

Energy Auditing to make a Change



Eileen Peppard

Center for Smart Building and Community Design

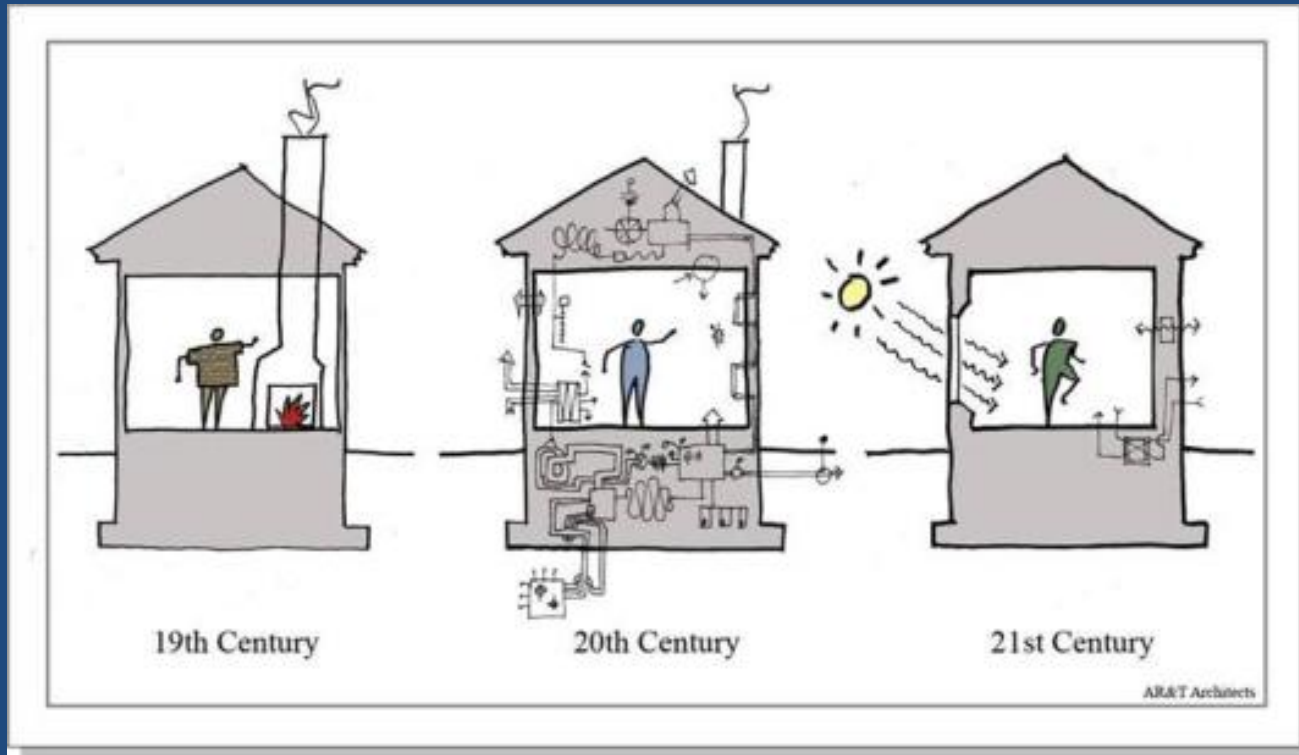
Sea Grant College Program

University of Hawaii Manoa

<http://sbcd.seagrantsoest.hawaii.edu/>

epeppard@hawaii.edu

The History of Architecture and Human Comfort:



Energy Auditing and Monitoring:

Commercial Example: Kuykendall Hall, UH Manoa

80,000 sq ft

7-story office tower

4-story classroom building

Built 1964

Goal: net zero energy



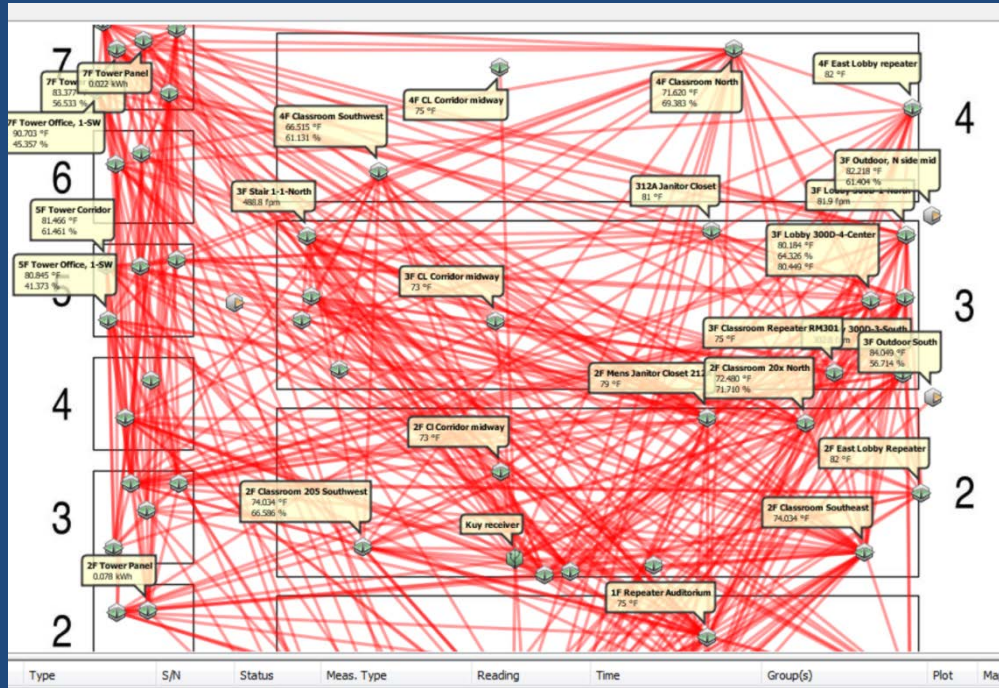
Kuykendall Hall

DOE Commercial Building Partnership

- Lawrence Berkeley National Laboratory
- Local architects & engineers
- UH Manoa staff



Kuykendall Hall: Monitoring



- ~100 wireless sensors
- Sub-metering 25 electrical circuits
- Collecting temperature, humidity, and air speed data



Kuykendall Hall: Monitoring

Manual downloads:

- Data loggers for window AC units
- Occupancy/light sensors



Kuykendall Hall: Monitoring

Weather station data – used in simulations to inform the design.

- Rainfall
- Wind speed & direction
- Solar insolation
- Temperature
- Humidity



Kuykendall Hall: Verification

Monitoring after retrofit



The future Kuykendall

Residential Energy Auditing:

Residential Example: Forest City Military Housing



- Military construction, built 1993-1996, 2002
- 950 to 1200 sq ft
- Forest City management: 2004

Residential Energy Auditing:

Forest City Military Housing

- 5 – 8 houses/neighborhood
- Inventory appliances, lighting, etc.
- Monitor electricity for 1 month:
 - Whole house
 - AC
 - Water heater
 - Clothes dryer
- Monitor temperature & humidity



Installing current transducers

Residential Energy Auditing: Forest City Military Housing



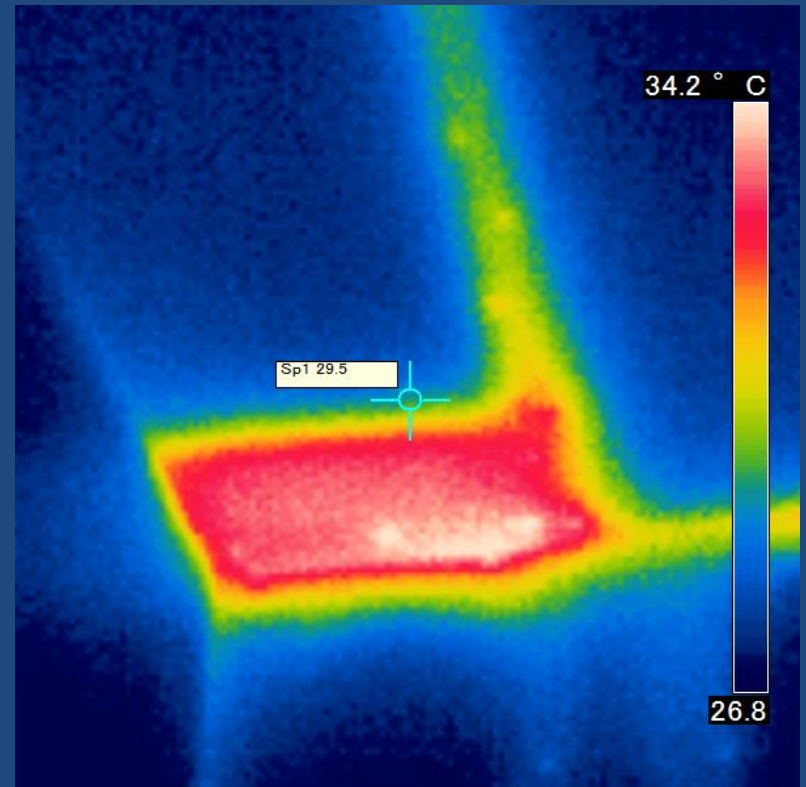
Blower door and duct testing on empty houses

Residential Energy Auditing: Forest City Military Housing



Duct testing in an occupied home

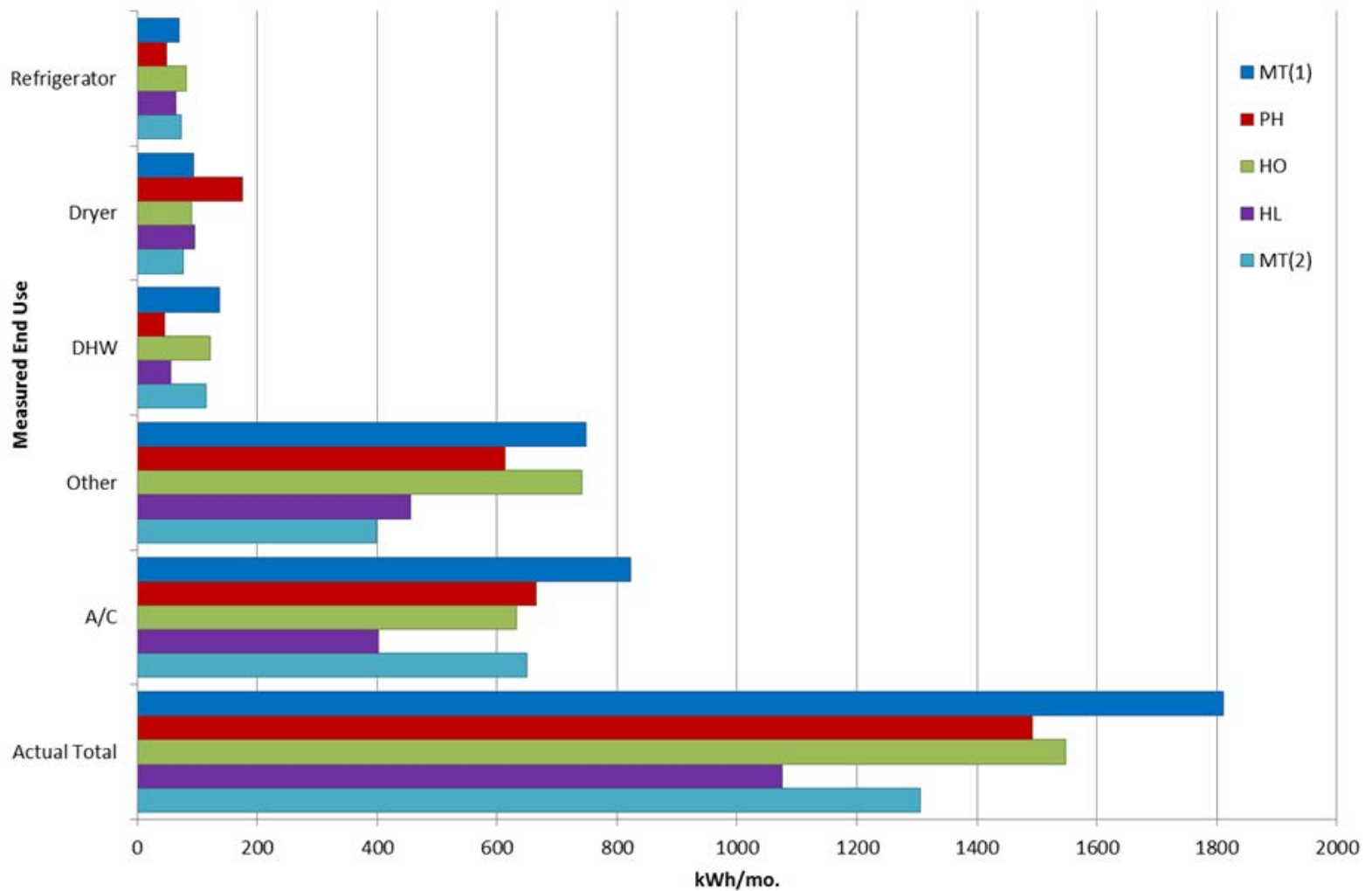
Residential Energy Auditing: Forest City Military Housing



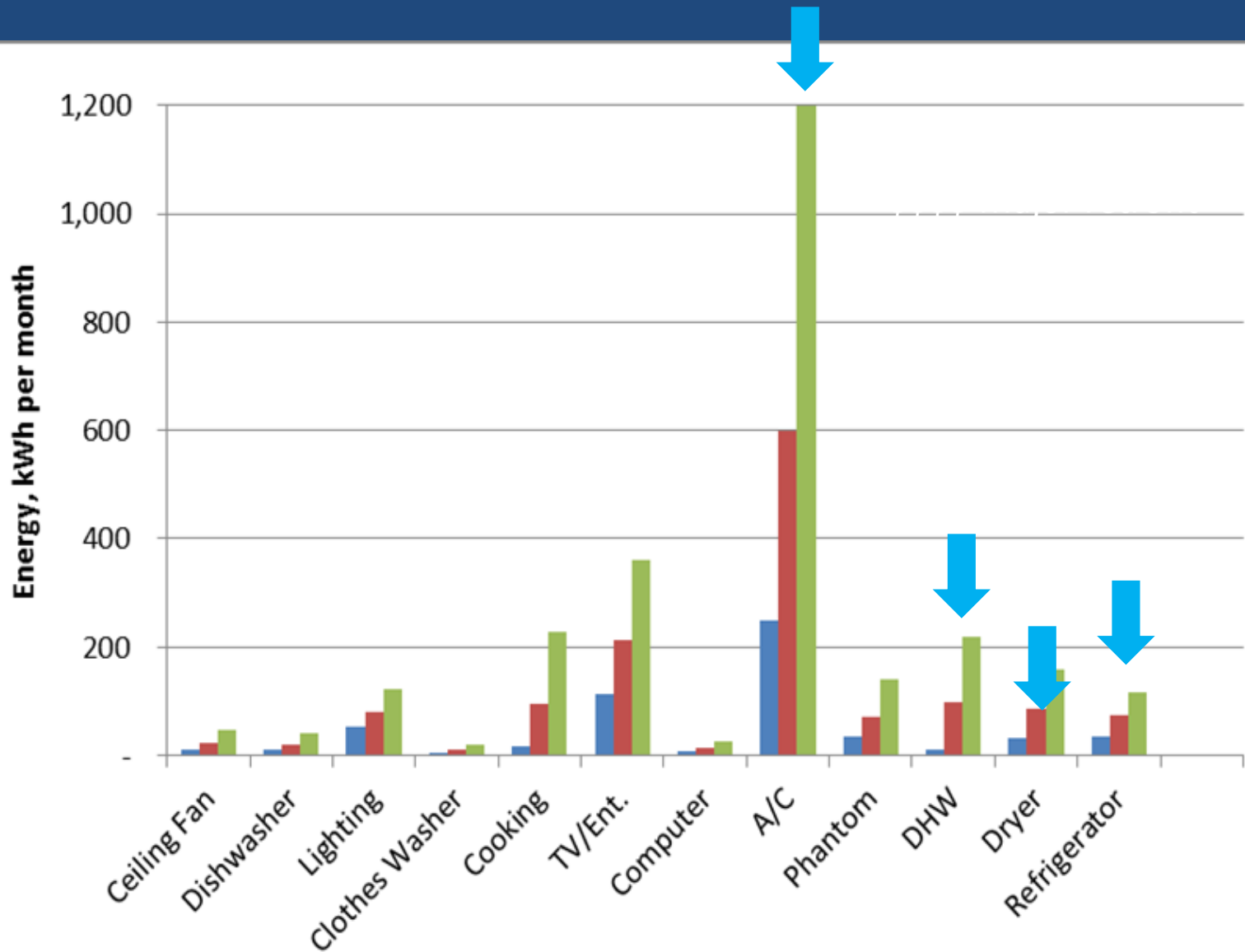
Infrared camera, missing insulation

Disaggregation of Energy Use

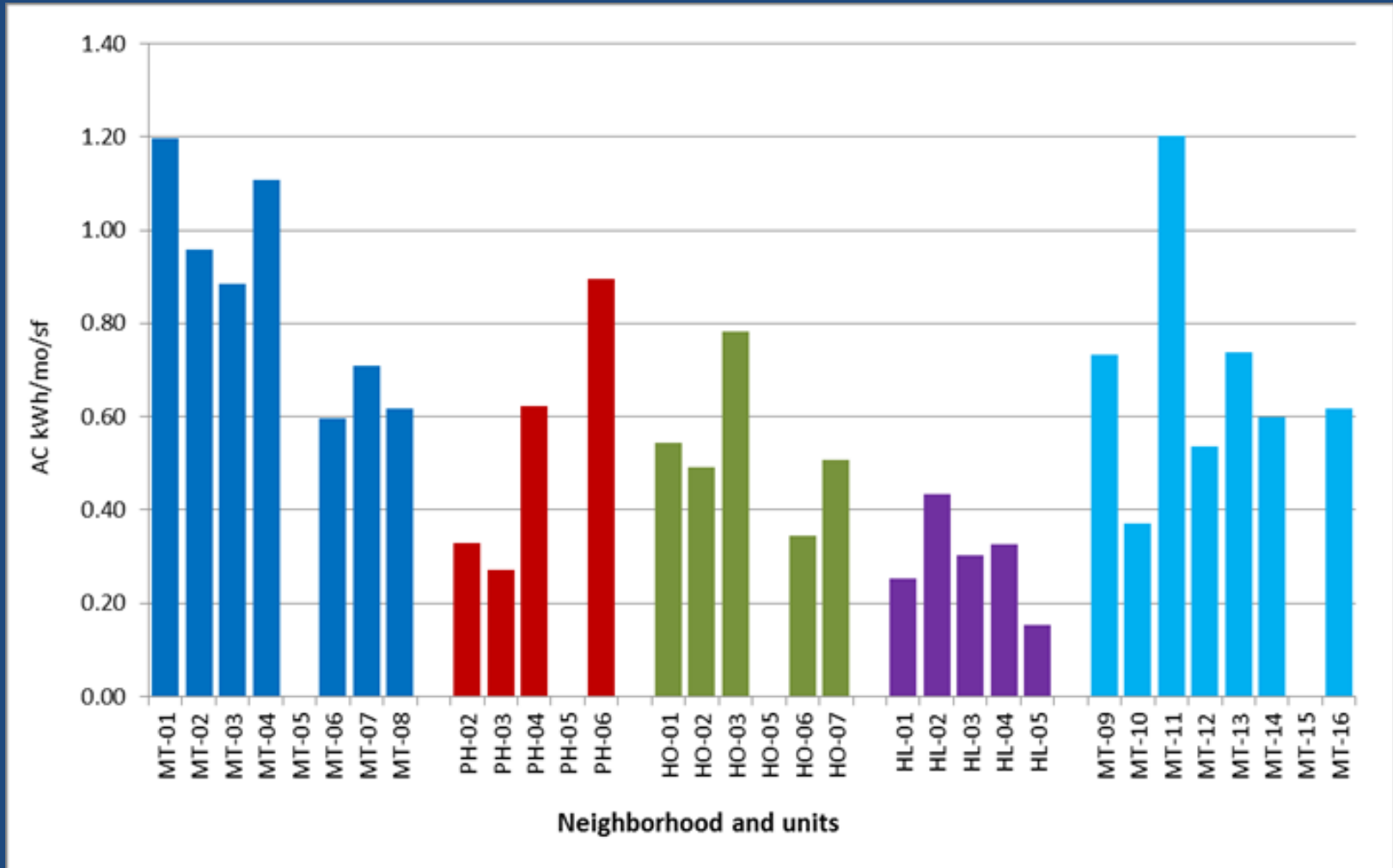
Comparison of measured end uses by neighborhood



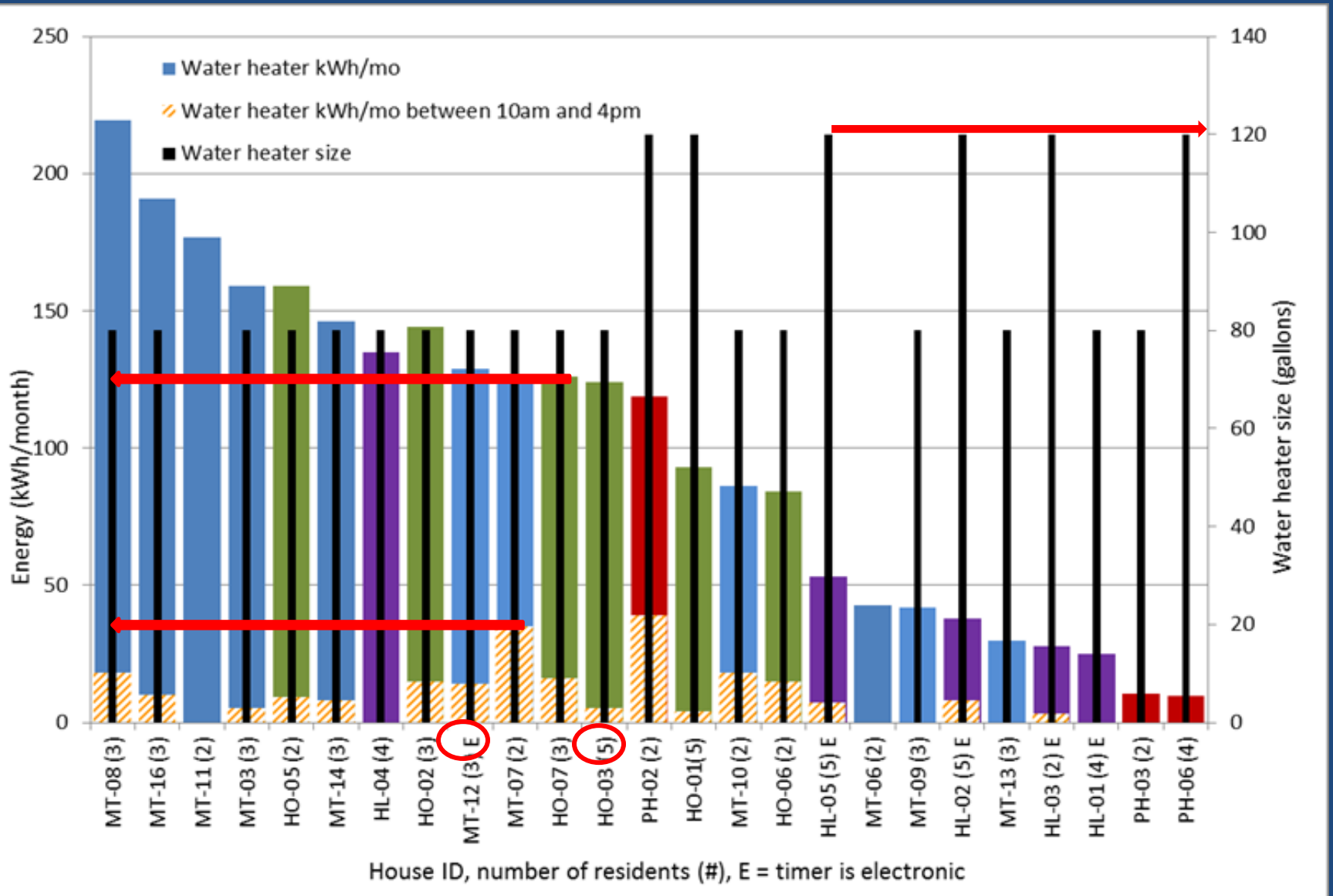
Estimated low, medium, and high users.



Energy use for air conditioning per square foot per month.



Comparison of energy for water heating, water heater size, number of residents in home.



Water heater and solar pump

24453 =IF(O124453>100, O124453, "")

A	M	N	O	P	Q	R	S	T
	Whole house (W)	AC (W)	Water heating total (W)	Dryer (W)	Stove (W)	Dryer hrs/mo	Solar pump	Electric water heater (W)
2012/1/26/ 10:11	2,948	2,081	47	-	-	0	47	
2012/1/26/ 10:12	3,003	2,081	48	-	-	0	48	
2012/1/26/ 10:13	3,087	2,081	48	-	-	0	48	
2012/1/26/ 10:14	3,061	2,081	24	-	-	0	24	
2012/1/26/ 10:15	3,006	2,062	2	-	-	0		
2012/1/26/ 10:16	3,027	2,091	2	-	-	0		
2012/1/26/ 10:17	3,038	2,099	2	-	-	0		
2012/1/26/ 10:18	3,035	2,099	2	-	-	0		
2012/1/26/ 10:19	3,039	2,070	33	-	-	0	33	
2012/1/26/ 10:20	3,045	2,062	48	-	-	0	48	
2012/1/26/ 10:21	3,025	2,051	42	-	-	0	42	
2012/1/26/ 10:22	2,672	1,722	2	-	-	0		
2012/1/26/ 10:23	1,273	293	2	-	-	0		
2012/1/26/ 10:24	1,273	293	2	-	-	0		
2012/1/26/ 10:25	1,275	293	2	-	-	0		
2012/1/26/ 10:26	1,272	293	2	-	-	0		
2012/1/26/ 10:27	3,672	292	2,436	1	-	0		2,436
2012/1/26/ 10:28	5,332	291	4,119	1	-	0		4,119
2012/1/26/ 10:29	5,620	564	4,125	1	-	0		4,125
2012/1/26/ 10:30	7,073		4,159	1	-	0		4,159
2012/1/26/ 10:31	7,101		4,163	1	-	0		4,163
2012/1/26/ 10:32	7,090		4,165	1	0	0		4,165
2012/1/26/ 10:33	7,100		4,157					4,157
2012/1/26/ 10:34	7,095		4,155	1	-	0		4,155
2012/1/26/ 10:35	8,248	2,110	4,148	863	-	1		4,148
2012/1/26/ 10:36	10,555	2,041	4,097	2,776	-	1		4,097
2012/1/26/ 10:37	7,324	2,071	4,113	152	-	1		4,113
2012/1/26/ 10:38	9,107	2,059	4,104	1,591	-	1		4,104

5300 Fuqua energy calcs All Data to graph Nov data Jan data Dec data Nov chart all Nov chart pump

Solar pump

Junk

Electric heating element

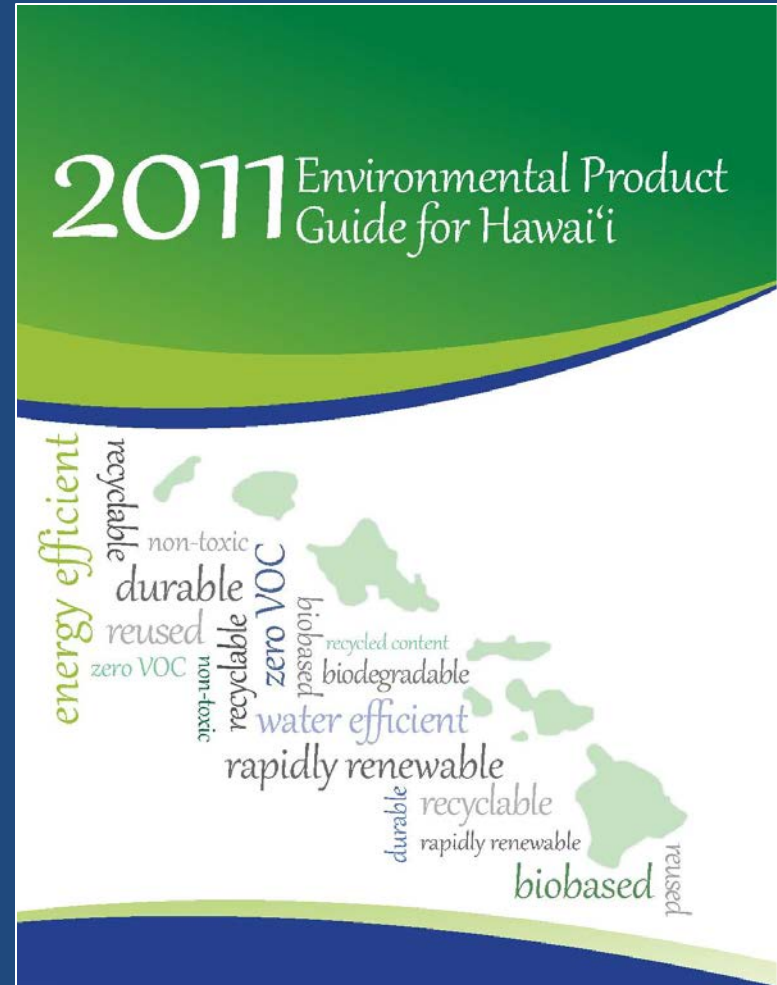
=IF(AND(O124105>10, O124105<100), O124105, "")

More Information

<http://sbcd.seagrant.soest.hawaii.edu/>

Expo table: UH School of Architecture –
Environmental Research and Design Lab

epeppard@hawaii.edu



Free guides