

REPORT

Hawaii Energy Codes Compliance Study

Prepared for
Hawaii Energy

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Executive Summary

The report describes results of a building energy code compliance study for nonresidential and high-rise residential buildings in the Counties of Hawaii and Maui. A study of Honolulu County compliance is planned for a later phase.

County Building Energy Codes

The current building energy code in Hawaii, Maui and Honolulu Counties as of early 2015 is the 2006 International Energy Conservation Code (2006 IECC) adopted with several amendments. Those amendments extend the building envelope requirements to some unconditioned buildings, require designers to provide a signed compliance certification on their plans, require a commissioning plan for mechanical systems, and require tenant electricity sub-metering in some cases.

Compliance Study Method

A sample of 10 recently permitted projects were selected in each County. In Hawaii County those plans were reviewed on-site in the building department offices. For Maui County electronic plans were downloaded and reviewed remotely. The projects were selected to provide a mix of large and small projects and new construction and renovation projects. The review of each project took an average of two hours and covered the buildings' interior lighting, exterior lighting, envelope, HVAC and water heating systems.

Summary of Reviewed Projects

The ten projects in Hawaii County range in size from about 800 sf to 42,000 sf, with an average floor area of 13,000 sf. The ten projects in Maui County range in size from about 1,500 sf to 294,000 sf with an average of 85,000 sf.

Summary of Compliance Review Results

Designer Compliance Certification

A designer signature and certification was included on 19 of 20 projects (95%). However the one project with missing certification did include a separate compliance report. Roughly 20% of projects are missing at least one relevant certification, either envelope, mechanical or electrical.

Interior Lighting Power

Interior lighting power is the code requirement with one of the higher rates of non-compliance, equal to 42% of the projects. Small retail projects account for the majority of non-complying projects. Improper accounting for track lighting power is a common compliance problem. Specifications for lighting fixture input power are missing from most projects.

- Complies: 10 of 19 (53%)
- Does not comply: 8 of 19 (42%)
- Not verified: 1 of 19 (5%)

Exterior Lighting Power

Exterior lighting power compliance is generally good, and the designed power is often 50% to 70% below the allowed lighting power. One problem occurring in a few projects is improper accounting for lighting power of screw-base fixtures, where designers take credit for compact fluorescent lamps while the code requires use of the maximum rated fixture power in compliance calculations.

- Complies: 9 of 12 (75%)
- Does not comply: 2 of 12 (17%)
- Not verified: 1 of 12 (8%)

Roof Insulation

Roof insulation R-value specifications are missing from a majority of the reviewed projects. The code requires that information such as insulation R-value be included on the construction documents that are submitted for permit. Due to this lack of information, the compliance for many of the projects could not be verified. However, it is expected that the actual compliance rate is fairly good. The one non-compliance case identified in this study specified R-19 insulation where the requirement is R-30 for insulation installed under the roof deck.

- Unknown: 7 of 12 (58%)
- Complies: 4 of 12 (33%)
- Does not comply: 1 of 12 (8%)

Wall Insulation

Wall insulation compliance rates are good. Just as with roof insulation, the R-value information is often missing from the plans, but in the case of walls there is no insulation required for concrete walls. Therefore, a greater fraction of projects can be verified to comply.

- Unknown: 2 of 12 (17%)
- Complies: 10 of 12 (83%)
- Does not comply: 0 of 12 (0%)

Fenestration

Window solar heat gain coefficient (SHGC) requirements could not be verified for a majority of the reviewed projects because window specifications are not included on the construction documents submitted to the building department. While it is likely that a significant fraction of these projects do in reality comply with the SHGC limits, there is also a reasonable chance that some do not. Several projects show single-pane glazing, which would require very dark tint or reflective coatings in order to meet the code requirements.

- Unknown: 11 of 13 (85%)
- Complies: 1 of 13 (8%)
- Partial compliance: 1 of 13 (8%)
- Does not comply: 0 of 13 (0%)

HVAC Cooling Efficiency

A large fraction, and potentially all, of the reviewed projects comply with the code's cooling equipment efficiency requirements. Performance specifications are missing from 20% of the projects, but most

equipment that is currently available on the market will meet the minimum efficiency requirements of the 2006 IECC.

- Unknown: 3 of 15 (20%)
- Complies: 12 of 15 (80%)
- Does not comply: 0 of 15 (0%)

HVAC Insulation

Duct insulation specifications are missing from 64% of the reviewed projects.

Other HVAC Requirements

HVAC commissioning notes were missing from the plans in every case.

Summary of Recommendations

Recommendations are provided as follows. More details are provided within the body of the report.

- Develop simple guidelines that show which performance information that the designer must include on the plans submitted for permit approval.
- Improve awareness of the County code amendments, such as the commissioning-plan requirement, perhaps by encouraging use of code compliance checklists.
- Develop simple compliance guidance and/or incentive programs for small retail projects, especially to focus on lighting power compliance.
- Develop guidance for improving window compliance for projects in general.

Introduction

Hawaii Energy commissioned this study to evaluate the level of compliance with building energy codes in the Counties of Hawaii, Honolulu, and Maui as of early 2015. A primary goal of this work is to identify whether there are compliance problem areas and whether there are corresponding savings opportunities available from improving the compliance rates.

Part of the inspiration for this work is a 1998 study that looked at compliance rates in Honolulu and Hawaii Counties for the energy codes that they had adopted in 1995 and 1994 respectively.¹ The current study follows similar methods to the 1998 study.

The target of this study is nonresidential and high-rise residential buildings. This study does not address compliance for low-rise residential buildings.

This report covers the first of three phases of work, a compliance assessment based on plan review. Plans for subsequent work include a field assessment of compliance and development of materials to support a program targeting improved code compliance.

The work described in this report took place in the period March through June 2015. The work was performed by Erik Kolderup of Kolderup Consulting. Ramsey Brown of Hawaii Energy served as contract manager.

Many thanks go to County staff who assisted by providing access to building plans for review: Jai Ho Cheng, Neil Erickson, and Jessica Andrews of Hawaii County; and Glen Ueno and Jarvis Chun of Maui County.

Current Energy Codes

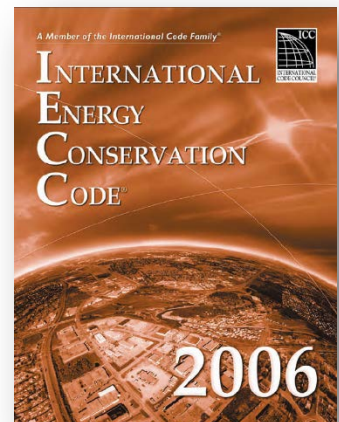
The energy code in affect at the time of this study in each of the three counties is the 2006 International Energy Conservation Code (2006 IECC) with several amendments specific to Hawaii. Most of the amendments are same for each county, however there are a few differences which are highlighted in the sections below.

In 2012 the State Building Code Council approved a set of amendments to the 2009 IECC for County adoption, but that updated code has not been adopted in these counties. Efforts are underway by the State Building Code Council to develop a similar set of amendments to the 2015 IECC for County adoption.

2006 IECC Overview

The scope of the 2006 IECC covers the following building design elements for nonresidential buildings. Some of the primary requirements from each section are highlighted. See also Appendix 1 for more details.

- Envelope
 - o Roof insulation, R-15 continuous or R-30 batt
 - o Wall insulation, R-13 for framed walls, none for concrete walls



¹ Eley Associates, *Energy Code Compliance Study: Honolulu and Hawaii Counties*, 1999. Available at <http://energycodesocean.org/resource/energy-code-compliance-study-honolulu-and-hawaii-counties>.

- Window area, maximum 40% of wall area
- Window glazing, maximum solar heat gain coefficient (SHGC) ranging from 0.25 to 0.40 depending on overhang size
- Unconditioned spaces are exempted from the building envelope requirements. (Revised by County amendments as described later below)
- Interior lighting
 - Maximum lighting power, varies by building type
 - Light reduction controls
 - Automatic shutoff controls
- Exterior lighting
 - Maximum lighting power
 - Automatic control
- HVAC
 - Cooling equipment efficiency
 - Off-hour controls
 - Duct and pipe insulation
 - System adjusting and balancing required
- Service water heating
 - Water heater efficiency
 - Pipe insulation
 - Circulator controls

In addition to the performance requirements, the 2006 IECC requires that performance information be included in the construction documents so that compliance with the code may be verified. Section 104.2 states, "Details shall include, but are not limited to, insulation materials and their R-values; fenestration U-factors and SGHCs; system and equipment efficiencies, types, sizes and controls; duct sealing, insulation and location; and air sealing details."

The 2006 IECC allows two compliance paths: prescriptive and total building performance. The total building performance path requires building energy simulation models of the proposed design and a standard design, and this path allows tradeoffs between the performance of different systems. A primary reason for using the total building performance path is to show compliance for projects with window area greater than 40%.

ASHRAE Standard 90.1-2004 is allowed as an alternative compliance path for non-residential and high-rise residential buildings in the 2006 IECC.

County Code Amendments

Each of the counties has adopted amendments to the 2006 IECC, which are very similar with only a few exceptions. The amendments that are relevant to non-residential buildings and residential buildings greater than 3 stories are described here. There are additional amendments not listed here that apply only to low-rise residential buildings.

- **Hawaii.** Chapter 5, Article 5, Section 5-84. Adopted October 2010

- **Honolulu.** Chapter 32 Building Energy Conservation Code. Adopted November 2009
- **Maui.** Chapter 16.16A. Adopted October 2009

Table 1. Summary of County Code Amendments

Amendment	Hawaii	Honolulu	Maui
Habitable unconditioned spaces must meet the envelope requirements.		✓	✓
The responsible design professional shall provide a signed statement of compliance on the plans.	✓	✓	✓
Section 105 covering inspection requirements is deleted	✓	✓	✓
Mechanical system commissioning plan is required.	✓	✓	✓
Tenant electricity sub-metering required.	✓		

Energy Code Enforcement Process

County of Hawaii Enforcement

Plan reviewers check that the designers have provided a certificate of compliance on the plans. Otherwise no specific plan review is performed to verify compliance. Typically separate certifications are included on the plans for envelope, lighting, mechanical and water heating. Plan review takes place in two offices: Hilo and Kailua-Kona.

County of Honolulu Enforcement

[To be completed]

County of Maui Enforcement

[To be completed]

Compliance Review Method

Sampling Method

The target was set at 40 projects to be reviewed in this study, with a breakdown as is listed in Table 2. These targets were set based on judgment, with the goal being to provide reasonably representative and useful results with a reasonable level of effort. This target is also similar to the number of projects reviewed for the previous compliance study in 1998.

Table 2. Sampling Targets, Number of Projects for Review

Project Type	Hawaii	Honolulu	Maui	Total
New construction – small <25k ft2	2	4	2	8
New construction – medium/large	2	4	2	8
Renovation – small <25k ft2	2	4	2	8
Renovation – medium/large	2	4	2	8
High-rise residential	2	4	2	8
Totals	10	20	10	40

An additional goal was to review a mix of non-residential building types, in such as office, retail, restaurant, and lodging.

As a point of reference regarding sample size, the US Department of Energy provides an online “State Sample Generator”, developed for the purpose of energy code compliance studies. The recommended sample sizes are shown in Figure 1 for new construction projects and Figure 2 for renovation projects. The methodology behind these samples is described in a report available at <https://www.energycodes.gov/compliance-evaluation>. These results call for a total new-construction sample of 31 for Hawaii, Honolulu and Maui Counties. That total is a bit higher than the proposed sample size of 24 new-construction projects. For renovation projects the recommended sample size is 39 projects, which is again a bit larger than the planned sample of 16 renovation projects.

Commercial New Construction
 Construction starts represent an annual average from 2008-2010 data.

Location	Construction Starts	Sample Size				
		Small	Medium	Large	X-Large	XX-Large
State Totals	107	11	11	11	2	1
Climate Zone 1 Totals	107	11	11	11		
Hawaii County	37	4	5	2		
Honolulu County	48	6	5	4		
Kauai County	6	1	-	1		
Maui County	15	-	1	4		

Figure 1. State Sample Generator Results – Commercial New Construction

US Department of Energy Building Energy Codes Program,
<https://www.energycodes.gov/compliance-evaluation>

Commercial Renovations

Construction starts represent an annual average from 2008-2010 data.

Location	Construction Starts	Sample Size
State Totals	371	40
Climate Zone 1 Totals	371	40
Hawaii County	69	5
Honolulu County	249	29
Kauai County	13	1
Maui County	39	5

Figure 2. State Sample Generator Results – Commercial Renovations

US Department of Energy Building Energy Codes Program,
<https://www.energycodes.gov/compliance-evaluation>

Hawaii County Sampling

Projects were selected from among the recently permitted project plans stored on shelves in the Hilo and Kailua-Kona offices. Four projects were reviewed in Kailua-Kona and six in Hilo.

Honolulu County Sampling

[To be completed]

Maui County Sampling

Internet access to electronic plans is available in Maui.² The building department provided a list of 10 projects and their ID numbers which matched the project-type categories listed above in Table 2. Plans were downloaded for review.

Plan Review Method

Each project was reviewed for one to two hours and information was recorded in a spreadsheet checklist. See Appendix 2 for a list of information collected in the checklist. The review process included the following steps.

- Collect project information. Building type, size, and location.
- Note designer compliance certifications
- Review envelope compliance. Check roof and wall construction types and insulation levels, window area, glazing specifications, skylight area, and skylight specifications.
- Review interior lighting compliance. Calculate interior lighting power based on count of fixtures and fixture input power. Determine allowed lighting power based on floor area and space types. Check for lighting controls.
- Review exterior lighting power compliance. Calculate exterior lighting power based on count of fixtures and fixture input power. Determine allowed lighting power based on illuminated area and lighting application. Check for exterior lighting controls.

² <http://public.co.maui.hi.us/records/index.aspx>

- Review mechanical compliance. Check cooling equipment efficiency. Check duct and pipe insulation. Check off-hour controls. Check for commissioning plan notes. Check for adjusting and balancing notes. Check for additional requirements for complex HVAC systems.
- Review water heating compliance. Check equipment efficiency, pipe insulation and controls.

Following each review a subjective assessment of compliance level was recorded. This same method was used in the previous study and is repeated in this study for consistency. Each compliance category, such as roof compliance or interior lighting power compliance, was assessed on the following scale:

- **Exceeds code.** Performance level is significantly better than required by the code. For example, lighting power is more than about 25% lower than required.
- **Meets code.** Performance level equal to or better than required.
- **Minor non-compliance.** Close to compliance, but not quite. Within roughly 10% of required performance, or a small element of a system is not in compliance or is not documented on the plans.
- **Moderate non-compliance.** This includes cases when non-compliance is significant but not complete. For example, lighting power is 10% to 50% higher than allowed, or envelope insulation is not adequate
- **Major non-compliance.** This category includes things like no roof insulation and installed lighting power 50% to 100% greater than allowed. These cases will have significant energy impacts
- **Not applicable**

Compliance Review Results

Summary of Reviewed Projects

The tables in this section provide an overview of the type and size of projects reviewed for each county.

Table 3. List of Projects– Hawaii County

ID	Building type	Construction phase	Plan date	Stories	Floor area
1	Mixed use, office/retail, warehouse	New	May-14	2	11,932
2	Medical office building	New	Jul-13	2	29,600
3	Lounge/food service	Renovation	Sep-14	1	815
4	Retail	Renovation	Jul-14	1	4,382
5	Gymnasium	New	Jan-12	1	4,489
6	Retail	Renovation	Jan-13	1	1,620
7	Bank	Renovation	Feb-14	1	6,000
8	Gymnasium, Multipurpose	New	Jun-12	1	42,182
9	Warehouse	New	Apr-14	1	10,800
10	Hotel	Renovation	Oct-14	2	17,708
				Total	129,528
				Average	12,953
				Median	8,400

Table 4. List of Projects – Honolulu County

[To be completed]

Table 5. List of Projects – Maui County

ID	Building type	Construction phase	Plan date	Stories	Floor area
11	Retail	New	Jun-13	1	137,462
12	Warehouse	New	Jun-13	1	46,475
13	Retail	New	Feb-14	1	26,092
14	Bank	New	Oct-13	2	11,700
15	Retail	Renovation	Apr-14	1	4,000
16	Retail	Renovation	Dec-13	1	1,475
17	Retail	Renovation	Jul-14	1	13,897
18	Hotel	New	May-11	4	75,891
19	High rise residential	New	Aug-11	12	237,000
20	Hotel	Renovation	Aug-11	7	294,000
				Total	847,992
				Average	84,799
				Median	36,284

Summary of Compliance Level Results

The following set of tables summarize the level of compliance using the categories described earlier that indicate whether the project exceeds the code, meets the code, or does not comply with the code. These summaries are presented in two ways: 1) a count of projects at each compliance level and 2) the percentage of projects at each compliance level. The final summary in Table 12 lists the compliance level results for each of the reviewed projects. Please see the following sections for discussion of compliance findings.

Table 6. Number of Projects at Each Compliance Level – Hawaii County

Code Requirement	Exceeds Code	Meets Code	Minor non-compliance	Moderate non-compliance	Major non-compliance	Not Applicable
Lighting power - interior	3	1	1	4	0	1
Lighting power - exterior	2	3	1	0	0	4
Lighting controls - interior	0	5	4	0	0	1
Lighting controls - exterior	0	4	2	0	0	4
Envelope - roof	0	1	3	0	0	6
Envelope - wall	0	3	1	0	0	6
Envelope - windows	0	1	2	2	0	5
Envelope - skylights	0	0	1	0	0	9
HVAC - efficiency	0	4	2	0	0	4
HVAC - insulation	0	3	2	0	0	5
HVAC - other	0	4	2	0	0	4
HVAC commissioning	0	0	0	6	0	4
HVAC adjusting and balancing	0	3	0	3	0	4
WH - efficiency	1	5	1	0	0	3
WH - insulation	0	4	3	0	0	3
WH - controls	0	2	0	0	0	8
Tenant electrical submetering	0	3	1	0	0	6

Table 7. Percent of Projects at Each Compliance Level – Hawaii County

Code Requirement	Number of Applicable Projects	Exceeds Code	Meets Code	Minor non-compliance	Moderate non-compliance	Major non-compliance
Lighting power - interior	9	33%	11%	11%	44%	0%
Lighting power - exterior	6	33%	50%	17%	0%	0%
Lighting controls - interior	9	0%	56%	44%	0%	0%
Lighting controls - exterior	6	0%	67%	33%	0%	0%
Envelope - roof	4	0%	25%	75%	0%	0%
Envelope - wall	4	0%	75%	25%	0%	0%
Envelope - windows	5	0%	20%	40%	40%	0%
Envelope - skylights	1	0%	0%	100%	0%	0%
HVAC - efficiency	6	0%	67%	33%	0%	0%
HVAC - insulation	5	0%	60%	40%	0%	0%
HVAC - other	6	0%	67%	33%	0%	0%
HVAC commissioning	6	0%	0%	0%	100%	0%
HVAC adjusting and balancing	6	0%	50%	0%	50%	0%
WH - efficiency	7	14%	71%	14%	0%	0%
WH - insulation	7	0%	57%	43%	0%	0%
WH - controls	2	0%	100%	0%	0%	0%
Tenant electrical submetering	4	0%	75%	25%	0%	0%

Table 8. Number of Projects at Each Compliance Level – Honolulu County

[To be completed]

Table 9. Percent of Projects at Each Compliance Level – Honolulu County

[To be completed]

Table 10. Number of Projects at Each Compliance Level – Maui County

Code Requirement	Exceeds Code	Meets Code	Minor non-compliance	Moderate non-compliance	Major non-compliance	Not Applicable
Lighting power - interior	2	4	3	1	0	0
Lighting power - exterior	0	5	1	0	0	4
Lighting controls - interior	0	6	4	0	0	0
Lighting controls - exterior	0	4	2	0	0	4
Envelope - roof	0	5	2	0	0	3
Envelope - wall	0	6	1	0	0	3
Envelope - windows	0	0	7	0	0	3
Envelope - skylights	0	0	1	1	0	8
HVAC - efficiency	0	7	2	0	0	1
HVAC - insulation	0	3	6	0	0	1
HVAC - other	0	6	3	0	0	1
HVAC commissioning	0	0	0	9	0	1
HVAC adjusting and balancing	0	4	0	5	0	1
WH - efficiency	0	6	3	0	0	1
WH - insulation	0	2	6	0	0	2
WH - controls	0	1	4	0	0	5
Tenant electrical submetering	0	0	0	0	0	10

Table 11. Percent of Projects at Each Compliance Level – Maui County

Code Requirement	Number of Applicable Projects	Exceeds Code	Meets Code	Minor non-compliance	Moderate non-compliance	Major non-compliance
Lighting power - interior	10	20%	40%	30%	10%	0%
Lighting power - exterior	6	0%	83%	17%	0%	0%
Lighting controls - interior	10	0%	60%	40%	0%	0%
Lighting controls - exterior	6	0%	67%	33%	0%	0%
Envelope - roof	7	0%	71%	29%	0%	0%
Envelope - wall	7	0%	86%	14%	0%	0%
Envelope - windows	7	0%	0%	100%	0%	0%
Envelope - skylights	2	0%	0%	50%	50%	0%
HVAC - efficiency	9	0%	78%	22%	0%	0%
HVAC - insulation	9	0%	33%	67%	0%	0%
HVAC - other	9	0%	67%	33%	0%	0%
HVAC commissioning	9	0%	0%	0%	100%	0%
HVAC adjusting and balancing	9	0%	44%	0%	56%	0%
WH - efficiency	9	0%	67%	33%	0%	0%
WH - insulation	8	0%	25%	75%	0%	0%
WH - controls	5	0%	20%	80%	0%	0%
Tenant electrical submetering	0	n/a	n/a	n/a	n/a	n/a

Table 12. Compliance Level by Project

ID	Building Type	County	Phase	Floor Area (ft2)	Lighting power - interior	Lighting power - exterior	Lighting controls - interior	Lighting controls - exterior	Envelope - roof	Envelope - wall	Envelope - windows	Envelope - skylights	HVAC - efficiency	HVAC - insulation	HVAC - other	HVAC commissioning	HVAC adjusting and balancing	WH - efficiency	WH - insulation	WH - controls	Tenant electrical submetering
1	Mixed use	Hawaii	New	11,932	0	-1	0	1	2	2	2	0	0	0	0	0	0	0	0	0	1
2	Medical office building	Hawaii	New	29,600	-1	-1	1	2	2	1	1	0	1	2	1	3	3	-1	2	1	0
3	Lounge/food service	Hawaii	Renovation	815	3	0	1	0	0	0	0	0	0	0	0	0	0	1	2	0	1
4	Retail	Hawaii	Renovation	4,382	3	0	1	0	0	0	3	0	1	1	1	3	1	1	1	1	1
5	Gymnasium	Hawaii	New	4,489	3	1	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
6	Retail	Hawaii	Renovation	1,620	3	0	1	0	0	0	0	0	2	1	1	3	1	1	1	0	2
7	Bank	Hawaii	Renovation	6,000	-1	1	1	2	2	1	3	2	2	1	1	3	3	2	1	0	0
8	Gymnasium, Multipurpose	Hawaii	New	42,182	1	1	2	1	1	1	2	0	1	2	2	3	3	1	2	0	0
9	Warehouse	Hawaii	New	10,800	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
10	Hotel	Hawaii	Renovation	17,708	-1	0	2	0	0	0	0	0	1	0	2	3	1	1	1	0	0
11	Retail	Maui	New	137,462	-1	0	1	0	1	1	2	0	1	2	1	3	3	1	2	1	0
12	Warehouse	Maui	New	46,475	-1	1	2	2	1	1	2	0	1	2	1	3	3	1	2	0	0
13	Retail	Maui	New	26,092	1	1	1	1	2	1	2	0	2	1	1	3	1	1	1	0	0
14	Bank	Maui	New	11,700	1	1	1	1	1	2	2	3	1	2	1	3	1	1	2	0	0
15	Retail	Maui	Renovation	4,000	3	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	Retail	Maui	Renovation	1,475	2	0	1	0	0	0	0	0	1	1	1	3	3	1	0	0	0
17	Retail	Maui	Renovation	13,897	2	0	2	0	0	0	0	0	1	2	2	3	1	2	1	2	0
18	Hotel	Maui	New	75,891	1	1	1	1	1	1	2	0	1	1	2	3	1	2	2	2	0
19	High rise residential	Maui	New	237,000	1	1	1	1	2	1	2	0	1	2	2	3	3	1	2	2	0
20	Hotel	Maui	Renovation	294,000	2	2	2	2	1	1	2	2	2	2	1	3	3	2	2	2	0

Note: -1 = exceeds code, 0 = not applicable, 1 = meets code, 2 = minor non-compliance, 3 = moderate non-compliance, 4 = major non-compliance.

Compliance Certification Results

The code amendments adopted in each county require that the responsible designer include a signed statement on the plans indicating compliance with the energy code. An example certification block is shown in Figure 3. Typically there are separate certifications provided by designers of the building envelope, HVAC and lighting systems.

COUNTY OF MAUI
MAUI COUNTY CODE, CHAPTER 16.16A ENERGY CODE

To the best of my knowledge, this project's design substantially conforms to the Energy Code for:

Building Component Systems

Electrical Component Systems

Mechanical Component Systems

Signature: _____ Date: 1/27/2011

Name: _____

Title: REGISTERED PROFESSIONAL ARCHITECT

License No: _____

Figure 3. Example Compliance Certification

Of the 20 projects in the review sample there was only one case where no certification block was found. However, that one case did have a separate compliance report produced by the software Comcheck.

In several cases compliance blocks were not found for one or more relevant sections. For example, in one case the lighting and mechanical designers had provided compliance blocks but the envelope certification was missing. The following are the findings for compliance certifications in the 20 projects:

- Envelope: 14 of 18 applicable projects, 78% compliance
- Lighting: 17 of 20 applicable projects, 85% compliance
- Mechanical: 14 of 17 applicable projects, 82% compliance

Interior Lighting Results

Of the 20 projects in the sample, ten comply with the lighting power requirements, meaning that the designed lighting power was equal to or lower than the allowed interior lighting power. Eight projects do not comply and have designed power higher than the allowed limit. Of the final two projects one did not include interior lighting in the design and the other did not have enough information on the plans to confirm interior lighting compliance. Table 13 lists the results for installed and allowed interior lighting power for each project.

- Complies: 10 of 19 (53%)
- Does not comply: 8 of 19 (42%)
- Not verified: 1 of 19 (5%)

Table 13. Interior Lighting Power Results by Project

ID	Building Type	Floor Area	Installed interior lighting power (W/sf)	Allowed interior lighting power (W/sf)	Diff. (W/sf)	Diff. (%)
1	Mixed use, office/retail, warehouse	11932	n/a	n/a	n/a	n/a
2	Medical office building	29600	0.8	1.0	-0.2	-20%
3	Lounge/food service	815	1.5	1.3	0.2	15%
4	Retail	4382	3.1	1.5	1.6	107%
5	Gymnasium	4489	1.4	1.1	0.3	27%
6	Retail	1620	3.1	2.0	1.1	55%
7	Bank	6000	0.8	1.0	-0.2	-20%
8	Gymnasium, Multipurpose	42182	1.1	1.1	0.0	-2%
9	Warehouse	10800	1.4	0.9	0.5	56%
10	Hotel	17708	0.4	1.0	-0.6	-60%
11	Retail	137462	0.6	1.5	-0.9	-60%
12	Warehouse	46475	0.4	0.9	-0.5	-55%
13	Retail	26092	1.2	1.5	-0.3	-20%
14	Bank	11700	0.9	1.0	-0.1	-10%
15	Retail	4000	3.2	2.3	0.9	39%
16	Retail	1475	1.6	1.5	0.1	7%
17	Retail	13897	2.0	1.9	0.1	5%
18	Hotel	75891	0.8	1.0	-0.2	-20%
19	High rise residential	237000	1.0	1.0	0.0	0%
20	Hotel	294000		1.0	n/a	n/a

The difference between installed lighting power and allowed lighting power is illustrated in Figure 4. A compliance margin greater than zero indicates a non-complying project; installed power is greater than allowed. A negative margin indicates that installed power is below the limit.

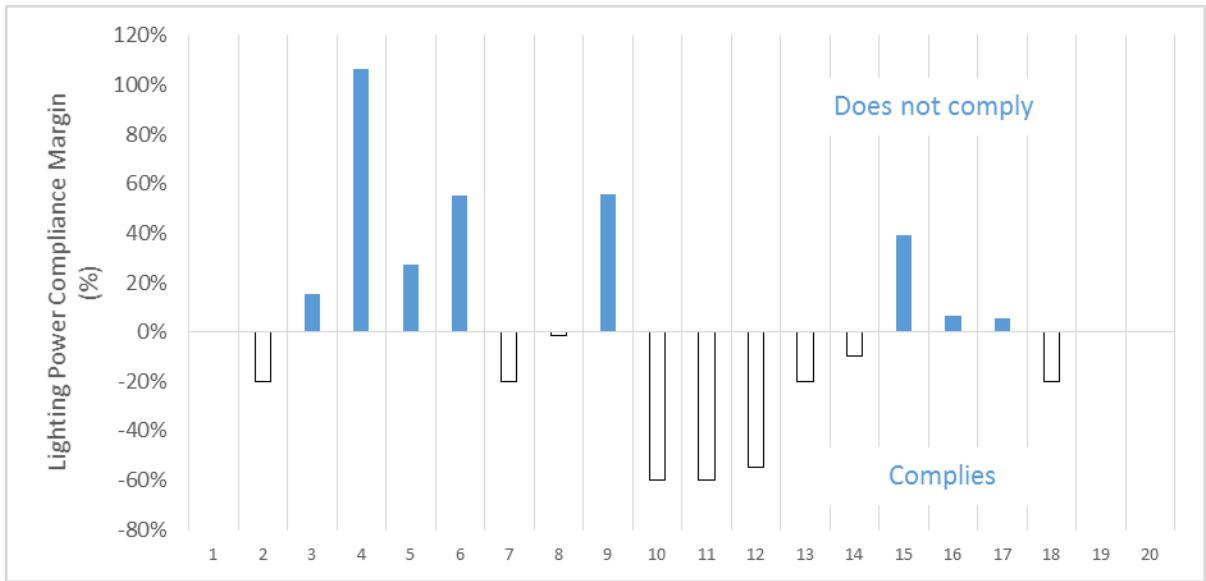


Figure 4. Interior Lighting Power Compliance Margins

Total and average results for interior lighting power compliance are listed in Table 14. These results show that the floor area of complying buildings in the sample is much greater than non-complying buildings, 630,110 sf vs. 41,478 sf. In addition, the non-complying projects tend to be much smaller. The median size of non-complying buildings is 4,191 sf while the median for complying projects is 35,891 sf. Table 13 shows that the majority of non-complying cases are retail projects.

For the complying buildings, interior lighting power is 23% lower than the allowance on an area-weighted average basis. For the non-complying buildings, the lighting power is 37% higher than the allowance on average. Considering the entire sample of buildings, the area-weighted average interior lighting power is 20% below the allowed limit.

Table 14. Interior Lighting Power Results Summary

		Complying Projects	Non-Complying Projects	All Projects
Floor Area (sf)	Average	63,011	5,185	37,310
	Median	35,891	4,191	12,799
	Total	630,110	41,478	671,588
Allowed Power (W/sf)	Average	1.10	1.56	1.31
	Median	1.00	1.50	1.11
	Area Weighted Avg.	1.13	1.53	1.15
Installed Power (W/sf)	Average	0.80	2.16	1.31
	Median	0.80	1.80	1.11
	Area Weighted Avg.	0.83	2.03	0.90
Compliance Margin (W/sf)	Average	-0.30	0.60	0.10
	Median	-0.20	0.40	-0.01
	Area Weighted Avg.	-0.30	0.50	-0.25
Compliance Margin (%)	Average	-27%	39%	2%
	Median	-20%	33%	-1%
	Area Weighted Avg.	-23%	37%	-20%

Interior Lighting Observations

These results show that the majority of projects are complying with the interior lighting power requirements, but there are several important observations and some potential areas for improved compliance.

- Small retail projects comprise the majority of non-complying cases and present an opportunity for savings.
- Use of track lighting is a common compliance problem in retail projects. The code requires that input power for line-voltage track lighting be counted at 30 watts per linear foot. It appears that some designers are not heeding this requirement in their compliance calculations.
- For the majority of projects the luminaire input power is missing from the plans. The code requires that the plans include information that allows compliance to be verified. Therefore, input power should be included in the lighting fixture schedule. For the purpose of this review, the information on lamp type and quantity was used to estimate the likely actual input power.
- In a few cases in Hawaii County a designer showed lighting power compliance calculations on the plans but was using the allowed values from the previous version of the Hawaii County code that applied prior to October 2010.

Exterior Lighting Results

Of the 20 projects in the review sample, 12 included exterior lighting. And of those 12 projects only two showed designed exterior lighting power exceeding the code allowance. Nine of the 12 showed exterior lighting power lower than the allowance, often by a significant margin. One project could not be verified because the plans did not including lighting fixture specifications. Table 15 lists the review results for each project, showing designed exterior power and allowed exterior power. Figure 5 illustrates the results, showing the compliance margin in percentage terms. In Figure 5 negative values indicate that designed exterior lighting power is lower than the allowed limit. The graph shows that in many cases the designed power is 50% to 70% lower than the maximum allowance.

- Complies: 9 of 12 (75%)
- Does not comply: 2 of 12 (17%)
- Not verified: 1 of 12 (8%)

There were only two non-complying cases:

- Project #9 is a small warehouse using exterior lighting fixtures with a medium screw base. The code requires that the assumed input power for screw-base fixtures be the maximum rated power of the luminaire. For the purpose of this review the maximum power was assumed to be 75 watts. The designer had stated that 13 watt self-ballasted compact-fluorescent lamps would be used. In reality that may be true, however for purposes of code compliance it would be necessary to use dedicated pin-base fixtures in order to take credit for the lower lighting power of a compact fluorescent.
- Project #12 is a warehouse using metal-halide parking-lot lighting, and the installed power is only slightly higher than the calculated allowance.

Table 15. Exterior Lighting Power Results by Project

ID	Building Type	Designed exterior lighting power (W)	Allowed exterior lighting power (W)	Diff. (W/sf)	Diff. (%)
1	Mixed use, office/retail, warehouse	2,925	5,063	-2,138	n/a
2	Medical office building	2,640	7,400	-4,760	-64%
3	Lounge/food service	n/a	n/a	n/a	n/a
4	Retail	n/a	n/a	n/a	n/a
5	Gymnasium	1,195	2,773	-1,578	-57%
6	Retail	n/a	n/a	n/a	n/a
7	Bank	254	600	-346	-58%
8	Gymnasium, Multipurpose	4,496	16,120	-11,624	-72%
9	Warehouse	450	360	90	25%
10	Hotel	n/a	n/a	n/a	n/a
11	Retail	n/a	n/a	n/a	n/a
12	Warehouse	3,080	3,000	80	3%
13	Retail	26,050	30,500	-4,450	-15%
14	Bank	2,160	4,400	-2,240	-51%
15	Retail	n/a	n/a	n/a	n/a
16	Retail	n/a	n/a	n/a	n/a
17	Retail	n/a	n/a	n/a	n/a
18	Hotel	10,567	13,516	-2,949	-22%
19	High rise residential	5,000	15,000	-10,000	-67%
20	Hotel	Not verified	Not verified	n/a	n/a

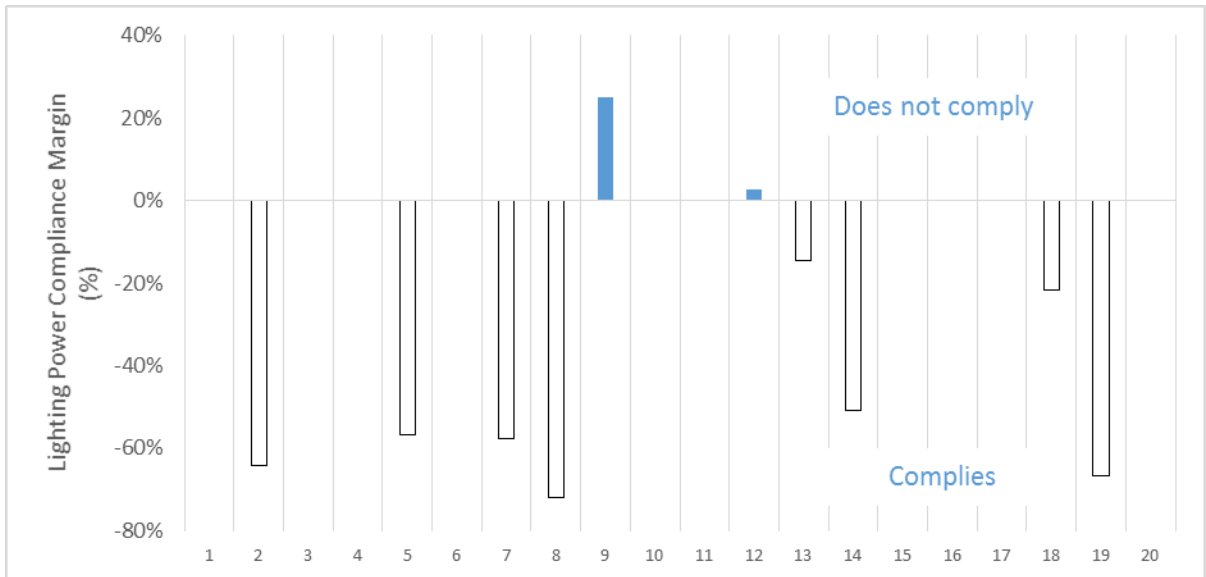


Figure 5. Exterior Lighting Power Compliance Margins

Exterior Lighting Observations

The large majority of projects are complying with the exterior lighting power limits. However, there are a few observations:

- Some designers are using medium screw-base fixtures for exterior lighting. Per the code, the installed power for those fixtures must be counted as the maximum rated power for the fixture. In a few projects designers were taking credit for self-ballasted compact fluorescent lamps or screw-in LED lamps.

- Many designers are neglecting to include the luminaire input power in the plans. This information should be included in the luminaire schedule. This is the same problem mentioned earlier for interior lighting luminaires.

Envelope Results

Roof Insulation

Table 16 lists the designed roof insulation R-value for each project along with the minimum required R-value. The required R-value varies depending on the type of roof construction. For many of the projects the roof insulation requirements are not applicable because they are renovations or tenant improvements within an existing shell.

Unfortunately, in the majority of applicable cases the designed R-value for roof insulation is not indicated on the plans and compliance cannot be verified. Of the 12 applicable projects:

- Unknown: 7 of 12 (58%)
- Complies: 4 of 12 (33%)
- Does not comply: 1 of 12 (8%)

Table 16. Roof Insulation Results by Project

ID	Building Type	Designed Roof Insulation R-value	Required Roof Insulation R-value	Complies?
1	Mixed use, office/retail, warehouse	Missing	R-19+R-10	Unknown
2	Medical office building	Missing	R-15	Unknown
3	Lounge/food service	n/a	n/a	n/a
4	Retail	n/a	n/a	n/a
5	Gymnasium	R-30	R-30	Yes
6	Retail	n/a	n/a	n/a
7	Bank	Missing	R-15	Unknown
8	Gymnasium, Multipurpose	R-19	R-30	No
9	Warehouse	n/a	n/a	n/a
10	Hotel	n/a	n/a	n/a
11	Retail	Missing	R-15	Unknown
12	Warehouse	R-17.5	R-15	Yes
13	Retail	Missing	R-15	Unknown
14	Bank	R-19	R-15	Yes
15	Retail	n/a	n/a	n/a
16	Retail	n/a	n/a	n/a
17	Retail	n/a	n/a	n/a
18	Hotel	Missing	R-30	Unknown
19	High rise residential	Missing	R-30	Unknown
20	Hotel	R-19	R-15	Yes

Wall Insulation

Table 17 lists the designed wall insulation R-value along with the corresponding required R-value. R-13 is required for framed wall constructions and no insulation is required for concrete walls. As was the case for roof insulation, the designed R-value for wall insulation is missing from the plans in several cases. However, the R-value of insulation could be inferred in a few cases from the thickness of the framing cavity. Therefore, wall insulation compliance could be verified for the most of the projects:

- Unknown: 2 of 12 (17%)
- Complies: 10 of 12 (83%)

- Does not comply: 0 of 12 (0%)

Table 17. Wall Insulation Results by Project

ID	Building Type	Designed Wall Insulation R-value	Required Wall Insulation R-value	Complies?
1	Mixed use, office/retail, warehouse	Missing	R-13	Unknown
2	Medical office building	R-13	R-13	Yes
3	Lounge/food service	n/a	n/a	n/a
4	Retail	n/a	n/a	n/a
5	Gymnasium	R-13	R-13	Yes
6	Retail	n/a	n/a	n/a
7	Bank	Missing	None	Yes
8	Gymnasium, Multipurpose	Missing	R-13	Unknown
9	Warehouse	n/a	n/a	n/a
10	Hotel	n/a	n/a	n/a
11	Retail	R-6	None	Yes
12	Warehouse	R-20	R-13	Yes
13	Retail	R-6	None	Yes
14	Bank	R-13	R-13	Yes
15	Retail	n/a	n/a	n/a
16	Retail	n/a	n/a	n/a
17	Retail	n/a	n/a	n/a
18	Hotel	R-13+R-10	R-13	Yes
19	High rise residential	R-13+R-6	R-13	Yes
20	Hotel	None	None	Yes

Fenestration

Table 18 shows the designed solar heat gain coefficient (SGHC) for each project along with the corresponding maximum SGHC allowed by code based on the size of the overhangs in the specific project. The primary code requirement for windows is a maximum limit on SHGC. The SHGC limit increases if a window is shaded by an overhang. The allowed maximum varies from 0.25 to 0.40.

The designed SHGC was indicated on the plans in only 2 of the 13 applicable projects. Therefore, window compliance cannot be verified for the large majority of these projects. In one project a note on the plans referred to a separate report for window performance information, but that report was not part of the permit submittal. It is likely that in some cases there is a separate set of specifications that includes the designer's window performance requirements but those specifications have not been provided to the building department.

In the two cases where SHGC information was provided on the plans, one complies and in the other most of the windows comply with the exception of a few that have smaller overhangs.

- Unknown: 11 of 13 (85%)
- Complies: 1 of 13 (8%)
- Partial compliance: 1 of 13 (8%)
- Does not comply: 0 of 13 (0%)

Table 18. Window SHGC Results by Project

ID	Building Type	Designed Window SHGC	Required Max. Window SHGC	Complies?
1	Mixed use, office/retail, warehouse	Missing	0.4	Unknown
2	Medical office building	0.27	0.33	Yes
3	Lounge/food service	n/a	n/a	n/a
4	Retail	Missing	0.33	Unknown
5	Gymnasium	0.3	0.25-0.40	Partial
6	Retail	n/a	n/a	n/a
7	Bank	Missing	0.33	Unknown
8	Gymnasium, Multipurpose	Missing	0.4	Unknown
9	Warehouse	n/a	n/a	n/a
10	Hotel	n/a	n/a	n/a
11	Retail	Missing	0.33	Unknown
12	Warehouse	Missing	0.25	Unknown
13	Retail	Missing	0.4	Unknown
14	Bank	Missing	0.25-0.40	Unknown
15	Retail	n/a	n/a	n/a
16	Retail	n/a	n/a	n/a
17	Retail	n/a	n/a	n/a
18	Hotel	Missing	0.25-0.33	Unknown
19	High rise residential	Missing	0.4	Unknown
20	Hotel	Missing	0.4	Unknown

Envelope Observations

The primary issue with envelope compliance is that performance information is missing from the permit submittal in many cases. This problem is most prevalent for window SHGC specifications and roof insulation R-value, but it also applies to wall insulation R-value. As noted earlier, the 2006 IECC states the following requirement for construction documents:

Details shall include, but are not limited to, insulation materials and their R-values; fenestration U-factors and SGHCs; system and equipment efficiencies, types, sizes and controls; duct sealing, insulation and location; and air sealing details. (Section 104.2)

While envelope compliance could not be verified for all cases, there are several useful observations:

- While insulation R-value information is often missing, the actual roof insulation compliance rates are likely good. In most cases the plans indicate that there is some insulation even if the specific R-value and/or insulation thickness is not specified on the plans. For projects with roof insulation above deck it is likely that the minimum requirement of R-15 is met in most cases. It is less clear whether all projects with insulation installed below the roof deck are complying because the requirement is R-30. One of the reviewed projects indicated R-19 is to be installed, but R-30 was required. It appears that some designers believe that R-19 is the requirement for all roofs, which is not correct for the 2006 IECC.
- Wall insulation compliance rates appear to be good.
- Window SHGC compliance rates are uncertain. It seems likely that some of the “unknown” cases listed above will comply because it is indicated on the plans that dual-pane, low-e will be used. But not all dual-pane, low-e windows will meet the SHGC requirements. And in a few cases single-pane glazing is shown on the plans, and there is a good chance that it would not meet the low SHGC requirements in the code. Therefore, it is likely that there is a moderate fraction of projects that are not meeting the window SGHC requirements.
- Window performance is a good candidate for improved plan review and enforcement.

HVAC Results

Cooling Efficiency

Compliance with the cooling efficiency requirements of the code is good. Table 19 shows that of the 15 applicable projects only three were missing efficiency specifications on the plans, and it is likely that in those cases the equipment would meet the code's requirements as well. National manufacturers build equipment to meet more recent requirements, therefore most of the cooling equipment available on the market will meet the minimum requirements in the 2006 IECC.

- Unknown: 3 of 15 (20%)
- Complies: 12 of 15 (80%)
- Does not comply: 0 of 15 (0%)

Table 19. Cooling Efficiency Results by Project

ID	Building Type	Designed Cooling Efficiency	Required Cooling Efficiency	Complies?
1	Mixed use, office/retail, warehouse	n/a	n/a	n/a
2	Medical office building	EER 10.3 & 12.1	EER 9.2 & 9.7	Yes
3	Lounge/food service	n/a	n/a	n/a
4	Retail	EER 11.5	EER 10.3	Yes
5	Gymnasium	n/a	n/a	n/a
6	Retail	Missing	EER 10.3	Unknown
7	Bank	Missing	EER 10.3	Unknown
8	Gymnasium, Multipurpose	EER 11.0	EER 9.5	Yes
9	Warehouse	n/a	n/a	n/a
10	Hotel	SEER 16.7	SEER 10.0	Yes
11	Retail	EER 11.4 to 12.4	EER 9.5-10.3	Yes
12	Warehouse	EER 11, 12.3, 12.7	EER 9.7-10.3	Yes
13	Retail	Missing	EER 9.7-10.3	Unknown
14	Bank	EER 11.2 & 12.0	EER 9.7	Yes
15	Retail	n/a	n/a	n/a
16	Retail	SEER 13.0	SEER 10.0	Yes
17	Retail	EER 11.0 & 11.2	EER 10.3	Yes
18	Hotel	EER 12.0-12.7	EER 9.3-10.3	Yes
19	High rise residential	0.673 kW/ton	0.79 kW/ton	Yes
20	Hotel	0.65 kW/ton	0.72 kW/ton	Yes

HVAC Insulation

The required duct insulation is often not indicated on the plans. In 9 of the 14 applicable projects (64%) duct insulation is not specified. The code requires R-5 insulation for ducts in unconditioned spaces and R-8 insulation for ducts located outdoors.

Other HVAC Results

HVAC control specifications are often not included in the plans. The code requires, at a minimum, automatic off-hour controls such as a programmable thermostat. Five of 15 applicable projects did not include HVAC control information. However most of those five projects are likely to have complying controls because time-clock controls are relatively standard practice. Only 1 of the 15 was clearly not complying because it showed only manual on/off control of the HVAC system.

One project did not comply with the code's energy recovery requirement. The energy recovery requirements apply to large air handlers (>5,000 cfm) with a high outdoor airflow requirement (>70%).

This requirement applies to only two of the 20 reviewed projects. One of those project complies by employing a “wrap-around” heat pipe for energy recovery. However the other project does not show any form of heat recovery and therefore is not in compliance.

HVAC commissioning notes were missing from the plans in every case. As noted earlier, each County’s adopted 2006 IECC amendments require that a commissioning plan be developed for the HVAC system and that “drawing notes shall require commissioning and completion requirements...”. It appears that designers are not aware of this requirement.

HVAC system adjusting and balancing requirements were also missing in about one-half of the reviewed projects. There is also low awareness of this requirement.

HVAC Observations

Compliance with the HVAC requirements is generally good, however performance information is missing from the submittals in some cases. Areas for improvement include the following:

- Include cooling efficiency specifications on the plan in all cases.
- Indicate duct insulation on the plans.
- Indicate HVAC controls on the plans
- Include commissioning requirements note on the plans
- Include system adjusting and balancing requirements note on the plans.

Water Heating Results

For water-heating systems, as for the HVAC systems discussed above, compliance appears to be generally good except that performance specifications are often missing from the plans.

The majority of systems are electric water heaters that are likely to meet the efficiency requirements for those systems, but the efficiency ratings were missing in every case. Three of the projects included gas water heaters and those cases were also missing rated efficiency for the selected water heaters. Again, it is likely that they meet the minimum efficiency requirements in the code.

Hot water pipe insulation information is missing from 8 of the 15 applicable projects.

Controls for hot water circulation systems are missing from 4 of 7 applicable projects.

Recommendations

Performance Information on Plans

Develop simple guidelines that show minimum performance information that needs to be included on the plans for permit submittal. Key items are lighting-fixture input power and window SHGC. Other examples include roof insulation R-value, wall insulation R-value, cooling equipment efficiency, duct insulation R-value, and water heating equipment efficiency. This information is often missing from the plans but is required by code.

Awareness of County Amendments

Improve awareness of the requirements in the County amendments, perhaps by encouraging the use of code compliance checklists that include requirements in the County amendments. It appears that designers are not aware of some of the code’s requirements, especially the County amendments that require HVAC system commissioning and HVAC system adjusting and balancing.

Guidance for Small Retail Compliance

Develop simple compliance information and/or incentive programs for small retail projects, including both new construction and renovations. Focus on lighting code compliance, including the compliance implications of track lighting. In this study, small retail projects are the type of project with the greatest lighting compliance issues.

Guidance for Fenestration Compliance

As noted earlier, window performance information is not shown on the plans for most of the reviewed projects. Due to the potentially significant impact on cooling loads and cooling energy consumption, efforts to improve window compliance are recommended.

Appendix 1 – Summary of Selected Code Requirements

This section includes excerpts from the 2006 IECC.

Opaque Envelope Requirements

TABLE 502.2(1)
BUILDING ENVELOPE REQUIREMENTS – OPAQUE ASSEMBLIES

CLIMATE ZONE	1	2	3	4 except Marine	5 and Marine 4	6
Roofs						
Insulation entirely above deck	R-15 ci	R-15 ci	R-15 ci	R-15 ci	R-20 ci	R-20
Metal buildings (with R-5 thermal blocks ^a) ^b	R-19 + R-10	R-19	R-19	R-19	R-19	R-1
Attic and other	R-30	R-30	R-30	R-30	R-30	R-3
Walls, Above Grade						
Mass	NR	NR	R-5.7 ci ^{c, e}	R-5.7 ci ^c	R-7.6 ci	R-9.5
Metal building ^b	R-13	R-13	R-13	R-13	R-13 + R-13	R-13 R-1
Metal framed	R-13	R-13	R-13	R-13	R-13 + R-3.8 ci	R-13 R-3.8
Wood framed and other	R-13	R-13	R-13	R-13	R-13	R-1
Walls, Below Grade						
Below grade wall ^d	NR	NR	NR	NR	NR	NR
Floors						
Mass	NR	R-5 ci	R-5 ci	R-10 ci	R-10 ci	R-10
Joist/Framing	NR	R-19	R-19	R-19	R-19	R-3
Slab-on-Grade Floors						
Unheated slabs	NR	NR	NR	NR	NR	NR
Heated slabs	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 12 in. below	R-7.5 for 24 in. below	R-1 for 36 below
Opaque Doors						
Swinging	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0.70	U – 0
Roll-up or sliding	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 1.45	U – 0

Fenestration Requirements

**TABLE 502.3
BUILDING ENVELOPE REQUIREMENTS: FENESTRATION**

Climate Zone	1	2	3	4 except Marine	5 and Marine 4
Vertical Fenestration (40% maximum of above-grade wall)					
<i>U</i> -Factor					
Framing materials other than metal with or without metal reinforcement or cladding					
<i>U</i> -Factor	1.20	0.75	0.65	0.40	0.35
Metal framing with or without thermal break					
Curtain Wall/Storefront <i>U</i> -Factor	1.20	0.70	0.60	0.50	0.45
Entrance Door <i>U</i> -Factor	1.20	1.10	0.90	0.85	0.80
All Other <i>U</i> -Factor ^a	1.20	0.75	0.65	0.55	0.55
SHGC-All Frame Types					
SHGC: PF < 0.25	0.25	0.25	0.25	0.40	0.40
SHGC: 0.25 ≤ PF < 0.5	0.33	0.33	0.33	NR	NR
SHGC: PF ≥ 0.5	0.40	0.40	0.40	NR	NR
Skylights (3% maximum)					
Glass					
<i>U</i> -Factor	1.60	1.05	0.90	0.60	0.60
SHGC	0.40	0.40	0.40	0.40	0.40
Plastic					
<i>U</i> -Factor	1.90	1.90	1.30	1.30	1.30
SHGC	0.35	0.35	0.35	0.62	0.62

NR = No requirement.

PF = Projection factor (See Section 502.3.2)

a. All others includes operable windows, fixed windows and non-entrance doors.

Interior Lighting Power Allowances

**TABLE 505.5.2
INTERIOR LIGHTING POWER ALLOWANCES**

LIGHTING POWER DENSITY	
Building Area Type ^a	(W/ft ²)
Automotive Facility	0.9
Convention Center	1.2
Court House	1.2
Dining: Bar Lounge/Leisure	1.3
Dining: Cafeteria/Fast Food	1.4
Dining: Family	1.6
Dormitory	1.0
Exercise Center	1.0
Gymnasium	1.1
Healthcare-Clinic	1.0
Hospital	1.2
Hotel	1.0
Library	1.3
Manufacturing Facility	1.3
Motel	1.0
Motion Picture Theater	1.2
Multi-Family	0.7
Museum	1.1
Office	1.0
Parking Garage	0.3
Penitentiary	1.0
Performing Arts Theater	1.6
Police/Fire Station	1.0
Post Office	1.1
Religious Building	1.3
Retail ^b	1.5
School/University	1.2
Sports Arena	1.1
Town Hall	1.1
Transportation	1.0
Warehouse	0.8
Workshop	1.4

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m².

- a. In cases where both a general building area type and a more specific building area type are listed, the more specific building area type shall apply.
- b. Where lighting equipment is specified to be installed to highlight specific merchandise in addition to lighting equipment specified for general lighting and is switched or dimmed on circuits different from the circuits for general lighting, the smaller of the actual wattage of the lighting equipment installed specifically for merchandise, or 1.6 W/ft² times the area of the specific display but not to exceed 50% of the floor area, or 3.9 W/ft² times the actual case or shelf area for displaying and selling jewelry, china or silver, shall be added to the interior lighting power determined in accordance with this line item.

Exterior Lighting Power Allowances

**TABLE 505.6.2
LIGHTING POWER DENSITIES FOR BUILDING EXTERIORS**

APPLICATIONS	LIGHTING POWER DENSITIES
Tradable Surfaces (Lighting Power Densities for uncovered parking areas, building grounds, building entrances and exits, canopies and overhangs, and outdoor sales areas may be traded.)	
Uncovered Parking Areas	
Parking Lots and drives	0.15 W/ft ²
Building Grounds	
Walkways less than 10 feet wide	1.0 watts/linear foot
Walkways 10 feet wide or greater, plaza areas and special feature areas	0.2 W/ft ²
Stairways	1.0 W/ft ²
Building Entrances and Exits	
Main entries	30 watts/linear foot of door width
Other doors	20 watts/linear foot of door width
Canopies and Overhangs	
Canopies (free standing & attached and overhangs)	1.25 W/ft ²
Outdoor Sales	
Open areas (including vehicle sales lots)	0.5 W/ft ²
Street frontage for vehicle sales lots in addition to "open area" allowance	20 watts/linear foot
Nontradable Surfaces (Lighting Power Density calculations for the following applications can be used only for the specific application and cannot be traded between surfaces or with other exterior lighting. The following allowances are in addition to any allowance otherwise permitted in the Tradable Surfaces section of this table.)	
Building facades	0.2 W/ft ² for each illuminated wall or surface or 5.0 Watts/linear foot for each illuminated wall or surface length
Automated teller machines and night depositories	270 watts per location plus 90 watts per additional ATM per location
Entrances and gatehouse inspection stations at guarded facilities	1.25 W/ft ² of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces)
Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft ² of uncovered area (covered areas are included in the Canopies and Overhangs section of Tradable Surfaces)
Drive-up windows at fast food restaurants	400 watts per drive-through
Parking near 24-hour retail entrances	800 watts per main entry

For SI: 1 foot = 304.8 mm, 1 watt per square foot = W/0.0929 m².

Unitary Air Conditioner Efficiency Requirements

**TABLE 503.2.3(1)
UNITARY AIR CONDITIONERS AND CONDENSING UNITS,
ELECTRICALLY OPERATED, MINIMUM EFFICIENCY REQUIREMENTS**

EQUIPMENT TYPE	SIZE CATEGORY	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY ^b	TEST PROCEDURE ^a
Air conditioners, Air cooled	< 65,000 Btu/h ^d	Split system	10.0 SEER	ARI 210/240
		Single package	9.7 SEER	
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	10.3 EER ^c	ARI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	9.7 EER ^c	
	≥ 240,000 Btu/h and < 760,000 Btu/h	Split system and single package	9.5 EER ^c 9.7 IPLV ^c	
≥ 760,000 Btu/h	Split system and single package	9.2 EER ^c 9.4 IPLV ^c		
Air conditioners, Water and evaporatively cooled	< 65,000 Btu/h	Split system and single package	12.1 EER	ARI 210/240
	≥ 65,000 Btu/h and < 135,000 Btu/h	Split system and single package	11.5 EER ^c	ARI 340/360
	≥ 135,000 Btu/h and < 240,000 Btu/h	Split system and single package	11.0 EER ^c	
	≥ 240,000 Btu/h	Split system and single package	11.0 EER ^c 10.3 IPLV ^c	

For SI: 1 British thermal unit per hour = 0.2931 W

a. Chapter 6 contains a complete specification of the referenced test procedure, including the referenced year version of the test procedure.

b. IPLVs are only applicable to equipment with capacity modulation.

c. Deduct 0.2 from the required EERs and IPLVs for units with a heating section other than electric resistance heat.

d. Single-phase air-cooled air conditioners < 65,000 Btu/h are regulated by the National Appliance Energy Conservation Act of 1987 (NAECA), SEER values are those set by NAECA.

Appendix 2 - Project Review Checklist

The information listed in the following table was recorded for each project in a spreadsheet.

IDENTIFICATION
Review date
Review location
Review time
Project Name
County
Address
County ID number
Architect
Plan date
Sample group
Construction phase
DESCRIPTION
General description
Building type
Floor area
Number of stories
Compliance method
Software used
Notes
CERTIFICATION
Certification - envelope
Certification - lighting
Certification - mechanical
Certification - water heating
Other compliance information
LIGHTING
Notes
Lighting luminaire description(s)
Installed interior lighting power
Allowed interior lighting power
Designed interior lighting power (for report)
Allowed interior lighting power (for report)
Light reduction controls.
Automatic lighting shutoff
Exterior efficiency sources (if >100W, then >60 lumens/W)
Exterior lighting power
Allowed exterior lighting power
Designed exterior lighting power (for report)
Allowed exterior lighting power (for report)
Exterior lighting controls
Screw lamp, low-voltage, track luminaires
ENVELOPE - OPAQUE
Notes
Roof type (above deck, metal bldg., attic/other)
Insulation type
Insulation R-value

Roof insulation R-value (for report)
Required roof insulation R-value
Membrane (cool roof)
Wall type (mass, metal, steel frame, wood)
Insulation type
Insulation R-value
Wall insulation R-value (for report)
Required wall insulation R-value
ENVELOPE - FENESTRATION
Notes
Window area/WWR
Glazing type
Frame type
Window U-factor
Window SHGC north
Window SHGC non-north
Window shading type
Window overhang projection factor
Skylight area
Skylight-roof area ratio
Skylight glazing type
Skylight frame type
Skylight U-factor
Skylight SHGC
HVAC
Notes
Cooling equipment type
Cooling equipment capacity
Cooling equipment efficiency
Fan system efficiency (not in IECC)
Off-hour controls
Energy recovery (if >5000 cfm & >70% OA)
Duct insulation (R-5 in unconditioned, R-8 outdoors)
VAV fan control
Hydronic system controls
Heat rejection equipment fan speed control
Multiple-zone system control (min flow)
Heat recovery for water heating (if >500 tons & 24 hr.)
Commissioning (drawing notes required)
Systems adjusting and balancing (drawing notes required)
SERVICE WATER HEATING
Notes
Water heater efficiency
Pipe insulation
Manual or auto shutoff for circulating controls
ELECTRICAL
Tenant sub metering (Hawaii only)