Energy Audit Procedures

Prepared for the

U.S. Department of Energy
Office of Electricity Delivery and Energy Reliability

Under Cooperative Agreement No. DE-EE0003507
Hawai‘i Energy Sustainability Program

Subtask 3.5: End-use Energy Efficiency and Demand Response

Prepared by

University of Hawai‘i's
Environmental Research and Design Laboratory,
Sea Grant Center for Smart Building and Community Design,
and Hawai‘i Natural Energy Institute

Submitted by

Hawai‘i Natural Energy Institute
School of Ocean and Earth Science and Technology
University of Hawai‘i

April 2013

Acknowledgement: This material is based upon work supported by the United States Department of Energy under Cooperative Agreement Number DE-EE0003507.

Project Report 1: Energy Audit Procedures

Provided to the Hawai'i Natural Energy Institute

March 21, 2013

Project funded by US Department of Energy

Principal Investigators:

Stephen Meder, DArch [1, 2]

Eileen Peppard, MS [1, 2]

Arthur James Maskrey, MEP, MBA [1, 3]

James Griffin, PhD [3]

Author:

Eileen Peppard

[1] The School of Architecture's Environmental Research and Design Laboratory

[2] Sea Grant Center for Smart Building and Community Design

[3] Hawai'i Natural Energy Institute

University of Hawai'i Manoa

TABLE OF CONTENTS

HNEI FUNDING 1

OVERAL PROJECT GOALS 1

PROJECT SHORT-TERM GOALS 1

PROJECT STAFF 2

FOREST CITY STAFF AND RESIDENT VOLUNTEERS 2

INTRODUCTION: THE WATT WATCHER TEAM 2

ENERGY AUDIT TRAINING 3

ENERGY AUDIT STUDY: FOREST CITY PHASE I

- ***STUDY OBJECTIVES*** 6
- ***METHODS***
  - Power Monitoring Procedures 6
  - Comfort Monitoring 7
  - Other Data Collected 8
  - Resident Volunteer Selection 8
  - Workflow 9

ENERGY AUDITS: FOREST CITY PHASE II

- ***STUDY OBJECTIVES*** 10
- ***METHODS*** 11

DATA MANAGEMENT PROCEDURES 13

Appendix A - Residential Energy Audit Lighting Catalog 15

Appendix B - Data Sheets 25

Appendix C - Energy Tips Sheet for Residents 33

Appendix D – Wiki for Energy Projects (PDF format) 35

HNEI FUNDING

This overall project has been funded by two consecutive agreements between the Hawaiʻi Natural Energy Institute (HNEI) and the School of Architecture (SOA). These have been account #6660925 (dates: 7/15/10 to 8/31/12) for $119,111 and account #6662338 (dates: 1/1/11 to present) for $264,721.

OVERAL PROJECT OBJECTIVES

The intent of the relationship between the Hawaiʻi Natural Energy Institute and the School of Architecture's Environmental Research and Design Laboratory (ERDL) is to change the current approach to architectural design and energy use in the State of Hawaiʻi. The overall objectives of this project are:

1. Expand technical capacity of the interdisciplinary ERDL Team; ensure knowledge transfer and institutional program stability:
    a. Expand core team of staff; and
    b. Obtain training opportunities for staff and students.
2. Leverage local projects as learning opportunities for team members in order to build capacity, publish research, and enhance the team's value to the community.
3. Leverage outside public and private sector resources to expand scope and assist program sustainability.
4. The long-term goal is to build a strong research team that conducts innovative research, provides extension services to influence the design and energy consumption of buildings in our climate zone, and provides education and field experience for university students.

PROJECT SHORT-TERM GOALS

The short-term goals of this project were to develop technical skills for the ERDL team in the following disciplines:

1. Residential energy auditing;
2. Monitoring equipment deployment;
3. Residential energy analytics;
4. Data capturing, management and reporting;
5. Building simulation;
6. Energy modeling; and
7. Experimental techniques for testing building design strategies and studying energy utilization.

PROJECT STAFF

This project was managed by Arthur James Maskrey and Eileen Peppard. Part-time undergraduate engineering student assistants who worked on this project were: Trevor Wilkey, Jason Epperson, Christian Damo, Adam Oberbeck. An urban planning graduate student worked on this project: Justin Witty.

FOREST CITY STAFF AND RESIDENT VOLUNTEERS

This project would not have been possible without the dedication of Forest City Vice President of Development, Will Boudra, the determination of Project Manager, Brent Arakaki, and the collaborative efforts of many staff members and electricians.

Military residents who participated in these studies volunteered to allow access and monitoring of their homes. The Watt Watcher Team expresses their sincere appreciation for the residents' cooperation. Without their consent, these studies would not have been possible.

INTRODUCTION: *THE WATT WATCHER TEAM*

Residential housing managed by Forest City Military Communities has been used as the study subject for these training and research exercises. The name chosen for the ERDL team conducting the audits for Forest City was the "Watt Watcher Team." Forest City manages approximately 7,000 residential units for the Navy and Marine Corps in Hawaiʻi. These units are ideal subjects of study because of the similarities in construction and the sheer number of units under the same management. They also consume more energy than typical Hawaiʻian residences and Forest City is motivated to make changes to save on utility costs. Three factors play a role in the high energy use of these homes: the residents are not necessarily accustomed to the climate; the homes were designed with the intention of using central air-conditioning; and the traditional billing system discouraged conservation.

Traditionally, service members received a basic allowance for housing that included both rent and utilities combined. When a service member chose to rent a home in one of the Forest City Military Communities (rather than renting in the private sector), they paid the entire housing allowance to Forest City without regard to how much electricity was used. In order to promote energy conservation, the Office of the Secretary of Defense mandated that all Public Private Venture housing start a new system of billing for utilities. Hawaiʻi and Beaufort/Parris Island, South Carolina were chosen as pilot sites to initiate this mandate. In conjunction with Hawaiʻi's

Navy Region Commander, the partnership created the Resident Energy Conservation Program. Under this program, residents are billed for the excess power if their consumption exceeds 20 percent over the average (>70th percentile) consumption for their peer group. The groups are broken down by neighborhood and house size. As residents conserve energy, the average consumption for the peer group goes down, making it more challenging for individual residents to stay in the non-payment zone. Residents consuming less than 20 percent below average (<30th percentile) receive a rebate. This type of billing creates accountability for excessive energy consumption while motivating residents to earn a rebate for significant energy conservation. Since Forest City is still paying the bill, their incentive for making energy improvements to the properties remains in place.

In September 2010, a “mock billing” period started. The residents received a bill that showed what they would pay if the new billing system had started. The actual “live billing” started January 2011. These energy audit studies were divided into two phases. Phase I entailed general energy auditing, which took place between October 2010 and April 2011. “Mock billing” was in effect for the first half of this study and “live billing” was in effect during the second half. Phase II involved an air conditioning retrofit in which the homes were monitored before and after the retrofits. Phase II took place from September 2011 to February 2012, during “live billing.”

For both of these phases, Forest City requested the auditing be performed on their most energy intensive housing. These homes were constructed by the military between 1993 and 2002. They ranged from 948 to 1431 square feet in size and they were equipped with central air conditioning and solar water heating systems.

ENERGY AUDIT TRAINING

In July 2010, Glenn Dickey of Sentech, Inc., was contracted to conduct a 4-day intensive workshop in energy audit techniques which included a lighting audit, appliance audit, building envelop inspection, blower door testing and duct pressurization testing. Attending were 17 students of Architecture and Engineering and two faculty members, all ERDL staff members. The training consisted of two days of classroom instruction and two days of practical experience auditing empty houses managed by Forest City.

ERDL Students and staff (more individuals than those listed as staff working on this particular project) gained energy auditing experience during Phase I and Phase II of the work with Forest City as well as energy auditing and energy modeling training during these other opportunities:

1. April 6, 2011. Workshop: Blower Door testing/HERS rating. Gentry housing, Ewa Beach. Partners: Eli Chamberlain and Mitchell Johnson of Pacific SBS (Solutions for the Built Environment, 1136 Union Mall, Suite 402, Honolulu HI 96813) in collaboration with Gentry Homes. Number of participants: 5.
2. June 16, 2011. Workshop: Home Energy Auditing, Monitoring, and Study of Natural Ventilation. Building Industry Association's "First Hawaiian Home", sustainable home in Kaimuki, Honolulu. Partners: Instructors: Eileen Peppard and Jim Maskrey in collaboration with the Building Industry Association (BIA) of Hawaii. Number of participants: 6.
3. July 13, 14, 15 and 18, 2011. Workshop: Wireless Mesh Network Sensor Installation, Trouble-Shooting, and Maintenance Training. Kuykendall Hall, University of Hawaii Manoa. Partners: Instructor: Matt Denny of QUEST, monitoring and verification consultant from California. Number of participants: 5.
4. July 16, 2011. Workshop: Weather Station Installation and Troubleshooting. Kuykendall Hall, University of Hawaii Manoa. Partners: Instructor: Matt Denny of QUEST, monitoring and verification consultant from California. Number of participants: 2.
5. July 18-22, 2011. Workshop: Wind Tunnel Testing for Architectural Design. California. Partners: Lawrence Berkeley National Laboratory. Number of participants: 2.
6. August 29, 2011. Workshop: Basic Energy Audit Training. UH Manoa. Partners: Eileen Peppard and Trevor Wilkey. Number of participants: 2.
7. September 07, 2011. Workshop: Basic Energy Audit Training. UH Manoa. Partners: Eileen Peppard and Trevor Wilkey. Number of participants: 3.
8. September 20, 2011. Workshop: Blower Door Training. UH Manoa. Number of participants: 6.
9. November 7 and 8, 2011. Working with Consol consultant, Alex Vantaggiato. Number of Participants: 3.
10. December 01-02, 2011. BeOPT Training. Honolulu Community College. Instructor: Kosol Kiatreungwattana, National Renewable Energy Lab, Golden CO. Number of participants: 3.
11. July 06, 2012. Workshop: Blower Door and Duct Pressurization Training. Hickam AFB. Partners: Justin Witty assisted with training new staff member, Christian Damo.
12. March 02, 2011. Workshop: EcoTect Tutorial, Advanced Modeling. Environmental Research and Design Lab, School of Architecture. Partners: Instructor: George Raco. Number of participants: 6.
13. February 23, 2011. Workshop: Ecotect Tutorial, Basic Modeling. Environmental Research and Design Lab, School of Architecture. Partners: Instructor: Eric Siwy. Number of participants: 6.

14. February 04, 2011. Workshop: Adaptive Thermal Comfort: Background, Simulations, Future Decisions. Sea Grant Conference Room. Partners: Video conference from the Lawrence Berkeley National Laboratory; Instructor: Richard De Dear, PhD, Faculty of Architecture, Design & Planning, Univ of Sydney, Australia. Number of participants: 11.

Trainings provided by ERDL to local community or a combination of local community and ERDL staff:

1. January 10, 2012. ARCH 692 Whole Building Energy Simulation (semester course). UH Manoa. Partners: Kim Claucherty and Manfred Zapka. Number of participants: 18.
2. October 31, 2012. Presentation: Energy consumption feedback to Forest City residents. Online. Partners: As part of a study funded by Hawaii Energy, we are providing energy consumption information to 32 residents in 15 homes in military housing. Number of participants: 32.
3. August 02, 2012.Conference: Residential AC retrofits: energy savings verification. Honolulu. Partners: Forest City Military Communities. Number of participants: 12.
4. July 06, 2012.Workshop: Blower Door and Duct Pressurization Training. Hickam AFB. Partners: Justin Witty assisted with training staff member, Christian Damo.
5. June 12-September 04, 2012.Workshop: Provided energy simulation interns to local firms. Four local firms and UH Manoa. Partners: Partners: Student interns trained in whole building energy simulation worked at 3 local architecture firms, HECO, and UH Manoa over the summer. The interns completed energy simulation projects, ending with a report and presentation to the firms. Number of participants: 64.
6. April 26, 2012. Presentation: Monitoring and Verification. Chaminade University. Partners: Elizabeth Song Lockard's sustainability class. Number of participants: 7.
7. April 14, 2012. Workshop: Methods and Tools for Efficient Lighting Design. UHM School of Architecture, room 215. Partners: Instructors for Loisos Ubbelohde: George Loisos, Susan Ubbelohde, Abe Shameson. Funded by DBEDT and Oahu Worklinks. Number of participants: 28.
8. April 13, 2012. Workshop: Methods and Tools for Efficient Lighting Design. State Office Tower, 1403. Partners: Loisos Ubbelohde instructors: George Loisos, Susan Ubbelohde, Abe Shameson. Funded by DBEDT and Oahu Worklinks. Number of participants: 31.
9. April 03, 2012. Conference: Energy Auditing to Make a Change. The Conference Center, Honolulu. Partners: Build & Buy Green Conference and Expo, sponsored by DBEDT. Number of participants: 70.
10. March 16, 2012. Workshop: Energy and Sustainable Design for Kauai. Kauai Community College. Partners: Steve Meder and I conducted workshop sponsored by Kauai Community College and the County of Kauai. Number of participants: 20.

ENERGY AUDIT STUDY: FOREST CITY PHASE I

STUDY OBJECTIVES

This phase was intended to collect general energy audit information to inform Forest City of key observations they can use to assist in managing its Resident Energy Conservation Program "live billing" program, implemented in January of 2011. It also served to training ERDL staff and students. Specific objectives included:

- Quantify energy consumption for air conditioning, clothes drying, water heating and "other" energy end uses;
- Estimate common energy end-uses in the home;
- Compare the energy consumption of the energy end-uses against each other;
- Compare the energy profiles of homes in one community against the other;
- Observe relationships between temperature and comfort and energy consumption;
- Make preliminary recommendations to improve energy consumption:
    - Recommendations to Forest City management; and
    - Recommendations to residents of Forest City properties.

METHODS

Power Monitoring Procedures

The Watt Watcher Team instrumented 32 homes in Phase I, but data were successfully recorded in only 28 homes due to failure of monitoring equipment in four homes. Power data at 1-minute intervals was collected on power lines for whole house, AC compressor, water heater, clothes dryer within the breaker panel. Five batches of five to eight houses were monitored for one month. Monitoring started on the first houses on October 23, 2010 and monitoring ended on the last houses on April 19, 2011.

For the first two batches of houses, the power monitoring device used was the TED 5000, manufactured by Energy Inc., with four pairs of current transducers (CTs) – all rated for 200 amps. This device proved unreliable. It sends the data signal over the neutral wire which appeared to encounter interference from other devices in the house (it measured accurately when tested in a team member's house which has almost no electronic equipment but often had strange readings in Forest City houses that had a lot of electronic equipment). It has no memory, so it cannot log data. Third party software on a laptop computer was installed to log data which added complexity to the setup, and introduced additional equipment failure and compatibility issues. Often no data was received or there were missing data points.

Starting with the third batch of houses (December 22, 2010), the eGauge monitor was used for sub-metering at the electrical panel. This device proved to be very reliable and has built-in solid state memory that can store data from 12 current transducers of 1-minute granularity for one year. Data was downloaded from the device at the end of the 1-month monitoring period.

A Kill-A-Watt™ EZ P2260 device was used to measure the refrigerator energy. It plugs into the outlet and the refrigerator plugs into the device. This particular model does not store the data once it is unplugged. If there is a power outage, data are lost. It logs total kWh used and the number of hours it has measured.

Comfort Monitoring

To determine comfort levels achieved in the homes, temperature and humidity were measured in seven locations inside the home: living room; kitchen; master bedroom; bedroom 2; bedroom 3; master bathroom; attic; and one location outside on the covered back porch (out of direct sunlight). The temperature in the attic is an indication of the radiant heat to which the building is being exposed.

Hobo® U12-012 sensors, made by Onset, were used to log temperature and humidity. The sensors were place on the wall near the light switch. Sensors were configured to record 5-minute averages (vs. the 1-minute averages of the power data) over the 1-month period due to a small memory capacity. Sensors were equipped with two layers of removable double-sided foam tape which will not damage paint on walls (the double thickness helped the adhesive layer extend beyond the support nubs on the devices and allow for better adhesion to the walls). They were normally placed next to the light switch in the room and out of the path of direct sunlight. The sensor for the attic was attached to a string for easy of retrieval and placed on top of the insulation. The sensor to be placed outdoors on the covered back porch was equipped with a plastic cable tie and attached to a light fixture high up on the wall to keep it out of line of direct sunlight.

Temperatures in the different locations were compared. Temperature and humidity combinations were plotted against time. Temperature in the living room and master bedroom were plotted against the AC compressor energy consumption. Because the temperature monitors were recording data in 5-minute intervals and power monitors recorded data in 1-minute intervals, the energy data had to be translated into 5-minute data for graphing purposes.

The HOBO sensor also recorded light levels, but since we cannot determine whether the light was natural or electric lighting, we have not used it for our analysis. It has been useful in explaining some temperature data in upstairs bedrooms where the temperature rises dramatically around 3:00 PM and there is a corresponding spike in the light reading which indicates the room is receiving direct sunlight on the west side of the home.

Other Data Collected

The date and time of the start of the audit (and the end of monitoring period) was always recorded in order to delete unwanted data from sensors and to help identify digital photos. A lighting inventory was conducted (see Appendix A for lighting catalog for Forest City housing). Data on the make, model, serial number, and condition of the major appliances were collected. The settings on the water heater timer were recorded. Basic construction materials of the house were recorded. Plug loads introduced by the resident were inventoried as well as all the lighting. A basic survey of their energy and water use was conducted with the resident. Data sheets provided in Appendix B include:

- Resident Survey;
- Appliance Datasheet;
- Lighting Audit datasheet;
- Plug Loads Datasheet; and
- Description Infrared Photos (if taken).

Resident Volunteer Selection

Forest City management selected the neighborhoods to be monitored. Selection criteria for volunteers were: they had been residing in the home for a year; they were not moving out during the monitoring period; and there would be an even mix of high users and low users. This did not always prove to be the case. The Navy side had more success in recruiting volunteer families and those families appeared to be more interested in the energy audit process. The Marine Corps side had more difficulty recruiting volunteers and those they did recruit showed less commitment to responding to phone calls or being present in the home for the appointment. Lessons learned by the Watt Watcher Team in regards to interactions with the residents:

- The spouse who made the appointment with the team sometimes had not informed the other spouse who was the only one home and answered the door for the appointment. Sometimes appointment was cancelled or postponed for this reason. If the spouse who makes the appointment won't be present, ask to speak to the other spouse to explain the procedure.

- The team learned the importance of describing the audit process over the phone when making the appointment - otherwise the resident did not realize the team would enter each room of the house. For the first installment, some residents thought the team would work only outside and they were embarrassed the house was not clean.
- If a resident expressed second thoughts on participating in the program, the team member only provided information but did not try to persuade the resident in their decision.
- It was important to stress how much coordination and time commitment was required for this project and it was very wasteful if the resident does not show up for the appointment. There were a lot of "no shows" on the Marine Corps side. As a reminder, this Phase I occurred before the billing started, so many residents had little interest in their energy consumption. In subsequent studies, residents were much more motivated to learn about their energy use patterns.
- It is helpful to have a woman on the audit team. It appeared that the female residents were more comfortable with a woman present during the audit. The female team member usually conducted the survey with the resident.
- Make the appointment 3-7 days in advance and make a reminder call the day before.

Workflow

At least 2 weeks in advance, communication was made with Forest City to ensure they scheduled an electrician and had recruited all the volunteer families. At three to seven days in advance, specific appointments were made with the residents. The appointment timeframe was made for a longer duration than needed to build in for contingencies. At least one day in advance, the residents were called with a reminder of the appointment (a voice mail was sufficient) and all the equipment and datasheets for each house were prepared, clearly labeled and stored in separate plastic boxes. The Hobo sensors were supplied with the removable double-sided tape, battery power checked and devices were launched to begin recording at 6pm of the day of installation so there would be no extraneous information on the sensors from before the audit. Software on power monitors was updated if necessary. Battery-operated devices were charged. A tool bag was equipped and ready as well as several clipboards and pencils. A small step ladder was in the equipment list for use in conducting lighting audits.

For this initial study, there were 3-4 members of the Watt Watcher Team conducting the audit plus a Forest City Electrician. The team introduced themselves to the occupant and explained the devices to be installed. One person conducted the energy use survey with the occupant, collected data on appliances and plug loads, and deployed the Hobo temperature sensors and Kill-A-Watt meter. A second team member conducted a lighting audit. A third team member worked with the electrician to install the current transducers and power monitor, configure it and test that it was functioning. Due to the trouble-shooting issues of the power monitors in the first three sets of audits, there was usually a fourth person helping with that task. The audit took 45 minutes if nothing went wrong with the power monitor setup. The team allowed one hour per home to account for travel time (eight hours for eight homes). Upon return to the ERDL laboratory, photos were downloaded and cataloged; data sheets were scanned and filed as backups. A thank you note was mailed to the resident as a follow-up to this visit.

Collection of the equipment a month later was much simpler. The devices could be collected in from eight homes in four hours. The power monitor was downloaded before the device was removed by the electrician. The refrigerator data on the Kill-A-Watt™ EZ P2260 was read before it was unplugged from the outlet. The HOBO temperature sensors were collected for download later (all devices were clearly labeled). The resident was mailed a letter with a breakdown of their energy use, provided advice and given an "Energy Tips" sheet (See Appendix C).

ENERGY AUDITS: FOREST CITY PHASE II

STUDY OBJECTIVES

The objective of Phase II was to inform Forest City of key observations they could use to assist in reducing the cooling load in older homes of their Moanalua Terrace neighborhood. Specific objectives include:

- Quantify energy consumption for air conditioning, clothes drying, water heating, stove, refrigerator, and "other" end uses.
- Observe relationships between temperature, comfort and air conditioning energy use.
- Quantify energy savings from retrofits.
- Determine which method of additional insulation provided the most significant reduction.
- Make recommendations to improve energy consumption:
    - Recommendations to Forest City management
    - Recommendations to residents of Forest City properties

METHODS

In Phase II, the Watt Watcher Team monitored homes to understand how much energy could be saved by retrofitting air conditioning systems and improving the thermal envelope of residences. The retrofit recommendations for Phase II were made by a consulting firm named Consol, in a relationship they had with Forest City as part of the Department of Energy's Build America Program. Consol is a California-based energy consulting firm that specializes in home energy audits, building simulation, and code compliance. ERDL entered into an informal agreement with Consol to provide on-site labor, equipment, and data collection for the study in exchange for training by Consol.

The team monitored homes for approximately five months each. In each home, temperature and humidity were recorded along with energy consumption for the whole house and individual circuits for the air conditioner, the domestic water heater system, the stove, and the clothes dryer. Other appliances and devices were inventoried. A survey was conducted with the resident which provides an anecdotal self-description of the residents' usage patterns.

Forest City management located six families to volunteer to participate in this study starting in August and September, 2011. Description of homes:

- 949 sq. ft. in floor area;
- Two stories and one half of a duplex;
- Located in the Moanalua Terrace Phase III or Phase IV neighborhoods;
- Built in 1996;
- Original 1997 Carrier 2-ton air conditioners in need of replacement; and
- R-19 fiberglass batt insulation in the attic, located on the attic floor.

Of the six homes monitored, two homes (houses MT-17 and MT-19) served as controls and were not retrofitted. The remaining four homes received air conditioning retrofits which included the following:

- Trane 1.5-ton SEER 16 compressor unit model # 4TTB4018E;
- Trane 2.0-ton variable speed air handler unit model # TAM7A0A24H21SA;
- Thermostat with humidistat – Trane XL803 model # TCONT803AS32DA;
- Weatherization strip was added around door in laundry room leading to garage;
- Added 3" polystyrene foam core insulation to metal attic hatch door;
- Lined interior of return air plenum with anti-microbial duct board sealed seams with UL 181 mastic and UL 181 tape;
- An additional curb was added for ease of access to the air handler unit's filter slot;

- Each duct register (10 total per home) was sealed where the ceiling drywall meets the metal in order to mitigate cooling loss back into the attic space; and
- Checked jumper ducts in attic for leakage.

In addition to these air conditioning retrofits, three of the four retrofitted homes also received changes to the thermal envelope and the fourth (MT-18) served as an AC retrofit-only control:

- MT-21 had an additional layer of R-19 fiberglass batt insulation added to the existing R-19 on the attic floor, increasing insulation to R-38.
- MT-20 had blown-in cellulose insulation added on top of existing R-19 fiberglass batt insulation on attic floor, increasing insulation to R-38.
- MT-22 had no insulation added but a radiant barrier was stapled to the roof rafters in the attic.

All experimental homes had their envelopes and ducts tested for air tightness with pressurization tests before and after retrofit. Energy and environmental sensors were installed a minimum of 6 weeks before retrofit to collect baseline data (see Table 1 for monitoring periods). Data was collected for a minimum of 7 weeks after the retrofit. The family in one of the control homes, MT-17, unexpectedly relocated and a new family moved in during the study. The drastic differences in energy habits of the two families rendered this control home minimally useful for the study. All environmental sensors inside the home were removed by the moving company, so temperature and humidity data were lost for MT-17. House MT-20 had the shortest post-retrofit monitoring period because the new air handler froze-up and then the occupants were away for the December holidays.

Table 1. Thermal envelope treatments and monitoring periods for experimental homes.

		Before retrofit			After retrofit		
House ID	Treatment	Date start	Date end	# days	Date start	Date end	# days
MT-19	Control	8/29/11	2/23/12	174			
MT-17	Control (family 1)	8/29/11	10/20/11	51			
MT-17	Control (family 2)	11/1/11	1/26/12	85			
MT-18	AC, duct retrofit only	8/29/11	12/9/11	100	12/10/11	2/23/12	73
MT-20	AC retrofit + R-19 blown-in cellulose	9/7/11	11/14/11	67	1/5/12	2/23/12	48
MT-21	AC retrofit + R-19 fiberglass batt	9/23/11	11/6/11	43	11/11/11	1/26/12	75
MT-22	AC retrofit + Radiant barrier	9/23/11	11/7/11	44	11/9/11	2/23/12	104

DATA MANAGEMENT PROCEDURES

For Phase I, data was downloaded to comma separate values (CSV) files and analyzed with the spreadsheet program, Excel. Issues with the actual word “Null” appearing as inputs (from the TED devices), and determining percent time devices were on or off, were handled with “if, then” statements in Excel. Energy consumption results were normalized to a 30-day month for comparisons. Energy per sq. ft. of home area was used to compare energy intensities of houses of different sizes. Power data was recorded in 1-minute intervals while temperature and humidity data were recorded in 5-minute intervals. The power data was converted from 1-minute to 5-minute intervals using manual manipulations in Excel. It was later learned that other programs such as “Universal Translator,” software developed by the Pacific Energy Center, could perform this conversion automatically.

For Phase II, data was downloaded as CSV files, pre-processed and uploaded to a PostgreSQL database for analysis. Data from this phase was more complete (attributed to the reliability of the eGauge device) and PostgeSQL scripts were written to analyze the data. Data were graphed in either Excel or for trending, in Gnuplot. Scripting to graph data in Gnuplot proved to be laborious for studying experimental data (it could prove quite useful in other situations). The team has since acquired the software Tableau for easier graphing and data mining.

The conditions of the homes for before and after retrofit were modeled in BEopt™ (Building Energy Optimization) software. This software was developed by the National Renewable Energy Laboratory (NREL) which, according their website “provides capabilities to evaluate residential building designs and identify cost-optimal efficiency packages at various levels of whole-house energy savings along the path to zero net energy.”

All procedures have been documented in a wiki, a server-based, secure website designed for documentation. Members of the working group are granted secure access to view and add content. This is a growing resource for the research and education team. See Appendix D for a PDF version of this wiki.

APPENDIX A

Residential Energy Audit Lighting Catalog

Watt Watcher Program

University of Hawaii School of Architecture
Hawaii Natural Energy Institute
Sea Grant Program

Compact Fluorescent
PL 13 W

(2) **Incandescen**t
Wattage varies

Surface Mounted Fixtures

Compact Fluorescent

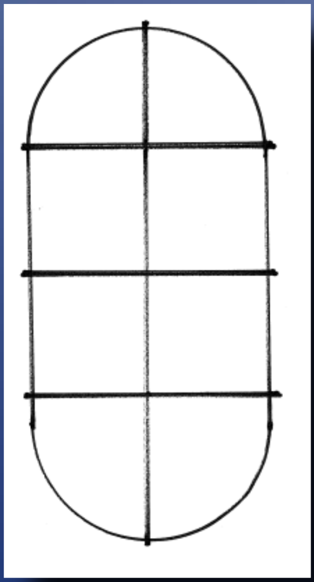
Circline 22 W inner ring

Circline 32 W outer ring

Surface Mounted Fixtures

Compact Fluorescent
PL 13 W

T12 **Fluorescent** tubes
(3) F40 48”
(1) F34 48” (Green end)



Compact Fluorescent
PL 13 W
(Patio and Entry)

Single lamp ceiling fan
Lamp wattage varies

Four lamp ceiling fan
Lamp wattage varies
(incandescent shown)

Ceiling Fan

Type	Length	Watt	Diameter
T8 F32	48”	30 W	1”
T8 F25	36”	25 W	1”
T8 F17	24”	17 W	1”

Type	Length	Watt	Diameter
T12 F40	48”	40 W	1.5”
T12 F34	48”	34 W	1.5”
T12 F36	36”	30 W	1.5”
T12 F24	24”	20 W	1.5”

T8 (8/8” = 1” diameter)

T12 (12/8” = 1.5” diameter)

Linear Fluorescent
T12 F34 Low Mercury

Linear Fluorescent Tubes

Compact Fluorescent
(Wattage varies)
Helical (left); straight (right)

Compact Fluorescent
(Globe; Wattage varies)

Compact Fluorescent
(PL Tube Wattage varies
9W, **13W**, 15W)

Vanity Compact Fluorescent
(Note: 3 CFL and 1 incandescent
in this photo)

Compact Fluorescent
(2) PL Tubes Wattage varies
9W, **13W**, 15W)

Vanity Compact Fluorescent
(Specialty helical within Globe;
Wattage varies 9W, **13W,** 15W)

T12 **Fluorescent** tubes
(2) F40   48"

Compact Fluorescent
(PL Tubes 13 Watt

Type A Base (Medium)

Pin Mount Base (Biax, Triaz, Quad)

Bayonet Base (rare)

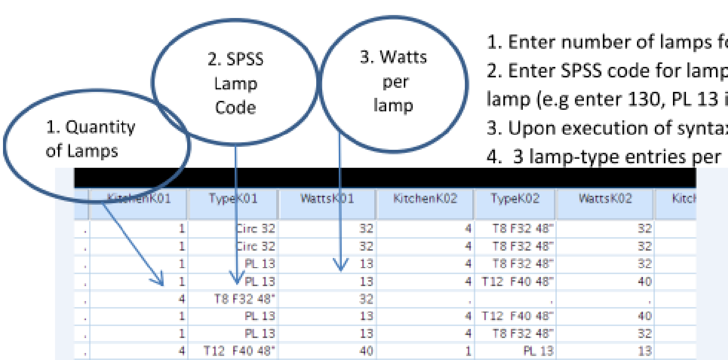
Compact Fluorescent Base Types

SPSS Lighting Codes

		Lamp Type	SPSS Code	Calculation Wattage
CFL				
	PL	9 W	90	9
		13 W	130	13
		20 W	200	20
	Helical	9-13	131	13
		14-20	201	18
		21-26	260	23
	Circline	22 W	222	22
		32 W	322	32
Fluorescent				
	T8	F17 (24")	17	17
		F25 (36")	25	25
		F32 (48")	32	32
	T12	F24 (24")	24	20
		F36 (36")	*36*	30
		F34 (48")	*34*	34
		F40 (48")	48	40
Incandescent		<40	39	25
		40	40	40
		60	60	60
		75	75	75
		100	100	100
		150	150	150
		Other		

Note: A 27 W PL may be represented in SPSS data collection sheets as (2) PL13

SPSS Files:	**File type**	**File name**
	Data	/home/modeler/FC_Master DATASHEET _7_12_11.sav (or recent date)
	Syntax	home/modeler/documents/WattsInfo_Syntax.sps



	KitchenK01	TypeK01	WattsK01	KitchenK02	TypeK02	WattsK02
.	1	Circ 32	32	4	T8 F32 48"	32
.	1	Circ 32	32	4	T8 F32 48"	32
.	1	PL 13	13	4	T8 F32 48"	32
.	1	PL 13	13	4	T12 F40 48"	40
.	4	T8 F32 48"	32	.	.	.
.	1	PL 13	13	4	T12 F40 48"	40
.	1	PL 13	13	4	T8 F32 48"	32
.	4	T12 F40 48"	40	1	PL 13	13

1. Enter number of lamps for each type lamp
2. Enter SPSS code for lamp type, will return description of lamp (e.g enter 130, PL 13 is returned)
3. Upon execution of syntax file, watts per lamp appears
4. 3 lamp-type entries per room

APPENDIX A - Data Sheets

Occupant Survey

1. Number of stories to the home 1, 2, or 3

2. Including yourself, how many people live in the home on a full-time basis?

	0	1	2	3	4
Children 0-10					
Children 11-18					
Adults 18+					

3. At what temperature do you normally set your thermostat for air conditioning?

    68-70 __

    71-73 __

    74-76 __

    77-80 __

    Other, please specify: ________________________

4. If you set your temperature higher at night or while out of the house, to what temperature do you set it?

    68-70 __

    71-73 __

    74-76 __

    77-80 __

    Other, please specify: ________________________

5. Is the air conditioner in operation…

    ___All of the time

    ___Most of the time

    ___Some of the time

    ___During hot spells only

    Other, please specify: ________________________

6. Do you open and close your windows for fresh air and ventilation?

    __ Yes

    __ Sometimes

    __ Never

7. If and when you open the windows for fresh air and ventilation, do you…

___Always turn off the AC

___Sometimes leave the AC on because cooling is needed in certain rooms

___Always leave the AC on

8. Information regarding household water use:

Approximately how many showers are taken each week?

Average length of each shower?

How many baths are taken each week?

9. Information regarding refrigerators and freezers: Do you used a 2nd refrigerator or freezer?
10. Approximately how many loads per week do you run your dishwasher?
11. Are they full loads or partial loads?
12. Approximately how many times power week do you hand-wash your dishes?
13. Approximately how many burner-minutes per day do you use your range? (Example: 2 burners for 15 minutes = 30 burner minutes).
14. Approximately how many hours per week do you use your oven?
15. Approximately how many minutes per day do you use your microwave oven?
16. Laundry profile in your home:

	0	1- 2	3-4	5- 6	7- 8	9-10
Total loads/week						
Cold water loads						
Warm water loads						
Hot water loads						

17. Approximately how many loads per week do you run in your clothes dryer?

Small loads/week ____

Large loads/week____

18. We also ask if they happen to have any problems with the appliances:

AC work okay?

Get enough hot water?

Dryer work okay?

General Notes and Checklists

Neighborhood:	0	Address:	0	Date:
Kit #		Kit color:		1/0/1900
HOBO #	**Room**	**deployed date/time**	**collected date/time**	**Description of location in room**
1	Outside, Lanai			
2	Livingroom			
3	Attic ambient air			
4	Attic UNDER insulation			
5	Bedroom master ambient			
6	Bedroom master GLOBE			
7	Bedroom 2			
8	Bedroom 2 GLOBE			
	Kill-A-Watt meter			
	E-Gauge			

Start checklist:	**Finish checklist**		Date for removal: ___________________
__AC closet unlocked	**__Get reading off Kill-A-Watt meter!!**		Preferrred time for removal:
__Attic unlocked	__Collect Kill-A-Watt meter		__ 8:00 AM to 10:00 AM
Inspect attic	Collect hobos		10:00 AM to Noon
Solar pump on auto	Uninstall Egauge		Noon to 2:00 PM
Hot water timer set/on	Attic locked		2:00 PM to 4:00 PM
Install eGauge/computer			
Deploy Hobos			
Install Kill-a-watt meter		Second Kill-A-Watt meter	Kill-A-Watt meter on main refrigerator:
Appliance data			
Lighting assessment		kwh:	kwh:
Plug loads			
Photo		hours:	hours:

Appliance Data Sheet

Neighborhood:		Address:		Date:
0		0		1/0/00
Appliance Data:	**Make**	**Model**	**SN and date of man**	**Condition**
AC unit - compressor	Carrier Trane Dayton	38CK024 38CKB02420-1 38CKB024320-1 38BRC030 2TTB3024A1000AA GCG030S2AS2A 38BRC024310-1		Excellent Good Fair/Corroded Poor/VeryCorroded
Location of compressor	enclosed in fencing open area weeds growing on it			
AC unit - air handler	Carrier Trane Dayton	FA4ANF02000AEAA FA4ANF024000ABAA FA4NF030		Is air filter clean? Y / N
Location of air handler	outdoor closet laundry room		fresh air intake?	yes / no / where:
Clothes washer	Whirlpool Hotpoint			
Clothes dryer	Whirlpool Hotpoint			
Dryer venting?	direct to outside vented but longer run			
Hot water heater	American Rheem 80 gal 120 gal Temperature setting:			
Hot water timer	on / off	pins set / not set on: off: on: off:		time off by? Hrs
Notes:				
Solar water pump	on / off / auto	functioning / broken		
pump controller	Delta T Goldline/SunEarth Setting for delta T: GoldLine off temp:			
Notes:				
Thermostat (livingroom)	manual / programmable		Temp setting:	
Refrigerator	Whirlpool			
Dishwasher	Whirlpool			
Stove	Whirlpool 4-burner electric NEW OK OLD			
Microwave				
Kitchen exhst fan?	yes / no	Full bath exhaust fans?		yes / no
Material types:				
Roofing	concrete tile asphalt composition			
Exterior wall surface	vinyl siding stucco-look			
Foundation/stories	slab-on-grade Stories: single two three			
Wall assembly	wood studs steel studs			
Attic insulation	R-19 on ceiling on rafters insulation in good shape some insulation moved			
Interior wall surfaces	painted drywall			
Flooring	vinyl tile wall-to-wall carpeting ceramic tile			
Windows	single pane double pane			

Plug Loads

Neighborhood:	Address	Date:		
0	0	1/0/00		
TVs				
VCRs				
DVD players				
Video Game Consoles	X-Box PlayStation3 Wii			
Desktop CPUs				
Computer monitors				
Laptop computers				
Printers				
Stereos				
Extra refrigerator				
Extra Freezer				
Air purification system				
Other	Toaster oven Pop up toaster rice cooker coffee maker breadmaker hot water pot water cooler desk lamp floor lamp satellite dish floor fans			

Lighting Survey

Subdivision Name:

Home Address:

Date__________1/0/00____________________

Indicate "T" for Table Lamp "F" for ceiling fan n e)(t to lamp count

Room	CFL (No. Lamp)								Linear Fluore cent (No. Lamp)							Incande cant (No. Lamp)							ClgFam			Lamp
	PL(W)			Helical (Al1			Cirdine		TO			Tl2						(W)					(YarN)			Type
Interior	9W	11W	20W	9 13	f 14-20	f 21·261f	22W	32W	F17 (24")	f25 (36")	(48 1	f24(24")	F36 (36")1	F34 (48)	f40 (48")	<40	f 40	f 60	f '''	f 100	f 150	f Other	ll!np	21 mp	41 p	
51)55 ax/	90	130	200	131	201	260	222	322	17	25	32	24	36	34	48	39	40	60	75	100	150					
Kitchen																										
Kit (Ran<e)																										
Livin																										
Olnln																										
Entr y/Int																										
H alllst																										
Hall 2nd																										
Sta ir (upper)																										
stair(low er)																										
Laund ry																										
Mbed																										
Mbed Closet																										
Bed2																										
Bedl																										
Bed4																										
Mbath																										
Bath2																										
Bath 3																										
Guage																										
Storage1st																										
storage 2nd																										
Exterior																										
Entry/E>d:																										
Patio																										
Stora																										
Other																										

Comments — — —————————————————————— — — ——————————————————————————__________________

Pressurization Testing

Neighborhood:	0	Address:	0
		Date:	1/0/00

Pressure across closed bedroom doors (with AC on):

Master bedroom	
Bedroom 2	
Bedroom 3	

Blower Door

Turn AC OFF!! Make sure air handling unit is off. Exhaust fans & dryer off, windows closed, interior doors open; Blower door blowing out; just A or B ring

Door CFM50			
Zone Testing to Garage	should be >48Pa		

Pressure pan (with blower door running):

Living room		Stairway	
Dining room		Upstairs hall	
Kitchen		Master Bed	
Hall		Master Bath	
Bathroom		Bed 2	
Laundry		Bed 3	

Duct Testing

Turn off blower door. Set up duct blaster, no rings; tape over all registers; put blue tube into supply register; regulate pressure with manual dial

Duct CFM25 total			

Turn blower door fan around to blow in and turn on to 25 Pa. Run duct blaster again and set pressure to 0

Duct CFM25 outside	

House volume in cu ft

APPENDIX C

University of Hawaii Watt Watcher Program

Forest City Resident Energy Saving Tips

Power in Hawaii is, on average, twice as expensive as it is on the mainland. What you consider a "high" bill in dollars here might be charging for the same number of kilowatt hours as a "normal" bill on the mainland. It's the kWh of use you should look at – but most people only pay attention to the dollar amount of the bill.

Hawaii is 92% reliant on fossil fuel to generate electricity vs. 70% for the US average, and 76% reliant on oil specifically vs. 1% for the US average (which uses 45% coal and 24% natural gas). The oil brought into Hawaii is 96% *foreign oil* shipped in from Southeast Asia and the Middle East. Our remote location adds a high shipping cost to our fuel, adding to our cost of electricity. The price of our electricity rises directly with oil prices.

Electricity production from fossil fuels in Hawaii is a concern from several standpoints: economic (trade deficit = we send our dollars offshore), security, and environmental. One thing we can do as individuals is conserve electricity.

Air Conditioning can use up to 69% of the electricity in a military home in Hawaii.

Air Conditioning Tips:

- Turn off AC, open windows, and use fans when outdoor temperature is amendable.
- If running the AC – set thermostat higher and use a fan to aid comfort (turn off fan when you are not in that room since it does not cool the room, but cools your skin).
- Turn off AC when leaving the house and close drapes to keep the sun out.
- Use the ventilation fan in the bathroom when showering and the kitchen when cooking to remove humidity from the home.
- Change the AC air filter regularly.
- Keep personal items away from the AC compressor – it needs air circulation to cool the fins. Compressors enclosed in a fence are often cluttered with storage of toys,
- recycling, or trash.
- Keep grass, leaves, and debris clear of AC compressor.

Water heaters can consume 10 to 210 kWh/month in a military home in Hawaii.

Hot Water Tips:

- Check pins on water heater timer and check time is set correctly - the arrow should point at the correct time. It should be set to come on from 4 to 8 am and 4 to 8 pm.
- If you don't feel you need extra water heating, you can remove a pair of pins (a pair is made up of one brass pin and one aluminum pin) and leave electric heater off for that time period or set pins closer together so the heater turns off sooner. The electric element uses 4 kW of energy when it runs. The more hot water you use, the longer it has to stay on to heat the additional water.

- If you have a "Delta T" controller, keep it on "auto" (only turn to "on" when you will be away for more than 2 days and then turn it back to "auto" when you return).
- Use hot water during the sunny hours of the day when solar water heating is running for free hot water!
- Report problems to FC: not getting hot water during a sunny day; any water leakage in the home; if you notice the solar pump (on top of water heater) never comes on.
- Take short showers – this uses less water heating and introduces less heat and humidity into the house which will in turn allow AC to work less.

Clothes Dryer Tips

- After showering, hang your bath towel to dry and reuse it to save water and electricity. Your clothes dryer uses about 5.5 kW when the heating element comes on – that is like running 4 or 5 hairdryers at the same time.
- Hang laundry to dry or run the dryer for the shortest time necessary to dry the clothes. Auto sensors that let you choose "more dry" or "less dry" can be helpful.
- Don't choose a "touch up" feature that runs the dryer for a few minutes several times an hour until you unload it hours later.
- And don't walk away and leave the dryer door open if it has a light inside.

Dishwasher Tips

- Use your dishwasher and run only full loads.
- Scrape, don't pre-rinse before loading dishes.
- Avoid hand washing dishes to save water.
- Use the energy saving "no heat" drying mode or air dry your dishes.
- Use the "delay start timer" to run during peak solar water heating hours (10am to 4pm).

Other tips:

- Avoid using an extra refrigerator or freezer. If necessary, use an Energy Star model.
- Turn off lights and televisions when you leave a room.
- Use Energy Star computers, televisions, etc. Put items on a power strip and turn off power strip when not using devises – this prevents "ghost loads" (small amount of electricity each electronic device consumes in standby mode).
- Fluorescent light bulbs use 75% less energy than incandescent bulbs. Don't replace compact fluorescent bulbs with incandescent – Forest City will provide replacements if you bring your burned-out bulb to your community center.
- See the Energy Star website for other information. http://www.energystar.gov/

References

http://www.eia.gov/cneaf/electricity/st_profiles/hawaii.html Table 4. Electric Power Industry Capability by Primary Energy Source, 1990 Through 2008.
http://www.eia.doe.gov/cneaf/electricity/epm/table1_1.html Net generation by energy source.
http://energy.hawaii.gov/wp-content/uploads/2011/10/erc09.pdf
http://www.hawaii.gov/dbedt/info/energy/publications/briefing050120.ppt http://aceee.org/consumer/dishwashing

APPENDIX D
Wiki for Energy Projects

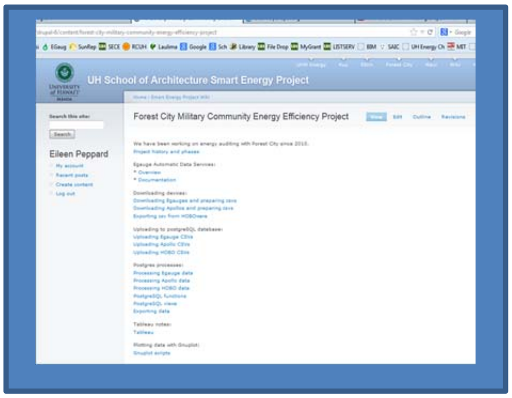
Documentation of Research Methods and Results for Collaboration

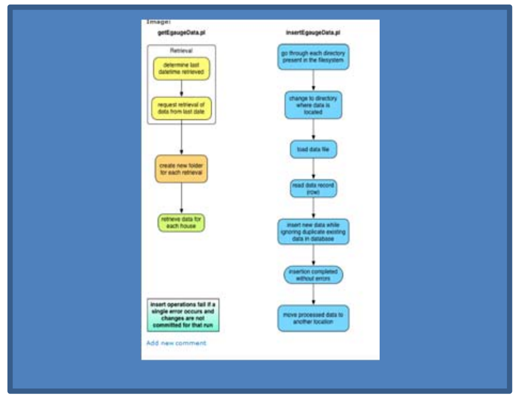
With Hawai‘i Natural Energy Institute

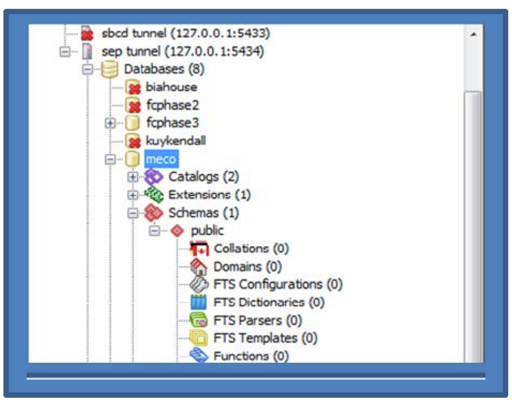
by

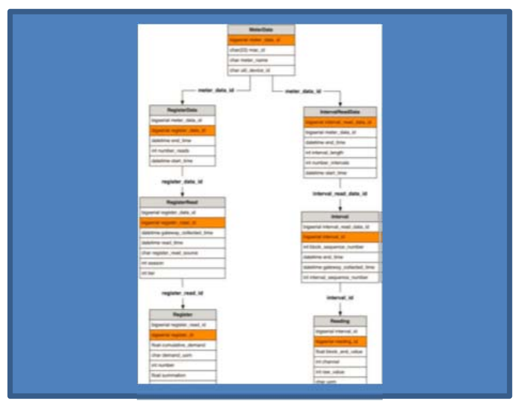
The School of Architecture’s

Environmental Research and Design Laboratory







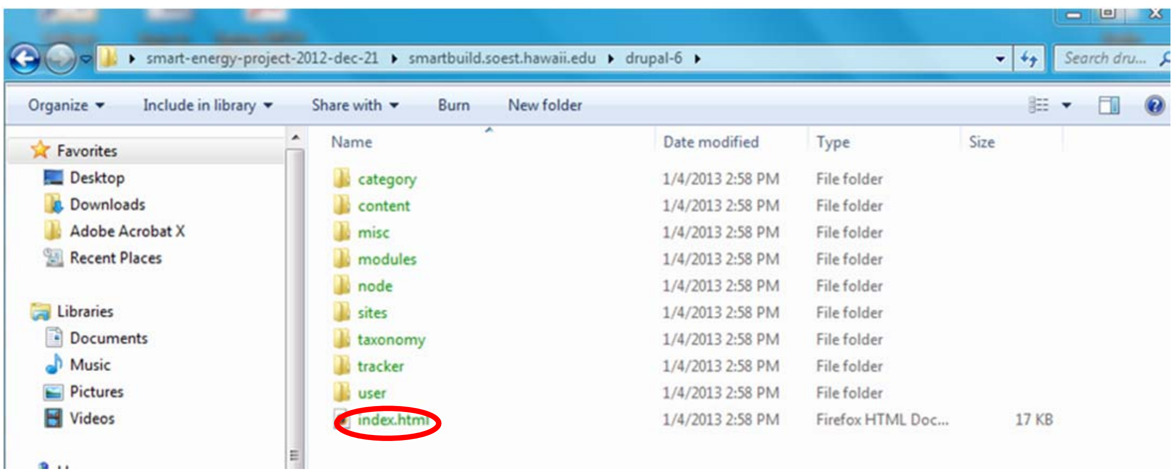


The following is a PDF version of the wiki - a server-based, secure website which is used for documenting procedures and sharing information on a team.

Wiki Description

All procedures are being documented on a wiki (a website hosted on our server) with secured access. Other members of the working group can have access to this wiki, as needed. Otherwise, a static version of the wiki (see accompanying zipped folder) will be provided with the progress reports and more frequently if the working group requests an update. The static wiki is created with a Mac-compatible program called “Sitesucker.” To access this static wiki in Windows, right click the zipped folder and select “Extract all.” Once the files are extracted, click on the new folder, e.g. “smart-energy-project-2012-dec-21”, then the only folder inside, “smartbuild.soes.hawaii.edu” and then select “index.html” to open the static wiki (Fig 1).

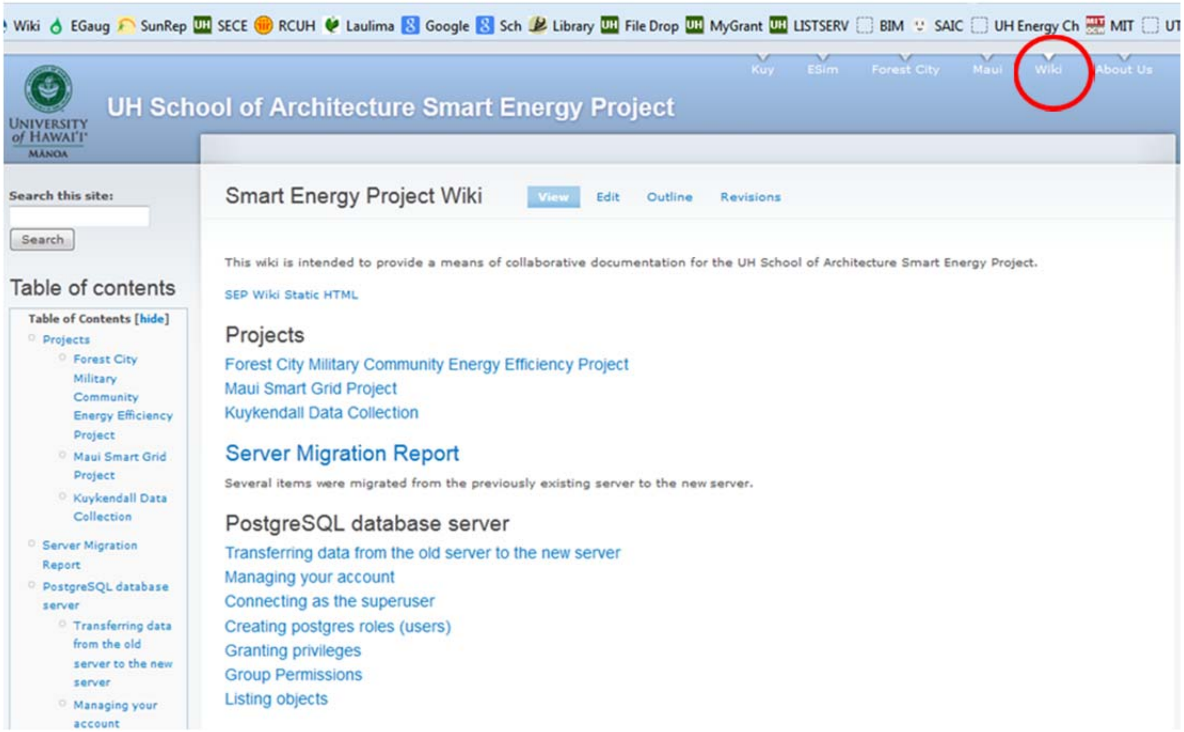
Figure 1. Opening the static wiki.



The tabs across the top of the page (Fig 2) give quick access to each project. The “Wiki” tab which gives details of the server administration. The other projects covered in the wiki are:

- Forest City Energy Auditing Research
- Energy Simulation Education
- Maui Smart Grid Research
- UHM Energy Reporting

Figure 2. Wiki tabs are at the top of the page.



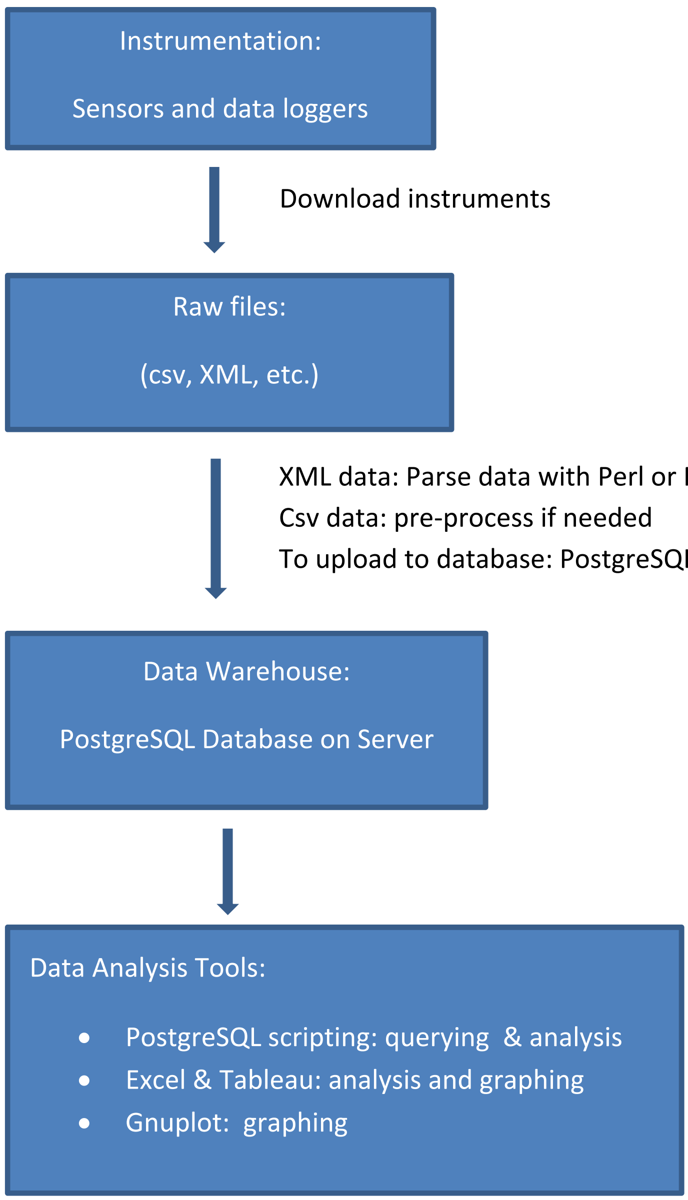
Each project has further links to procedures used to conduct the research, details of the equipment used, the scripts used to load the data into the PostgreSQL database, reports written, etc. This is a work in progress and the content will be changed and supplemented on a regular basis.

Attached to this report are appendices which are print-outs of the wiki pages. Using the actual wiki is a much more user-friendly way to find information. And links can be shared between projects. For example, if an “eGauge” device is used on 2 projects, the description on how to use it needs to be written once but the link can be used on multiple pages.

Data Flow

Figure 3 is a simplified depiction the process of collecting data for these projects, storing, processing and graphing data.

Figure 3. Data flow.



Forest City Military Community Energy Efficiency Project

We have been working on energy auditing with Forest City since 2010.
Project history and phases

Egauge Automatic Data Services:
* Overview
* Documentation

Downloading devices:
Downloading Egauges and preparing csvs
Downloading Apollos and preparing csvs
Exporting csv from HOBOware

Uploading to postgreSQL database:
Uploading Egauge CSVs
Uploading Apollo CSVs
Uploading HOBO CSVs

Postgres processes:
Processing Egauge data
Processing Apollo data
Processing HOBO data
PostgreSQL functions
PostgreSQL views
Exporting data

Tableau notes:
Tableau

Plotting data with Gnuplot:
Gnuplot scripts

Device manuals:
eGauge Documentation
eGauge Manual
Apollo Manual
Solar water heating temp differential controllers

Energy Audit on Site
Audit Procedures
Light fixtures
Data sheets

Air leakage testing:
Blower door instructions
Duct blaster instructions
Pressure pan instructions

Apollo Manual

We are using the Sunreports Apollo I in the Phase 3 of this project.

Attachment	Size
Apollo1-QuickStart-Guide-Thermal.pdf	913.92 KB
Apollo1SpecSheet20100726.pdf	493.78 KB
Apollo-Installation-Manual.pdf	886.66 KB

Audit Procedures

Staffing

This is written based on Phase 3 of the project. We normally have 3 of us plus the Forest City electrician. One person does the resident survey, collects appliance data, plug loads, takes photos, basic info on the house, orientation of the house (e.g. 355 N). The second person installs the EGauge with the electrician and tests all the appliances show up on the Egauge when turned on. The third person installs the Apollo. We no longer do lighting surveys since we've already reported on that and it is very time consuming. If all goes well, we can be finished in an hour. If it doesn't go well, it's a different story. We gave up on connectivity in one house after 2 visits totaling 5 hours.

Resident appointments

- Forest City recruits the residents but they usually don't know much about the program and what to expect.
- Don't call from phone that blocks caller ID, they may not pick up the phone.
- Introduce yourself and your affiliation with Forest City's energy program.
- Explain what the program is about.
- Let them know how many people will be coming (including FC electrician) and what they will be doing: installing device in breaker panel, collecting data on appliances, questionnaire, accessing each room, accessing router, etc.
- Let them know how long it will take (1 hr, 1-2 hrs, etc).
- Ask if they will be the person home at the time. If not, ask for the contact information of the family member who will be home so you can explain it to them also. Spouses often don't inform each other and your visit will come as a surprise.
- Unless you are making the appointment within 2 days of the visit, make a follow up call the day before to remind them. Leaving a voice mail at that point is okay.
- If you need access to their router, check if they use a static IP address so you can be prepared for how long it might take to set up connectivity and allow for that in your schedule.

Resident Survey

- This is fairly straight forward. It's best to design the survey to be specific and you can dumb it down later. At first we used temperature ranges for answer options for the thermostat, e.g. 72-74, but it's best to just put down the exact number, e.g. 73. You can lump them into bins later.
- Self-reporting is not always accurate. When asking if they have an extra refrigerator or freezer, they might actually forget the chest freezer in the garage. Or they might have a wine cooler and that was not in the question.
- Data sheets are here http://smartbuild.soest.hawaii.edu/drupal-6/node/44

Collecting data on major appliances

- The serial number on AC units often gives a clue to the capacity , e.g. "30" indicating 30 BTUs, and the age, e.g. "0749" would be 2007 and the 49th week. You can google this for the manufacturer to get the data.
- Most ACs at Forest City have the size (BTUs) of compressor match the size of the air handler. They are often not the same brand/age because the compressor was replaced sooner. The latest retrofits may have a smaller compressor than air handler (e.g. 1.5 BTU vs. 2.0 BTU, respectively for the retrofits in the Fall 2011 retrofit study).
- Refrigerator model number often gives the cubic feet, e.g. 21 cu ft and it often gives the date of manufacture on the label. Refrigerators manufactured after July 2001 use 30% less energy than those meeting the 1993 efficiency regulations. http://ees.ead.lbl.gov/projects/past_projects/refrigerators The models that use the least energy are: smaller in size; have the freezer on top configuration; and areENERGY STAR-rated. The most energy intensive configuration is the side-by-side design with through the door water/ice.
- Water heater timers: digital, analog, load control device. Take note if current time is correct, the on/off setting hours, or if it's not set at all. See http://smartbuild.soest.hawaii.edu/drupal-6/node/42 for models of controllers.
- Water heaters: take note of the size (usually 80 or 120 gal), condition if particularly bad, and open the panel and take note of the thermostat setting.
- Solar water heater controllers: there are different brands/models types and there are different types of data to collect, depending on the model: record make and model, note if it's set to on/off/auto on an exterior switch, open panel and see settings for the max temp and temp differential, or scroll through settings on computer display and see the max temp.
- You may want to note if there is a water mixing valve to prevent scalding, so far we haven't had any use for that information.
- Datasheets are here http://smartbuild.soest.hawaii.edu/drupal-6/node/44

Lighting survey

- We did a lighting survey in Phase 1 of this project. See Lighting Fixtures http://smartbuild.soest.hawaii.edu/drupal-6/node/43 for a catalog of lights found at Forest City.
- Distinguish between lights supplied by property management and lights brought in by the resident. For Phase 3 we are only noting what the residents brought in and just count fluorescent vs incandescent bulbs.

House data

- Square footage, number of bedrooms, year it was built is nice
- Type of roofing material, siding material, floor materials, type of windows (single or double pane)
- Orientation of the home: we use a compass and get a reading for the side that has the front door, if it's in a nook, making it 90 degree angle from the driveway, we use the driveway direction as the general orientation.
- Orientation of the solar panels and if they are racked in a particular direction.
- Datasheets are here http://smartbuild.soest.hawaii.edu/drupal-6/node/44

Blower door instructions

Manuals for blower door and handheld gauge are attached.

File Attachment:
ManualDoorFanOperation.pdf
Manual-DM-2 Operation.pdf

Data sheets

These are the data sheets we've used for Phase 3: solar water heating study. For the excel sheet, if you put the address and date on the first sheet, it populates those cells in the other sheets. You'll have to hand write the house and date on the survey and be sure to label each page.

Attachment	Size
Appliance+Materials_datasheet V4.xls	133 KB
Occupant survey_edited.doc	42 KB

Downloading Apollos and preparing csvs

Manually downloading Sunreports Apollo

Daniel will eventually set up an automated download to the database

- Sign in on the Sunreports website http://www.sunreports.com/app/login
- Click on the device you want to download
- Click on "view data readings"
- Select dates (it can't retain more than 100 days of data)
- Click "update"
- Click download csv
- Store these with house ID # in file name and download date, e.g. 2_SunreportsData_2012.11.05 keep the raw files untouched, copy them over to another folder before manipulating them to clean up for uploading.
- As of 11/5/12, the "pump on/off" data is not downloading in csv, we only get "flow data" unless we plug the pump sensor into the flow port.
- Sometimes a line is repeated and so it won't upload. Posgresql will tell you what line in the csv is violating the primary key rule and you just open the file and remove the duplicate line. Excel does have a "remove dublicates" feature in the Data section.
- If the pump data is blank, it has a " in the cell (you can see it if you open the file in a text editor) and postgres will have a problem with that since it's not double precision, so you will need to clear the blank cells.
- It's best to trim data in files to all the same time, so if you started downloading at 10:05 this morning and finish the last one at 10:50, trim to 10:00 so it's easier to get files ready for next time. Our database has a view for loading and earliest and latest timestamps to know where to pick up again.
- If temperatures are 0 you should remove them so they are null. If you've uploaded them, you can repair it in the database but it's a bit dangerous, so make a copy of the table just in case. Then repair with these commands:

To make a backup table:

```
CREATE TABLE apollo_backup AS TABLE apollo;
```

To change the zero temperatures to null:

```
UPDATE apollo SET t1 = null WHERE t1=0;
UPDATE apollo SET t2 = null WHERE t2=0;
UPDATE apollo SET t3 = null WHERE t3=0;
```

Downloading Egauges and preparing csvs

Manual Download of Data

Daniel is working on a script that will automatically download the data. Here I'll describe how to do it manually.

This can be done online at the office:

- An account on the EGauge website can be set up so you see the listing of only your devices.
- Click on the EGauge number to download.
- In the top left corner of the graph there is a little down arrow (triangle) - click on that.
- Select download data to spreadsheet (CSV).
- Select to dates to download.
- If you pick a start date that is before the date you started monitoring the house, you will get data from a previous monitoring and you will have to figure that out and trim it. It's best to not go earlier than you know it has been monitoring.
- Select the interval - we use 1 minute data. You have to select this. The default is one day.
- Wait for the csv to download, it can take several minutes if you are grabbing 2 months of minute data.
- Make sure there are no empty rows at the end of the file or postgres will not upload it because it contains NULLS. I could not delete these in Excel, but I could do it in a text editor.

If the EGauge has not been online and you need to visit the house to download:

- You can download with LAN line in the house directly from the EGauge.
- Put a homeplug adapter into a socket and hook it up to your computer with a CAT5 cable.
- You'll have to disconnect the existing homeplug that's connected to the router so it stops trying to find internet.
- Cycle the EGauge to reset it: turn off the double breaker it is wired to, wait a few seconds, turn it back on and wait for it to reboot.
- Open browser on computer and put in http://192.168.1.88/
- This should find the EGauge. All of this is in the EGauge Owner's Manual.
- Download as described above.

Duct blaster instructions

Duct blaster manuals, quick guide, and handheld meter manual attached.

File Attachment:
Manual-DucTester Operation & Testing.pdf
QuickGuide-DucTester 200-QG130.pdf
Spec-Model 200-SP200.pdf
Manual-DM-2 Operation.pdf

Exporting csv from HOBOware

Downloading HOBOs

The stand-alone hobo devices (made by Onset) download to HOBOware software using a USB cable ("read out" device).

Exporting data from HOBOware

When you read out the device in Hoboware, uncheck the “Internal Logger Events to Plot” by clicking []None
You have to do this every time.

Postgres needs the date to be in this format 2012-09-20 15:00 (which is ISO 8601). We also need to get rid of line number column and extra title line.
In Hoboware change settings:

```
File – Preferences
        General – Export settings
            Include line number column  [] uncheck
            Include plot title in header    [] uncheck
            Date format                 YMD
            Date separator          Dash(-)
            Time format                 24-hour
```

```
Display – Date/Time
    Date                YMD
    Date separator      Dash(-)
    Year format                 4-digit year
    Time format         24-hour
```

Check that the csv does not have extra columns before uploading to database and be sure your script matches the columns.

Exporting data

To export data for graphing, need to get absolute values and watts:

```
SELECT  abs(use_kw)*1000 AS "Whole house",
abs(ac_kW)*1000 AS "AC compressor",
abs(fan_kW)*1000 AS "AC fan",
abs(dhw_kW)*1000 AS "Water heater",
abs(stove_kw)*1000 AS "Stove",
abs(dryer_kw)*1000 AS "Dryer",
abs(clotheswasher_kw)*1000 AS "Clotheswasher",
abs(dishwasher_kw)*1000 AS "Dishwasher",
abs(solarpump_kw)*1000 AS "Solar pump",
abs(microwave_kw)*1000AS "Microwave"
FROM energy WHERE house_id = 1;
```

To export data directly to a csv for plotting it must be done from the sql shell:

```
\COPY energy to 'C:\Users\Eileen\Desktop\database_learning\test_1.csv' delimiter ',' CSV HEADER;
```

To copy only certain columns:

```
\COPY energy (house_id, datetime, use_kw) to
'C:\Users\Eileen\Desktop\database_learning\test_3.csv'
delimiter ',' CSV HEADER;
```

Trying to send only absolute values but can't make it work:

```
\COPY energy (abs[use_kw]) to 'C:\Users\Eileen\Desktop\database_learning\test_4.csv' delimiter ',' CSV HEADER;
```

Light fixtures

Jim Maskrey put this together during Phase 1 of the Forest City Project (2010-2011). Some lights in ceiling fans had been replaced by incandescents by residents, but for the most part, Forest City was doing a pretty good job of keeping the lighting fluorescent. The one bulb that is still not fluorescent is the one over the stove, in the hood.

Attachment	Size
Light Fixture catalog2.pdf	744.42 KB

PostgreSQL functions

"Appliance is on" function = apon

```
CREATE OR REPLACE FUNCTION apon(double precision)
RETURNS integer AS
'SELECT CASE WHEN $1 >0.010 THEN 1 ELSE 0 END;'
LANGUAGE sql VOLATILE
COST 100;
```

THI (temperature-humidity index) function = thi

```
CREATE OR REPLACE FUNCTION thi(double precision, double precision)
RETURNS double precision AS
'SELECT $1 - (0.55 - 0.55*($2/100))*($1 - 58)'
LANGUAGE sql VOLATILE
COST 100;
```

THI is > 70 function = thi70

```
CREATE OR REPLACE FUNCTION thi70(double precision)
RETURNS integer AS
'SELECT CASE WHEN $1 > 70 THEN 1 ELSE 0 END;'
LANGUAGE sql VOLATILE
COST 100;
```

THI is > 75 function = thi75

```
CREATE OR REPLACE FUNCTION thi75(double precision)
RETURNS integer AS
'SELECT CASE WHEN $1 > 75 THEN 1 ELSE 0 END;'
LANGUAGE sql VOLATILE
COST 100;
```

PostgreSQL views

Earliest and Latest dates for apollo data:

```
CREATE OR REPLACE VIEW apollo_house_dates AS
SELECT apollo.house_id, min(apollo.datetime)
AS "A Start Date", max(apollo.datetime) AS "A Latest Date"
FROM apollo
GROUP BY apollo.house_id
ORDER by energy.house_id;
```

Earliest and Latest dates for egause data:

```
CREATE OR REPLACE VIEW energy_house_dates AS
SELECT energy.house_id, min(energy.datetime) AS "E Start Date",
max(energy.datetime) AS "E Latest Date"
FROM energy
GROUP BY energy.house_id
ORDER by energy.house_id;
```

Earliest and Latest dates for hobo data:

```
CREATE OR REPLACE VIEW environment_house_dates AS
SELECT environment.house_id, house.nickname,
environment.room_id AS room, room.room_name,
min(environment.datetime) AS "HOBO Start Date",
max(environment.datetime) AS "HOBO Latest Date"
FROM environment, room, house
WHERE environment.room_id = room.room_id
AND environment.house_id = house.house_id
GROUP BY environment.house_id, environment.room_id,
room.room_name, house.nickname;
```

I've tried to combine the egauge and apollo views but can't get it to work.

```
SELECT house.house_id,
min(apollo.datetime) AS "Apollo Start Date",
max(apollo.datetime) AS "Apollo Latest Date",
min(energy.datetime) AS "E Start Date",
max(energy.datetime) AS "E Latest Date"
FROM public.apollo,
public.energy,
public.house
WHERE energy.house_id = house.house_id AND apollo.house_id = house.house_id
GROUP BY house.house_id
ORDER by house.house_id
```

Pressure pan instructions

Instructions for using pressure pan on registers to locate leaky ducts

File Attachment:
presspanuser.pdf

Processing Apollo data

Extracted the hour of day:

```
SELECT house_id, extract (hour from test.datetime) "hour",
sum(pump_on_bit) "Frequency pump on"
FROM  (select cast(case when pump_on = 'TRUE' THEN 1 else 0 end as integer)
as pump_on_bit, * from apollo) as test
GROUP by test.house_id, hour
ORDER by house_id, hour
```

To extract by hour but separate by month!

```
SELECT test.house_id, month, hour, sum(pump_on_bit)
"Frequency pump on" from
(SELECT house_id, extract (month from datetime) as month,
extract (hour from datetime)as hour,
cast(case when pump_on = 'TRUE' THEN 1 else 0 end as integer)
as pump_on_bit
FROM apollo) as test
GROUP BY test.house_id, month, hour
ORDER by test.house_id, month, hour
```

Now let's look at max and min tank temps:

```
SELECT test.house_id, day, min(t3) mintemp, max(t3) maxtemp
FROM (SELECT house_id, t3, extract (day from datetime) as day
FROM apollo) as test
GROUP BY test.house_id, day
ORDER by test.house_id, day
```

Processing Egauge data

Removing outliers

TO CHECK FOR OUTLIERS:

```
SELECT * FROM energy WHERE
abs(use_kw) > 25 or
abs(ac_kw) > 10 or
abs(fan_kw) > 10 or
abs(dhw_kw) > 10 or
abs(stove_kw) > 10 or
abs(dryer_kw) > 10 or
abs(clotheswasher_kw) > 10 or
abs(dishwasher_kw) > 10 or
abs(solarpump_kw) >10 or
abs(microwave_kw) > 10;
```

To copy outliers to reject table:

```
INSERT INTO energy_rejects
SELECT * FROM energy WHERE
abs(use_kw) > 25 or
abs(ac_kw) > 10 or
abs(fan_kw) > 10 or
abs(dhw_kw) > 10 or
abs(stove_kw) > 10 or
abs(dryer_kw) > 10 or
abs(clotheswasher_kw) > 10 or
abs(dishwasher_kw) > 10 or
abs(solarpump_kw) >10 or
abs(microwave_kw) > 10;
```

To delete outliers from energy table:

```
DELETE FROM energy WHERE
abs(use_kw) > 25 or
abs(ac_kw) > 10 or
abs(fan_kw) > 10 or
abs(dhw_kw) > 10 or
abs(stove_kw) > 10 or
abs(dryer_kw) > 10 or
```

```
abs(clotheswasher_kw) > 10 or
abs(dishwasher_kw) > 10 or
abs(solarpump_kw) >10 or
abs(microwave_kw) > 10;
```

Analysis by month, rounding output to nearest integer:

```
SELECT count(*)/(60*24) "Days", house_id, date_trunc ('month', datetime) "Month",
round(sum(abs(use_kw))/60) "Whole House kwh/month",
round(sum(abs(ac_kw))/60) "AC kwh/month",
round(sum(abs(fan_kw))/60) "Fan kwh/month",
round(sum(abs(dhw_kw))/60) "Water Heater kwh/month",
round(sum(abs(stove_kw))/60) "Stove kwh/month",
round(sum(abs(dryer_kw))/60) "Dryer kwh/month",
round(sum(abs(clotheswasher_kw))/60) "Clotheswasher kwh/month",
round(sum(abs(dishwasher_kw))/60) "Dishwasher kwh/month",
round(sum(abs(solarpump_kw))/60) "Solar Pump kwh/month",
round(sum(abs(microwave_kw))/60) "Microwave kwh/month"
from energy group by house_id, date_trunc('month', datetime);
```

Linking tables house and energy to add nickname to analysis:

```
SELECT count(*)/(60*24) "Days", energy.house_id, house.nickname, date_trunc ('month', datetime) "Month",
round(sum(abs(use_kw))/60) "Whole House kwh/month",
round(sum(abs(ac_kw))/60) "AC kwh/month",
round(sum(abs(fan_kw))/60) "Fan kwh/month",
round(sum(abs(dhw_kw))/60) "Water Heater kwh/month",
round(sum(abs(stove_kw))/60) "Stove kwh/month",
round(sum(abs(dryer_kw))/60) "Dryer kwh/month",
round(sum(abs(clotheswasher_kw))/60) "Clotheswasher kwh/month",
round(sum(abs(dishwasher_kw))/60) "Dishwasher kwh/month",
round(sum(abs(solarpump_kw))/60) "Solar Pump kwh/month",
round(sum(abs(microwave_kw))/60) "Microwave kwh/month"
FROM energy, house
WHERE energy.house_id = house.house_id
GROUP by energy.house_id, date_trunc('month', datetime), house.nickname;
```

To show earliest and latest dates for houses: ##

```
CREATE or REPLACE VIEW house_dates
AS select  house_id,  min(datetime) "Start Date", max(datetime) "Latest Date"
from energy group by house_id;
```

To extract certain dates:

```
SELECT *
FROM energy WHERE house_id = 16 AND datetime >= '2012-08-01' AND datetime <= '2012-08-31';
```

To show total time home as been monitored:

```
Select house_id, min(datetime), max(datetime), max(datetime)-min(datetime)
"Monitoring Time"
FROM energy
Group by house_id;
```

We need % time AC and fan are on, created fuctions for when it is greater than 0.010 kw:

```
SELECT house_id, date_trunc ('month', datetime), (sum(ac1)/count(*)::numeric)*100
as "Pct AC compressor on",(sum(fan1)/count(*)::numeric)*100 as "Pct AC fan on"
FROM (
SELECT datetime, house_id, ac_kw, acon(ac_kw) AS ac1, fanon(fan_kw) as fan1
FROM energy ) as test2
GROUP BY house_id, date_trunc ('month', datetime);
```

how do I combine the above with the main disaggregation? This worked:

```
SELECT house_id, date_trunc ('month', datetime),
round(sum(abs(use_kw))/60) "Whole House kwh",
round(sum(abs(ac_kw))/60) "AC kwh",
round(sum(abs(fan_kw))/60) "Fan kwh",
round(sum(abs(dhw_kw))/60) "Water Heater kwh",
round(sum(abs(stove_kw))/60) "Stove kwh",
round(sum(abs(dryer_kw))/60) "Dryer kwh",
round(sum(abs(clotheswasher_kw))/60) "Clotheswasher kwh",
```

```
round(sum(abs(dishwasher_kw))/60) "Dishwasher kwh",
round(sum(abs(solarpump_kw))/60) "Solar Pump kwh",
round(sum(abs(microwave_kw))/60) "Microwave kwh",
round((sum(ac1)/count(*)::numeric)*100) as "Pct AC compressor on",
round((sum(fan1)/count(*)::numeric)*100) as "Pct AC fan on"
FROM (
SELECT datetime, house_id, use_kw, ac_kw, fan_kw, dhw_kw,
stove_kw, dryer_kw, clotheswasher_kw, dishwasher_kw, solarpump_kw,
microwave_kw, acon(ac_kw) AS ac1, fanon(fan_kw) as fan1
FROM energy ) as test2
GROUP BY house_id, date_trunc ('month', datetime);
```

Now clean up to all same >10w function and add dryer hours:

```
SELECT house_id, date_trunc ('month', datetime),
round(sum(abs(use_kw))/60) "Whole House kwh",
round(sum(abs(ac_kw))/60) "AC kwh",
round(sum(abs(fan_kw))/60) "Fan kwh",
round(sum(abs(dhw_kw))/60) "Water Heater kwh",
round(sum(abs(stove_kw))/60) "Stove kwh",
round(sum(abs(dryer_kw))/60) "Dryer kwh",
round(sum(abs(clotheswasher_kw))/60) "Clotheswasher kwh",
round(sum(abs(dishwasher_kw))/60) "Dishwasher kwh",
round(sum(abs(solarpump_kw))/60) "Solar Pump kwh",
round(sum(abs(microwave_kw))/60) "Microwave kwh",
round((sum(acon)/count(*)::numeric)*100) as "Pct AC compressor on",
round((sum(fanon)/count(*)::numeric)*100) as "Pct AC fan on",
round(sum(dryeron)/60) as "Dryer hrs"
FROM (
SELECT datetime, house_id, use_kw, ac_kw, fan_kw, dhw_kw,
stove_kw, dryer_kw, clotheswasher_kw, dishwasher_kw, solarpump_kw,
microwave_kw, apon(ac_kw) AS acon, apon(fan_kw) as fanon,
apon(dryer_kw) as dryeron
FROM energy ) as test2
GROUP BY house_id, date_trunc ('month', datetime);
```

This works the same way but more specific to alias of subquery:

```
SELECT test2.house_id, date_trunc ('month', test2.datetime),
round(sum(abs(use_kw))/60) "Whole House kwh",
round(sum(abs(ac_kw))/60) "AC kwh",
round(sum(abs(fan_kw))/60) "Fan kwh",
round(sum(abs(dhw_kw))/60) "Water Heater kwh",
round(sum(abs(stove_kw))/60) "Stove kwh",
round(sum(abs(dryer_kw))/60) "Dryer kwh",
round(sum(abs(clotheswasher_kw))/60) "Clotheswasher kwh",
round(sum(abs(dishwasher_kw))/60) "Dishwasher kwh",
round(sum(abs(solarpump_kw))/60) "Solar Pump kwh",
round(sum(abs(microwave_kw))/60) "Microwave kwh",
round((sum(acon)/count(*)::numeric)*100) as "Pct AC compressor on",
round((sum(fanon)/count(*)::numeric)*100) as "Pct AC fan on",
round(sum(dryeron)/60) as "Dryer hrs"
FROM (
SELECT datetime, house_id, use_kw, ac_kw, fan_kw, dhw_kw,
stove_kw, dryer_kw, clotheswasher_kw, dishwasher_kw,
solarpump_kw, microwave_kw, apon(ac_kw) AS acon,
apon(fan_kw) as fanon, apon(dryer_kw) as dryeron
FROM energy ) as test2
GROUP BY test2.house_id, date_trunc ('month', test2.datetime)
```

Now I need to add the nickname:

```
SELECT house.nickname, test2.house_id, date_trunc ('month', test2.datetime),
round(sum(abs(use_kw))/60) "Whole House kwh",
round(sum(abs(ac_kw))/60) "AC kwh",
round(sum(abs(fan_kw))/60) "Fan kwh",
round(sum(abs(dhw_kw))/60) "Water Heater kwh",
round(sum(abs(stove_kw))/60) "Stove kwh",
round(sum(abs(dryer_kw))/60) "Dryer kwh",
round(sum(abs(clotheswasher_kw))/60) "Clotheswasher kwh",
round(sum(abs(dishwasher_kw))/60) "Dishwasher kwh",
round(sum(abs(solarpump_kw))/60) "Solar Pump kwh",
round(sum(abs(microwave_kw))/60) "Microwave kwh",
round((sum(acon)/count(*)::numeric)*100) as "Pct AC compressor on",
round((sum(fanon)/count(*)::numeric)*100) as "Pct AC fan on",
round(sum(dryeron)/60) as "Dryer hrs"
FROM (
SELECT datetime, house_id, use_kw, ac_kw, fan_kw, dhw_kw, stove_kw,
dryer_kw, clotheswasher_kw, dishwasher_kw, solarpump_kw, microwave_kw,
```

```
apon(ac_kw) AS acon, apon(fan_kw) as fanon, apon(dryer_kw) as dryeron
FROM energy ) as test2, house
WHERE test2.house_id = house.house_id
GROUP BY house.nickname, test2.house_id, date_trunc ('month', test2.datetime)
```

Now I need to get # days back in:

```
SELECT count(*)/(60*24) "Days", house.nickname, test2.house_id,
date_trunc ('month', test2.datetime) "Month",
round(sum(abs(use_kw))/60) "Whole House kwh",
round(sum(abs(ac_kw))/60) "AC kwh",
round(sum(abs(fan_kw))/60) "Fan kwh",
round(sum(abs(dhw_kw))/60) "Water Heater kwh",
round(sum(abs(stove_kw))/60) "Stove kwh",
round(sum(abs(dryer_kw))/60) "Dryer kwh",
round(sum(abs(clotheswasher_kw))/60) "Clotheswasher kwh",
round(sum(abs(dishwasher_kw))/60) "Dishwasher kwh",
round(sum(abs(solarpump_kw))/60) "Solar Pump kwh",
round(sum(abs(microwave_kw))/60) "Microwave kwh",
round((sum(acon)/count(*)::numeric)*100) as
"Pct AC compressor on",round((sum(fanon)/count(\*)::numeric)*100)
as "Pct AC fan on",
round(sum(dryeron)/60) as "Dryer hrs"
FROM (
SELECT datetime, house_id, use_kw, ac_kw, fan_kw, dhw_kw, stove_kw,
dryer_kw, clotheswasher_kw, dishwasher_kw, solarpump_kw, microwave_kw,
apon(ac_kw) AS acon, apon
(fan_kw) as fanon, apon(dryer_kw) as dryeron
FROM energy ) as test2, house
WHERE test2.house_id = house.house_id
GROUP BY house.nickname, test2.house_id, date_trunc ('month', test2.datetime)
```

NEXT: need ac total (ac + fan), AC%total, each other percent total,
and possibly other but might have problems with null

Processing HOBO data

To find min and max dates on HOBO data

```
CREATE OR REPLACE VIEW environment_house_dates AS
SELECT environment.house_id, house.nickname, environment.room,
room.room_name, min(environment.datetime) AS "HOBO Start Date",
max(environment.datetime) AS "HOBO Latest Date"
FROM environment, room, house
WHERE environment.room = room.room_id
AND environment.house_id = house.house_id
GROUP BY environment.house_id, environment.room,
room.room_name, house.nickname
```

HOBO data analysis by month

```
SELECT environment.house_id, house.nickname, environment.room_id,
room.room_name, date_trunc ('month', datetime) "Month",
count(*)/(6*24) "Days",
avg(temp_f) "Average Temperature, F",
min(temp_f) "Min Temp F",
max(temp_f) "Max Temp F",
avg(rh_pct) "Ave Rel Hum %",
min(rh_pct) "Ave Rel Hum %",
max(rh_pct) "Ave Rel Hum %"
FROM environment, house, room
WHERE environment.house_id = house.house_id
AND room.room_id = environment.room_id
GROUP by environment.house_id, house.nickname,
environment.room_id, room.room_name, date_trunc('month', datetime)
```

Different output for plotting- can't figure out:

```
SELECT environment.house_id, house.nickname, environment.room_id,
room.room_name, date_trunc ('month', datetime) "Month",count(*)/(6*24) "Days",
avg(temp_f) WHERE environment.room_id = 1 "Ave LR Temp",
FROM environment, house, room
WHERE environment.house_id = 16 AND environment.house_id = house.house_id AND room.room_id = environment.room_id
GROUP by environment.house_id, house.nickname, environment.room_id, room.room_name, date_trunc('month', datetime)
```

Calculate the thi for a room:

```
SELECT datetime, house_id, room_id, temp_f, rh_pct,
((temp_f) - (0.55 - 0.55*((rh_pct)/100))* ((temp_f)-58)) AS "THI"
FROM environment
where room_id = 1
```

This is the THI built-in function:

```
CREATE FUNCTION thi(double precision, double precision)
RETURNS double precision AS
'SELECT $1 - (0.55 - 0.55*($2/100))*($1 - 58)'
LANGUAGE sql VOLATILE
COST 100;
```

Calculate thi using the built-in function:

```
SELECT datetime, house_id, room_id, temp_f, rh_pct,
thi(temp_f, rh_pct) AS "THI"
FROM environment
```

Here is the funcion for THI over 70:

```
CREATE OR REPLACE FUNCTION thi70(double precision)
RETURNS integer AS
'SELECT CASE WHEN $1 > 70 THEN 1 ELSE 0 END;'
LANGUAGE sql VOLATILE
COST 100;
```

Daniel wrote a subquery that finally works:

```
SELECT sum(gt70),count(gt70) from
(SELECT datetime, house_id, room_id, temp_f, rh_pct,
thi(temp_f, rh_pct), thi70(thi(temp_f, rh_pct))
as gt70 FROM environment) as test
```

To get over over 70 and 75 now:

```
SELECT house_id, room_id,date_trunc ('month', datetime) "Month",
(sum(gt70)/count(gt70)::numeric)*100 AS "Pct THI over 70",
(sum(gt75)/count(gt75)::numeric)*100 AS "Pct THI over 75"
FROM (SELECT
datetime, house_id, room_id, temp_f, rh_pct, thi(temp_f, rh_pct),
thi70(thi(temp_f, rh_pct)) as gt70, thi75(thi(temp_f, rh_pct))
as gt75 FROM environment) as test
GROUP by house_id, room_id, date_trunc ('month', datetime)
```

Solar water heating temp differential controllers

Forest City has several differential controllers

Attachment	Size
Delta_T_DTT-94.pdf	1.35 MB
gl30_install_manual.pdf	262.48 KB
Steca_TR0301_U_instruction_EN.pdf	2.12 MB

Uploading Apollo CSVs

To upload apollo data

Putty into server as usual.
Use SQLshell to input data - select 5433 and fcphase3
See most recent set of scripts in files.

Examples, not necessarily most updated:

For house_id = 1 which as flow rate data:

```
ALTER TABLE apollo ALTER COLUMN house_id SET DEFAULT 1;
ALTER TABLE apollo ALTER COLUMN upload_date SET DEFAULT now();
\copy apollo (datetime, t2, t1, t3, pump_on, flowrate_gpm) from 'C:\Users\Eileen\Desktop\downloads\1_SunReportsData.csv'
ALTER TABLE apollo ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE apollo ALTER COLUMN upload_date DROP DEFAULT;
```

For house_id = 3 which does NOT have flow rate data:

```
ALTER TABLE apollo ALTER COLUMN house_id SET DEFAULT 3;
ALTER TABLE apollo ALTER COLUMN upload_date SET DEFAULT now();
\copy apollo (datetime, t2, t1, t3, pump_on) from 'C:\Users\Eileen\Desktop\downloads\3_SunReportsData.csv' CSV HEADER;
ALTER TABLE apollo ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE apollo ALTER COLUMN upload_date DROP DEFAULT;
```

To look at when solar recirc pump is on:

```
SELECT * FROM apollo
WHERE pump_on = 'TRUE';
```

Uploading Egauge CSVs

Uploading egauge files

- To upload csv's, you have to list the columns in the order they appear in the csv so they go in the correct colum in the database.
- The upload must be done in the PostgreSQL shell, not PG Admin.
- To the add house_id column, you need to not have it in csv and add as a default and delete the default when done.
- Add a timestamp of when data was uploaded so if it was done incorrectly (e.g. you used the the wrong house_id) it can be found and removed easily.
- These commands cannot be word wrapped - you will get an error. If drafting in notepad, turn off word wrap.

To practice:

```
ALTER TABLE energy ALTER COLUMN house_id SET DEFAULT 101;
ALTER TABLE energy ALTER COLUMN upload_date SET DEFAULT now();
\copy energy (datetime, use_kw, gen_kw, grid_kw, ac_kw, fan_kw,
dhw_kw, stove_kw, dryer_kw, solarpump_kw, clotheswasher_kw)
from 'C:\Users\Eileen\Desktop\MP011.csv' CSV HEADER;
ALTER TABLE energy ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE energy ALTER COLUMN upload_date DROP DEFAULT;
```

I practiced uploading bogus data with house__id = 101 and
then deleted the data with:

```
DELETE from energy WHERE house_id = 101;
```

For real energy uploads (from Egauge downloads):

--for MP-01:

```
ALTER TABLE energy ALTER COLUMN house_id SET DEFAULT 1;
ALTER TABLE energy ALTER COLUMN upload_date SET DEFAULT now();
\copy energy (datetime, use_kw, gen_kw, grid_kw, ac_kw, fan_kw,
dhw_kw, stove_kw, dryer_kw, solarpump_kw, clotheswasher_kw)
from 'C:\Users\Eileen\Desktop\MP01.csv' CSV HEADER;
ALTER TABLE energy ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE energy ALTER COLUMN upload_date DROP DEFAULT;
```

--for HMo-01:

```
ALTER TABLE energy ALTER COLUMN house_id SET DEFAULT 2;
ALTER TABLE energy ALTER COLUMN upload_date SET DEFAULT now();
\copy energy (datetime, use_kw, gen_kw, grid_kw, ac_kw, fan_kw,
dhw_kw, stove_kw, dryer_kw, clotheswasher_kw, dishwasher_kw)
from 'C:\Users\Eileen\Desktop\inputfile.csv' CSV HEADER;
ALTER TABLE energy ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE energy ALTER COLUMN upload_date DROP DEFAULT;
```

--for PC-01:

```
ALTER TABLE energy ALTER COLUMN house_id SET DEFAULT 3;
ALTER TABLE energy ALTER COLUMN upload_date SET DEFAULT now();
\copy energy (datetime, use_kw, gen_kw, grid_kw, ac_kw, fan_kw,
dhw_kw, stove_kw, dryer_kw, clotheswasher_kw, dishwasher_kw)
from 'C:\Users\Eileen\Desktop\downloads\3_PC-01_09.30.csv' CSV HEADER;
ALTER TABLE energy ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE energy ALTER COLUMN upload_date DROP DEFAULT;
```

--for RT-01:

```
ALTER TABLE energy ALTER COLUMN house_id SET DEFAULT 5;
ALTER TABLE energy ALTER COLUMN upload_date SET DEFAULT now();
\copy energy (datetime, use_kw, gen_kw, grid_kw, ac_kw, fan_kw,
dhw_kw, stove_kw, dryer_kw, clotheswasher_kw, dishwasher_kw)
from 'C:\Users\Eileen\Desktop\inputfile.csv' CSV HEADER;
ALTER TABLE energy ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE energy ALTER COLUMN upload_date DROP DEFAULT;
```

--for MO-01:

```
ALTER TABLE energy ALTER COLUMN house_id SET DEFAULT 6;
ALTER TABLE energy ALTER COLUMN upload_date SET DEFAULT now();
\copy energy (datetime, use_kw, gen_kw, grid_kw, ac_kw, fan_kw,
dhw_kw, stove_kw, dryer_kw, clotheswasher_kw, dishwasher_kw)
from 'C:\Users\Eileen\Desktop\MO-01_09.30.csv' CSV HEADER;
ALTER TABLE energy ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE energy ALTER COLUMN upload_date DROP DEFAULT;
```

--HO-01:

```
ALTER TABLE energy ALTER COLUMN house_id SET DEFAULT 9;
ALTER TABLE energy ALTER COLUMN upload_date SET DEFAULT now();
\copy energy (datetime, use_kw, gen_kw, grid_kw, ac_kw, fan_kw,
dhw_kw, stove_kw, dryer_kw, clotheswasher_kw, dishwasher_kw)
from 'C:\Users\Eileen\Desktop\downloads\9_HO-08_09.30.csv' CSV HEADER;
ALTER TABLE energy ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE energy ALTER COLUMN upload_date DROP DEFAULT;
```

--HMa-01:

```
ALTER TABLE energy ALTER COLUMN house_id SET DEFAULT 4;
ALTER TABLE energy ALTER COLUMN upload_date SET DEFAULT now();
\copy energy (datetime, use_kw, gen_kw, grid_kw, ac_kw, fan_kw,
dhw_kw, stove_kw, dryer_kw, clotheswasher_kw, solarpump_kw)
from 'C:\Users\Eileen\Desktop\downloads\4_HMa-01.csv' CSV HEADER;
ALTER TABLE energy ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE energy ALTER COLUMN upload_date DROP DEFAULT;
```

--for PH-07:

```
ALTER TABLE energy ALTER COLUMN house_id SET DEFAULT 7;
ALTER TABLE energy ALTER COLUMN upload_date SET DEFAULT now();
\copy energy (datetime, use_kw, gen_kw, grid_kw, ac_kw, fan_kw,
dhw_kw, stove_kw, dryer_kw, clotheswasher_kw, solarpump_kw)
from 'C:\Users\Eileen\Desktop\downloads\7_PH-07_09.30.csv' CSV HEADER;
ALTER TABLE energy ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE energy ALTER COLUMN upload_date DROP DEFAULT;
```

--for PH-08:

```
ALTER TABLE energy ALTER COLUMN house_id SET DEFAULT 8;
ALTER TABLE energy ALTER COLUMN upload_date SET DEFAULT now();
\copy energy (datetime, use_kw, gen_kw, grid_kw, ac_kw, fan_kw,
dhw_kw, stove_kw, dryer_kw, solarpump_kw, dishwasher_kw)
from 'C:\Users\Eileen\Desktop\downloads\8_PH-08_09.30.csv' CSV HEADER;
ALTER TABLE energy ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE energy ALTER COLUMN upload_date DROP DEFAULT;
```

--for OV-01:

```
ALTER TABLE energy ALTER COLUMN house_id SET DEFAULT 16;
ALTER TABLE energy ALTER COLUMN upload_date SET DEFAULT now();
\copy energy (datetime, use_kw, gen_kw, dhw_kw, stove_kw,
dishwasher_kw, microwave_kw, dryer_kw, grid_kw, ac_kw, fan_kw)
from 'C:\Users\Eileen\Desktop\OV01energy.csv' CSV HEADER;
ALTER TABLE energy ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE energy ALTER COLUMN upload_date DROP DEFAULT;
```

Uploading HOBO CSVs

To prepare hobo files

Delete the first column (with 1,2,3 going down) and delete blank column on right to leave off extra comma in csv.

To upload files

You need to be in the PostgreSQL shell to upload (can't do it from PGAdmin).

Uploading justin's hobo from living room (room 1):

```
ALTER TABLE environment ALTER COLUMN house_id SET DEFAULT 16;
ALTER TABLE environment ALTER COLUMN room SET DEFAULT 1;
ALTER TABLE environment ALTER COLUMN upload_date SET DEFAULT now();
\copy environment (datetime, temp_f, rh_pct) from 'C:\Users\Eileen\Desktop\Justin\OV-01_1_LivingRoom.csv' CSV HEADER;
ALTER TABLE environment ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN room DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN upload_date DROP DEFAULT;
```

Uploading justin's hobo from master bedroom (room 2):

```
ALTER TABLE environment ALTER COLUMN house_id SET DEFAULT 16;
ALTER TABLE environment ALTER COLUMN room SET DEFAULT 2;
ALTER TABLE environment ALTER COLUMN upload_date SET DEFAULT now();
\copy environment (datetime, temp_f, rh_pct) from 'C:\Users\Eileen\Desktop\Justin\OV-01_2_MasterBedroom.csv' CSV HEADER;
ALTER TABLE environment ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN room DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN upload_date DROP DEFAULT;
```

Uploading justin's hobo from bedroom 2 (room 3):

```
ALTER TABLE environment ALTER COLUMN house_id SET DEFAULT 16;
ALTER TABLE environment ALTER COLUMN room SET DEFAULT 3;
ALTER TABLE environment ALTER COLUMN upload_date SET DEFAULT now();
\copy environment (datetime, temp_f, rh_pct) from 'C:\Users\Eileen\Desktop\Justin\OV-01_3_bed2.csv' CSV HEADER;
ALTER TABLE environment ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN room DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN upload_date DROP DEFAULT;
```

Uploading justin's hobo from attic (room 4):

```
ALTER TABLE environment ALTER COLUMN house_id SET DEFAULT 16;
ALTER TABLE environment ALTER COLUMN room SET DEFAULT 4;
ALTER TABLE environment ALTER COLUMN upload_date SET DEFAULT now();
\copy environment (datetime, temp_f, rh_pct) from 'C:\Users\Eileen\Desktop\Justin\OV-01_4_ Attic.csv' CSV HEADER;
ALTER TABLE environment ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN room DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN upload_date DROP DEFAULT;
```

Uploading justin's hobo data for outside (room 5):

```
ALTER TABLE environment ALTER COLUMN house_id SET DEFAULT 16;
ALTER TABLE environment ALTER COLUMN room SET DEFAULT 5;
ALTER TABLE environment ALTER COLUMN upload_date SET DEFAULT now();
\copy environment (datetime, temp_f, rh_pct) from 'C:\Users\Eileen\Desktop\Justin\OV-01_5_outside.csv' CSV HEADER;
ALTER TABLE environment ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN room DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN upload_date DROP DEFAULT;
```

Uploading justin's hobo from kitchen (room 6):

```
ALTER TABLE environment ALTER COLUMN house_id SET DEFAULT 16;
ALTER TABLE environment ALTER COLUMN room SET DEFAULT 6;
ALTER TABLE environment ALTER COLUMN upload_date SET DEFAULT now();
\copy environment (datetime, temp_f, rh_pct) from 'C:\Users\Eileen\Desktop\Justin\OV-01_6_Kitchen.csv' CSV HEADER;
ALTER TABLE environment ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN room DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN upload_date DROP DEFAULT;
```

Uploading justin's hobo from garage (room 7):

```
ALTER TABLE environment ALTER COLUMN house_id SET DEFAULT 16;
ALTER TABLE environment ALTER COLUMN room SET DEFAULT 7;
ALTER TABLE environment ALTER COLUMN upload_date SET DEFAULT now();
```

```
\copy environment (datetime, temp_f, rh_pct) from 'C:\Users\Eileen\Desktop\Justin\OV-01_7_Garage.csv' CSV HEADER;
ALTER TABLE environment ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN room DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN upload_date DROP DEFAULT;
```

Uploading justin's hobo from master bathroom (room 8):

```
ALTER TABLE environment ALTER COLUMN house_id SET DEFAULT 16;
ALTER TABLE environment ALTER COLUMN room SET DEFAULT 8;
ALTER TABLE environment ALTER COLUMN upload_date SET DEFAULT now();
\copy environment (datetime, temp_f, rh_pct) from 'C:\Users\Eileen\Desktop\Justin\OV-01_8_MasterBath.csv' CSV HEADER;
ALTER TABLE environment ALTER COLUMN house_id DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN room DROP DEFAULT;
ALTER TABLE environment ALTER COLUMN upload_date DROP DEFAULT;
```

eGauge Documentation

On Oct 16, 2012, David from eGauge Support Team support@egauge.net wrote:

> I attached the XML API documentation as it will apply to v1.2 of the firmware, which we hope to release in a week or two. It has a separate section on push data set up etc.

The document is attached here.

Attachment	Size
egauge-xml-api.pdf	167.41 KB

eGauge Manual

Attachment	Size
egauge2b-manual.pdf	6.4 MB

Energy Simulation

This is the Spring 2012 Whole Building Energy Simulation Course taught by Manfred Zapka, Kim Suman Claucherty, and George Somers Reid. The class covered building science and used Design Builder software for energy simulation. This software uses an EnergyPlus engine but it has a graphical interface.

The class is being offered a second time by Manfred, Spring 2013.

Class Lectures

Design Builder Exercises

Class Lectures

File Attachment:
E_Sim_lectures.zip

Design Builder Exercises

File Attachment:
ESim_DesignBuilder.zip

Maui Smart Grid Project

- Direct Derived Schema
- Initial Derived Schema (deprecated)
- MECO XML Export Data Decomposition
- Homeowner Surveys
- Weather Data
- VPN connection with Silver Springs Networks (SSN)

Data parsing

MECO Data Operations
Sample parsing from Python-based system
Raw data
Sample RegisterData Parse
Sample IntervalReadData Parse

Technical Details

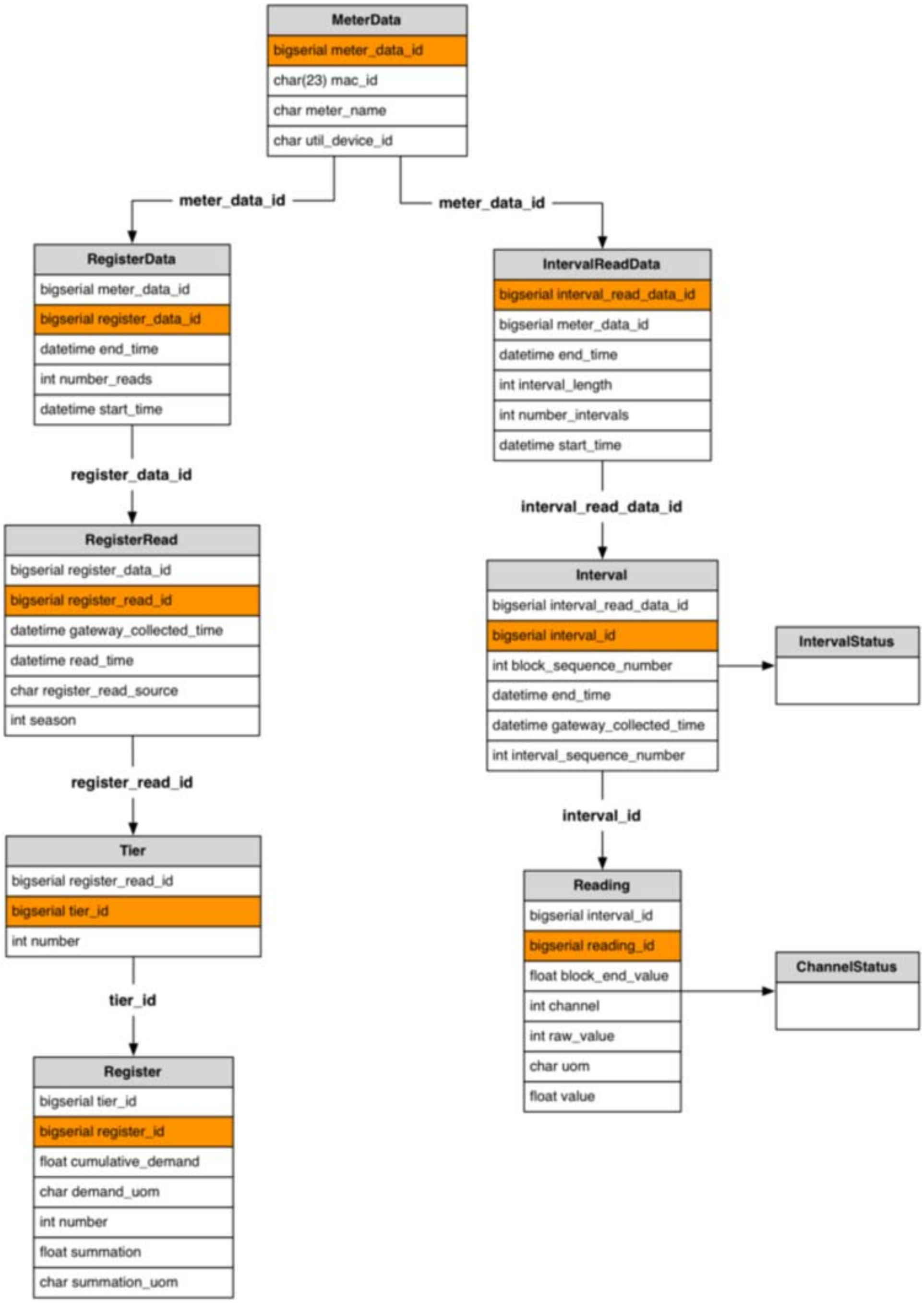
Sequence Ownership
Erase Everything

Progress Reports

Report #1 January 4, 2013

Direct Derived Schema

Image:



Erase Everything

SQL to wipe out MECO data.

```
delete from "Reading";
delete from "Interval";
delete from "IntervalReadData";
delete from "MeterData";
SELECT setval('interval_id_seq', 1);
SELECT setval('intervalreaddata_id_seq', 1);
SELECT setval('meterdata_id_seq', 1);
SELECT setval('reading_id_seq', 1);
SELECT setval('register_id_seq', 1);
SELECT setval('registerdata_id_seq', 1);
SELECT setval('registerread_id_seq', 1);
SELECT setval('tier_id_seq', 1);
```

Homeowner Surveys

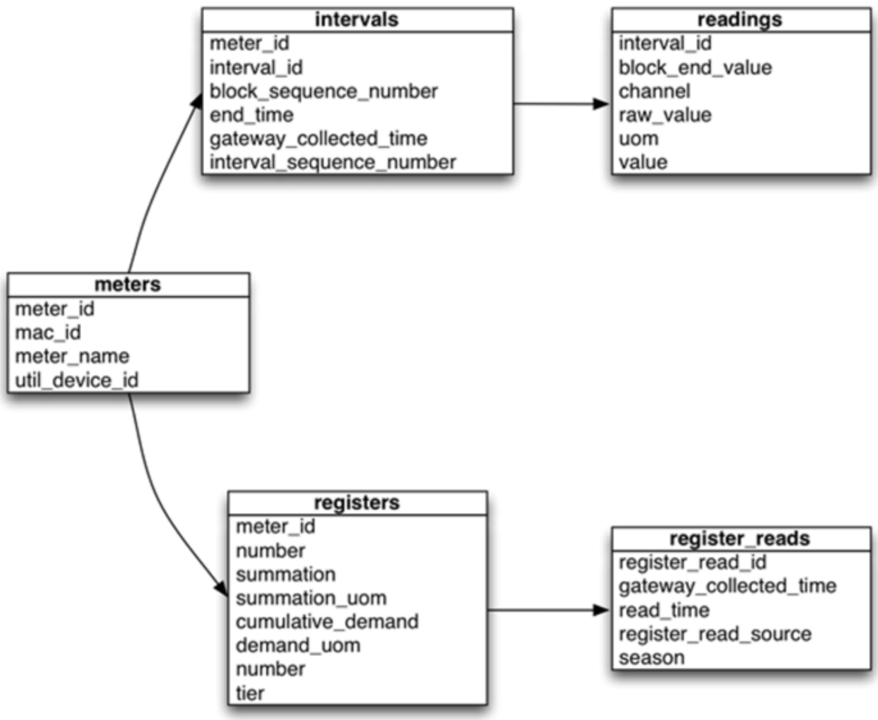
This data is from SLIM at UH Maui (Melanie Stephens and Jennifer Chirico) and Kristin Simeone from MEDB. I received files from Brad Kellaway of Manaolana-international.com on 12/15/12.

File Attachment:
[Homeowner Survey_28521496.pdf]
[Maui Meadows Sign Up-customer master list20120912.zip]

Initial Derived Schema

This image depicts the DB schema derived from the provided XML data.

Image:

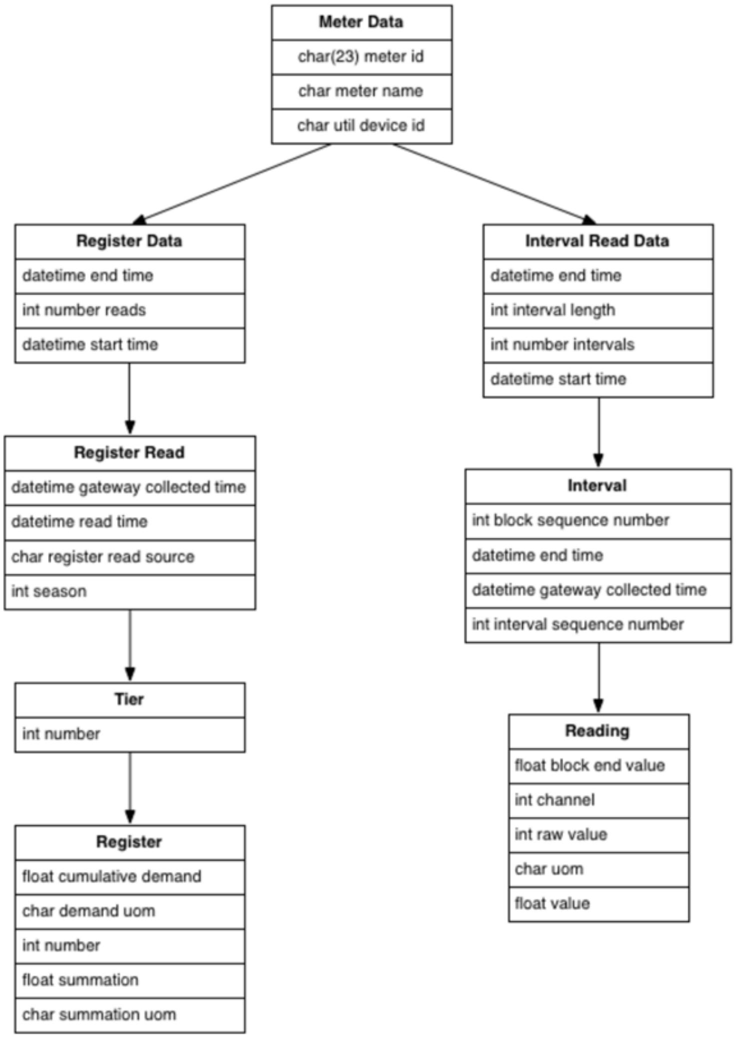


MECO Data Operations

- Implemented in Python 2.7.
- Test suite implemented with unittest framework.
- Parses XML data managed by SSN.
- Inserts data to PostgreSQL database.

MECO XML Export Data Decomposition

Image:



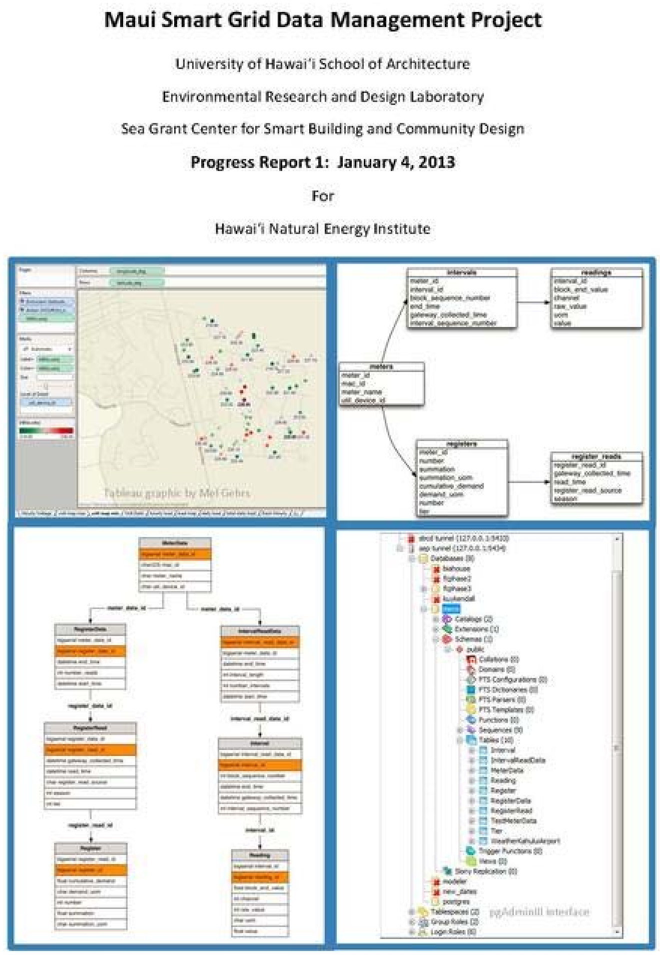
Raw data

Received from Curtis Johnson at SSN.

File Attachment:
[August2012.zip]
[September2012.zip]
[October2012.zip]

Report #1 January 4, 2013

Image:


Maui Smart Grid Data Management Project

University of Hawai'i School of Architecture

Environmental Research and Design Laboratory

Sea Grant Center for Smart Building and Community Design

Progress Report 1: January 4, 2013

For

Hawai'i Natural Energy Institute

File Attachment:
[MSG_ProgressReport1.pdf]

Sample IntervalReadData Parse

IntervalReadData:

```
intervalDataRef = $VAR1 = 'Interval';
$VAR2 = [
          {
            'GatewayCollectedTime' => '2012-08-08T14:15:50.191-10:00',
            'Reading' => [
                           {
                             'Value' => '0.1150',
                             'RawValue' => '230',
                             'BlockEndValue' => '3244.8563',
                             'Channel' => '1',
                             'UOM' => 'kWh'
                           },
                           {
                             'Value' => '0',
                             'RawValue' => '0',
                             'Channel' => '2',
                             'UOM' => 'kWh(rec)'
                           },
                           {
                             'Value' => '0.1150',
                             'RawValue' => '230',
```

```
                          'BlockEndValue' => '2648.9491',
                          'Channel' => '3',
                          'UOM' => 'kWh'
                        },
                        {
                          'Value' => '239.7000',
                          'RawValue' => '2397',
                          'Channel' => '4',
                          'UOM' => 'VrmsA-N'
                        }
                      ],
            'IntervalSequenceNumber' => '6',
            'EndTime' => '2012-08-08T14:00:00.000-10:00',
            'BlockSequenceNumber' => '26'
          },

...

$VAR3 = 'IntervalLength';
$VAR4 = '15';
$VAR5 = 'NumberIntervals';
$VAR6 = '2295';
$VAR7 = 'StartTime';
$VAR8 = '2012-08-08T13:45:00.000-10:00';
$VAR9 = 'EndTime';
$VAR10 = '2012-08-31T00:00:00.000-10:00';
```

Sample RegisterData Parse

RegisterData:

```
registerDataRef = $VAR1 = 'NumberReads';
$VAR2 = '22';
$VAR3 = 'RegisterRead';
$VAR4 = [
          {
            'Tier' => [
                      {
                        'Number' => '0',
                        'Register' => [
                                      {
                                        'Number' => '1010',
                                        'SummationUOM' => 'kWh',
                                        'Summation' => '3260.6217'
                                      },
                                      {
                                        'Number' => '1011',
                                        'DemandUOM' => 'kW',
                                        'CumulativeDemand' => '0.0000'
                                      },
                                      {
                                        'Number' => '1020',
                                        'SummationUOM' => 'kWh(rec)',
                                        'Summation' => '0.0000'
                                      },
                                      {
                                        'Number' => '1021',
                                        'DemandUOM' => 'kW(rec)',
                                        'CumulativeDemand' => '0.0000'
                                      }
                                    ]
                      },
                      {
                        'Number' => '1',
                        'Register' => [
                                      {
                                        'Number' => '2010',
                                        'SummationUOM' => 'kWh',
                                        'Summation' => '0.0000'
                                      },
                                      {
                                        'Number' => '2011',
                                        'DemandUOM' => 'kW',
                                        'CumulativeDemand' => '0.0000'
                                      },
                                      {
                                        'Number' => '2020',
                                        'SummationUOM' => 'kWh(rec)',
                                        'Summation' => '0.0000'
                                      },
```

```
                                    {
                                      'Number' => '2021',
                                      'DemandUOM' => 'kW(rec)',
                                      'CumulativeDemand' => '0.0000'
                                    }
                                  ]
                  }
                ],
            'ReadTime' => '2012-08-09T06:00:51.742-10:00',
            'Season' => '0',
            'RegisterReadSource' => 'REG_SRC_TYPE_TBL23',
            'GatewayCollectedTime' => '2012-08-09T06:01:47.758-10:00'
          },

...

$VAR5 = 'StartTime';
$VAR6 = '2012-08-09T06:00:51.742-10:00';
$VAR7 = 'EndTime';
$VAR8 = '2012-08-30T06:00:08.829-10:00';
```

Sample parsing from Python-based system

Data being prepared for insertion:

```
----------MeterData----------
{'UtilDeviceID': 'util_device_id', 'MacID': 'mac_id', 'MeterName': 'meter_name', '_pkey': 'meter_data_id'}
{'MeterName': '115477', 'UtilDeviceID': '115477', 'MacID': '00:13:50:01:01:40:16:21'}
util_device_id 115477
mac_id 00:13:50:01:01:40:16:21
meter_name 115477
meter_data_id DEFAULT
----------RegisterData----------
{'NumberReads': 'number_reads', 'EndTime': 'end_time', '_fkey': 'meter_data_id', 'StartTime': 'start_time', '_pkey': 'regi
{'NumberReads': '22', 'EndTime': '2012-08-30T06:00:08.829-10:00', 'StartTime': '2012-08-09T06:00:51.742-10:00'}
number_reads 22
end_time 2012-08-30T06:00:08.829-10:00
meter_data_id FKEY_VALUE
start_time 2012-08-09T06:00:51.742-10:00
register_data_id DEFAULT
----------RegisterRead----------
{'Season': 'season', '_pkey': 'register_read_id', 'GatewayCollectedTime': 'gateway_collected_time', '_fkey': 'register_dat
{'Season': '0', 'GatewayCollectedTime': '2012-08-09T06:01:47.758-10:00', 'RegisterReadSource': 'REG_SRC_TYPE_TBL23', 'Read
season 0
register_read_id DEFAULT
gateway_collected_time 2012-08-09T06:01:47.758-10:00
register_data_id FKEY_VALUE
register_read_source REG_SRC_TYPE_TBL23
read_time 2012-08-09T06:00:51.742-10:00
----------Tier----------
{'Number': 'number', '_fkey': 'register_read_id', '_pkey': 'tier_id'}
{'Number': '0'}
number 0
register_read_id FKEY_VALUE
tier_id DEFAULT
----------Register----------
{'Number': 'number', 'CumulativeDemand': 'cumulative_demand', 'DemandUOM': 'demand_uom', 'SummationUOM': 'summation_uom',
{'Summation': '3260.6217', 'Number': '1010', 'SummationUOM': 'kWh'}
number 1010
cumulative_demand NULL
demand_uom NULL
summation_uom kWh
summation 3260.6217
register_data_id FKEY_VALUE
register_id DEFAULT
----------Register----------
{'Number': 'number', 'CumulativeDemand': 'cumulative_demand', 'DemandUOM': 'demand_uom', 'SummationUOM': 'summation_uom',
{'CumulativeDemand': '0.0000', 'DemandUOM': 'kW', 'Number': '1011'}
number 1011
cumulative_demand 0.0000
demand_uom kW
summation_uom NULL
summation NULL
register_data_id FKEY_VALUE
register_id DEFAULT
```

Sequence Ownership

It's critical that sequence ownership be set correctly. Here are the commands for the meco database.

```
alter sequence interval_id_seq owned by "Interval".interval_id;
alter sequence intervalreaddata_id_seq owned by "IntervalReadData".interval_read_data_id;
alter sequence meterdataid_id_seq owned by "MeterData".meter_data_id;
alter sequence reading_id_seq owned by "Reading".reading_id;
alter sequence register_id_seq owned by "Register".register_id;
alter sequence registerdata_id_seq owned by "RegisterData".register_data_id;
alter sequence registerread_id_seq owned by "RegisterRead".register_read_id;
alter sequence tier_id_seq owned by "Tier".tier_id;
alter sequence testmeterdata_id_seq owned by "TestMeterData".meter_data_id;
```

VPN connection with Silver Springs Networks (SSN)

- This is a site to site connection that cannot use a private address.
- We will be purchasing a VPN router.
- The destination address is 74.121.18.81 - we should open a browser on the host and point it to this address.
- Jimmy Chiang at SSN verbally gave us a key - we use the same key on both sides of the connection.

Weather Data

This is from Larry Markel:

Therese sent us the monthly average historical weather data. It is interesting to look at, to assess overall climate characteristics, but this is not what we need.
We wanted hourly weather data. Specifically, we wanted:
• Dry bulb temperature
• Wet bulb temperature
• Solar irradiance
The good news is that the link Therese provided gives the temperature data. I quickly downloaded the November 2012 data, and I've attached it, so you can see that it's available.
(I've copied Eileen, as she will probably want to download the hourly data to the UH data warehouse.)

I want to address 1) what data we want, and 2) where (the locations) we want it from

1) What Data we would like, on an hourly basis
• We want dry bulb (air) temperature
• We probably want wet bulb (relative humidity)
• Chris Reynolds said that MECO has a "weather index variable" they use for short term forecasting. This includes humidity-related characteristics. I would like to know what that index is (i.e., how is it calculated, based on dry bulb, wet bulb, wind, solar, etc.), and I'd like to know if MECO has the historical values of this. By "historical," I mean hourly 9or 3-hourly, whenever MECO updates their weather index. If it's more often than hourly, we'd like hourly). If MECO doesn't save the weather index, then we should ask if they could begin to save it now and transfer it (flat file0 on a weekly basis to Eileen.
• Solar irradiance

2) Locations:
• Kahului airport (we have this via NOAA, except for solar)
• Chris Reynolds said MECO has a weather station at the Kihei sub, reporting via the SCADA system. from that, on an hourly basis, we would like:
o Dry bulb
o Wet bulb
o Irradiance, or whatever solar variable is measured
• Our understanding is that there is an NREL weather station in the Wailea sub. From NREL we would like to obtain, via a flat file transfer, on a weekly or monthly basis:
o Dry bulb
o Wet bulb
o Irradiance, or whatever solar variable is measured

I have also attached my memo on substation equipment, as I am suggesting we install a small PV panel and a pyranometer in the Wailea sub, and we would want to obtain that data, too

---

This information is from Therese Klaty at Maui Electric (therese.klaty@mauielectric.com):

We use the Quality Controlled Local Climatological Data (QCLCD) for Kahului Airport from this site:

http://www.ncdc.noaa.gov/land-based-station-data/quality-controlled-loca...

We use this site to get rainfall data for other locations:
http://www.prh.noaa.gov/hnl/pages/hydrology.php

The QCLCD data needs some work before it can be uploaded to postresql:
- The header is 8 lines.
- The date and time are separate columns and the time is in a strange format.

File Attachment:
KahuluiQCLCD_2012_08to11.zip

UHM Campus Energy

Energy reporting

- EPA Energy Star
  https://www.energystar.gov/istar/pmpam/index.cfm?fuseaction=login.loginE...
  portfolio account name: CSBCD2012.
  Check with Eileen for password.
- Better Buildings Challenge BBC portfolio account name: DOE-BBC-Hawaii uses EPA login

Background:
EPA portfolio manage was started by Dave Hafner (former asst vice chancellor for facilities), Denise Konan and a grad student of Denise's (old portfolio was named dhafner). Eileen's former student, Justin Witty, updated it in 2012 but he thinks there are some discrepancies. Justin's updated portfolio is called CSBCD2012.

Facilities Contacts:

- Stacy Inouyi at Facilities has all the utility billing data 956-5240 and sinouye7@hawaii.edu
- Allan Sawai has some PV data 956-4093.
- Blake Arakaki would know about the AC loop.
- Dennis Kamite and Mark Nishimoto would know the most about what meters measure what buildings.
- Edwin Espina and Steve Leong are the meter readers.

BBC contacts are:

- Monica Neukomm, Department of Energy, monica.neukomm@ee.doe.gov, 202-287-5189; she's the head, she lets the other guys handle the contacts.
- Rahul Young Rahul.Young@icfi.com was contacting me in 2012.
- Brian Carroll brian.carroll@icfi.com 703.934.3253 is contacting me in 2013.

Campus PV Data

Campus PV Data

PV on campus – as of 9/11/12

Shidler

Installed 3/5/2009, I could access monthly data and entered into spreadsheet
https://www.sunpowermonitor.com/residential/kiosk.aspx?id=53CF1BCA-13C1-...

Saunders

I don't have access to download data or reports, Justin tried to contact Dave Nixon, no response.
Installed 8/9/2009, 5 panels with microinverters, installed by Hawaii Energy Connection LLC
http://www.publicpolicycenter.hawaii.edu/solaronsaunders.html

Sinclair Library

Alan Sawai trying to get me access to this

PBRC

Alan tried to get me access to this

Holmes Hall

contact Tony Kuh and Dave Garmire

C-MORE

Steve Poulos at C-MORE is having trouble with the network interface so he doesn't have a log of data, just a total produced.
8.16 kw system installed, info from Steve:
Universolar From Kauai did the Installation
We have 60 Unisolar Panels - each PVL-136 - Watt (these are roll down stick on type of panels)
SMA Sunny Boy 7000 US Solar Inverter

It was officially hooked up and turned on 8 June 2011

It has an RS485 interface that I have been attempting to
setup as a real-time readout from the web (purchased a RS485 serial
to network interface module, but so far my conversations with
the SMA Engineers have not solved problem) - so far still
on my list to be completed...

Info as of today 9/11/12:
Accumulated E-Total 18830 kW hrs Accumulated hours online - 5526hrs
(since turn on or installation)
Today 42.52kW as of 4:15pm
Its readout says: 32010 lbs of CO_2 saved
At the moment of reading - it was generating 4335 watts