage: 56,000 sq ft
Building Type (e.g., school, office bldg., hospital, etc.): Office/Mixed Use

Year	Electricity			Natural Gas		
Month	Consumed kWh	Electric MMBTU kWh x 0.003413	Electric Cost	Consumed Therms	Gas MMBTU Therms x 0.10	Gas Cost
January	110,000	375.4	11,000	155	15.5	175
February	115,000	392.5	11,500	150	15.0	170
March	107,500	366.9	10,750	165	16.5	185
April	100,000	341.3	10,000	130	13.0	150
May	105,000	358.4	10,500	160	16.0	180
June	105,000	358.4	10,500	115	11.5	135
July	100,000	341.3	10,000	120	12.0	140
August	102,500	349.8	10,250	100	10.0	120
September	100,000	341.3	10,000	120	12.0	140
October	107,500	366.9	10,750	125	12.5	145
November	110,000	375.4	11,000	120	12.0	140
December	115,000	392.5	11,500	180	18.0	200
Annual Totals	1,277,500	4360.1	127,750	1,640	164.0	1,880

1. Enter monthly electrical kWh and cost from utility bill.
2. Convert monthly kWh to MMBTU.
3. Enter monthly natural gas Therms and cost from utility bill.
4. Convert monthly Therms to MMBTU.
5. Total all columns

2B KEY PART 2: Office/Mixed Use

Use the annual totals from the previous page for the following calculations:

1. Calculate Energy Use Index (BTU / Square Foot / Year)

4360.1	+	1,640	=	6,000.1	÷	56,000	X	1,000	=	107.1
Annual Electric MMBTU		Annual Gas MMBTU		Annual Total MMBTU		Square Footage		Conversion Factor		Energy Use Index 1,000 BTU/FT^2

2. Calculate Annual Cost per Square Foot (Dollars / Square Foot)

127,750	+	1,880	=	129,630	÷	56,000	=	2.31
Annual Electric Cost		Annual Gas Cost		Annual Energy Cost		Square Footage		Annual Cost Per Ft^2

3. Calculate Annual Electric Benchmark (kWh / Square Foot / Year)

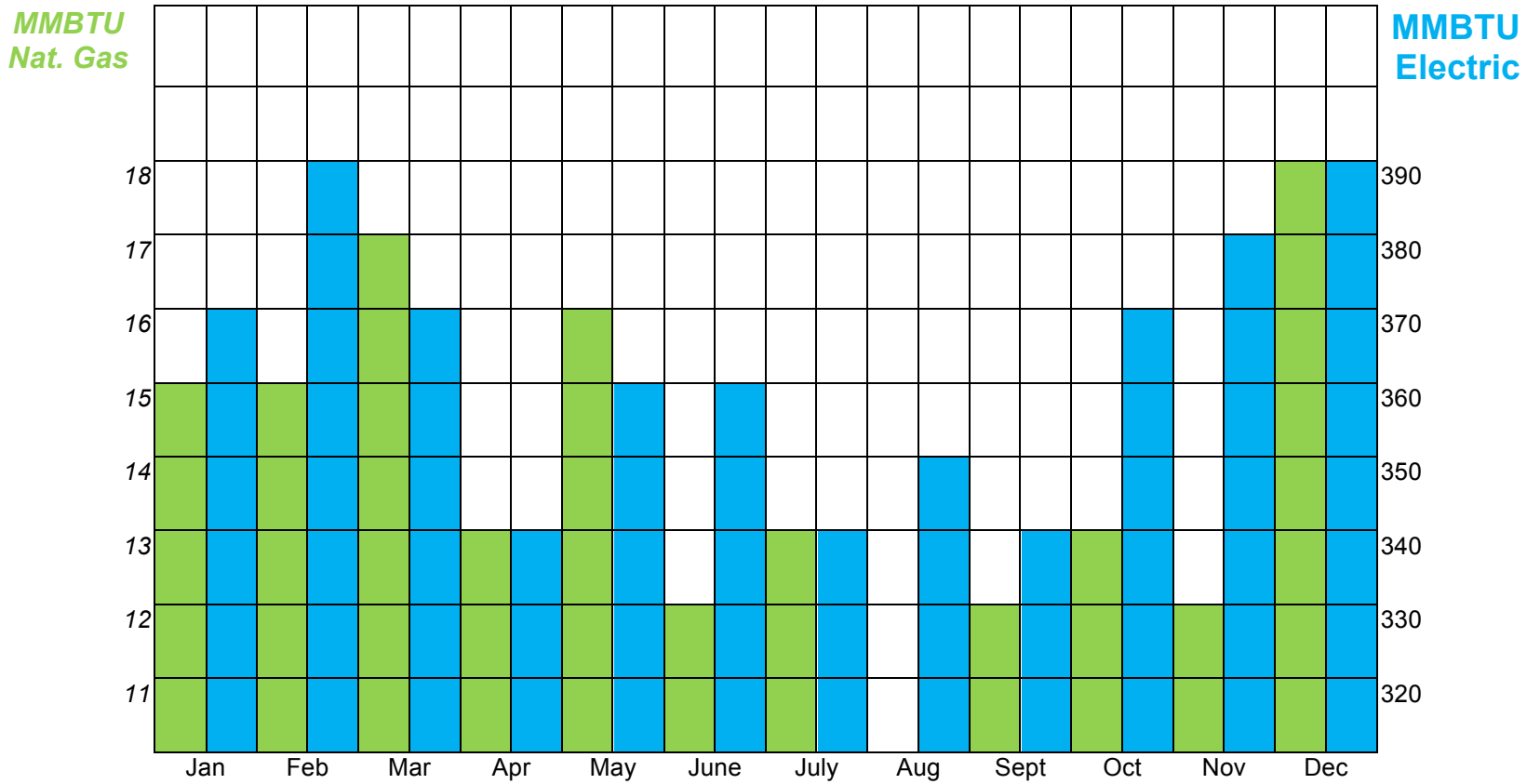
1,277,500	÷	56,000	=	22.8	(For Base Year)
Annual Electric kWh		Square Footage		Annual Electric Benchmark	

4. Complete the Benchmark Analysis Worksheet found on page 21 in your BOC Project Workbook.

2B KEY PART 4: Office/Mixed Use

Fuel Consumption by Type

Million BTU Per Month



Assignment 3: Lighting Survey

Debriefing Instructions

At the start of class, participants turn in Assignment 2 for grading. The coordinator and instructor should review the assignment objectives, instructions, project examples, and answer keys ahead of time. At the start of class, the instructor should lead a 5 minute discussion by asking general questions such as: What went well? What didn't go well? How did you address challenges? Why did things happen? What will you do differently/better next time? How will you use this?

***Suggested discussion question*:** How can you use the PM data you collected?

Implementation Instructions

This is a 3-part project assignment. In Part I, participants conduct a lighting survey on the building from assignment 1 & 2. In Part II, they research local lighting incentives and in Part III, they estimate the cost of a lighting retrofit using a typical utility incentive. Students will be required to demonstrate knowledge of lighting levels and re-commissioning methods to reduce energy use associated with lighting while maintaining recommended lighting levels needed for productivity and safety. The class exercises set students up to successfully complete the project, so instructors need to check whether students understand keys concepts and topics throughout the class. Objective #9 of the project is covered in exercise 3 of the student handbook.

At the beginning of class, refer participants to the project rubric and explain that the rubric will be used to grade the assignment. Review each item and the project instructions. Ask participants to share details of lighting retrofits. Discuss potential challenges and solutions such data gathering, terminology (i.e. luminaire). Ask participants if they feel confident in their ability to complete the project. Answer questions.

Grading

To receive full credit for the assignment, participants should complete/ print and turn in the four documents enumerated below:

1. Lighting Power Survey Worksheet
2. Lighting Energy Use Survey Worksheet
3. Utility Incentive Research
4. Lighting Retrofit Worksheet

To score the assignment, use the rubrics provided in the project workbook. In the office-use section, initial, date, and score the project. The project grade should be recorded in participant record along with the exam score.

The rubric has 23 items to be graded. Count up the correct answers and round to the nearest whole number. Participants must show their work supporting how they arrived at the answer. Deduct ½ point for each calculation that does not show their work. 23 out of 23 correct answers equal a score of 100% (20.5 out of 23 = 87%, etc.).

BOC 1003 Retrofit Lighting Worksheet Key

	Current	Proposed
Watts per fixture (A)	148 watts	90 watts
Operating hours (B)	6,000 hours	6,000 hours
Number of fixtures (C)	250	250
Annual consumption (A) x (B) x (C)	222,000 kWh/year	135,000 kWh/year
Note: divide the total by 1,000 to get kilowatt-hours		
Cost per year Note: kWh/year x $.10	$22,200	$13,500

Calculations

Energy savings	222,000 kWh Current annual consumption	minus	135,000 kWh Proposed annual consumption		87,000 kWh Annual energy savings (kWh)
Cost savings	87,000 kWh Annual energy savings (kWh)	X	$0.10 Energy rate per kWh		$8,700 Annual cost savings
Utility Incentive	87,000 kWh Annual energy savings (kWh)	X	$0.20 Utility incentive in $/kWh		$17,400 Utility incentive
Net Project cost	$28,500 Project capital cost	minus	$17,400 Utility incentive		$11,100 Net project cost
Payback period	$11,100 Net project cost	divided by	$8,700 annual dollar savings		1.28 years Payback in years
Return on investment (ROI)	1	divided by	1.28 Payback in years		78% ROI

Note: ROI is 1 divided by the payback

Assignment 4: HVAC Controls Review

Debriefing Instructions

At the start of class, participants turn in Assignment 3 for grading. The coordinator and instructor should review the assignment objectives, instructions, project examples, and answer keys ahead of time. At the start of class, the instructor should lead a 5 minute discussion by asking general questions such as: What went well? What didn't go well? How did you address challenges? Why did things happen? What will you do differently/better next time? How will you use this?

Suggested discussion question: What's your existing lighting system? What rebates are available? Were you able to calculate power density and does it make sense? Work through Retrofit Worksheet calculations as a group.

Implementation Instructions

This is a 5-part project assignment. Participants complete:

1) Building and Mechanical Zone Information

2) Heating System Operation Review Worksheet

3) Ventilation Systems Worksheet

4) Cooling Systems and/or Heat Pump Operations Worksheet

5) Control Systems Review Worksheet

By successfully completing this workbook assignment, participants demonstrate their knowledge of the proper operation of mechanical systems, mechanical controls, and the value of re-commissioning in order to reduce energy use without reduction of comfort, indoor air quality or function needed for productivity and safety. During class, provide an example of a sequence of operation and demonstrate how you would do it. Suggested online resources:

- www.ctrlspecbuilder.com
- www.buildapedia.com
- www.engineeringtoolbox.com

At the beginning of class, refer participants to the project rubric and explain that the rubric will be used to grade the assignment. Review each item and the project instructions. Discuss potential challenges and solutions such as not being able to find equipment, time constraints. Ask participants if they feel confident in their ability to complete the project. Answer questions.

Grading

To receive full credit for the assignment, participants should complete/ print and turn in the four documents enumerated in the implementation instructions above.

To score the assignment, use the rubrics provided in the project workbook. In the office-use section, initial, date, and score the project. The project grade should be recorded in participant record along with the exam score.

The rubric has 20 or 15 items to be graded depending on whether the building space studied has a boiler. Count up the correct answers and round to the nearest whole number. Participants must show their work supporting how they arrived at the answer. 20 out of 20 correct answers equal a score of 100% (17 out of 20 = 85%, etc.).

Assignment 5: Occupancy Schedule

Debriefing Instructions

At the start of class, participants turn in Assignment 4 for grading. The coordinator and instructor should review the assignment objectives, instructions, project examples, and answer keys ahead of time. At the start of class, the instructor should lead a 5 minute discussion by asking general questions such as: What went well? What didn't go well? How did you address challenges? Why did things happen? What will you do differently/better next time? How will you use this?

Implementation Instructions

In this 3-part project assignment, participants document and analyze the effects of occupant density, hours of use and other occupant factors occurring within buildings. By successfully completing this workbook assignment, participants should be able to discuss how building controls could increase occupant comfort, improve air quality, and reduce energy.

At the beginning of class, refer participants to the project rubric and explain that the rubric will be used to grade the assignment. Review each item and the project instructions. Discuss potential challenges and solutions like communicating with occupants. Point out and discuss the relationship between occupancy and energy use. Ask participants if they feel confident in their ability to complete the project. Answer questions.

Grading

To receive full credit for the assignment, participants should complete/ print and turn in the three documents enumerated below:

1. Building Occupancy Schedule
2. An Occupancy Profile for each zone listed on the schedule
3. Occupancy Profile Analysis questionnaire

To score the assignment, use the rubrics provided in the project workbook. In the office-use section, initial, date, and score the project. The project grade should be recorded in participant record along with the exam score.

The rubric has 17 items to be graded depending on whether the building space studied has a boiler. Count up the correct answers and round to the nearest whole number. Participants must show their work supporting how they arrived at the answer. 17 out of 17 correct answers equal a score of 100% (15 out of 17 = 88%, etc.).

