# RESIDENCE LIFE RETRO-COMMISIONING

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## 6.1 Introduction

With each passing year, Chapman University's student population continues to grow. This rising influx of new first year students residing in the residence halls plays a big role in understanding and managing resource consumption. Residence halls are in constant use year round and include a significantly higher amount of bathrooms and showers than the rest of Chapman University's campus. Additionally, residence halls include the cafeteria, which requires a high-energy input to maintain functionality. The residence halls combined use roughly 16% (about 6,000,000 KWh per year) of Chapman's overall energy (see **Figure 6.1**), and about 40% of Chapman's overall water (see **Figure 6.2**), making it an important component of this audit.

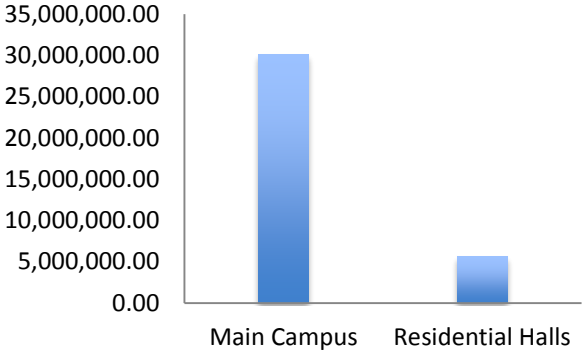


***Figure 6.1** Energy use (KWh) comparison in year 2014 between Main Campus and Residential buildings.*

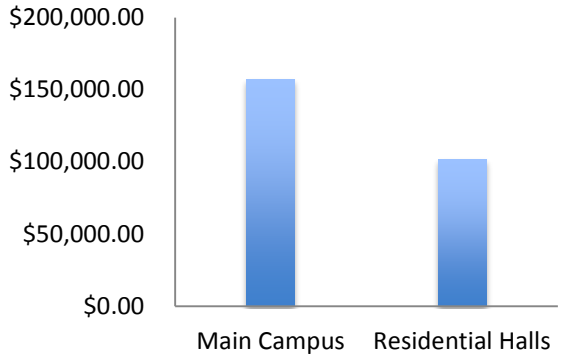


***Figure 6.2** Water cost comparison in year 2014 between Main Campus and Residential buildings*

This section of the Chapman University 2015 Energy and Building Construction Audit will investigate previous retro-commissioning projects deployed in the Residence halls both on Chapman University's campus and other college campuses. Additionally this audit will make suggestions on future dormitory projects that will reduce energy consumption and increase sustainability on campus. It is in Chapman's best interest to reduce energy consumption for financial and sustainability reasons. The main goals of this chapter are as follows:

- Up-to-date energy use information in residential buildings
- Evaluating how much energy the Telkonet system can save if it is installed in all eligible residential halls
- Exploring energy efficient ways to remodel South Morlan
- Reviewing Chapman's current residential energy saving practices
- Identifying areas of high-energy consumption and making recommendations for change

## 6.2 History of Residential Buildings at Chapman

### *6.2.1 Overview*

Retro-commissioning and retrofits compliment each other because both seek to improve the appliances and building systems in order to increase energy efficiency. See Chapter 5 for in depth information on Residence Life Retrofits. Where the two differ is instead of replacing light fixtures or PTAC units through retrofits, retro-commissioning (RCx) rather optimizes the building's overall operations and maintenance; in essence fixing what is already present. This means focusing on how exactly mechanical equipment, lighting and related controls operate and how these systems function together. Some examples may include improving the efficiency of the HVAC unit or sealing the ducts for better airflow. In the past, not many projects have been accomplished in the dorms in terms of RCx, which leaves a lot of room for future retrofits and retro-commissioning projects.

### *6.2.3 Historical Energy, Gas, and Water Usage*

The 2013 Audit compiled campus-wide energy, gas, and water usage for the first time, but the three different utilities were not analyzed in the scope of residential buildings. **Table 6.1** shows residential area energy, gas, and water usage in kilowatts per hour (KWh), therms, and hundred cubic feet (hcf), respectively. Despite the increase in students from 2012-2013 to 2013-2014, the usage in all three utilities has decreased. Reasons for this can be attributed past accomplishments

**Table 6.1** Residential energy, gas, and water usage from 2011-2014.

| Academic Year | Energy Usage (KWh) | Gas Usage (therms) | Water Usage (hcf) | Residential Student Count |
|---|---|---|---|---|
| 2011-2012 | 4956294 | 191672 | 35617 | 1927 |
| 2012-2013 | 5018500 | 180049 | 38862 | 1883 |
| 2013-2014 | 4936254 | 167730 | 37471 | 1953 |

Another important unit of measure to consider is the cost of each of these utilities. **Figure 6.3** compares the energy, gas, and water cost from 2011-2014 in residential buildings. This figure indicates that the energy bill is in fact where Chapman University should be focusing their sustainable efforts considering it is the most costly. It should also be noted that although energy and gas usage decreased (reference **Table 6.1**) this decrease does not necessarily translate to decreases in utility costs as depicted in the figure below. Because the cost of the utility is out of the university's control, it is essential to manage and cutback utility usage to buffer any possible inflation in costs.

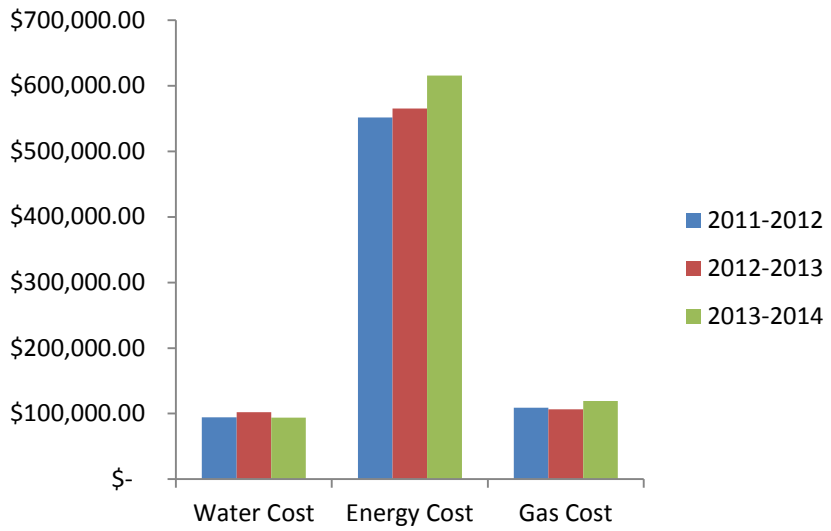


***Figure 6.3*** *Energy, gas, and water cost comparison from 2011-2014*

### *6.2.4 Past Accomplishments*

In 2012 recirculation pumps were installed in all dorms except Davis, saving gas and thus energy. **Figure 6.4** shows the gas usage pre and post installation of recirculation pumps. Gas is used to heat water in all the residential halls on campus. Since the addition of recirculation pumps water is only heated when it is called for instead of all the time. Overall there is a downward trend, which reaffirms the importance of recirculation pumps and managing gas usage. In the summer of 2014 low flow showerheads were installed universally in the residential halls. Additionally 50+ low flow toilets were installed and there is a systematic plan for replacing old toilets with new low flow units. These retrofits not only reduce water consumption but further decrease gas and energy consumption too. This is because energy is needed to both pump and heat the water (Blett, Turgeon, & Wilson, 2011). Furthermore, the low-flow showerheads require a lesser amount of water to be heated. These three significant retrofits have resulted in a 12.5% decrease in gas usage (since 2012). Although, these retrofits have helped reduce all three utilities, there lacks progress in substantially reducing energy consumption. The next section will explore various systems in the residential halls that can be improved through RCx projects to further reduce energy consumption.

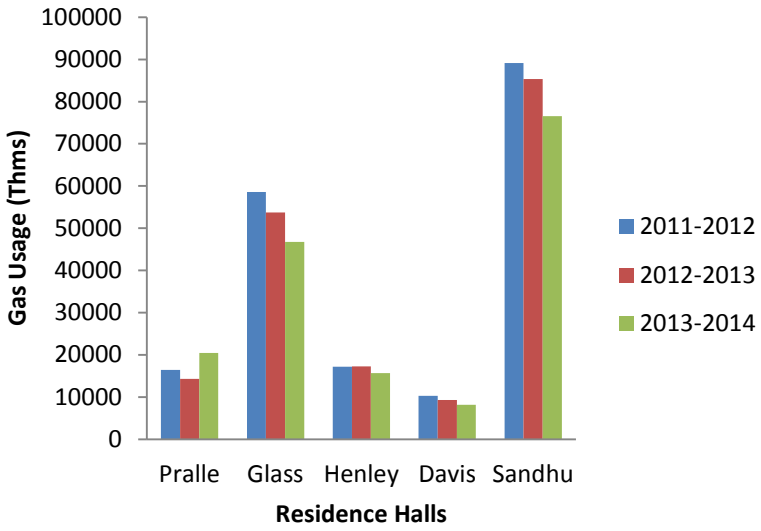


***Figure 6.4*** *Dorm gas usage by residence hall from 2011-2014.*

## 6.3 Current Status of Residential Buildings at Chapman

### *6.3.1 Overview*

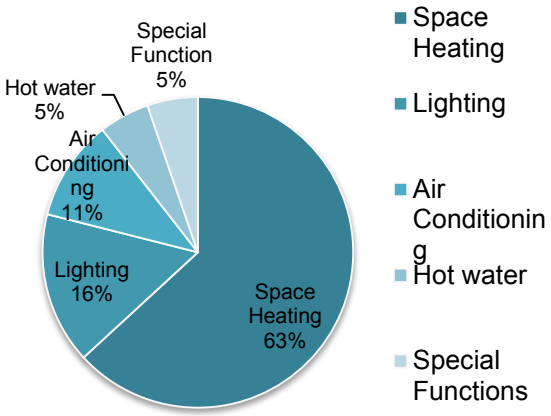


***Figure 6.5*** *Energy distribution in residential buildings.*

While the 2013 Audit analyzed energy usage on Chapman University's campus from a broad perspective and the 2014 Audit analyzed water usage in depth within residential buildings, this chapter focuses on evaluating the mechanical systems within the residential buildings and recommending improvements through retro-commissioning. By doing so, systems that use the most energy can be targeted as high priority projects. In **Figure 6.6** the USA gov estimated energy distribution is illustrated, highlighting the large percentage of energy that HVAC systems require (74%). (HVAC Optimization)

### *6.3.2 HVAC and Telkonet*

HVAC units are one of the biggest sources of energy consumption, usually accounting anywhere between 17-49% of the average annual electricity bill. In summer months, this number can rise to over 50%. (HVACOPTIMIZATION) With 847 separate rooms in the dorms and roughly 659 individual air conditioning units, Chapman could benefit greatly by investing in an efficient HVAC system. Fortunately, a very promising project has just begun called Telkonet that streamlines the individual heating and air conditioning units present in each dorm room. This system connects and controls individual packaged terminal air conditioners (PTAC) units, located in each room to a central control system, using thermostats and occupancy sensors. This way, baseline temperatures can be set and when rooms are left unoccupied the PTAC units will either shut off or set back to conserve energy. Over spring break, 57 EcoWave Thermostats and EcoSense Occupancy Sensors were installed in the Pralle-Sodaro Hall. There are still 25 eligible units in Pralle-Sodaro hall and 41 eligible units in Henley. So far, after 37.53 days of installation there were a savings of 1804.23 hours of runtime, 2333.49 electric consumption (kWh), and $350.02. **Figure 6.6** was pulled directly from the Telkonet report and indicates that since the installation, there has been a 20% savings. It is difficult to estimate savings based on this figure because the system has only been in place for 37 days. But based on the case study found in section **6.3.3** Chapman can expect

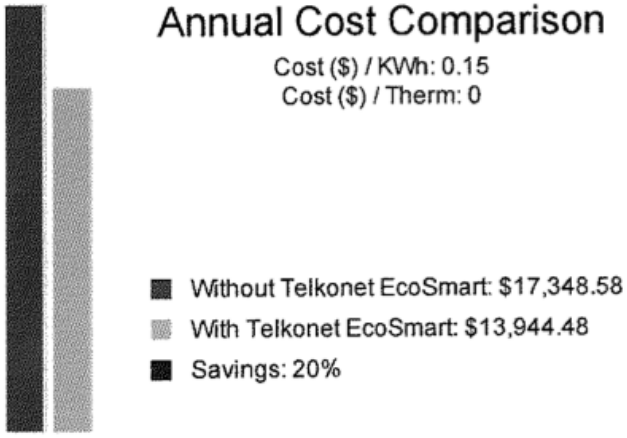


***Figure 6.6*** *Projected annual savings from Telkonet software*

a 20-32% decrease in runtime and a visible return on investment especially once the summer months hit. **Table 6.2** highlights the cost of installing Telkonet throughout the rest of Pralle, Henley, and Glass. As mentioned earlier, not all existing units are eligible. In the table below, an Amana unit is considered eligible for Telkonet while a non-Amana unit must be replaced or fitted with a relay board in order to work.

**Table 6.2** Estimated cost of Telkonet installation in residential buildings

| Residence Halls | Details | Cost | Cost per room |
|---|---|---|---|
| Pralle Hall | Install Telkonet on remaining 25 Amana rooms | $14,111 | $565 |
| Pralle Hall | Install on remaining 104 rooms (25 Amana/79 non Amana with relay board) | $62,581 | $602 |
| Henley Hall | Install Telkonet in all 161 rooms plus full network (41 Amana/120 non Amana with relay board | $103,605 | $644 |
| Glass Hall | Install Telkonet in all 192 rooms plus full network (192 with relay boards) | $128,266 | $668 |
| Window sensors | Material and labor included | | $75-100 |

### *6.3.3 Case Study at NYU – Maximizing Dorm Energy Savings with Intelligent HVAC Controls*

New York University Sustainability team wanted to install an intelligent HVAC control system because they realized that close to 49% of their energy consumption was due to space heating and air conditioning. This case study was chosen because it mimics the current Telkonet project occurring in Pralle-Sodaro hall, except NYU is doing so on a much larger scale. Additionally, both projects were implemented in Residence Halls as opposed to commercial buildings, so statistics should translate due to similarities of University housing. (Anderson, 2011)

Challenges faced prior to installation similar to Chapman University challenges:

- Students leaving room and neglecting to shut off or adjust set point
- Impossible to manually monitor dorm room temperature
- Increasing ‘green’ mindset on campus does not always translate to green action
- Continued rise in utility rates
- Differing HVAC types

Solutions and benefits of Telkonet system:

- Reduce wasted heating and cooling
- Lower utility expenses
- Improved controls for students
- Ability to set campus wide set-point ranges
- Limit student impact
- Maintainability
- Return on investment
- Remote confirmation of thermostats

NYU installed occupancy base HVAC controls (Telkonet Smart Energy System) in 11 different residence halls, totaling 4,629 units. This allowed for controlling runtime when room was left unoccupied, imposing limits on maximum and minimum temperatures, less maintenance, comfort increased, and lowering peak demand. NYU's project resulted in a 20-32% reduction in HVAC runtime and a return on investment in 24-36 months.

**Table 6.3** Telkonet installation cost, savings, and simple payback at NYU

| | Total Installation Cost | Total Savings per Year | Simple Payback |
|---|---|---|---|
| **NYU** | ~$1.9 million | ~$650K | 2.9 years |

### *6.3.4 Metering*

When considering energy usage and management its extremely important to be able to differentiate and target certain buildings that use more energy than others in order to help reduce costs. Currently, Henley, Pralle-Sodaro, Glass, and Sandhu are sub-metered, but unfortunately South and North Morlan are clumped together. Davis and Harris are on entirely separate meters. With future plans of redoing South Morlan's mechanical systems, lighting, and plumbing fixtures, it would be essential to add a meter to differentiate the energy use between South and North Morlan. Fortunately, the funding for this project was just approved and plans for installation are set for the summer of 2015. If the appliances put into the soon-to-be remodeled South Morlan are energy efficient, South Morlan can be used similarly to a case study in order to project potential energy savings across the rest of the residential halls if comparable energy saving systems are installed.

One particular issue present amongst the sub metered residence halls is Sandhu. This is because Sandhu not only contains dorm rooms, but also runs on the same meter as the cafeteria. This makes it difficult to calculate for the sustainability team to track the energy, gas, and water usage of its residents. This would then allow the residents to participate in competitions such as the ecolympics and would provide enhanced energy consumption data.

The benefit to investing in improved meters is that although they may not have a direct return on investment, they require little to no maintenance and no additional staffing. Additional meters also provide the maintenance team and sustainability team a wealth of knowledge when it comes to evaluating and pin pointing Chapman University's high areas of energy consumption.

### *6.3.5 Lighting*

Lighting accounts for roughly 16% of total energy use in a residential building as shown in **Figure 6.5.** This makes reducing lighting energy consumption yet another key component to the 2015 Audit. Similar to PTAC units, lighting is controlled by each individual as opposed to a central system, which can create challenges in reducing Chapman's overall energy consumption. Two ways to combat these challenges is through reducing operation time and increasing the energy efficiency of each lighting fixture through retrofits. Please see Chapter 5 for a more in depth analysis on lighting retrofits in the residence halls.

### *6.3.6 South Morlan*

One of the most exciting projects planned this coming summer is the remodeling of the South Morlan residence hall, originally built in 1963. With this remodeling plan lies an opportunity to equip to the dorm rooms with the most energy efficient technology and energy saving systems. Additionally, with the new funding for an individual South Morlan sub meter, Chapman can track the savings post retrofit in order to project future savings if these systems were to be installed in other residence halls. South Morlan can be seen as green pilot project and aide the potential installation of sustainable systems into the dorms. The sub meter will track the data and savings that green building can accomplish and hopefully create a larger eco-conscious environment on Chapman University's campus. Please see Chapter 1 for a more in depth information on LEED EBOM and ways to make our campus more sustainable through building construction.

## 6.4 Conclusions/Characterization

### *6.4.1 Areas of Progress*

Chapman University has just begun to make big jumps forward in reducing their overall energy and water consumption. With the California drought worsening, taking measures to reduce our overall consumption is critical in not only reducing our utility bills but also our carbon footprint. With the recent addition of Telkonet, Chapman should see a substantial decrease in energy consumption, especially once Telkonet is installed in more residence halls. Water and gas consumption are projected to keep decreasing as more low flow toilets are installed and drought awareness is increased. To further reduce water consumption native gardens are being planted as a result of the 2014 Audit.

### *6.4.2 Areas in which to improve*

One of the biggest challenges that Chapman University faces is creating behavior change on campus within the student body and the culture of Chapman. Although the survey suggested students would like to see increased sustainable efforts in the residence halls and on main campus, there still remains a disconnect that is not reflected by their actions. For example, leaving the air conditioning or lighting on when leaving their room. Regardless of how many retrofits and RCx projects are deployed on campus, if the student body does not understand the new technology or embrace the changes made the maximum potential savings will not be achieved.

Another area in which to improve is to fully invest in systems like Telkonet. The reason NYU saw such a big ROI and short simple payback period is because they installed Telkonet universally throughout their residence buildings. The more Chapman invests in energy efficient systems now the more money they will save in the long run.

### *6.4.3 Existing gaps in knowledge*

Thus far, there is not enough data on the saving potential of Telkonet on Chapman University's campus. Because it has only been running for just over a month its difficult to project the savings that Telkonet could have if installed in all residential buildings. Furthermore, South and North Morlan are not on their own meter so calculating their energy consumption may not be exact.

Another knowledge gap is differentiating the energy and water consumption in Sandhu between the cafeteria and dorm rooms. This would enable the Sandhu residents to participate in Ecolympics with exact data.

## 6.5 Recommendations

### *6.5.1 Low cost/effort*

Most of the RCx recommendations for the residence buildings are not low cost. But one way to amplify savings is to help the students' understand the new systems being installed into their rooms. One low cost recommendation is creating a one-time program that informs students what the Telkonet system does and in what ways they can make these systems more effective.

### *6.5.2 Moderate cost/effort*

One moderate recommendation that has already been approved is to install a sub-meter on South Morlan. The benefit with meters is that although they are pricey upfront, they require little to no maintenance after installation. They also provide a wealth of knowledge when it comes to managing energy consumption. This is especially important considering South Morlan will be remodeled and hopefully equipped with the best energy efficient systems and appliances.

### *6.5.3 High cost/effort*

Lastly but most importantly is the high cost recommendation to install the Telkonet system throughout all eligible residence halls. What makes a residence hall eligible is whether or not they have individual PTAC units or a central HVAC system. If they have individual units, Telkonet can be installed and thus a central system can manage and store information on HVAC usage. This makes Pralle, Henley, Glass, and South Morlan eligible. This system is expensive to install, especially when PTAC units are not up to date, but once it is up and running throughout multiple residence halls the savings will be tremendous.

### *6.5.4 Future areas of research*

Future areas of research include installing meters that publish energy, water, and gas consumption so that students living in those residence halls can monitor their personal consumption and carbon footprint. This would also contribute to eco awareness and behavior change.

Another area of residence halls that should be analyzed is the Randall Dining Commons (cafeteria). They are grouped under the Sandhu meter because technically they are part of the same building. This makes it difficult to pinpoint ways to reduce consumption.

Lastly, future research should be done on Telkonet potential savings. Hopefully, Pralle-Sodaro hall will be completed over the summer and future research can analyze the savings over longer periods of time.

## 6.6 Contacts

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