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The Business Value of Buildings, an Exploratory Study

Morgan J. Westbrook
University of Colorado at Boulder, morgan.j.westbrook@gmail.com

THE BUSINESS VALUE OF BUILDINGS

AN EXPLORATORY STUDY

by

MORGAN J WESTBROOK

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Department of Architectural Engineering

Matthew Hallowell

Nathalie Moyen

Date_____

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The Business Value of Buildings, An Exploratory Study

Thesis directed by Associate Professor Matthew R. Hallowell

This paper examines current methods for determining the value associated with building investments. The purpose of this research is to model the current practice of value creation as it applies to buildings. Specifically, the research aims to explore how agents of value deliver financial returns from building investments. Analysis of interviews with current decision makers shows a Simple Payback analysis to be the determining factor for most decisions. Along with exploration into current practice, this thesis presents a potential model, developed with a group of both industry and academic members, for building valuation that incorporates a more holistic view of building investment decisions. While confirming common assumptions related to finance, this paper provides a starting point for further exploration into how decisions about buildings are made, and how to influence those decisions in the future.

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Chapter 1: Introduction

1.1 Why is this important?

"People in developed countries/regions spend more than 90% of their time indoors in homes, offices, schools, vehicles, airplanes, etc." (Li et al. 2007, p.3) Anyone who spends their days working with buildings knows how often building systems have to be maintained, replaced, or even upgraded. Given a building's importance in the daily life of the average American, the value of a building has become more important over the last few decades. This project seeks to understand how owners, investors, and decision makers consider the value of a building, whether that is the financial return on investment or the impacts the building has on the environment and people that it interacts with, or some combination. By examining current literature and working with industry professionals this research established a baseline for how buildings and building systems are currently being valued and a proposed framework for determining building value in the future.

1.2 Existing Valuation Methods

Simple Payback, Life Cycle Cost Analysis (LCCA), and Total Cost of Ownership (TCO) are all methods for determining the value of a building or building system. Simple Payback is concerned only with the financial value of the investment. LCCA and TCO begin to consider other factors, such as environmental impact. While LCCA is used to value a single building system, TCO can be utilized to value an entire building. Each of these concepts and their parts in the evolution of Building Value will be explained in more detail in Chapter 2.

1.3 Research Objectives

The purpose of this research is to first develop a definition of Building Value based on existing valuation methods and other literature on the subject. After the definition of Building Value will follow the identification and defining of key terms for the development of a more comprehensive valuation framework: *investment, agent,* and *benefit.* These are terms and concepts developed during structured discussion with industry professionals. These discussions will work to answer the questions:

- how to buildings deliver business value?
- what qualifies as an investment?
- what qualifies as an agent?
- what qualifies as a benefit?

This research will also work to document the current state of practice via case studies related to specific building system projects. This documentation will include Building Value as it is currently estimated, as well as the existence and use of various data sources that may be useful in further work on Building Value. Specifically we will answer the question: *how do current industry professionals consider the value of a building system investment?*

Through examining literature and conducting case studies about building value, it is possible to identify gaps in current knowledge. It is also easier to bring together dispersed research from throughout the building industry to develop a comprehensive Building Value framework to incorporate more aspects of a building and be easier to use than some of the established models. During exploration of literature it was discovered that a fair amount of research on the effects of lighting and HVAC systems is available. By limiting case studies to these types of projects more depth of knowledge can be achieved. Working with industry professionals on valuation framework development and establishing a baseline to start from a baseline this research will gather enough evidence to begin the process of creating a new valuation model for the building industry.

Chapter 2: Literature Review

2.1 Assessing the Business Value of Buildings

In the late 1980s, a few researchers began to explore the use of economic principles when estimating construction costs in buildings. For example, Carr (1989) produced a document providing a high-level outline of the proper methods to use when cost estimating. He notes the importance of including both direct and indirect costs, and concisely describes the necessary levels of detail and completeness of financial data needed for projection. These combined costs were considered in conjunction with the expected payback period of the investment, defined as the time-period over which the expected returns entirely cover the costs of the investment (Lefley 1996). Although useful, this method is limited because it fails to consider benefits that remain after the payback period (Lefley 1996).

Since Carr's (1989) payback-period model, more complex approaches have been proposed. These include Life Cycle Cost Analysis (LCCA) and Total Cost of Ownership (TCO) methodologies. Each has been explained in more detail in the following sections. It is important to note that the 'payback-period' method is the most simplistic, LCCA is generally used for one-time decisions, and TCO attempts to aggregate the results of multiple decisions. Finally, both TCO and LCCA focus on the costs associated with an investment rather than the benefits returned.

2.1.1 Life Cycle Cost Analysis

The Federal Energy Management Program defines Lifecycle cost analysis (LCCA) as, "an economic method of project evaluation in which all costs arising from owning, operating, maintaining, and ultimately disposing of a project are considered to be potentially important to that decision." (Fuller and Peterson 1996). LCCA is a combination of both the Life Cycle Cost (LCC) approach and the Life Cycle Analysis (LCA) approach, where LCC economically compares investment alternatives (Norris

2001) and LCA compares the environmental performance of investment options (Norris 2001). LCCA brings these concepts together to create a method to analyze both the cost-effectiveness and environmental performance of decision alternatives simultaneously.

LCCA is often used to predict the lifetime costs of investment alternatives so that a decision maker can choose the option with the lowest cost over the alternative's lifespan that still meets quality and performance expectations (Fuller S. 2006). LCCA considers all costs associated with purchasing and operating a building component including the materials used in production, maintenance, energy consumption, cost of disposal at the end of life, and all other costs. One of the key aspects of LCCA is time (Norris 2001; Fuller and Peterson 1996; Fuller S. 2006). As a LCCA requires the inclusion of a variety of factors related to the cost of a decision, it is an extremely flexible model. Inherently, this can make a LCCA model difficult for a company to implement because there is no single application. However, customization also makes LCCA an invaluable tool that can be tailored to best suite a particular situation (Durairaj et al. 2002).

2.1.1.1 American Society for Testing and Materials

The American Society for Testing and Materials (ASTM) produced a standard practice for the application of LCCA to buildings and building systems in Practice E 917-15. In this practice, LCCA considers cost from the design phase to the eventual disposal of the investment over a given time period This can include purchasing, leasing, construction, operation, repairs, and any other costs relevant to the investment. (ASTM International 2015).

The Practice indicates that the implementation of a LCCA model requires that more than one option be available for consideration, allowing for a comparative analysis. In most cases related to this

study, a decision will be made between two different building design alternatives (e.g., upgrade options to HVAC). In some cases, the 'do nothing' alternative may also be considered.

When performing LCCA, a time period must be selected that encompasses the lifespan of the building, system, or organization. By evaluating costs throughout this time period and converting them to a net present value, it is possible to determine a singular estimate of the financial costs of an investment alternative (Durairaj et al. 2002).. On a theoretical level, Life Cycle Cost in present value can be calculated with the following:

$$PVLCC = \sum_{t=0}^{N} \frac{C_t}{(1+i)^t}$$

C_t = the sum of all relevant costs occurring in year *t*,

N = length of study period, years, and

I = the discount rate

ASTM E917-15 provides clear examples of this financial analysis and suggests methods for determining how to handle uncertainty. While LCCA is a quantitative analysis, there is an expectation that qualitative data should also be considered to ensure that all costs are considered. Expectations for such reporting can be found in ASTM E917-15. Case study examples have been provided in the standard to show the method used in context.

LCCA does have some notable limitations. It is not a method recommended for use among non-mutually exclusive investment alternatives (Fuller and Peterson 1996). Attempting to use this methodology on alternatives that are not mutually exclusive invalidates the found predictions, undermining the process of a LCCA. Attempting to compare non-mutually exclusive alternatives prevents

the true benefits of each alternative from being isolated for an accurate comparison. It is also not recommended for analysis of investments that would produce differing revenue streams or other benefits. In the case of alternatives that produce differing benefits there are more robust methodologies available, such as payback methods and net benefits. (ASTM International 2015)

2.1.2 Total Cost of Ownership (TCO)

Total Cost of Ownership (TCO) is a method of evaluating the cost of an item, similar to LCCA, but in the context of the network of systems that it is associated with. Typical considerations include factors other than the capital necessary to acquire the product. TCO encompasses costs included in a typical LCCA like procurement, maintenance, warranty and the costs associated with use (Ellram 1993). However, unlike LCCA, the comparisons made during a TCO analysis are not made in isolation, they are made with consideration of the building system's place within the greater context of the entire building in which it operates. TCO also differs from LCCA in that it requires the user to evaluate tradeoffs in terms of a dollar value, even qualitative costs such as improved mood or communication. TCO is made up of three areas: Pre-transaction Components (such as Identifying Need), Transaction Components (such as Inspections), and Post Transaction Components (such as Repair/Replacement) (Ellram 1993). In this way, again, it is similar to LCCA.

Almost a decade after Ellram (1993) introduced the concept of TCO, Ferrin and Plank conducted a survey study of the implementation of TCO in organizations to determine the extent of its use among supply chain managers. Responses indicated that most organizations used some forms of TCO although some used the method informally and occasionally. The implementation of TCO is acknowledged to be difficult (Ferrin and Plank 2002) because it requires a complete departure from traditional cost tracking philosophies (Ellram 1993). Nevertheless, TCO became pervasive in the technology sector by the late 2000s (Kim and Sohn 2009; Koomey et al. 2008). Within the technology and manufacturing sectors the

acquiring of products, flow of work, and interaction of systems is often linear. Due to this inherent structure TCO in these industries requires less intense data collection and a smaller matrix of systems than one might expect in the building industry.

TCO has not yet seen widespread use in the building construction industry. This is perhaps due to the diversity of materials, suppliers, owners, and other transactions that are associated with buildings. Building owners must consider a vast array of investments such as large-scale materials like concrete, mechanical components like HVAC systems, and delicate items like art and finishes. These investments also must be considered over a relatively long timeframe with dynamic occupants. Although the concept of TCO has been discussed by industry organizations (e.g., APPA) (APPA 2017), it is considerably wieldier to implement properly in this new context. APPA: Leader in Educational Facilities has begun to put together a model and an implementation guide for just such a process.

It should be noted that, although industry organizations have begun to explore TCO, there is a dearth of empirical research or academic publication of TCO in building construction.

2.2.1.1 APPA

APPA has taken initial steps to introduce and standardize the use of TCO in the building construction industry. In fact, they have developed a draft Standard for Total Cost of Ownership for Facilities Asset Management, a document providing guidance to practitioners in the introduction and application of TCO. The perspectives of APPA are reviewed below, as they are the only known guidelines for TCO specific to building construction.

APPA defines TCO evaluation as, “a financial management strategy that accounts for the complete life-cycle (cradle-to-grave) measurement and management of a physical asset’s useful life.” (APPA 2017) They advocate using TCO to model all costs associated with a building. APPA recognizes

that the desire for a cradle-to-grave cost analysis of a whole building has been present in the building and construction industry for years; however, there has yet to be a concerted effort towards an industry standard. APPA advocates for every member of an organization to take part in maintaining a current and accurate database of all building related costs. This is complemented by a Strategic Investment Pyramid to assist trustees, donors, decision makers, and other employees of the organization in determining the most beneficial methods for investing in building acquisition, upkeep, upgrades, or disposal (Christensen 2016). The Strategic Investment Pyramid is a suggested line of questioning that begins with strategic inquiries about the timing and affordability of the investment, and moves on to questions about facilities data and metrics, decision perspectives, and finally a specific asset investment strategy. This pyramid of questioning, combined with proper utilization of the suggested database, would provide decision makers with clear goals, and a clear understanding of the true impacts of their investment decisions – allowing them to better target investments according to their goals.

The Total Cost of Ownership methodology inherently defines the value of a building by its financial value. Some decisions are made based on the energy efficiency or energy consumption of an asset lending TCO evaluation some nuance in its definition of value – but ultimately finances are the determining factor for this method.

2.2 Defining and Delivering Value via Buildings

2.2.1 Defining Value

Researchers and practitioners have long focused on the costs associated with a building and its components, various models for determining such cost are readily available in the industry. However, there is a notable absence in literature associated with non-financial value obtained from building investments. In fact, there is not yet a formal definition or example provided of this value. Nevertheless, there is a body of literature that quantifies some benefits obtained from different building investments, and most focus on improvements in occupant well being.

Practitioners have discussed the concept of *value* for the last decade. The predominant industry report, *Be Value* (Saxon 2005) defines the concept of building value and was used to set the epistemological perspective of the study. Thus, the salient tenants of the Be Valuable document are described below.

Saxon's (2005) report presents a Design Quality Indicator (DQI), along with a Value in Design (VALiD) framework that can be used to familiarize decision makers with non-financial aspects of building value such as a sense of belonging, or a meaning in work. It is clear that although the industry is beginning to recognize a building's value outside of its financial worth, what each company considers to be valuable is subjective, being based on the goals and objectives of the company. The VALiD framework is a tool to aid discussion among owners and investors to establish shared company values. Along with creating a shared vocabulary, bringing decision makers together to decide what they deem valuable is a process in itself. Methods of value mapping have been developed to do just that (Bocken et al. 2015), making it easier for decision makers and investors from different departments of a company to work together. The DQI, developed in the late 1990s, is a tool to assist investors and owners in comparing individual building evaluations based on *Functionality*, *Build Quality*, and *Impact* (Saxon 2005). Utilizing this tool, shown in Figure 1, stakeholders are able to visually compare their views and reach a greater level of cohesion moving forward. Both the VALiD tool and the DQI methods start conversation among building investors and decision makers regarding their shared or conflicting priorities and facilitate a greater level of communication.

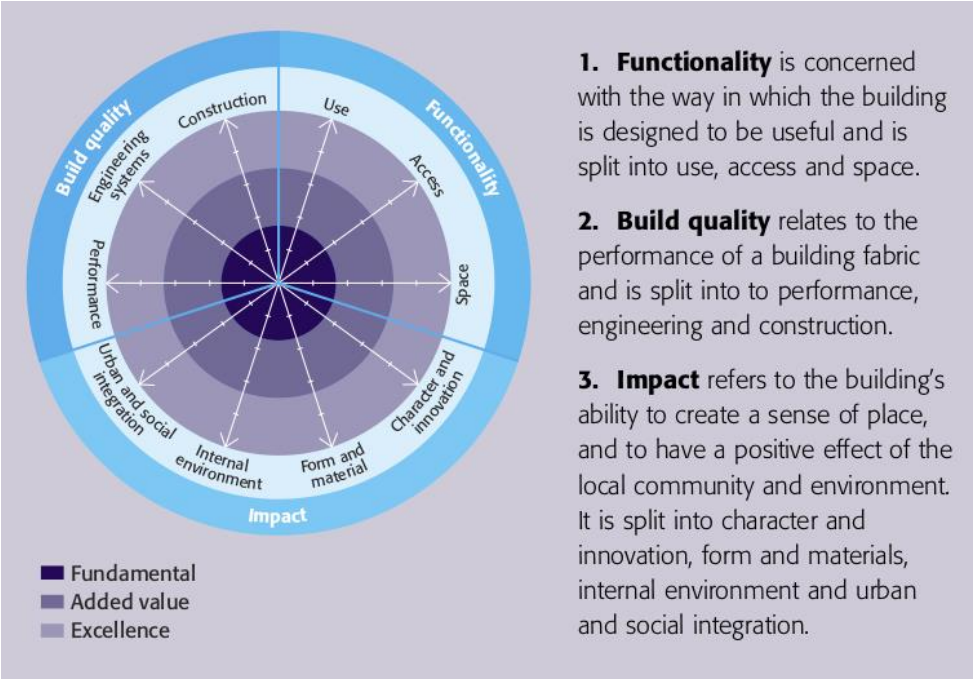

Figure 1: Design Quality Indicator

Ease of communication among decision makers and investors is critical for greater effectiveness in future investments (Emerson 2003). Emerson calls for the development and tracking of systems to measure social impacts of investment decisions - any decision is more than its financial implications. A decision as personal as choosing a vehicle to purchase brings with it statements about the owner's priorities in terms of brand, gas mileage, terrain capabilities, number of occupants, and many other qualities. For an investment as large as a building there is currently an unquantifiable exchange of value. Every choice makes statements about priorities similar to those identified in the purchase of a vehicle (Emerson 2003). The heightened level of economic, social, and environmental integration this paper calls for easily transfers to discussions of overall building value. With this study, we seek to determine the extent to which a comprehensive definition of value is utilized currently in the building construction industry.

2.3 Performance-Related Empirical Research

2.3.1 Overview

Many benefits associated with building upgrades have been studied from the perspective of human resources. For example, there is research that shows employee retention and engagement can be improved through increasing the comfort of occupants (Knoll 2014). There is a strong and logical argument for a focus on human resources, being that the cost of a full staff of paid employees greatly outweighs the financial cost of a building. (Knoll 2014, p. 1) Once a building is in operation, the costs of maintaining a staff, with salaries and benefits, hiring costs, and turnover costs, far outweighs the cost of the building itself (Saxon 2005). In an early study, Heerwagen (2000) found that specific building systems influence building occupants. For example, the author noted that Indoor Environmental Quality (IEQ) can be influenced by advanced ventilating and mechanical systems, building materials and furnishings, and inclusion of high quality, energy efficient lighting, and others (Heerwagen 2000).

Countering the positive aspects mentioned, buildings can also have a negative effect on their occupants. It has been known for at least two decades that Sick Building Syndrome and other parts of the built environment have a negative effect on a building's occupants (Fisk and Rosenfeld 1997; Wu et al. 2007). Although Sick Building Syndrome has been acknowledged in the industry for years, there are several barriers to the consideration of IEQ, which include:

i. IEQ and IEQ-related health effects currently have no meaningful metric. (Mendell et al. 2002)
ii. the relationship between IEQ and health have not been studied enough to produce sufficient guidelines or standards (Mendell et al. 2002)
iii. costs and benefits of health-related building practices have not been thoroughly investigated (Mendell et al. 2002)

iv. the economic capability of the industry to make these changes does not match it's desire (Wu et al. 2007)

v. a permeating perception that the benefit of implementing healthier systems will not outweigh the cost (Wu et al. 2007)

vi. the fact that the occupants of the building, rather than the decision makers, often carry the legal and economic burdens of a poor building IEQ (Mendell et al. 2002)

There are few legal standards that demand the consideration of these indoor conditions (Mendell et al. 2002; Wu et al. 2007). Since this early work, connections between building systems and their effects on building occupants have been studied.

Addressing both items i. and ii., is the Well Building Standard. Still not widely used in practice, the Well Building Standard uses research related to the health of building occupants and sorts it into categories based on the seven major concepts of Indoor Environmental Quality for application. Functioning similar to LEED in that organizations can include certain building aspects to gain a score to rate their building, the Well Building Standard is on the forefront of incorporating the human experience into building considerations. The standard uses 11 biological systems, such as the cardiovascular system, and the nervous system to clearly communicate how different elements of IEQ affect the human body (International Well Building Institute, 2015). Appendix A contains a lighting example pulled from the Well Building Standard that shows considerations brought up in both items i. and ii. listed above.

Item iii., documentation of costs versus benefits, can be shown via the associations found between improved IEQ and greater productivity and also in the decrease in costs that owners face in insurance and medical costs of employees (Knoll 2014).

Items iv., v., and vi. bring up more sociological obstacles, ones that must be faced once a scientific relationship or numerical model between different systems and their effects are in place.

2.3.2 Impact of HVAC on Occupant Performance

HVAC systems are installed to prevent negative health effects on occupants and clean the building as well as maintain the system itself (Bluyssen et al. 2003). There is significant research that shows an association between Indoor Environmental Quality and respiratory health (Fisk and Rosenfeld 1997; Allen et al. 2015) as well as worker productivity (Fisk and Rosenfeld 1997; Allen et al. 2016). The main functions of an HVAC system are to improve IEQ, however, it has been found that the filters and ducts of the HVAC system can become the largest building pollutant - even greater than the building occupants (Bluyssen et al. 2003).

When an HVAC system is overwhelmed, or when it was improperly chosen for a certain area, problems such as dampness and mold can occur in occupied spaces. In 2004 the Institute of Medicine reached the conclusion that an excess of dampness in indoor spaces is a public health problem. Mold and dampness have been found to increase varied health problems by 30-50% (Fisk et al. 2007). Although a direct causal relationship has not been clearly established, it has become evident that side effects associated with dampness lead to respiratory problems and a decreased IEQ (Fisk et al. 2007). There is a difference between the effects of dampness in the home and in an office, showing that size and context are important. Overall, a clear connection exists between mold, dampness, and respiratory and asthma related symptoms (Sahakian et al. 2009). Dampness and mold are some of the most thoroughly researched symptoms resulting from the HVAC system itself.

That is not to downplay the effects of the occupants. When an HVAC system is improperly sized, it is unable to properly clean the air of occupant-contributed gases. One study on this topic found students

in classrooms with lower airflow rates, therefore increased levels of CO_2, showed higher levels of absenteeism than students in areas with lower levels of CO_2 (Shendell et al, 2004). The 10-20% relative increase in student absences could point to a similar finding in non-school settings. The build up of CO_2 in this case was caused by insufficient HVAC systems and the presence of a consistent population. CO_2, though dangerous in excess, is a rather benign chemical, one that humans interact with at certain levels on a daily basis. However, infectious disease presents more serious problems. Evidence suggests that disease can be transferred via the air ventilation system from an infected area into another space (Li et al. 2007). In facilities such as hospitals, this encourages the use of HVAC systems creating pressure differentials to control for the spread of disease. In other facilities, it is yet unclear what the solution may be, and further research into the specifics of necessary airflow rates should be conducted (Li et al. 2007).

Improvements in HVAC systems are expected to decrease the number of health related concerns and symptoms expressed by building occupants. The potential to increase worker productivity based on an improved IEQ is one incentive to make these improvements (Fisk and Rosenfeld 1997). Self-reported studies show that workers believe themselves to be both more productive and absent less often upon the improvement of IEQ and the reduction of respiratory or allergy related symptoms (Allen et al. 2016). A double blind study conducted in an office space provided verifying results. Building occupants are more productive and less frequently absent with the implementation of effective HVAC systems (Allen et al. 2015).

Overall, this research shows the importance of maintaining a well functioning HVAC system that is appropriate for the space it serves. Based on that idea and the fact that investments in HVAC maintenance and upgrades are a typical part of building maintenance budgets and processes, HVAC systems have been chosen as a system to investigation during the Case Study phase of this research.

2.3.3 Impacts of Lighting on Occupant Performance

Lighting systems are installed to provide workers with sufficient visibility to perform their tasks. In some cases lighting may also be installed for its aesthetic appeal. There is significant debate surrounding the effects of lighting on the human body. This is due to complexity of these effects, and conflicting study results in this field (Küller and Wetterberg 1993; Lockley et al. 2006; Phipps-Nelson et al. 2003). Lighting systems are known to have both physical and psychological effects on humans though much research is still required to understand the extent of these effects. Studies have shown that both light intensity (Avery et al. 2001) and the temperature color of light (Deguchi and Sato 1992; Lockley et al. 2006) have effects on the alertness and productivity of those exposed to it.

A 2001 study states that approximately 20% of the population of the United States suffers from some kind of Seasonal Affective Disorder, though a scale among this disorder is acknowledged. Its effects include drowsiness, generally 'feeling down,' a lack of energy, a lack of productivity, etc. By introducing bright lights to the workplace for a couple of hours in the day, some of the negative effects of this disorder can be combated, improving the mood, productivity, and alertness of the building occupants (Lockley et al. 2006). Even on days that are not as sunny, the typical indoor work environment is only about a tenth as illuminated as the outdoors. (Lockley et al. 2006) This, along with their study, would suggest that creating an environment more closely emulating the outdoors is better for occupant health. Confirming the benefits of emulating the outside, another study shows that, although participants reported the 'daylight' fluorescent bulbs to be more stress inducing, they did indeed improve visual acuity throughout the experiment (Küller and Wetterberg 1993).

Other studies have shown that the color of light (the wavelength) also has an effect, with blue light being more activating than yellow light (Lockley et al. 2006). This was measured physically via the reaction of the eye and the brain to exposure of different light colors (Deguchi and Sato 1992). A study

from 2007 shows improvements of 30% or more in concentration, alertness, and activity with the introduction of lighting systems with a high color temperature (low wavelength) – meaning blue light. (Mills et al. 2007)

Although further research is needed in many areas concerning the effects of lighting, one researcher succinctly states that light is a salient factor in the indoor environment. Systematic changes can occur due to a moderate change in the lighting of an indoor space., (Lockley et al. 2006)" Based on the studies cited above, introducing brighter lights of a blue hue will increase productivity, alertness, and the mood of building occupants.

Lighting is in every building, and the effects that it has on the human body, though not entirely understood, are undeniable. For this reason lighting systems were selected as a system for investigation during the Case Study phase of this research.

2.4 Gaps in Knowledge

The gap in knowledge that we are hoping to address is the lack of connection between available qualitative, quantitative, and financial data. Building Value is a complex topic that requires extensive collaboration within the scientific community and related industry partners.

One glaring gap in the available literature is the lack of a record of methods decision makers are using in their investment decisions. Section 2.1 walks through available methods, however there is a lack of record regarding the utilization of these methods in practice. Investigating methods currently in use in the building industry will lay the groundwork for developing an effective building valuation model that will actually be implemented in the industry.

Specifically, the research team seeks to create a framework for decision makers to utilize that incorporates data related to all previously mentioned aspects of a building system into investment decisions. This framework will allow a more even consideration of priorities and a more full understanding of the total effect of the investment decision. The abundant examples of IEQ effects shown in the HVAC and lighting literature, and their lack of presence in available estimating methods show that decision makers are not yet able to consider all aspects of an investment. Once a framework is created that allows decision makers to consider more indirect costs and impacts on building occupants, then they will truly be able to make the most effective investments. By defining the input (investments), output (benefits), and mechanism (agents) of this framework, connections can begin to be solidified among the available qualitative, quantitative, and financial data.

Chapter 3: Methods

3.1 Phase 1: Framework Development Methodology

A group of industry professionals came together for a series of meetings related to further development of the concept of Building Value. This group conducted a series of three meetings. During these meetings the team worked to codify and organize existing literature, while also identifying and defining key terms for the development of a theoretical framework.

In-person meetings occurred as follows:

1. Exploration of existing literature to understand Building Value as it has been recorded.
2. Identification and defining of key terms:
    a. Business Value
    b. Investment
    c. Agent
    d. Benefit
3. Using previously defined terms to develop a framework for building valuation along with examples for each term.

3.1.1. Analysis and interpretation of data

After each meeting, members of the academic research team went through the notes, minutes, and related literature, to find examples of the produced concepts. As the topics of discussion in the meetings narrowed, the team was able to pull specific examples from both academic and industry literature to validate the framework that was taking shape. The results of these investigations can be found in Chapter 4.1.

3.2 Phase 2: Exploratory Case Studies

3.2.1. Research Objective

The objective of this research was to understand the methods that current decision makers in the industry use to determine the value of a building system. As established in the literature, there are methods available for use (LCCA and TCO) that focus on various elements of investment impact. However, minimal research has been conducted to determine the extent to which these methods have been integrated into the daily decision making of industry professionals. Ultimately the question resolved with this research was:

- How do current industry professionals consider the value of a building system investment?

3.2.2. Design and Scoping

Based on the results from the framework development work, one of the first areas for further research is how current industry professionals consider value when making building system investments. Conducting an exploratory study on this subject is necessary to establish a baseline from which a comprehensive and useful valuation model can be built. Examination of multiple cases is necessary to determine how the specific industry, building type, size, or project scope effect the decision-making process. Cases will be comparatively analyzed to establish a baseline for how current professionals are making decisions.

Seven case studies were conducted containing four lighting projects and three HVAC projects. This array of cases provides the variation and depth needed to detect and characterize patterns in the decision-making process. For each project an interview was conducted with one decision maker. No

decision maker was involved with more than one project ensuring that one investment style is not over-represented, biasing the data set. The cases were limited to investments in HVAC or lighting renovation or upgrades that have been made within the past five years (2012 to present). All of the lighting system upgrades involved an upgrade from fluorescent bulbs to LED bulbs. HVAC systems are more complex and therefore the projects contain more variety in the types of projects considered. The limited scope allowed for: isolation of the investment from other investments, projects, or socio-political drivers; verification that replaced features comply with and exceed current building code; and consideration of the potential influence of LEED, the Green Building Standard, and Zero Energy.

3.2.3. Case study interview questions

The following questions were developed based on exploratory interview theory (Harrell and Bradley 2009). By asking 'how' and 'why,' or otherwise open-ended questions, the interviewee is able to lead the discussion while going into depth with their responses (Seidman 1991). The questions do not imply a right or wrong answer and flow in a manner that is natural for the topic of conversation. The first set starts with some basic questions about what the project is and the context surrounding it, then continues into more directed questions about the factors that came into play during investment evaluation. The second set of questions attempts to bring light to more of the social and political factors that may have effected the investment.

1. Questions related to a specific HVAC or lighting system upgrade:
    a. Why did you select this building feature to upgrade?
    b. What alternatives did you consider?
    c. Why did you pick this alternative?
    d. How did you consider the return that you would get on this investment?
    e. What were predicted and actual performance changes, if any, related to this upgrade?

f. Please describe the specific financial limitations surrounding this investment decision.

g. Was this a decision that had to be made within a specific timescale and why?

h. Were choices in upgrade limited by external factors?

i. To what extent did you use TCO and LCCA in your decision-making process? Or, was the upgrade decision made primarily based upon first cost considerations?

j. To what extent were occupants involved in the decision-making process?

k. What data are available regarding the initial cost? TCO? Positive return resulting from the investment? Have energy models been used to determine operating expenditures?

l. When considering building investments, what financial computations are made?

m. How was the upgrade financed? Through internally-accumulated funds?

n. How long do you expect the upgrade to be functional (i.e., what's the expected lifetime of the upgrade)?

o. Did you take into account some non-monetary benefits when deciding to upgrade?

p. What benefits do you already see from the investment?

2. Questions about the decision makers:

a. Why is this building important to you?

b. What interaction or rapport do you have with the building occupants?

c. Do you live in a similar area and/or condition as the typical building occupant?

d. To what extent do you believe that our global climate is changing?

e. To what extent do you believe your personal beliefs are represented in the policies and standards this organization uses in their decision making process?

3.2.4. Objective Data Collection

The following Table 1 provides a list of objective data that was requested for each project based upon the agents found during Phase 1 of the project. A complete explanation of these agents can be found in Chapter 4.1.

Table 1: Requested Objective Data

Financial Information	Information Regarding Agents of Business Value

• First Cost including Design
• Total Cost of Operation
• Operations Costs
• Energy Bills
• Maintenance Costs
• Labor and Materials
• Repair Costs
• Finance Costs
• Financial Outcomes
• Expected Projections
• Actual Usage Costs
	• Absenteeism Records
	• Health/Wellness related records
	  • Health Insurance
	  • Injury Records
	  • Data related to Employee Obesity
	• Data related to Acoustical Comfort
	• Data related to Efficiency of Occupants
	• Data related to Facility Energy Use
	• Data related to Resource Consumption by the facility
	• Data related to Employee Fatigue
	• Data related to Employee Stress: Physical Stress, Mental Stress
	• Data related to Employee Motivation
	• Data related to Employee Satisfaction
	• Data related to Employee/Occupant Perception of Facility Quality
	• Data related to Criminal Activity both within and around the facility
	• Data related to the Use of New Technologies in the facility

3.2.5. Analysis

A type of problem-driven content analysis was used on the interviews. A recording and transcript of each interview, based on the above questions, is included with each case. These transcripts were generated by the interviewer and follow a set of notations and standards further explained in Appendix C. The content of each transcript was analyzed for certain topics and code words; examples include *environment, energy*, or *finance*. By using a content analysis platform such as NVIVO, it was possible to examine each of the interview transcripts for key words, phrases, and themes, which were compared among cases. Due to there being only seven interviews, quantitative analysis of the transcript content should be considered warily. Quantitative analysis of these interviews was completed, however the results only provide a starting point for analysis in further research. A sample size of seven does not provide the weight necessary to draw valid conclusions. Coding completed in NVivo was utilized to group and sort

through pieces of the interviews, which were then reviewed in context for a thorough understanding of each code and topic. This review included reading all of parts of each interview related to each node, or code word, as well as comparing results based on different combinations of themes for further understanding.

This method of analysis is a form of Pattern Matching (Krippendorff 2004). Conducted across multiple case studies, this method compared the decision-making priorities currently implemented among industry members. This analysis explored possible rival explanations that lead to the chosen investment results. Are the decision makers prioritizing cost as their only factor in choosing an upgrade, or are they prioritizing the environment or other factors? Based on the comparison of interviews it became clear why each specific upgrade was chosen.

The intent of this exploration was to retrieve both interviews and quantitative data from each observed project. This data would then be examined on the basis of thoroughness and useful application. Two of the seven projects were able to supply the team with quantitative data. With this being the case, the existence of or use of data mentioned in the interviews became the main source of understanding what kind of quantitative data is being collected and utilized in the field. Due to a lack of available quantitative data, pattern matching between interviews and recorded data could not be implemented.

Throughout this analysis process, and again once all of the interviews had been conducted, we looked for a certain level of data saturation. Still not a numerically defined term in any field, data saturation in this case will be taken to mean that the addition of new data will add little or no new themes or codes to the work that has been produced (Guest et al. 2006). Saturation implies that enough information has been gathered for another researcher to replicate this study (Fusch and Ness 2015). In this research, data saturation implies that conducting and analyzing more interviews will have minimal impact on the ultimate results of the study.

3.2.6 Promoting Validity

This study is comprised of a variety of facility types and sizes. Participants include decision makers from hospitals, universities, and other non-commercial facilities such as offices and lab spaces. Cases in this research represent facilities across the continental United States, the majority being in Colorado. This study will not be generalizable to the generic category of 'building,' however it will provide an outline and procedure for future research, expanding the industry's understanding of decision making processes to more types of buildings.

By following this protocol, transcribing the interviews and documenting all of the codes used in analysis, and their meanings, in a clear manner, the project should be reproducible by anyone with the following qualifications.

- Basic familiarity with the building industry
- An education that has covered building related processes in aspects of both construction and architectural engineering so that a common language is established
- Proficiency in the English language

The results reported in Chapter 4 should be reproducible by another researcher with the given project transcripts and procedures. However, if future researchers attempt to replicate this procedure with new interviews, the results would be expected to differ based on developing industry standards. These differences, if reported, would affirm the relationship between the decision makers and industry standards.

3.2.7. Study Limitations

One of the major limiting factors in this study is the small sample size. The recruitment of interview participants occurred over a three-month span, and only seven interviews were recorded. Inherently, this means that the findings from this study have limited generalizability to buildings as a whole. Keeping the scope of the project to only Lighting and HVAC system replacements does provide a level of depth for comparison, but it also means that results from this study should not be extended to systems outside of those scopes without further research.

During the interview process it became abundantly clear that none of the investment decisions were completely made by any one individual. Each organization contains a structure that evaluates the investment at different levels. For each case only one individual was interviewed, resulting in a clear understanding from one perspective, but an inability to understand the process in its entirety.

The participants have not been randomly selected and are all connected via the Construction Industry Institute (CII) network. This connection to CII indicates that these companies are on the forefront of the construction industry with their practices, and may not be a representative sample of the building industry as a whole.

Chapter 4: Results

4.1 Phase 1: Framework Development

The team developed the following definitions:

- Business Value: measure of expected benefits from investments over the facility's lifecycle.
- Investment: acquisition of a capital asset that is expected to generate benefit*.
- Agent: the mechanism that delivers benefit(s) from an investment.
- Benefit: income to the business unit, cost savings to the business unit, or impacts to the environment and society.

*Note: Investments here are expenditures in upgrades beyond required codes and company policies.

These definitions were both based on and validated by the literature reviewed in Chapter 2. Figure 2 depicts the framework that has resulted from a literature review and three team meetings. This process model, consistent with the definitions of investments, agents, and benefits, explains how value emanates from a monetary investment in a building feature. Throughout team discussions it became clear that although a building investment may be made to produce a certain benefit, it is rare that a benefit is the direct result of an investment. Taking an example from Figure 2: an organization may wish to increase their occupants' productivity (the benefit). To invest directly in occupant productivity is simply impossible. An investment may be made, however, in flexible building design. There is still no direct line from flexible building design to occupant productivity. A more flexible building is a building that is better able to adapt to developing technologies. As developing technologies are incorporated into this flexible design and made available for use, the occupants of the building will likely become more productive as a result. Therein lies the structure of the model below. Investments can be made in tangible, visible, or design elements. The agent provides the mechanism that ultimately produces the benefit. Note that the

team recognizes that one investment may affect several agents, which may then each create multiple benefits.

Through a combination of literature review and group brainstorming, our team identified and defined a salient investments, agents, and benefits. A sample of these is provided in Appendix B. Although these lists are by no means complete, they do involve a comprehensive review of literature and demonstrate the breadth of potential parameters in the model.

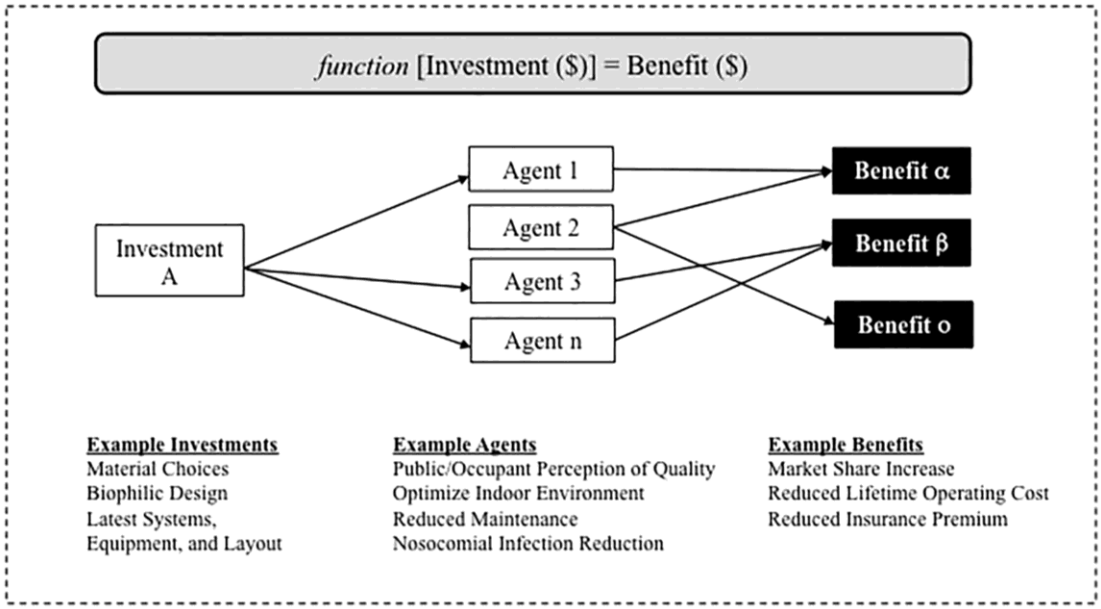

Figure 2: Investment, Agent, and Benefit Model

In this model the intent was to monetize the investment and benefit parameters in the LiVE modeling methodology and develop investment-benefit functions. The agents, however, are non-monetized reasons *why* investments yield benefits. By monetizing both the investments and the benefits, while allowing the agents to be non-monetized it should be possible, with further research, to develop a tool with which decision makers could input the decision that they are considering, and receive an output of the various impacts that this decision will produce. For example, an investment in upgraded

daylighting may improve occupant productivity because of improvements in employee motivation, happiness, lower absenteeism, and increased visual comfort. Also, via other agents, daylighting may reduce the cost of operation, improve talent recruitment, and enhance the reputation of the business, all of which can be monetized and linked to the long-term financial sustainability and competitiveness of the organization. This type of decision-making system is unique in that it accounts for many factors that have yet to be taken into consideration. A simple payback gives the decision maker an understanding of the financial impacts of their investment. LCCA, when thoroughly implemented, is able to give a comprehensive assessment of the financial impacts, but also various environmental impacts that one isolated investment may have. TCO takes this process to a higher level by analyzing the environmental and direct cost impacts that an investment may have in the context of a larger network of building systems. None of the currently available methods of investment consideration are expected to incorporate the extent of factors that the developed framework above intends to consider.

4.2 Exploratory Case Studies

4.2.1 Summary of Interview Question Responses

Question 1a:

- Why did you select this building feature to upgrade?

Answer 1a:

The cause of every investment observed can be traced to a need for replacement due to a system reaching its End Of Life (EOL). Six of the seven projects used this EOL replacement opportunity to upgrade their systems, while one project simply made a one-to-one replacement.

The lighting projects considered this an obvious time to upgrade in every case, though with the HVAC projects it was on more of a case-by-case basis.

"LED is much more efficient as you know, energy conservation wise, and when you add the O&M with it, then it just, it's head and shoulders above fluorescents or anything else, any other light source." – Case 4

Questions 1b,1c:

- What alternatives did you consider?
- Why did you pick this alternative?

Answer 1b,1c:

For the lighting projects, all being fluorescent to LED, no other bulb alternatives were considered. Greater variation occurred among the HVAC systems, with one project being a planned upgrade with a customized system, another project choosing to upgrade after doing some research when the time for replacement occurred, and the final project choosing not to upgrade then retroactively realizing that their system could have been updated for the building in order to be more efficient.

"…during the initial design phase we analyzed a couple of different technologies. The old boiler was called a noncondensing boiler. Those boilers operate at higher temperatures to prevent the fuel gas from condensing, which forms an acidic condensate which can damage boilers. But that technology operates at lower efficiencies, so we were looking at using a more current technology, like the condensing boilers or a heat pump system to see if we could get a higher efficiency out of the heating systems and lower the energy cost for the building." – Case 3

Question 1d:

- How did you consider the return that you would get on this investment?

Answer 1d:

Six of the seven interviewees mentioned a payback period that was set by their organization as a baseline for determining funding approval. The length of this payback varied from three to ten years

based on the organization. All of these payback periods were applied to systems being upgraded at the EOL of the existing system. The project that did not mention a payback period was an EOL one-to-one replacement, not an upgrade.

Other return considerations mentioned include:

- Payback
- First Cost
- Avoided Potential Cost
- Energy Savings
- Longer Life of System
- Reduced O&M
- Deferred Maintenance
- Minimum IRR (Internal Rate of Return) – not explained

"For most projects I typically look at the first cost. How much is this piece of equipment or system going to cost relative to others. Then I evaluate the energy costs or efficiencies because some mechanical systems or equipment may have really low energy costs, or they're efficient, but they may have very high first costs." – Case 3

Question 1e:

- What were predicted and actual performance changes, if any, related to this upgrade?

Answer 1e:

The predicted and actual performance changes of each project varied greatly based on the type of project as well as the size of the project. All of the projects predicted that their energy and O&M costs would either remain the same, or be reduced. Three of the projects have yet to be completed, although

the decision has been made and construction has begun. Those projects, comprised of two lighting and one HVAC upgrade, do not have data yet regarding actual performance of the upgrade. Those projects that do have data, with one exception, have reported energy savings, and still assume reduced O&M. One project, the one-to-one HVAC replacement, realized after the fact, that the installed system is over-sized and therefore inefficient for the needs of the building. That organization will be working further with the occupants of the building to ensure that needs are being met.

"Almost a million square feet, so that's why, it's big, and considering you have an average of maybe about twelve cents per kilowatt-hour that you pay. So that translates to a huge amount of savings there. That's why the Internal Rate of Return went to sixteen point eight." – Case 5

Question 1f:

- Please describe the specific financial limitations surrounding this investment decision.

Answer 1f:

Every interviewee mentioned a budget as a financial limitation for their investments. As reported with Question 1d, the decision makers were also held to a standard for the payback or internal rate of return for their replacement decision.

"I, with my funding, am required to meet a seven to ten year payback or less. That doesn't mean that every project I can contribute to will payback in that amount of time. But that's the amount, we have to look at the ROI, that's the amount I can then fund. So in these cases, the [partnering organization] is going to contribute I think some money on these, and then I'll contribute that difference in order to meet my ROI." – Case 1

Outside of these guidelines no other specific financial limitations were mentioned. It should be noted that two cases mentioned scope creep, dealing with other repairs that needed to take place for the

project, which were incorporated into the existing budget. While scope creep is not technically a financial limitation, it does put pressure on the finances that are available.

Question 1g:

- Was this a decision that had to be made within a specific timescale and why?

Answer 1g:

Responses among interviewees regarding a project timeline varied, but the sentiments were the same. Each project was to be completed in the same fiscal year(s) as its budget; some projects have a one-year goal, others were planned for multiple years. It was also important that the work be completed when the systems were not vital, and when it would case the least amount of disturbance to the building occupants.

"Yeah, there's always time limitations. Since this involved replacing the boilers for the heating water system, we had to do it during the summer, you know, before the temperatures in Colorado started to drop at night." – Case 3

Question 1h:

- Were choices in upgrade limited by external factors?

Answer 1h:

There was only one instance in which the decision maker reported that their decision was impacted by external factors. That case was an HVAC system upgrade in which enough planning was done to recognize that the scope was creeping before the ultimate decision was made. This allowed the team to adjust their choices in upgrade based on a budget incorporating the additional repairs.

"One thing that came up was the old boiler, the flue gases dumped into a chimney that went up the building. When we decided to go with the two boiler option we realized that the existing chimney was

not big enough. We couldn't use it, and we couldn't run any boiler flues up the chimney. So we had to find an alternative path outside of the building…" – Case 3

Question 1i:

- To what extent did you use TCO and LCCA in your decision-making process? Or, was the upgrade decision made primarily based upon first cost considerations?

Answer 1i:

Interviewees tended to use a loose definition of TCO and LCCA when explaining their use on the projects. LCCA and TCO were typically conflated, with the distinction between the two being lost on the decision makers. Often this loose definition only included the combination of initial cost, energy savings, and some inclusion of a reduced O&M. Other interviewees reported the projects being investigated were too small to warrant the use of LCCA or TCO according to their organization's standards.

"No, unfortunately not with this. We do have design guidelines of when to use Life Cycle Cost Analysis. And for [organization] standards, and for equipment replacement, that's not one of them." – Case 7

One exception being the customized HVAC upgrade, with which the decision maker spoke with clarity about some of their LCCA considerations. However, no objective data was available from that team, so the true extent of their use of LCCA is still unknown.

Question 1j:

- To what extent were occupants involved in the decision-making process?

Answer 1j:

A mix of building occupant participation was observed in the projects. Some projects greatly involved the occupants – having a representation committee of some kind getting input on the installed system. Other projects only considered the occupants in the timing of the construction.

"We did provide a couple of fixtures and we placed them strategically for them to get a feel of what the new fixtures will feel like, and there were a couple of different products, different colors of light." – Case 6

Question 1k:

- What data are available regarding the initial cost? TCO? Positive return resulting from the investment? Have energy models been used to determine operating expenditures?

Answer 1k:

Five of the seven projects were reportedly sent to outside contractors for initial estimations. Project teams used these contractors for design-build, engineering work, and even initial estimates to provide a ballpark cost. Other considerations were typically included in a spreadsheet, with only one project indicating use of an energy model.

"We have a contract proposal, they provided some options and then we picked one. And then I have costs for all the different change orders…And the documents, let's see, budget spreadsheet, maintenance cost, so our project manager did contracts, cash flow, design, construction design build, … contingency." – Case 7

Question 1l:

- When considering building investments, what financial computations are made?

Answer 1l:

Most answers to this question were in line with the responses to questions 1d and 1f, also relating to project finances. One project took place in a leased facility, therefore deviating from the typical O&M and energy cost computations.

"I do have the leasing agent to do the maintenance… unfortunately it's a leased facility so we don't actually meter because part of the natural gas and the lighting, electric is under the lease bill." – Case 7

Question 1m:

- How was the upgrade financed? Through internally accumulated funds?

Answer 1m:

Based on the answers received from interviewees, the conclusion can be drawn that typically these system upgrades are financed through internally accumulated funds. However, it was typical for a decision maker to know what account or which budget their funds came from, but not how that money got into that budget or account.

"So, it was all primarily, well, internally, it's kind of a rough, I don't know how to explain this so… It's really complicated when you deal with… and again, nothing is simple. I wish it was, so, depending on how our CFO decides to pay for this project, sometimes she'll take out a bond on it. But that's up to her discretion of whether, so there's kind of like, like a loan, but it's called a bond. Then she leverages that with her whole portfolio. It's very quite complicated. We may have some donors… but it always seems to feed into one big pot, and it's like a super pot, and then the CFO determines how it's allocated from there." – Case 2

Question 1n:

- How long do you expect the upgrade to be functional? (i.e., what's the expected lifetime of the upgrade?)

Answer 1n:

Lighting projects were expected to last between ten and twenty years, while the expected lifetime of the HVAC projects ranged from fifteen to fifty years.

"And then the LEDs last, the LED itself will last fifty to a hundred thousand hours… maintenance people don't have to touch them for anywhere from ten to twenty years. Obviously depending on how they're operating." – Case 4

Question 1o:

- Did you take into account any non-monetary benefits when deciding to upgrade?

Answer 1o:

All of the interviewees recognized that their project had some effect on the occupants of the building. In one case, the construction timing of the project itself was mentioned, and no other effects. The other six interviews contain recognition of positive and negative impacts related to the building occupants. The custom HVAC project considered the airflow needs of the lab spaces according to the activities in the lab, however the occupant was less the focus than the requirements of the lab activities themselves. None of the decision makers reported using anticipated impacts as part of their quantitative decision making process, although they did acknowledge their existence.

"…you know, this really promotes employee productivity. It's amazing when you come to the building and you're used to it being so dark because the fixtures are just dated. And to come into a new environment it's so nice and lit, and everybody's happy. It improves the mood of the patient, staff come in and it gives a different look to the building." – Case 6

Only one of the seven interviewees reported LEED being a driving environmental factor. Other than commenting on energy savings – which has an inherent connection to environmental improvement, the majority of interviewed decision makers did not identify environmental factors as playing a part in their decision making process for the specific building system.

Question 1p:

- What benefits do you already see from the investment?

Answer 1p:

As mentioned in the results for question 1e, there are three projects that have not yet been completed. The completed projects, other than the over-sized HVAC project, all report energy savings. Those who have been able to reconnect with the occupants at near completion, or after completion of the project report that occupants seem to be happier overall.

"…well the lab people are a lot happier, they're not in a dungeon anymore. But I'm going to encourage you to talk to them about that. I think they seem happier in their labs, but that is kind of subjective on my part so." – Case 2

Question 2a:

- Why is this building important to you?

Answer 2a:

Responses regarding the importance of the building centered around creating a comfortable, functional, or pleasant environment for the building occupants. This could be seen across all building types, sizes, and organizations.

"I mean… this might sound corny, but I hope I'm making a difference here… I want the students to have a fantastic learning environment." – Case 4

Question 2b:

- What interaction or rapport do you have with the building occupants?

Answer 2b:

Of the decision makers interviewed, the employees of the university reported having more interaction with building occupants. The other study participants placed themselves further from the occupants due to the size of the organization, and their specific role working with facilities and maintenance.

"Not too often. Only if there's a remodel, or if there's a work order that required engineering of their particular lab space." – Case 7

Question 2c:

- Do you live in a similar area and/or condition as the typical building occupant?

Answer 2c:

The intent behind this question was to understand if the lifestyle and standard of living expectation that the decision maker has are on the same level as those of the building occupant. This question was met with varying responses, some even only one word. Based on the variety of answers received for this question it is impossible to draw any real conclusions about decision-maker/building occupant lifestyle similarity.

Question 2d:

- To what extent do you believe our global climate is changing?

Answer 2d:

Every interviewed decision maker reported to believe that the global climate is changing. The level of certainty varied among the interviewees.

"It changes everyday, so yes, I believe in climate change… To the extent that we need to do something about it." – Case 7

"But I think that it'd be very difficult to determine exactly how much the climate is changing." – Case 3

Question 2e:

- To what extent do you believe your personal beliefs are represented in the policies and standards this organization uses in their decision making process?

Answer 2e:

Each of the decision makers in this study reported that their personal beliefs align with the standards and policies of their respective organizations. It is worth noting that all of these organizations can be considered on the forefront of implementing innovative technology and working to reduce environmental impact. One criticism was made regarding the limit of a ten year payback period for investments in energy, from the perspective that it is too short a timeline.

"Now, to be honest with you, I don't like this seven to ten year payback requirement on my funding. Because, low hanging fruit, as we call it in my business. Simple retrofits, the things that can save you energy have already all been done on this campus… So therefore when I'm looking for opportunities, just like this project… I cannot fund it entirely with my energy fund. It doesn't meet that seven to ten year payback… So I don't like that seven to ten year constraint on my funding, especially when the state of Colorado allows up to twenty five years."

4.2.2 Numerical Analysis Results

It is important that the reader recognize that numerical analysis conducted on these seven interviews should not be used to draw any concrete conclusions about the industry at large but should be used as a starting point for future research on this topic. This limitation is due to the sample size of seven obtained for this project. While a seven interview was sufficient for qualitative analysis – reaching an expected level of data saturation with regards to investment priorities, it is not sufficient for robust numerical or statistical analysis. The following analyses are included to provide future researchers with a base level of understanding, and a point to work from in future analyses.

Figures 3 and 4 give an overview of the frequency of topics discussed. Figure 3 indicates the number of interviews that touched on a topic while Figure 4 denotes the number of times that topic was discussed overall. Note that the majority or topics were discussed in all seven interviews, with the remaining occurring based on the project context. Technology, Operations and Maintenance, and the Environment only came up in six of the seven interviews. Standards are mentioned in five, while Future Use and Scope Creep are only mentioned in two of the interviews. Leasing and Risk were each brought up in a specific context and therefore only associate with one interview each. Note that the topic of Decision Maker was created as a subheading for the topics of Belief, Involvement, and Lifestyle, and therefore was not directly discussed in any interview. Not only was Finance discussed in each interview, Figure 4 also shows that it was the topic most discussed overall. Following behind Finance was discussion of Communication. Although there were no questions relating directly to communication it is a topic that was tracked among the interviews due to its frequency of occurrence.

Table 2 examines each interview individually and reports the percentage of content devoted to each topic. Showing again that Finance was the most discussed topic, this table also shows that each interview used an average of 18% of its content to discuss the topic. The narrow range of percentages found among the topics of discussion is likely due to the direct nature of the questions.

Table 3 below shows the amount of topic overlap found in responses to system related questions. A quick look will show that communication and finance are topics that come up alongside most other topics. For example, looking at Standards as a conversation topic, it is notable that 13% of the conversation about Standards also related to Communication, while 20% coincided with conversation about Finance. Note that although 16% of the conversation about Communication was related to Finance, only 12% of conversation related to Finance was about communication. This is due to the difference in overall volume of content related to Communication and Finance. It is also notable that 32% of content related to Energy was tied to Finance, while only 4% of Energy related content was tied to the Environment. This suggests that decision makers are not looking at energy in the context of environmental resource reduction when choosing decision alternatives, but instead are considering savings in energy mainly as a reduction in the costs associated with that energy. This table also shows that 67% of content related to Occupants has to do with Communication. While this suggests that the building occupants are involved in the decision making process, it should be noted that only 9% of content related to Communication has to do with the Occupants. Looking at this table as a whole will not give an accurate understanding of overlap relationships. The reader should examine each row in turn for a more full understanding of how content is interconnected.

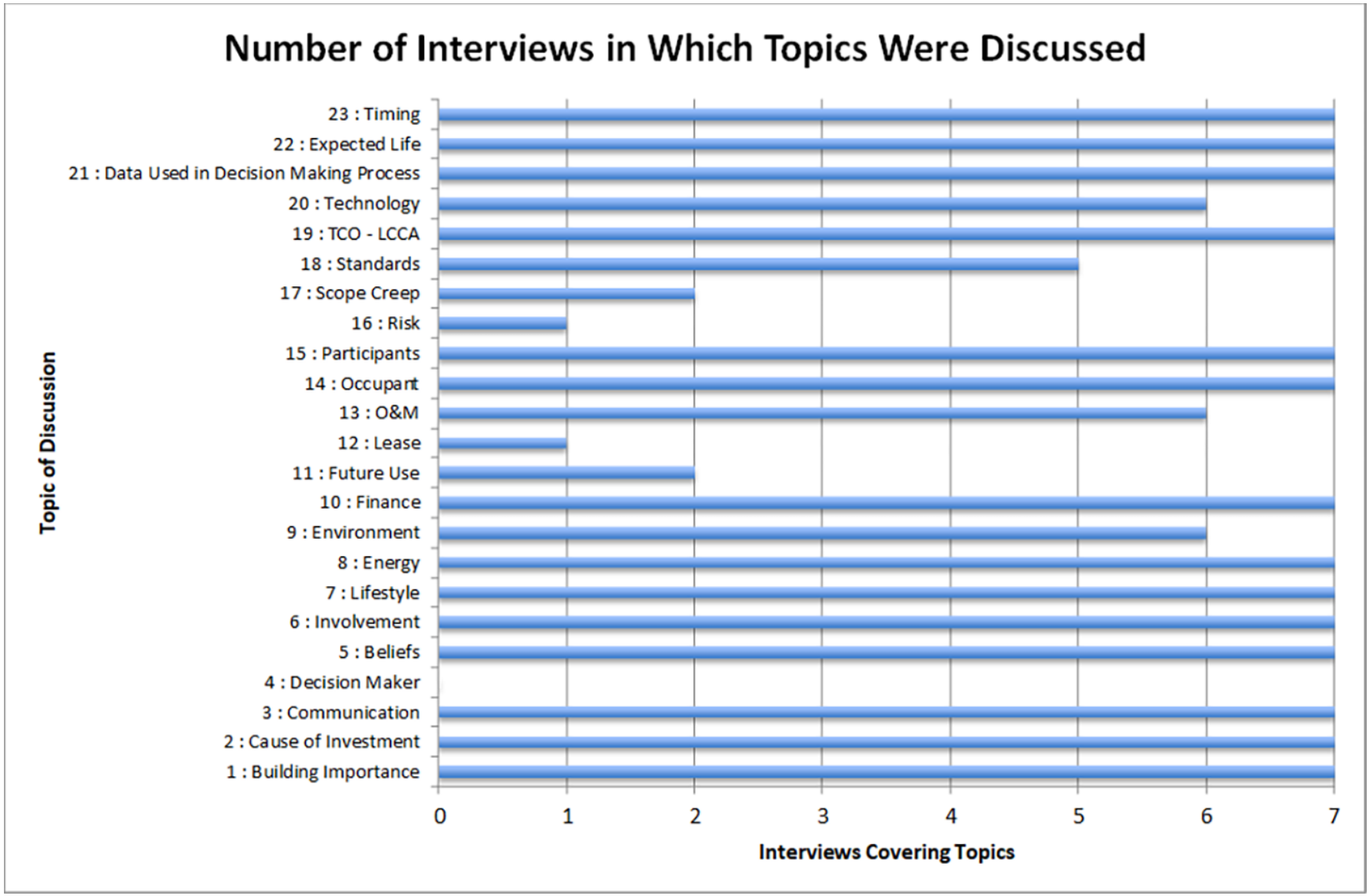

Figure 3: Number of Interviews in Which Topics Were Discussed

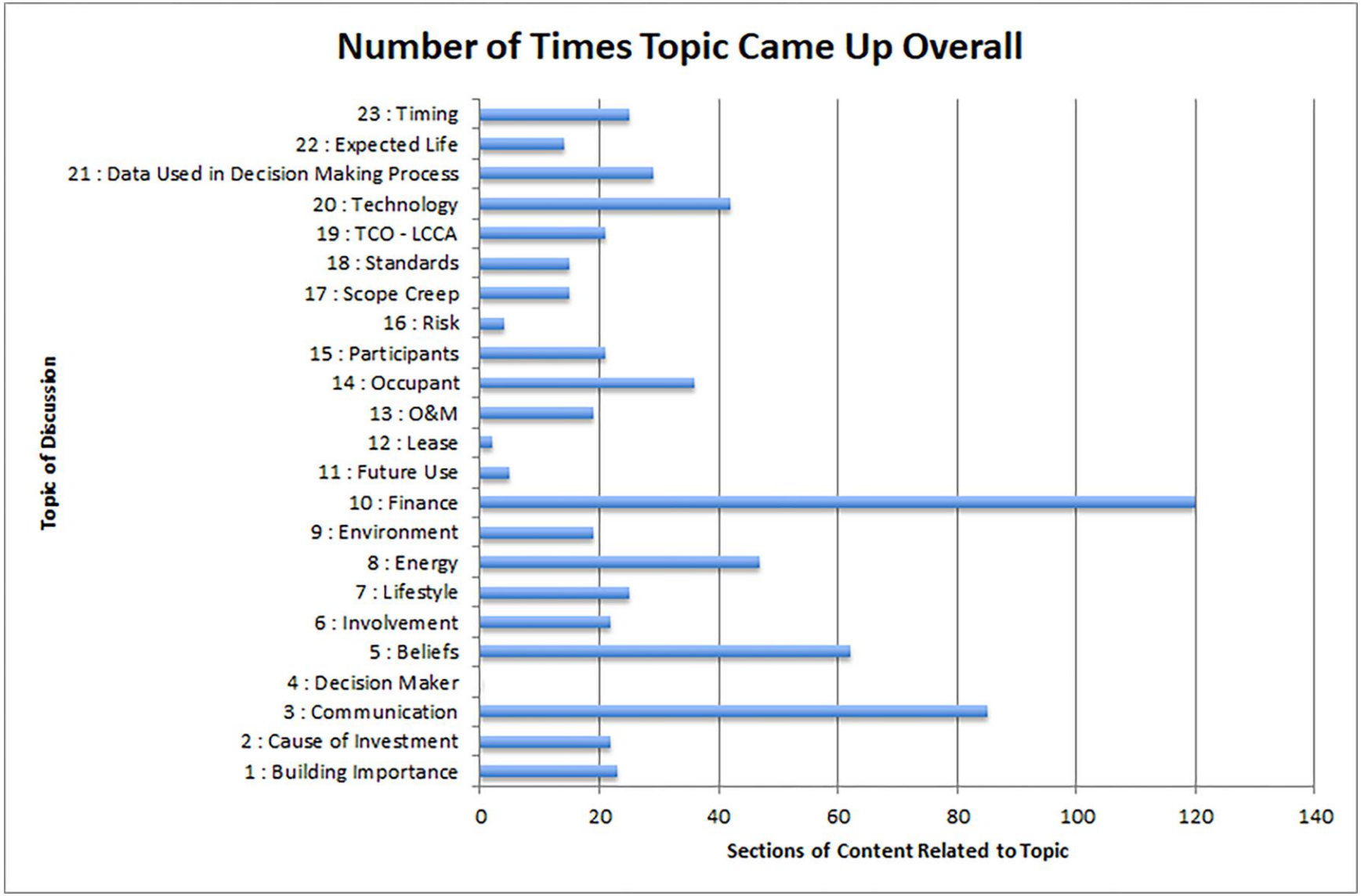

Figure 4: Number of Times Topic Came Up Overall

Table 2: Topics of Discussion within Interviews

Topics of Discussion	Interview #02-02-03-05	Interview #02-02-03-12a	Interview #02-02-03-12b	Interview #02-02-03-13	Interview #02-03-03-15	Interview #02-03-03-22	Interview #02-04-03-14	AVG
1 : Building Importance	3%	4%	1%	4%	1%	7%	3%	3%
2 : Cause of Investment	5%	2%	1%	3%	3%	3%	3%	3%
3 : Communication	16%	8%	11%	15%	8%	14%	15%	12%
5 : Beliefs	12%	12%	9%	8%	9%	7%	5%	9%
6 : Involvement	2%	1%	1%	9%	2%	6%	3%	4%
7 : Lifestyle	3%	1%	1%	1%	8%	10%	2%	4%
8 : Energy	5%	6%	12%	1%	13%	9%	3%	7%
9 : Environment	7%	0%	1%	1%	2%	3%	1%	2%
10 : Finance	18%	20%	16%	16%	18%	18%	18%	18%
11 : Future Use	0%	1%	5%	0%	0%	0%	0%	1%
12 : Lease	0%	0%	0%	0%	0%	0%	2%	0%
13 : O&M	1%	5%	5%	3%	0%	2%	4%	3%
14 : Occupant	5%	11%	1%	4%	9%	5%	2%	5%
15 : Participants	4%	4%	3%	4%	1%	5%	1%	3%
16 : Risk	0%	0%	0%	0%	0%	5%	0%	1%
17 : Scope Creep	0%	0%	11%	0%	0%	0%	7%	3%
18 : Standards	3%	3%	0%	1%	7%	0%	1%	2%
19 : TCO - LCCA	4%	5%	3%	3%	1%	1%	4%	3%
20 : Technology	3%	4%	7%	15%	8%	0%	10%	7%
21 : Data Used in Decision Making Process	4%	5%	4%	7%	4%	1%	5%	4%
22 : Expected Life	3%	1%	1%	3%	1%	1%	4%	2%
23 : Timing	2%	4%	4%	3%	4%	3%	6%	4%
TOTAL	100%	100%	100%	100%	100%	100%	100%	

Table 3: Percentages of Topic Overlap in System Related Question Responses

System Related Topics	A : Building Importance	B : Cause of Investment	C : Communication	D : Energy	E : Environment	F : Finance	G : Future Use	H : O&M	I : Occupant	J : Participants	K : Standards	L : TCO - LCCA	M : Technology	N : Data Used in Decision Making Process	O : Expected Life	P : Timing
1 : Building Importance	-	0%	4%	0%	0%	0%	0%	0%	9%	4%	0%	0%	0%	0%	0%	0%
2 : Cause of Investment	0%	-	5%	5%	0%	5%	0%	5%	5%	0%	0%	0%	0%	0%	0%	0%
3 : Communication	1%	1%	-	2%	2%	16%	1%	0%	9%	16%	2%	2%	1%	5%	0%	4%
4 : Energy	0%	2%	4%	-	4%	32%	0%	2%	0%	0%	2%	2%	17%	4%	0%	0%
5 : Environment	0%	0%	11%	11%	-	11%	0%	0%	0%	0%	0%	5%	5%	0%	0%	0%
6 : Finance	0%	1%	12%	13%	2%	-	0%	3%	1%	1%	3%	3%	5%	7%	0%	1%
7 : Future Use	0%	0%	20%	0%	0%	0%	-	0%	0%	0%	0%	0%	20%	0%	0%	0%
8 : O&M	0%	5%	0%	5%	0%	21%	0%	-	0%	0%	5%	0%	11%	0%	5%	0%
9 : Occupant	6%	3%	22%	0%	0%	3%	0%	0%	-	6%	8%	0%	11%	0%	0%	3%
10 : Participants	5%	0%	67%	0%	0%	5%	0%	0%	10%	-	0%	0%	0%	5%	0%	0%
11 : Standards	0%	0%	13%	7%	0%	20%	0%	7%	20%	0%	-	7%	0%	7%	0%	0%
12 : TCO - LCCA	0%	0%	10%	5%	5%	14%	0%	0%	0%	0%	5%	-	5%	0%	5%	0%
13 : Technology	0%	0%	2%	19%	2%	14%	2%	5%	10%	0%	0%	2%	-	0%	0%	0%
14 : Data Used in Decision Making Process	0%	0%	14%	7%	0%	28%	0%	0%	0%	3%	3%	0%	0%	-	0%	3%
15 : Expected Life	0%	0%	0%	0%	0%	0%	0%	7%	0%	0%	0%	7%	0%	0%	-	7%
16 : Timing	0%	0%	12%	0%	0%	4%	0%	0%	4%	0%	0%	0%	0%	4%	4%	-

The following tables are breakdowns based on the most common topics at they relate to System Type and Facility Size and Use. Table series "**Topic**" breaks down the content based on the topic it relates to. For example, in Table 4, 55% of content related to energy was found in interviews about lighting projects while 45% of content about energy was found in interviews about HVAC projects. Table series "**Classification**" breaks down the content based on the category listed in the column heading. For example, in Table 5, 11% of content in lighting interviews was related to energy, whereas 10% of content in HVAC interviews was related to energy. All of the tables show average values. The total amount of content related to each classification was divided by the number of interviews with that classification. This prevents weighting of the percentages due to an uneven distribution of interview contexts.

Table 4 clearly shows that lighting and HVAC projects are considered with similar priorities. However, a few notable differences exist. Among the interviews regarding lighting, there was no direct mention of how the lighting upgrade would affect the Future Use of the building, which was discussed in regards to HVAC. Not only do HVAC interviews show greater concern for the Future Use of the building, they also relay more content related to TCO or LCCA consideration and the timing of the decision. However, the lighting interviews did show far more concern for the environment as well as considerable amount of attention to the Occupants of the buildings and decision making Participants. The rest of the discussion topics differed by no more than 10%. While these differences are worth noting, further exploration in to this topic will be necessary to solidify any conclusions.

Table 4: System Type Content Allocation - Topic

AVERAGES	A : Facility and Project:System Type = Lighting	B : Facility and Project:System Type = HVAC	TOTAL
1 : Communication	55%	45%	**100%**
2 : Energy	55%	45%	**100%**
3 : Environment	86%	14%	**100%**
4 : Finance	52%	48%	**100%**
5 : Future Use	0%	100%	**100%**
6 : Occupant	57%	43%	**100%**
7 : Participants	60%	40%	**100%**
8 : TCO - LCCA	41%	59%	**100%**
9 : Technology	48%	52%	**100%**

Table 5: System Type Content Allocation - Classification

AVERAGES	A : Facility and Project:System Type = Lighting	B : Facility and Project:System Type = HVAC
1 : Communication	20%	17%
2 : Energy	11%	10%
3 : Environment	6%	1%
4 : Finance	26%	27%
5 : Future Use	0%	3%
6 : Occupant	9%	7%
7 : Participants	5%	4%
8 : TCO - LCCA	4%	6%
9 : Technology	9%	11%
10 : Data Used in Decision Making Process	6%	7%
11 : Timing	4%	7%
TOTAL	**100%**	**100%**

Tables 6 and 8 show a fairly even distribution of content among the classifications of facility size and use, while Tables 7 and 9 show that the topic of Finance consistently generates the most content among the interviews.

Table 6: Facility Size Content Allocation - Topic

AVERAGES	A : Facility and Project:Size = Unassigned	B : Facility and Project:Size = Not Applicable	C : Facility and Project:Size = 0 - 10,000 sf	D : Facility and Project:Size = 10,001 - 50,000 sf	E : Facility and Project:Size = 50,001 - 100,000 sf	F : Facility and Project:Size = 100,001 - 200,000 sf	G : Facility and Project:Size = > 500,001 sf	TOTAL
1 : Communication	0	0	0	28%	48%	0	24%	100%
2 : Energy	0	0	0	34%	20%	0	46%	100%
3 : Environment	0	0	0	16%	52%	0	32%	100%
4 : Finance	0	0	0	26%	40%	0	34%	100%
5 : Future Use	0	0	0	95%	5%	0	0%	100%
6 : Occupant	0	0	0	7%	38%	0	56%	100%
7 : Participants	0	0	0	30%	55%	0	15%	100%
8 : TCO - LCCA	0	0	0	30%	55%	0	15%	100%
9 : Technology	0	0	0	28%	33%	0	39%	100%

Table 7: Facility Size Content Allocation - Classification

AVERAGES	A : Facility and Project:Size = Unassigned	B : Facility and Project:Size = Not Applicable	C : Facility and Project:Size = 0 - 10,000 sf	D : Facility and Project:Size = 10,001 - 50,000 sf	E : Facility and Project:Size = 50,001 - 100,000 sf	F : Facility and Project:Size = 100,001 - 200,000 sf	G : Facility and Project:Size = > 500,001 sf
1 : Communication	0	0	0	16%	21%	0	11%
2 : Energy	0	0	0	18%	8%	0	19%
3 : Environment	0	0	0	2%	5%	0	3%
4 : Finance	0	0	0	24%	27%	0	26%
5 : Future Use	0	0	0	8%	0%	0	0%
6 : Occupant	0	0	0	2%	8%	0	13%
7 : Participants	0	0	0	4%	5%	0	2%
8 : TCO - LCCA	0	0	0	4%	5%	0	2%
9 : Technology	0	0	0	10%	9%	0	11%
10 : Data Used in Decisi	0	0	0	6%	7%	0	6%
11 : Timing	0	0	0	6%	5%	0	6%
TOTAL	0%	0%	0%	100%	100%	0%	100%

Table 8: Facility Use Content Allocation - Topic

AVERAGES	A : Facility and Project:Use = Unassigned	B : Facility and Project:Use = Not Applicable	C : Facility and Project:Use = Recreational	D : Facility and Project:Use = Educational	E : Facility and Project:Use = Office and Lab	F : Facility and Project:Use = Office	G : Facility and Project:Use = Medical Facility	TOTAL
1 : Communication	0	0	37%	13%	22%	10%	18%	100%
2 : Energy	0	0	22%	15%	8%	33%	22%	100%
3 : Environment	0	0	62%	4%	6%	11%	17%	100%
4 : Finance	0	0	30%	16%	20%	18%	18%	100%
5 : Future Use	0	0	0%	100%	0%	0%	0%	100%
6 : Occupant	0	0	30%	18%	8%	30%	15%	100%
7 : Participants	0	0	40%	20%	7%	7%	27%	100%
8 : TCO - LCCA	0	0	40%	20%	27%	7%	7%	100%
9 : Technology	0	0	17%	23%	35%	24%	0%	100%

Table 9: Facility Use Content Allocation - Classification

AVERAGES	A : Facility and Project:Use = Unassigned	B : Facility and Project:Use = Not Applicable	C : Facility and Project:Use = Recreational	D : Facility and Project:Use = Educational	E : Facility and Project:Use = Office and Lab	F : Facility and Project:Use = Office	G : Facility and Project:Use = Medical Facility
1 : Communication	0	0	24%	16%	23%	11%	23%
2 : Energy	0	0	8%	10%	5%	19%	15%
3 : Environment	0	0	10%	1%	2%	3%	6%
4 : Finance	0	0	26%	26%	28%	26%	31%
5 : Future Use	0	0	0%	3%	0%	0%	0%
6 : Occupant	0	0	8%	8%	3%	13%	8%
7 : Participants	0	0	6%	5%	2%	2%	8%
8 : TCO - LCCA	0	0	6%	5%	6%	2%	2%
9 : Technology	0	0	5%	12%	15%	11%	0%
10 : Data Used in Decision M	0	0	6%	8%	8%	6%	2%
11 : Timing	0	0	3%	5%	9%	6%	6%
TOTAL	**0**	**0**	**100%**	**100%**	**100%**	**100%**	**100%**

The following tables are breakdowns of content related to characteristics of the Decision Maker. These characteristics were collected via a demographic background information form that was released along with the consent to interview form. Each interviewee had the choice to complete, partially complete, or not complete this form. There are characteristics shown in the following tables for which interviewees decided not to provide their demographic information. Therefore the sample size for comparison in these areas has been made less than seven. Again, I caution readers not to make generalizations about the industry from these analyses, they should instead be considered as starting points or points of interest in future research. Once again with these analyses, Finance is shown to be the most common topic of discussion related to decision making, no matter the breakdown of the content (see Tables 11, 13, 15, 17, and 19).

Table 10:Age Content Allocation - Topic

AVERAGES	A : Interviewee: Age = Unassigned	B : Interviewee: Age = Not Applicable	C : Interviewee: Age = 20-29	D : Interviewee: Age = 30-39	E : Interviewee: Age = 40-49	F : Interviewee: Age = 50-59	G : Interviewee: Age = 60-69	TOTAL
1: Communication	19%	0%	0%	17%	32%	31%	0%	**100%**
2 : Energy	14%	0%	0%	36%	12%	38%	0%	**100%**
3 : Environment	6%	0%	0%	13%	13%	68%	0%	**100%**
4 : Finance	24%	0%	0%	18%	28%	30%	0%	**100%**
5 : Future Use	11%	0%	0%	89%	0%	0%	0%	**100%**
6 : Occupant	40%	0%	0%	6%	12%	41%	0%	**100%**
7 : Participants	34%	0%	0%	20%	10%	36%	0%	**100%**
8 : TCO - LCCA	29%	0%	0%	16%	33%	22%	0%	**100%**
9 : Technology	28%	0%	0%	19%	38%	15%	0%	**100%**
10 : Data Used in Decision Making Process	30%	0%	0%	18%	30%	22%	0%	**100%**
11 : Timing	20%	0%	0%	20%	39%	22%	0%	**100%**

Table 11: Age Content Allocation - Classification

AVERAGES	A : Interviewee: Age = Unassigned	B : Interviewee: Age = Not Applicable	C : Interviewee: Age = 20-29	D : Interviewee: Age = 30-39	E : Interviewee: Age = 40-49	F : Interviewee: Age = 50-59	G : Interviewee: Age = 60-69
1 : Communication	16%	0%	0%	16%	23%	20%	0%
2 : Energy	6%	0%	0%	18%	5%	13%	0%
3 : Environment	1%	0%	0%	2%	2%	7%	0%
4 : Finance	27%	0%	0%	24%	28%	27%	0%
5 : Future Use	1%	0%	0%	8%	0%	0%	0%
6 : Occupant	11%	0%	0%	2%	3%	9%	0%
7 : Participants	6%	0%	0%	4%	2%	5%	0%
8 : TCO - LCCA	6%	0%	0%	4%	6%	4%	0%
9 : Technology	13%	0%	0%	10%	15%	5%	0%
10 : Data Used in Decision Making Process	9%	0%	0%	6%	8%	5%	0%
11 : Timing	5%	0%	0%	6%	9%	5%	0%
TOTAL	**100%**	**0%**	**0%**	**100%**	**100%**	**100%**	**0%**

Table 12: Education Content Allocation - Topic

AVERAGES	A : Interviewee: Education = Unassigned	B : Interviewee: Education = Not Applicable	C : Interviewee: Education = Bachelors	D : Interviewee: Education = High School	TOTAL
1 : Communication	31%	0%	35%	34%	**100%**
2 : Energy	6%	0%	46%	48%	**100%**
3 : Environment	14%	0%	43%	43%	**100%**
4 : Finance	26%	0%	40%	34%	**100%**
5 : Future Use	0%	0%	100%	0%	**100%**
6 : Occupant	23%	0%	45%	31%	**100%**
7 : Participants	31%	0%	29%	41%	**100%**
8 : TCO - LCCA	30%	0%	55%	15%	**100%**
9 : Technology	64%	0%	36%	0%	**100%**
10 : Data Used in Decision Making Process	47%	0%	43%	9%	**100%**
11 : Timing	22%	0%	44%	33%	**100%**

Table 13: Education Content Allocation - Classification

AVERAGES	A : Interviewee: Education = Unassigned	B : Interviewee: Education = Not Applicable	C : Interviewee: Education = Bachelors	D : Interviewee: Education = High School
1 : Communication	22%	0%	18%	23%
2 : Energy	2%	0%	11%	15%
3 : Environment	2%	0%	4%	6%
4 : Finance	24%	0%	27%	31%
5 : Future Use	0%	0%	1%	0%
6 : Occupant	6%	0%	8%	8%
7 : Participants	6%	0%	4%	8%
8 : TCO - LCCA	4%	0%	5%	2%
9 : Technology	22%	0%	9%	0%
10 : Data Used in Decision Making Process	10%	0%	7%	2%
11 : Timing	4%	0%	6%	6%
TOTAL	**100%**	**0%**	**100%**	**100%**

Table 14: Place of Origin Content Allocation - Topic

AVERAGES	A : Interviewee: Place of Origin = Unassigned	B : Interviewee: Place of Origin = Not Applicable	C : Interviewee: Place of Origin = USA	D : Interviewee: Place of Origin = Canada	TOTAL
1 : Communication	29%	0%	31%	40%	**100%**
2 : Energy	8%	0%	68%	24%	**100%**
3 : Environment	19%	0%	63%	19%	**100%**
4 : Finance	25%	0%	38%	38%	**100%**
5 : Future Use	0%	0%	100%	0%	**100%**
6 : Occupant	27%	0%	55%	18%	**100%**
7 : Participants	41%	0%	46%	14%	**100%**
8 : TCO - LCCA	22%	0%	33%	44%	**100%**
9 : Technology	44%	0%	17%	40%	**100%**
10 : Data Used in Decision Making Process	36%	0%	28%	36%	**100%**
11 : Timing	18%	0%	30%	53%	**100%**

Table 15: Place of Origin Content Allocation - Classification

AVERAGES	A : Interviewee: Place of Origin = Unassigned	B : Interviewee: Place of Origin = Not Applicable	C : Interviewee: Place of Origin = USA	D : Interviewee: Place of Origin = Canada
1 : Communication	22%	0%	18%	23%
2 : Energy	2%	0%	13%	5%
3 : Environment	2%	0%	5%	2%
4 : Finance	24%	0%	27%	28%
5 : Future Use	0%	0%	1%	0%
6 : Occupant	6%	0%	9%	3%
7 : Participants	6%	0%	5%	2%
8 : TCO - LCCA	4%	0%	4%	6%
9 : Technology	22%	0%	6%	15%
10 : Data Used in Decision Making Process	10%	0%	6%	8%
11 : Timing	4%	0%	5%	9%
TOTAL	**100%**	**0%**	**100%**	**100%**

Table 16: Race Content Allocation - Topic

AVERAGES	A : Interviewee: Race = Unassigned	B : Interviewee: Race = Not Applicable	C : Interviewee: Race = Asian	D : Interviewee: Race = Caucasian	E : Interviewee: Race = Hispanic	TOTAL
1 : Communication	20%	0%	35%	18%	27%	**100%**
2 : Energy	12%	0%	27%	32%	28%	**100%**
3 : Environment	5%	0%	51%	11%	33%	**100%**
4 : Finance	24%	0%	32%	19%	25%	**100%**
5 : Future Use	11%	0%	0%	89%	0%	**100%**
6 : Occupant	37%	0%	34%	6%	23%	**100%**
7 : Participants	29%	0%	22%	16%	33%	**100%**
8 : TCO - LCCA	34%	0%	36%	20%	10%	**100%**
9 : Technology	38%	0%	37%	25%	0%	**100%**
10 : Data Used in Decision Making Process	36%	0%	36%	21%	7%	**100%**
11 : Timing	23%	0%	33%	23%	23%	**100%**

Table 17: Race Content Allocation - Classification

AVERAGES	A : Interviewee: Race = Unassigned	B : Interviewee: Race = Not Applicable	C : Interviewee: Race = Asian	D : Interviewee: Race = Caucasian	E : Interviewee: Race = Hispanic
1 : Communication	18%	0	25%	19%	30%
2 : Energy	7%	0	12%	21%	20%
3 : Environment	1%	0	8%	2%	8%
4 : Finance	32%	0	33%	29%	40%
5 : Future Use	1%	0	0%	10%	0%
6 : Occupant	13%	0	10%	2%	10%
7 : Participants	7%	0	4%	5%	10%
8 : TCO - LCCA	7%	0	6%	5%	3%
9 : Technology	15%	0	12%	12%	0%
10 : Data Used in Decision Making Process	10%	0	8%	7%	3%
11 : Timing	6%	0	7%	7%	8%
TOTAL	**100%**	**0%**	**100%**	**100%**	**100%**

Table 18: Gender Content Allocation - Topic

AVERAGES	A : Interviewee: Gender = Unassigned	B : Interviewee: Gender = Not Applicable	C : Interviewee: Gender = Male	D : Interviewee: Gender = Female	TOTAL
1 : Communication	31%	0%	25%	44%	**100%**
2 : Energy	6%	0%	59%	35%	**100%**
3 : Environment	14%	0%	29%	57%	**100%**
4 : Finance	25%	0%	31%	44%	**100%**
5 : Future Use	0%	0%	80%	20%	**100%**
6 : Occupant	21%	0%	31%	48%	**100%**
7 : Participants	33%	0%	26%	41%	**100%**
8 : TCO - LCCA	24%	0%	16%	60%	**100%**
9 : Technology	52%	0%	19%	30%	**100%**
10 : Data Used in Decision Making Process	38%	0%	21%	41%	**100%**
11 : Timing	21%	0%	34%	45%	**100%**

Table 19: Gender Content Allocation - Classification

AVERAGES	A : Interviewee: Gender = Unassigned	B : Interviewee: Gender = Not Applicable	C : Interviewee: Gender = Male	D : Interviewee: Gender = Female
1 : Communication	22%	0	16%	20%
2 : Energy	2%	0	18%	7%
3 : Environment	2%	0	4%	5%
4 : Finance	24%	0	27%	27%
5 : Future Use	0%	0	2%	0%
6 : Occupant	6%	0	8%	9%
7 : Participants	6%	0	4%	5%
8 : TCO - LCCA	4%	0	2%	6%
9 : Technology	22%	0	7%	8%
10 : Data Used in Decision Making Process	10%	0	5%	7%
11 : Timing	4%	0	6%	6%
TOTAL	**100%**	**0%**	**100%**	**100%**

Chapter 5: Discussion

5.1 Knowledge Gained

A common theme among the observed projects was that the necessity for replacement was seen as an opportunity to upgrade a building system. Note that among the lighting projects, it was assumed that the fixtures would be upgraded from fluorescent to LED. Several times the decision makers commented on the significant drop in price of LED bulbs from a few years ago, and the energy savings from installing these bulbs is undeniable. Among the HVAC projects this upgrade was not so assumed. Of the three HVAC projects, two began as one-to-one replacements; the third was always intended to be an upgrade. Of the intended replacements, during further investigation into available options, an upgrade was selected as the most economically wise investment. The decision maker involved with the replacement without an upgrade expressed the regret of a lack of communication among team members. Looking back, a more suitable system may have been installed, resulting in a type of upgrade for that project as well.

Asking the interviewees to explain their considerations of the return on the investment, terms such as first cost, energy savings, and reduced operations and maintenance were common. As presented in the results, six of the seven projects referred to some kind of payback period for their investments. Decision makers mentioned this having to do both with the lifetime of the system and the cost of borrowing money for investment. Whether the organization owned the building containing the system or was leasing it played a role in the expected return as well.

Although LCCA and TCO were familiar terms to the decision makers, these are not methods of system evaluation that were commonly used. Combining LCCA and TCO, a loose definition found among the interviews was a simple payback that included energy and operations savings. Other decision makers acknowledged that LCCA and TCO were not used on their projects because their organizations did not call for that level of analysis on the small scope of one system. This misunderstanding of the

terms would indicate that LCCA and TCO methods are not being used on the small-scale building system level, and may not be well understood by decision makers in the industry. Because many of these projects were sent to outside contractors for evaluation, it is impossible to know whether a more accurate LCCA method was utilized. Given the integrated nature of TCO it is more certain that this method was not utilized on any of the included projects.

Finances appear to be the root consideration of the participating decision makers. One project considered its LEED certification to be an important environmental indicator, however the majority of the projects considered the environment only in that they made an effort to reduce their energy consumption. A reduction in energy consumption has an environmental factor, however it was typically mentioned in the context of an economic savings for the organization.

Even in the instances that building occupants were included in the decision making process, there was no indication that the system's effects on the building occupants was a driving force behind selection of the building system. This is with the exception of an HVAC system designed for lab spaces in which the user can request alterations based on lab activities. This exception was spoken of with reference to both the safety of the lab occupants, and the efficiency and effectiveness of the HVAC system.

Overall, the interviews indicate that current industry practice is to consider a variation of a simple payback based on first cost, energy savings, and savings in O&M costs.

This use of a relatively simple payback analysis for decision-making contrasts sharply with the theoretical framework developed by our team to optimize building value. Analysis of the interviewed Decision Makers shows a valuation process that takes a simplified shape, considering little more than Simple Payback. This process, as compared to the developed framework, is extremely simplified. The

concept of agents is almost completely absent, with Decision Makers considering energy savings a benefit in itself.

During development of the valuation framework developed by the team there was some debate about certain terms, questioning and solidifying the definitions that were established. For example, current Decision Makers are talking about energy savings as a benefit. This is of course true to an extent, however, the team of professionals gathered for framework development meetings broke down the relatively clumsy term of energy savings. It was determined that a reduction in energy use should be considered an agent. It is an agent that leads to a reduction in the cost of operations, a benefit. It is also an agent that leads to the betterment of the environment surrounding the energy source, another agent, which will produce it's own associated benefits. With this one seemingly simple example, the complexity of the developed framework should become abundantly clear.

As with the current process, the developed framework intends to convert all investments and benefits to dollar numbers. This is for ease of comparison. It also means that significant research must take place in order to quantify some of the benefits that our team has named: Occupant Social Interaction and Communication, Acoustical Comfort, and Improved Neighboring Infrastructure for example.

One consistency between the processes is that they are iterative. Once a Decision Maker has found a potential investment, there is an inquiry into the benefit associated with that investment. If another potential investment is found then the process starts again, and the most beneficial of the presented investments will be chosen. In some cases, such as lighting systems, there may be an obvious investment, whereas in other cases, as with the HVAC systems, several possible options may need to be considered before a final decision is made.

The current decision making process shows that there is a lack of breadth to the considerations made about investments on a daily basis. Further development of a more comprehensive model has a clear place in the future of building valuation.

5.2 Limitations

As this research was conducted one of the most important findings was actually discovering how little has been documented to record the decision making process in the building industry. Understanding that this study would be limited, it was not clear the extent of those limitations until research was well underway. While networking and conducting interviews it became abundantly clear that this type of decision involves a team of individuals, each with a slightly different set of information and priorities. Given that this researcher was only able to speak with one decision maker per project, the perspective provided is narrow. In speaking with our decision makers it became clear that for a full understanding of the priorities involved in the decision making process, further research must be conducted in which every member, from the owner forward must be interviewed.

Further limitations recognized in this study are the inclusion of only two types of systems. A building is comprised of more than HVAC and lighting systems, so research containing only those systems can only be generalized to other similar systems.

Yet another way that this study was limited further than expected was in the lack of available qualitative data for analysis. The majority of the projects were not able to provide qualitative data to the team, eliminating the possibility of pattern matching trends in that data to the trends found in the interviews. This inability to provide data may be due to limited access or to a lack of records. Because

this data was not provided, yet each interviewee references some kind of data use, little speculation can be made about the nature of the utilized data sets.

Chapter 6: Conclusions and Recommendations

The interviews conducted in this study show that current industry practice for decision-making regarding individual system replacements is a Simple Payback evaluation. Decision makers across the board recognized that their investments had an impact on other areas such as the environment and the building occupants, however typically the investment decision ultimately came back to finances.

Currently, the literature on LCCA in the building industry is robust, and TCO is just coming on the scene. However, these concepts are not seen to be implemented at the low levels of building system investment. Interviews report that this is either due to the amount of effort required to complete a full LCCA, or a misunderstanding of the depth of a LCCA.

In a process of further validating these findings, repetition of this study will be necessary to expand the understood scope. A comprehensive study of one investment, speaking with every participant, from the owner or director of the organization to the workers who install the equipment may present interesting findings related to how the communication within the organization effects decision making. This, of course, will vary depending upon the company structure, requiring several of these types of investigations to draw generalizable conclusions.

Moving forward it will be important that the comprehensive effects of an investment are made simple to understand, to tailor to a specific project and location, and to analyze. The process model developed by our group of experienced practitioners will provide a structure for further research in these areas. The ultimate goal of this research being to create a tool that will assist decision makers in including more of the impacts of their investment in the decision making process.

Until further research is completed, this study has served to open up a proverbial can of worms, which should be examined until decision-making processes are well understood so that future ideas for change can be effectively implemented. This study works to confirm the assumption that researchers and industry members have been working from for decades – that the bottom line in any building system related decision is maximized financial gain or minimized financial loss. Results here show that assumption to be valid, though as was made clear, substantially more research is needed in this area to establish a firm baseline.

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Appendix A: Well Building Standard Example

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ELECTRIC LIGHT GLARE CONTROL

Non-diffuse, bright indoor lights create uneven levels of brightness in the visual field. The resulting glare, defined as "excessive brightness of the light-source, excessive brightness-contrasts and excessive quantity of light", can cause visual discomfort (discomfort glare), fatigue, visual impairment and even injury (disability glare), and can be attributed to either direct or reflected glare. In the case of glare caused by electric light sources, lamps should be shielded based on their luminance.

This feature sets limits on glare based on measures of luminous intensity, or luminance per area of light source. This quantity, often given in cd/m², can be measured directly or calculated from lighting specification sheets with sufficient detail. Light fixtures of greater luminous intensity require a greater shielding angle to reduce the likelihood of creating direct glare for occupants.

Muscular
Nervous
Skeletal

	Core and Shell	New and Existing Interiors	New and Existing Buildings
PART 1: LAMP SHIELDING	-	P	P

Lamps with the following luminance in regularly occupied spaces are shielded by the angles listed below or greater:

a. Less than 20,000 cd/m², including reflected sources: no shielding required.

b.[79] 20,000 to 50,000 cd/m²: 15°.

c.[79] 50,000 to 500,000 cd/m² : 20°.

d.[79] 500,000 cd/m² and above: 30°.

PART 2: GLARE MINIMIZATION	P	P	P

At workstations and desks, the following requirement is met:

a.[174] Bare lamps and luminaire surfaces more than 53° above the center of view (degrees above horizontal) have luminances less than 8,000 cd/m².

Appendix B: Investments, Agents, Benefits

Note that although these are listed in table format, there is no intended correlation among the rows.

Investment	Agent	Benefit

Building Systems	Political Outlook (Negative Agent)	Reduced Lifetime Operating Costs OR Value of Property
Outdoor Access	Improved Comfort	Improved Financial Benefit Due to Greater Occupant Productivity
Material Choices	Ability to modify Space/Flexible Designs	Drug Costs Reduced
Repair and Rehabilitation	Ability to adapt to new technology	Market Share Increase
Resilience	Performance (Negative and Positive Agent)	Philanthropy Increased
Universal Buildings	Occupant Well-being	ROI
Latest Equipment, Systems, and Layout	Reduced Carbon Footprint	Reduced Insurance Premiums
Information and Communication Technology	Improved Service through investment in technology/ IT services	Lower Prescription Costs
Optimizing Floorplates	Public/Occupant Perception on Quality	Lower Medical Costs
Energy Independence/Renewables	Reduced Maintenance and Replacement	
Service in Healthcare Facilities	Optimizing Indoor Environment	
Internal Aesthetics	Useful Organizational Patterns	
External Aesthetics	Building Reputation	
Access to Pleasing Views	Safety and Health Codes	
Furniture aiding in social interactions	Soft Landings and Training on Systems	
Sound absorbing surfaces	Resource Consumption [Positive and Negative Agent]	
Using Recycled Water for Irrigation Purposes	Occupant Motivation	
Facility to Deal with Waste	Occupant Satisfaction	
Staff Support Facilities	Spiritual Connection	
Space	Ergonomics	

Site Selection That Promotes Community Integration	Functionality	
Biophilic Design	Credit Worthiness	
Indoor Lighting and Natural Lighting	Building Resilience	
Incorporation of Art	Meeting Demands	
Green Roofs and Gardens	Employee and User's Physical and Mental Stress Reduction	
Sidewalks and Bike Trails	Employee and User's Fatigue	
Smart Technology	Noise (Negative agent)	
Occupant Controls	Ecologically Healthy Building	
Access to Fresh and Healthy Food Options	Reduce Construction Waste by Recycling Concrete from Demolished Structures	
Spaces Encouraging Physical Activity	Reduced Energy Use for Heating, Ventilation, and Air Conditioning	
Investing in Pushing for Zoning Regulations	Occupant output/productivity	
	Building Performance	
	Improved Ergonomics	
	Premium Rent	
	Ability to Lease Buildings More	
	Lower Absenteeism	
	Budget Concerns (Negative Agent)	
	Prioritization (Negative Agent)	
	Lack of Client Interest (Negative Agent)	
	Contractor and/or Owner Lack of Expertise	
	Lower Levels of Obesity	

	Fewer ER visits	
	Decrease in Hospital Admissions	
	Competitive Pressure	
	Acoustical Comfort	
	Nosocomial Infections Reduced	
	Reduced Students or Patient Transfers (Health Care and Education)	
	Improved Cognitive Ability	
	Reduced Natural Resource Consumption	
	Accessibility	
	Improved Neighboring Infrastructure	
	Urban Identity	
	Public Transport	
	Less Crime	
	Proffering	
	Access to Data	
	Occupant Social Interaction and Communication	
	Improve Health/ Reduced Injuries	
	Recruitment and Tourism	
	Sustainability Targets	

Appendix C: Transcription Notation Convention

In order to stay consistent across transcribers, we ask that you follow the following conventions when transcribing.

1. Spell out numbers and dates ("the twentieth of March" instead of "the 20th of March.")
2. If you can't understand part of what someone says, mark it with **XXX**
3. Include commas, question marks, and exclamation points as you prefer for readability. Avoid using hyphens and parentheses.
4. Be very accurate with false starts and filled pauses ("this..", "ahmm", "What ..what we decided…"). For filled pauses, try to use whichever of the below choices best fits the filled pause, making sure to keep the number of m's and h's constant.
    a. ahm
    b. uhm
    c. ehm
    d. ahh
    e. aha
5. Use the following symbols for non-speech items
    a. {SIL} – silence longer than ~ 2 seconds
    b. {LG} – laughter
    c. {NS} – random noise
6. Acronyms, Letters, and Abbreviations:
    a. If an interviewee says a letter "Starting with H", transcribe the single letter
    b. If they use an acronym that is spoken just like the names of the letters, break it down into separate letters. (D.F.)
    c. If they use an acronym that is pronounced different than the names of the letters (think OTAN [otan]), transcribe it as a single word.
7. If there is overlap between two speakers, be especially careful with boundaries! We need them to be extremely precise when there is overlap.
8. Don't use extra letters for when speakers stretch out for emphasis. "Oh," instead of "Ooooh,"
9. For non-standard lenition or aspiration processes, spell the "full" form. For instance, "talking" instead of "talkin'".

Appendix D: Nvivo Node Development

Set	Node Name	Description of Coded Content
Set 1	Building Importance	Mention of the importance of the building to the decision maker.
	Cause of Investment	Mention of the cause of the investment or the reasoning related to a simple replacement versus an upgrade.
	Decision Maker – Beliefs	Beliefs that the decision maker has regarding both the environment and their organization.
	Decision Maker – Involvement	The extent to which the decision maker interacts with the building occupants.
	Decision Maker - Lifestyle	Specifically related to question 2c.
	Energy	Any response relating to energy or energy savings.
	Environment	Any response relating to the environment.
	Finance	Any response related to finance.
	Future Use	Relating to the future use of the facility.
	Lease	Mention of a lease agreement or the consequences thereof.
	O&M	Mention of Operations and Maintenance.
	Occupant	Relating to the effects that the investment has on the building occupant.
	Participants	Relating to the types of individuals who are a part of the decision making process. Mostly with regards to building occupants.
	Standards	Relating to building codes or organizational standards.
	TCO/LCCA	Mention of TCO or LCCA, it's use or lack of.
	Timing	Related to the schedule of the project.
Set 2	Communication	Regarding any contact between the decision maker and an outside party.
	Risk	Related to safety, specifically mentioned 'risk.'
	Scope Creep	Mention of expansion of the project after the an initial scope has been established.
	Technology	Any content relating to the specific functionality or type of building system being installed.
	Technology – Data Used in Decision Making Process	Specifically marks mention of the types of data that are used in the decision making process.
	Technology – Expected Life	Expected life of the newly installed building system.

Appendix E: Interview Transcriptions

Interview 03-02-03-05

Start Time	End Time	Transcript 03-02-03-05	Speaker
00:00:00.0	00:00:08.3	Okay. How have you been today?	Interviewer
00:00:08.3	00:00:08.4	Pretty good. It's Monday. {LG}	Participant
00:00:11.4	00:00:14.3	Yeah, true.	Interviewer
00:00:14.3	00:00:14.4	Yeah. {LG}	Participant
00:00:14.3	00:00:37.5	Okay, so I'm looking at the background form and the consent form that you gave me and I just wanted to walk through and make sure that the consent form is really clear and then maybe go through and have you kind of set the stage for me a little bit with what this lighting project actually is.	Interviewer
00:00:37.5	00:00:37.6	Okay	Participant
00:00:40.7	00:00:48.6	Uhm, so unless you have any questions I'm going to kind of jump over the consent form.	Interviewer
00:00:48.6	00:00:49.8	That's fine.	Participant
00:00:49.8	00:00:59.9	Okay and so this says that there was a lighting replacement/upgrade in the Student Center.	Interviewer
00:00:59.9	00:01:00.0	Correct.	Participant
00:01:01.4	00:01:07.1	The one question that I had initially was, uhm, what year was that, that it happened?	Interviewer
00:01:07.1	00:01:14.5	We're proposing to do that this year. It should get under construction, hum, its in project management right now, it should get under construction shortly.	Participant
00:01:14.5	00:01:14.6	Okay	Interviewer
00:01:15.9	00:01:16.0	{NS}	Participant
00:01:15.9	00:01:28.6	Okay, and is that going to be the entire student recreation center? Or is there	Interviewer
00:01:28.6	00:01:38.4	No, theres three location within there. Theres three courts that we're looking at. A turf court, the upper basketball gym, and the lower basketball gym.	Participant
00:01:38.4	00:02:04.3	Okay. Okay, so I am going to go ahead and jump to some of the questions that I had already sent before. So specifically relating to this lighting system, why was this building feature selected to upgrade?	Interviewer
00:02:04.3	00:02:27.8	So, a little bit of background. The rec center went under, underwent a major renovation, uhm, I think it probably started about six years ago and finished up a couple years after that, so for about four years ago, it just finished up. So in that addition and renovation they added some areas as well uhm, upgraded the existing old facility.	Participant
00:02:27.8	00:03:02.7	When they did that they initially intended to use LED lighting hum, but because of cost overruns at the time it got value engineered out. Four years later now, a lot of the existing XXX fluorescents that were in there are now starting to burn out. So theres a major cost involved with going in and re-lamping which is why they approached me concerning an	Participant

		energy ma.. management project which can help pay for doing an upgrade now to LED.	
00:03:02.7	00:03:09.0	So those are just the three main areas in the rec center with large open courts.	Participant
00:03:09.0	00:03:09.1	Mhm	Interviewer
00:03:09.1	00:03:34.4	This basketball courts, and then the turf field is for soccer, that kind of thing. But its just a large open gymnasium. So they approached me, yea, its probably been about a couple of months ago now. Uhm, looking for funding to help fund a full replacement to LED. One, because they had to do some replacements anyways because the lamps are starting to burn out that are in there and two, of course, for energy savings cost savings.	Participant
00:03:34.4	00:03:37.8	Okay so you.. we're upgrading to LEDs? Or will be.	Interviewer
00:03:37.7	00:03:39.0	Correct	Participant
00:03:39.0	00:03:48.5	Were there any other alternatives that were considered for this or different areas of the building or was this kind of the..	Interviewer
00:03:48.5	00:04:39.3	We didn't.. We did not look at other areas of the building in this particular request. We previously did a lighting upgrade in the natatorium. Those went from some old metal high-rise to a new LED system that was completed, gosh, probably about a year ago now. Uhm, at least last summer that was completed. We look at projects and buildings like that, uhm most of the time, in a one off case. You know, as as either equipment is failing as in this case some of the light fixtures were burning out. Or if there's some other renovation going on we may look at one area over another. Most buildings we don't go in and just do a holistic lighting upgrade on our existing buildings uhm unless we're doing some type of a performance contract.	Participant
00:04:39.3	00:04:56.1	Okay. Uhm, so how.. You said they came to you a couple of years ago with asking for funding, so how did you consider the kind of returns that you would get from making this upgrade to LEDs?	Interviewer
00:04:56.1	00:05:04.7	So for these uhm projects, for the courts, they actually they didn't come a couple of years ago, it was just a couple of months ago probably.	Participant
00:05:03.5	00:05:04.7	Okay	Interviewer
00:05:04.7	00:05:35.8	Uhm and I, with my funding, am required to meet a seven to ten year payback or less. That doesn't mean that every project I can contribute to will pay back in that amount of time. But that's the amount, we have to look at the ROI, that's the amount I can then fund. So in these cases, uhm the Rec Center is going to contribute I think some money on these, and then I'll contribute that difference in order to meet my ROI.	Participant
00:05:35.8	00:05:46.5	Okay and that money.. so the Rec Center has a fund, and then the money that you would be funding would come from the Energy Department of the Facilities?	Interviewer
00:05:45.5	00:05:57.5	Correct. I have, I have two funding sources for Energy	Participant

		Conservation projects on campus. One is an expense account it has about five hundred thousand dollars in it each year.	
00:05:57.4	00:05:58.3	Mhm	Interviewer
00:05:58.3	00:06:10.5	Of which my costs, my employees' costs, our benefits, any expenses involved with the program come out of there first. So training, salaries, insurance, all that kind of stuff.	Participant
00:06:10.5	00:06:10.9	Mhm	Interviewer
00:06:10.9	00:06:47.0	And then the remainder, which is sometimes around three hundred thousand in the end, I can then use for expense type projects on campus, not capital. And those are delegated up to seventy five thousand dollars. So any small replacements, so on and so forth that uhm, or studies. Uhm, we're doing some work with NREL. We can do studies. Uhm, small projects up to about seventy five thousand dollars can be funded out of that funding source. And once again, anything that really involves equipment has to meet a seven to ten year payback on what I can fund.	Participant
00:06:47.7	00:07:12.4	And then I have a separate account which is for more, uhm, repair and replace. That's a capital fund. It does not have a cost limit as far as how much I can spend on a project. Of course theres a max because I only have a budget of five hundred thousand also in there. Uhm, but once again, it still has to meet a ROI of at least, between seven and ten years, or better. If I can find something better that'd be great. {LG}	Participant
00:07:12.4	00:07:14.8	Right, yeah.	Interviewer
00:07:14.8	00:07:40.7	Yeah, so what I do when they come to me with a project. I'll do the calculations to determine the energy savings, and then look at the ROI and say it comes out at fifteen years. Well, I can then only fund a buy down to get it to a seven year or ten year payback. So I contribute part of it and then our customer, in this case the Rec Center, contributes part of it.	Participant
00:07:40.7	00:07:51.2	Okay, and so uhm what were the predicted performance changes that you calculated? Rela.. For the specific..	Interviewer
00:07:50.1	00:07:58.0	Uhm, I can send you this lovely spreadsheet with all my calculations for the different areas. {LG} But we're hoping that the..	Participant
00:07:55.4	00:07:57.0	Okay, that sounds great.	Interviewer
00:07:58.4	00:07:58.8	Huh?	Participant
00:07:59.2	00:08:00.2	That sounds great.	Interviewer
00:08:00.2	00:08:38.5	Yeah, I'll send it to you. Uhm In the end, let's see here, I'm hoping to save about eighteen thousand dollars a year, in energy costs. And the total cost for all three projects came in at almost a hundred and thirty nine thousand, plus our project management cost, plus a contingency, which brought it all up to about a hundred and sixty eight thousand. Of which I can buy down those seven year paybacks and contribute almost a hundred and twenty thousand, and the rec center's putting in about forty eight thousand.	Participant
00:08:38.5	00:08:40.0	Okay	Interviewer

00:08:40.0	00:08:54.0	And I will send you this. Its just a quickie spreadsheet with all of the existing fixtures, new fixtures, uhm expected hours of operation, how much it costs to then operate the old versus the new.	Participant
00:08:54.0	00:09:12.2	Mhmm, that sounds really helpful. Uhm, so was there a specific timescale other than this payback period. Was the rec center, like, trying to get this project done by a certain date or..?	Interviewer
00:09:12.2	00:09:18.0	No, but like I said, they were having some existing fixtures there start to burn out.	Participant
00:09:18.0	00:09:18.8	Mhm	Interviewer
00:09:18.8	00:09:35.7	You notice when you go in the buildings if they're old fluorescent fixtures they start to color change. The temperature of the lamp itself changes. So they start, sometimes they tend to have a pink color. So next time you're walking around in the building and you see one of the fixtures that's really pink,	Participant
00:09:35.0	00:09:35.8	Mhm	Interviewer
00:09:35.7	00:09:51.3	That means that the lamps are about to to burn out, and in these particular areas. Uhm in these courts, that means you have to go rent a lift to come in to do those lamp replacements. So typically when you do a lamp replacement like that you do all of them.	Participant
00:09:51.3	00:09:52.2	Right	Interviewer
00:09:52.2	00:10:27.4	If you're going to rent a lift to come in there, yeah. You're not going to waste a lot of money doing onsie twosies. So then they have to take a look at uhm you know the best time if we're going to look at an upgrade versus just going in and do a lamp replacement. So when the rec center came to me you know they had some money already set aside to do lamp replacements but with my contribution, based on that seven year payback, it allowed them to use the money they would have used for a simple lamp replacement to do an energy upgrade uhm and get savings from their uh on their energy costs too.	Participant
00:10:27.4	00:10:28.6	Right	Interviewer
00:10:28.6	00:10:32.8	So in the end it didn't cost them any more, it may have even been less. I don't know how much money	Participant
00:10:32.8	00:10:34.0	{LG} Yeah.	Interviewer
00:10:34.0	00:10:43.9	um he had, he had originally. It could have been a great deal for him. But for me I'm always looking at projects like this, uhm, that need that payback that will save the the campus money of course.	Participant
00:10:43.9	00:10:51.2	Okay, so it sounds like you're using a lot of Life Cycle Cost kind of factors in your desi..	Interviewer
00:10:51.2	00:11:03.9	Not necessarily because uhm, our senior vice chancellor, whose name is Kelly Fox, she doesn't like us to look at all of the operation cost savings.	Participant
00:11:03.9	00:11:05.1	Okay	Interviewer

00:11:05.1	00:11:57.9	And that's because we have people on staff of course here that are maintenance workers and people that, we wouldn't fire them if we didn't do this. So I can't take a true dollar savings for operational cost savings. So even though by putting in LED, and these are going to last 20 years, you know. They don't burn out like a a fluorescent does. I as an energy manager, especially at previous jobs, would always go in and look at, how much is it really saving the entity, the owner. And I would include, well hey, you don't have to replace those lamps every five years, four years, so therefore you're saving the manual labor cost of somebody going in and doing this upgrade. Uhm, we don't like doing that on campus. And a lot of entities like ourselves, other universities, and cities, and counties, they don't like doing that because you're not really going to fire somebody {LG}.	Participant
00:11:57.9	00:12:05.4	You're not saving any man hours, it just allows them to go do other work. It opens up their time to do other things so..	Participant
00:11:58.2	00:11:59.4	Right.	Interviewer
00:12:05.3	00:12:13.3	I can't really take that Life Cycle Cost into account. All I can take into account is energy only right now.	Participant
00:12:13.6	00:12:30.5	Okay, so you haven't looked into any of, kind of, the beginning of that life cycle situation either, where like, where the bulbs are coming from or the transportation and, like, the company that you're purchasing them from and those kinds of things?	Interviewer
00:12:30.5	00:12:48.3	You know the University has some sustainability requirements for what we purchase. Uhm, that's all handled by procurement. They do try to be sustainable, make sure we're not ah shipping equipment in here from all over the world because of course theres a cost involved with that.	Participant
00:12:48.3	00:12:48.7	Right	Interviewer
00:12:48.7	00:12:59.6	By the time it gets to me and what we're doing, uhm, I don't look at those those things. We, in this particular case, you know, it'll go out to bid to three contractors.	Participant
00:12:59.6	00:13:00.6	Mhm	Interviewer
00:13:00.6	00:13:21.2	And whoever comes back with the best price and in the time frame will end up getting it. So I don't take into account any of that lifecycle as far as transportation. Now, I will say on new construction though, it's a little different. New construction for the University, we have to achieve LEED Gold, do you know what LEED is?	Participant
00:13:21.2	00:13:22.0	Yes.	Interviewer
00:13:22.0	00:13:27.3	Yeah, so we have to achieve LEED Gold by the state statutes.	Participant
00:13:27.3	00:13:28.1	Okay	Interviewer
00:13:28.1	00:13:44.8	And in order to get LEED points of course, you're looking at materials and equipment that don't come in from, you know, across the world. Uhm you get more points for buying products and pieces from, you know, within a hundred miles. Uhm	Participant

00:13:44.8	00:13:46.3	Mhm	Interviewer
00:13:46.3	00:13:53.9	There's there's extra ways to get points which the University looks at, which I do not have to look at in a retrofit project.	Participant
00:13:53.9	00:14:09.7	Okay, okay that makes sense. So those things were considered, well I guess all of it has been a retrofit, since they renovated the old facility in four years ago, and then this is upcoming.	Interviewer
00:14:09.7	00:14:14.4	That's correct, but the major renovation that was done four years ago was a capital project.	Participant
00:14:14.4	00:14:15.0	Okay.	Interviewer
00:14:15.0	00:14:19.9	So they did still have to meet LEED Gold requirements.	Participant
00:14:19.9	00:14:20.5	Okay.	Interviewer
00:14:20.5	00:14:35.4	So when they did that they did source local materials, recycled materials, all of the things that get you LEED points. Now when I'm doing this project here four or five years later after that major renovation capital work.	Participant
00:14:35.4	00:14:36.4	Mhm	Interviewer
00:14:36.4	00:14:45.1	I do not have to meet any kind of LEED, any kind of sustainability standards. I have to meet ROI. So.	Participant
00:14:45.1	00:14:56.1	Okay, so the ROI here's taking precedent. Do you still try to meet the LEED standards if you are able to, with in that? Is, are those..	Interviewer
00:14:56.1	00:15:02.8	Well keep in mind that when I'm doing upgrades and its energy efficiency, and LEED of course is Leadership in Energy and Efficiency Design. I'm,	Participant
00:15:02.8	00:15:03.1	Right	Interviewer
00:15:03.1	00:15:09.4	I'm, if we could have done LED in the major capital project we would have gotten more points.	Participant
00:15:09.4	00:15:10.3	Right	Interviewer
00:15:10.2	00:15:14.2	It is still meeting or exceeding the LEED Gold.	Participant
00:15:14.2	00:15:15.0	Okay	Interviewer
00:15:15.0	00:15:16.2	What I do.	Participant
00:15:16.2	00:15:16.3	Okay	Interviewer
00:15:16.5	00:15:24.3	Yea, but as far as material resourcing, like I said our procurement group manages the sustainability aspects of what we procure.	Participant
00:15:24.3	00:15:25.4	Mhm	Interviewer
00:15:25.4	00:15:40.9	So they're the ones looking at specific vendors, we have lists of vendors, we have lists of contractors who have agreed to meet those types of requirements and thats why they get to keep doing business with the university.	Participant
00:15:40.9	00:15:47.9	Okay, yeah, I think the university has a pretty high standard for all of the things, the people they work with.	Interviewer
00:15:47.9	00:16:00.0	That's correct. And then, once you're on that list, you're, you're the people that we go out to. Those vendors are the ones we go out to for bidding. We don't go generally out to the public for small projects like this.	Participant
00:16:00.0	00:16:19.7	Okay. Uhm, so, the next question that I have would be: to what extent were occupants involved in the decision making	Interviewer

		process? And I guess this would have kind of two elements, of the students or users, and and the employees possibly.	
00:16:19.7	00:16:26.7	So, student government fees uhm that you pay in your tuition, pay for the rec center.	Participant
00:16:26.7	00:16:27.7	Mhm.	Interviewer
00:16:27.7	00:16:56.1	So, in a way {LG} I guess, all students, who are students where, and are enrolled here, are helping to pay for these projects. Student, student council has a sustainability group that's always pushing that we do more and more sustainable upgrades to our buildings. They were not specifically a part of the decision making process. So that when I submitted my calculations back to the rec center on how much I could fund and what my cost estimate was	Participant
00:16:56.1	00:16:57.0	Mhm	Interviewer
00:16:57.0	00:17:13.5	it didn't go to the students to review, but it went to the staff at the rec center who said, this is great, we can save all this energy and become more efficient, and its only going to cost us, whatever. There was never, it never went back to like the student council or anybody.	Participant
00:17:13.5	00:17:14.3	Okay	Interviewer
00:17:14.3	00:17:23.0	Uhm, as far as occupants and people that use the building. You know, I don't know that many of them even notice {LG} to be honest with you.	Participant
00:17:23.0	00:17:24.0	Yea, probably not.	Interviewer
00:17:24.0	00:18:04.5	I think the only way they'll even know something is going on is because we have to close down those courts, and like we had to close down the natatorium, uhm for a short period of time while we did construction. Uhm, beyond that I don't know that they have any input. You know, I I know I tour classes through there. We tour all over the campus, uhm taking different engineering or sustainability or environmental classes there, and they always say, well, why don't we upgrade to more LEDs, why don't we do this, why don't we do that. So I guess in a sense, you know, they're telling me what they want, but they don't have a direct vote or decision making piece in our whole process.	Participant
00:18:04.5	00:18:04.6	Right, okay.	Interviewer
00:18:05.8	00:18:06.8	Yeah.	Participant
00:18:06.8	00:18:15.9	So theres no uhm, there's no other, like, student board thats working with you guys other than that sustainability group?	Interviewer
00:18:15.9	00:18:22.7	With student council, yeah. And and to be honest with you, I've not met even with their that group this year.	Participant
00:18:22.7	00:18:23.5	Okay	Interviewer
00:18:23.5	00:18:56.9	This school year {LG} Last year and the year before, the young man that was a in charge of it, met with him quite often, I met with him regularly, but this they they've never, they never reached out. Now there is a Energy Club, CU Energy Club. Uhm they come talk to me quite a bit and they do audits for me and, so they're involved. They're active in	Participant

		wanting to upgrade equipment on campus, fixtures on campus, uhm, but you know, once again, in the end they're not the ones making the decision to do it or not.	
00:18:56.9	00:19:04.8	Right, and they're, they have no direct access to the funding other than influencing..	Interviewer
00:19:03.2	00:19:12.1	Absolutely not. I am the only person who has a right to say where that funding goes {LG} I am fiduciarily responsible.	Participant
00:19:09.2	00:19:09.4	Okay	Interviewer
00:19:12.1	00:19:35.1	Okay {LG}. Uhm, so, do you have any data that you would be able to send me regarding, I know we've talked about it a little bit, but regarding the initial cost, this may be something I need to follow up with the procurement department, uhm regarding some of the initial costs of this project, and then..	Interviewer
00:19:35.1	00:19:46.9	So I do have a bid we were, well, I was working directly with them. But the rec center had reached out to a contractor they work with fairly regularly who is on our XXX list.	Participant
00:19:47.3	00:19:47.9	Okay	Interviewer
00:19:47.9	00:19:58.3	Uhm, he put together a bid just so that we had an estimate before I ever did any of my savings calls so that we'd know kind of where we were in the ballpark.	Participant
00:19:58.3	00:19:59.3	Mhm	Interviewer
00:19:59.3	00:20:02.1	I can send that to you, please don't share it with anybody. uhm	Participant
00:20:02.1	00:20:02.9	Okay	Interviewer
00:20:02.9	00:20:07.5	If you do put it in your report or anything, black out the name of the company.	Participant
00:20:07.5	00:20:12.3	Yeah, everything will be scrubbed for the reports that come from this.	Interviewer
00:20:12.3	00:20:19.6	Yeah, redact anything to do with their name and the address, phone, and all that. We're not supposed to share those types of things, they could get out to the public.	Participant
00:20:19.6	00:20:20.1	Right	Interviewer
00:20:20.1	00:20:25.0	Then their competitors would have it. I can send that to you as long as you promise to take all that out.	Participant
00:20:25.0	00:20:26.0	Yeah.	Interviewer
00:20:26.0	00:20:26.1	But, uhm, we have that estimate, I went through and did my calculations. I'll send you this spreadsheet that shows that. Uhm, there are costs in here that I add, like a project management cost, and then a contingency. Those could change. But this was then turned over to a project manager who will then bid this out to at least three vendors on that list. One of them of course will be the one that worked up the estimate already for us. And then they'll pick out two more. Whoever is qualified on our list.	Participant
00:20:58.2	00:20:59.2	Mhm.	Interviewer
00:20:59.2	00:21:34.9	Uhm, and I have not seen those bids back. I think they were supposed to go out a couple weeks ago but they may not be due back yet, and then from there we'll pick uhm low cost, best quality that meets our specs and our standards, which	Participant

		are, they're online, you can look up. Uhm and then our timeframe, so. And we're hoping to get this done, I think, you know the rec center would like over the summer ideally. Uhm we talked even at one point Spring Break, but it's there's no way we can get in there now. It's just any time when the rec center's not being used as much, and the students aren't around. Not often XXX.	
00:21:14.0	00:21:15.0	Mhm	Interviewer
00:21:36.4	00:21:37.7	Okay, thank you. Uhm.	Interviewer
00:21:37.7	00:21:39.7	You're welcome	Participant
00:21:39.7	00:21:47.2	Then I think that you mentioned this before, but how long are you expecting these LEDs to be functional once they're in place?	Interviewer
00:21:47.2	00:21:47.3	Uhm, LEDs and I don't have the spec sheets on these I don't think, I can find some for you. They can last hundreds of thousands of hours.	Participant
00:21:57.0	00:21:57.8	Okay	Interviewer
00:21:57.8	00:21:59.6	That's one of the cool things about LEDs	Participant
00:21:59.6	00:22:00.4	Mhm	Interviewer
00:22:00.4	00:22:04.9	Uhm, versus a fluorescent lamp which may burn out in ten thousand hours,	Participant
00:22:04.9	00:22:05.6	Right	Interviewer
00:22:05.6	00:22:16.9	These pretty much last forever. Uhm, as long as they're not cycled on and off and on and off and on and off constantly. And even new newer LEDs are doing much better now concerning that.	Participant
00:22:16.9	00:22:17.9	Right	Interviewer
00:22:17.9	00:22:42.7	So that's a great questions which leads into another topic concerning how we select projects and what I can fund. The final piece of equipment's life expectancy is say only five years, even though I have the ability to fund things that could be a seven year payback, if its less than that seven years expected life, I can't fund it.	Participant
00:22:42.7	00:22:43.4	Right	Interviewer
00:22:43.4	00:22:44.5	Make sense?	Participant
00:22:44.5	00:22:45.7	Yeah, that makes sense.	Interviewer
00:22:45.7	00:23:12.1	Yeah, so when we're looking at uhm performance contracts, the state of Colorado allows out to a twenty five year payback. Well, but in reality, some of the equipment, say a rooftop unit. They're expected life is only fifteen years, so I cannot make a I can't fund something that is beyond the life expectancy of the actual piece of equipment.	Participant
00:23:12.1	00:23:12.9	Right.	Interviewer
00:23:12.9	00:23:14.6	Yea.	Participant
00:23:14.6	00:23:44.3	Okay, so we have talked quite a bit about the finances behind this, but when the University wanted to upgrade to the LEDs in this case, were there any non-monetary benefits that were taken into consideration. Obviously energy was part of it, but were there any specifics within that or any others that we	Interviewer

		haven't talked about that would be beneficial in making this upgrade?	
00:23:44.3	00:24:08.4	Well, energy cost savings, you know, is is the biggie here. This will save us a lot of money, but then again you've got to look at the Rec Center, like I was saying. They don't have to, in four more years, pay to have the uhm courts shut down, bring in a lift, rent a lift, rent you know, all the equipment needed to go in and do more lamp replacements. So, theoretically, once we do this, it'll be a long long time {LG}	Participant
00:24:08.4	00:24:09.5	Right	Interviewer
00:24:09.5	00:24:32.9	Before they have to take those courts or those areas down, uhm, and spend money to go in and do lamp replacements. There's a theres a huge benefit to the student body, to the people, the occupants that are using the Rec Center, that they're not, theres not that down time. So, we try to schedule things, like I said, around, when the students are not here.	Participant
00:24:32.9	00:24:33.5	Mhm	Interviewer
00:24:33.5	00:25:06.3	Uhm, or when we know that there's slow times. You know, like during finals, not as many kids go in there any work out, because you're supposed to be studying {LG}. So theres definitely that benefit that we don't have to, you know, shut shut the building down. Uhm, when we're doing upgrades in say, a research lab, that's a huge part of that decision making process. Researchers cannot just pick up their their experiments and go somewhere else.	Participant
00:25:06.3	00:25:07.3	Right	Interviewer
00:25:07.3	00:25:12.3	They cannot just stop an experiment in the middle of a year long process.	Participant
00:25:12.3	00:25:13.1	Mhm	Interviewer
00:25:13.1	00:25:23.8	Uhm, so thats a huge piece of that decision making process. It just doesn't fit into the Rec Center beyond, you know, the usage of the facility itself.	Participant
00:25:23.8	00:25:25.4	Right	Interviewer
00:25:25.4	00:25:39.2	And, on the sustainability side keep in mind, every time you replace a lamp in a fixture, you're taking out a fluorescent lamp. What are you going to do with it? It's got to get recycled right? It's either gets recycled or god forbid it goes to a landfill.	Participant
00:25:39.2	00:25:40.0	Mhm	Interviewer
00:25:40.0	00:25:50.5	So theres cost involved with even recycling lamps. How do you dispose of them? how do you transport it? There's a cost involved with transporting it to a recycling facility.	Participant
00:25:50.6	00:25:51.2	Mhm	Interviewer
00:25:51.2	00:25:55.8	That will take that type of of lamp, and the glass, and the gases inside of it.	Participant
00:25:55.8	00:25:57.2	Right, is there..	Interviewer
00:25:57.2	00:25:59.0	Uhm, so on the sustainability side.. huh?	Participant
00:25:59.0	00:26:02.2	Do you have, is there a plan that's in place for doing that kind of thing?	Interviewer

00:26:02.2	00:26:05.6	So, there used to be. {LG}	Participant
00:26:05.6	00:26:06.2	Okay	Interviewer
00:26:06.2	00:26:34.9	Uhm, now let me see if I can find, there used to be a a web page {NS} Uhh Boulder, Construction. I might, I probably have links to it somewhere but our sustainability manager was managing this and then he quit, now we have a new guy and I don't know if he.. Here we go, Construction and Deconstruction Materials Recycling Program. I will send you the link to this.	Participant
00:26:34.9	00:26:35.7	Okay	Interviewer
00:26:35.7	00:26:48.6	But it talks about uhm, what materials you have to recycle, can you deliver them to a landfill, uhm, what types of requirements we make of our contractors	Participant
00:26:48.6	00:26:49.5	Mhm	Interviewer
00:26:49.5	00:26:53.7	To make sure they meet this program. {NS}	Participant
00:26:53.7	00:26:57.1	Okay {NS} okay. So one of the things that this study is going to be considering is uhm, the upcoming considerations of, like, occupant wellbeing in building spaces.	Interviewer
00:27:15.9	00:27:17.3	Mhm	Participant
00:27:17.3	00:27:37.9	So I was wondering if that, if there were any, like, effects on occupants that were taken into consideration for this upgrade or if everything has kind of been covered by the environmental slash energy and the financial considerations that you've been making?	Interviewer
00:27:37.9	00:27:53.0	So in other buildings, not the rec center, we're always looking at uhm, well we do, we, we're, we're concerned about the occupants in there of course, but, like in a lab we have to make sure we have the proper number of air changes. So if I'm going to replace a piece of equipment,	Participant
00:27:53.0	00:27:53.1	Mhm	Interviewer
00:27:53.4	00:28:25.4	or a fume hood, I have to make sure that the Occupational Heath and Safety group is involved to ensure that the right number of air changes due to the chemicals and smoke, or {LG} whatever they're doing in some of these buildings, are accounted for. At the Rec Center, uhm, that's not as critical uhm, of course, the building was designed to have the proper number of air changes for the people in there just for CO2, uhm, but we're not looking at health or or other occupant effects	Participant
00:28:25.4	00:28:26.0	Mhm	Interviewer
00:28:26.0	00:28:37.7	On a down side to that there have been studies that state that the bright white daylight LEDs which probably will go on a large space like this,	Participant
00:28:37.7	00:28:38.3	Mhm	Interviewer
00:28:38.2	00:28:45.9	Uhm, not the soft light LEDs, the bright white LEDs are {LG} having an effect on people's sleep patterns?	Participant
00:28:45.8	00:28:47.2	Oh, interesting	Interviewer
00:28:47.2	00:28:47.3	Somehow? {LG}	Participant
00:28:47.3	00:28:47.4	Mhm	Interviewer

00:28:48.5	00:28:52.3	It's it's kind of odd, and there's a lot of debate in the industry about this	Participant
00:28:52.3	00:28:52.4	Mhm	Interviewer
00:28:52.6	00:29:01.1	that when you go into a facility, say you're going to go play soccer at midnight, and its bright white light in there, you're body thinks its daylight	Participant
00:29:01.1	00:29:02.3	Oh	Interviewer
00:29:02.3	00:29:12.7	So they claim, yeah, they claim that by putting them in these rec centers that are operating in the evenings and the at night time, when you're body would normally think its night time? Bugs	Participant
00:29:12.7	00:29:13.3	Mhm	Interviewer
00:29:13.3	00:29:24.1	That the bright white light LEDs are messing up our circadian rhythms. Is it true? I don't know, I mean theres two sides to every debate {LG}	Participant
00:29:24.1	00:29:25.0	Right	Interviewer
00:29:25.1	00:29:27.2	Yep.	Participant
00:29:27.2	00:29:45.2	Okay. That looks like all the questions that I had regarding the system. Is there anything else that you think I should know, or that you had wanted to share and I haven't touched on it?	Interviewer
00:29:45.2	00:29:48.5	Well let's touch a little bit on standards	Participant
00:29:48.5	00:29:49.7	Okay	Interviewer
00:29:49.7	00:29:53.0	and what the University requires because that's a big piece of our decision making process.	Participant
00:29:53.0	00:29:53.9	Okay	Interviewer
00:29:53.9	00:30:06.8	The University, uhm Facilities Management, and our Planning, Design, and Construction group over there, have a full set of standards for what can be installed on our campus.	Participant
00:30:06.8	00:30:07.4	Okay	Interviewer
00:30:07.4	00:30:10.3	Big example here, you see red tile roof everywhere	Participant
00:30:10.3	00:30:11.1	Mhm	Interviewer
00:30:11.1	00:30:12.8	That's the standard for our campus.	Participant
00:30:13.2	00:30:13.6	{LG}	Interviewer
00:30:13.6	00:30:28.9	So, for lighting fixtures, theres a standard. How efficient do they need to be? What type of control do they have to have. That can have and play a roll in a decision on whether we go forward on a project or not because it effects our funding.	Participant
00:30:28.9	00:30:30.3	Right	Interviewer
00:30:30.3	00:30:34.9	Money of course, every time you add something, money, the cost goes up.	Participant
00:30:34.9	00:30:36.2	Mhm	Interviewer
00:30:36.2	00:30:44.8	So an example we're looking at doing an LED lighting upgrade in the Reagents Autopark, this parking garage. I'm over here by Coors.	Participant
00:30:44.8	00:30:45.4	Mhm	Interviewer
00:30:45.4	00:30:56.0	Uhm, initial estimates I think came in one fifty to two hundred thousand. Final estimates once the full project got bid to our standards was over three hundred and fifty	Participant

		thousand.	
00:30:56.0	00:30:57.2	Woo, that's a big..	Interviewer
00:30:57.2	00:30:59.4	I could no longer fund it.	Participant
00:30:59.4	00:31:01.7	Oh. Yeah, that's a big increase.	Interviewer
00:31:01.7	00:31:04.7	Killed the job. {LG} It's a huge increase.	Participant
00:31:04.7	00:31:04.9	{LG}	Interviewer
00:31:04.9	00:31:17.5	Uhm, so there's big difference when you originally go out to venders who, you know, they know they can give a less expensive fixture. They know they can get, you know, an off brand uhm sensor, or something.	Participant
00:31:17.5	00:31:18.1	Mhm	Interviewer
00:31:18.1	00:31:18.2	Our standards will dictate a level of quality uhm, that sometimes can push a project outside of what I can fund with energy projects, energy funding. Uhm, so that's that's a critical piece and we have our standard of course to maintain a quality level so that we're not going back out and doing maintenance on something that fails every other day. You know, we want good stuff on our campus that won't cost us a fortune in that Life Cycle uhm cost. But, like I said, it can have an effect on the decision making process from the beginning when we're just trying to propose a project too.	Participant
00:31:58.3	00:32:06.8	Mhm. Okay, that's that's very true.	Interviewer
00:32:06.8	00:32:08.2	Yep.	Participant
00:32:08.2	00:32:15.6	So, now I have some questions for you, as the decision maker in this process.	Interviewer
00:32:15.6	00:32:15.9	Mhm	Participant
00:32:15.9	00:32:21.4	So, the first one being, why is this building important to you?	Interviewer
00:32:21.4	00:32:26.2	Uhm, potentially the Student Rec center, because it is student funded.	Participant
00:32:26.2	00:32:27.2	Okay	Interviewer
00:32:27.2	00:32:34.5	Uhm, once again, it's paid for in your fees. And in the end, you, you know, I work for you {LG}.	Participant
00:32:34.5	00:32:35.7	{LG} Right	Interviewer
00:32:35.7	00:32:47.9	You're my boss in a way. The students are paying for it. Whereas, general fund buildings get some funding, not all, but some funding from the state. Research buildings get funding from grants.	Participant
00:32:47.9	00:32:48.9	Mhm	Interviewer
00:32:48.9	00:33:22.7	Uhm, housing of course, gets funding from students paying to live in the res. hall. So this is a student run facility, and uh, I really enjoy working with the students. It's probably the funnest part of my job. Sure isn't as boring as sitting here doing calculations {LG} all the time. So its important to me, and its used by not only our students, but its used by staff, its used by the community. People can come in and rent spaces in there from the community. You can come in and get membership. It serves more than just one particular group.	Participant
00:33:22.7	00:33:23.5	Mhm	Interviewer
00:33:23.5	00:33:39.8	Uhm, of people. And its a high profile building. It's one of the	Participant

		very few platinum buildings on our campus. So, any time uh, Dan, Dan's the gentleman over there that uhm calls me about projects. {LG} I always listen to him and go over and see what I can do.	
00:33:39.8	00:33:57.3	Mhm, {NS} okay, so speaking of students, what kind of interaction or rapport do you have with the students, and with, I guess, the other occupants, the users of this building and the staff. It sounds like you know them pretty well.	Interviewer
00:33:55.7	00:33:56.4	A whole lot.	Participant
00:33:57.4	00:33:58.2	Yeah.	Interviewer
00:33:58.2	00:34:28.4	Uhm, I, I've just been in my job about three years. When I interviewed they said, how do you feel about working with students, professors, you know, people out there in the community, that, that's a university. And I love kids, and I've got kids and I said, this would be great, you know, get me involved. I work a lot with student groups, with student clubs, I work with professors, I give guest lectures. Uhm, we give tours, particularly of the rec center, because it is a platinum building	Participant
00:34:28.4	00:34:29.0	Mhm	Interviewer
00:34:29.0	00:34:46.0	On campus to student groups. Uhm, students in this case play a big role, particularly with that building. But individually, it's, it's you know, probably about forty percent of my time now is working with students. Just like I'm doing with you, doing these types of projects.	Participant
00:34:46.0	00:34:46.4	Right	Interviewer
00:34:46.4	00:34:56.0	Uhm, I'm also a mentor for different Master's programs. Uhm, I have a couple of professors that every time they have to travel I get to go teach their class for them. {LG}	Participant
00:34:56.0	00:34:59.2	That sounds pretty cool.	Interviewer
00:34:59.3	00:35:00.3	It's fun stuff, but, I enjoy it. {LG}	Participant
00:35:00.3	00:35:02.1	Yeah. Okay, so do you live in the Boulder area? Do you, uhm, would you say you live.. somewhere	Interviewer
00:35:07.8	00:35:12.3	I live. I live in Erie. Which, I live in Erie, its Boulder County. It's about ten, twelve miles directly east Arapahoe, down Arapahoe	Participant
00:35:17.4	00:35:18.2	Mhm	Interviewer
00:35:18.2	00:35:19.3	Yeah, I can't afford to live in Boulder {LG}	Participant
00:35:19.3	00:35:25.7	Okay. There's a lot of people here, I think, with that that reaction actually {LG}	Interviewer
00:35:21.2	00:35:22.1	It's so expensive here.	Participant
00:35:25.8	00:35:31.3	Oh, yeah. I moved here three years ago, well about three and a half years ago now from the midwest, and uh	Participant
00:35:31.3	00:35:32.1	Mhm	Interviewer
00:35:32.1	00:35:34.8	I'm shocked at how much housing costs out here.	Participant
00:35:34.8	00:35:41.5	Right, yeah. I came from North Carolina, and its, the cost of living is drastically different.	Interviewer
00:35:41.5	00:35:43.7	Very different here.	Participant
00:35:43.7	00:35:44.3	Uhm	Interviewer

00:35:44.3	00:35:46.9	So I'm still in Boulder County. I'm, I'm not too far. {LG}	Participant
00:35:46.9	00:35:57.4	Okay, so this one's kind of, not like the rest, but, to what extent do you believe that our global climate is changing?	Interviewer
00:35:57.4	00:36:02.3	Oh very much so. I one hundred percent believe in climate change. {LG}	Participant
00:35:58.6	00:36:00.2	Very much so.	Interviewer
00:36:02.6	00:36:03.7	Okay	Interviewer
00:36:03.7	00:36:19.8	Uhm, yeah. The, I, there's more than enough scientific evidence to show a one degree, a two degree change can have a huge effect on our environment. Uhm, and also, I know that as I reduce carbon emissions as part of my job	Participant
00:36:19.8	00:36:20.8	Mhm	Interviewer
00:36:20.8	00:36:36.5	That it takes it's, it's combatting that uhm climate change the the the growth uhm, in that one two two degree rise. That's, that's really a part of my job too. We have a sustainability side.	Participant
00:36:36.5	00:36:37.3	Mhm	Interviewer
00:36:37.3	00:37:00.0	We have a chief sustainability officer uhm Heidi, and then we have a sustainability manager, Ed. Uhm, but we work very closely the three of us, plus my director Brian all together to determine what goals are realistic as far as carbon reductions. Uhm, what can be done on campus to reduce emissions. And its all for that reason, for climate change.	Participant
00:37:00.0	00:37:25.2	Mhm, okay, so this kind of leads into the next uhm, question. To what extent do you believe that your personal beliefs about climate change but also about, I guess, finances, and energy and some of these other things, are represented in the policies and standards that CU uses in their decision making processes?	Interviewer
00:37:25.2	00:37:27.1	Oh what a question. Uhm	Participant
00:37:27.1	00:37:27.8	{LG}	Interviewer
00:37:27.8	00:37:35.3	so in in broad terms, the University is committed to reducing our carbon emissions.	Participant
00:37:35.3	00:37:36.2	Mhm	Interviewer
00:37:36.2	00:37:42.8	They are committed to lowering our energy uhm consumption. That's where my job comes in.	Participant
00:37:42.8	00:37:43.5	Mhm	Interviewer
00:37:43.5	00:38:10.7	Now, to be honest with you, I don't like this seven to ten year payback requirement on my funding. Because, uhm, low hanging fruit, as we call it in our business. Simple retrofits, the things that can save you energy have already all been done on this campus. We have it in our standards. You can't do something here, build something here, construct something here, that's not efficient.	Participant
00:38:10.7	00:38:11.5	Right	Interviewer
00:38:11.5	00:38:25.2	So therefore, the, when, when I'm looking for opportunities, just like this project at the rec center. These three courts, I cannot fund it entirely with my energy funding. It doesn't meet that seven to ten year payback.	Participant

00:38:25.2	00:38:26.2	Mhm	Interviewer
00:38:26.2	00:38:31.4	So I then have to go asking my customer's, and in this case, the rec center, to help contribute.	Participant
00:38:31.4	00:38:32.4	Right	Interviewer
00:38:32.4	00:38:42.7	Some customers, like the rec center, athletics is wonderful, love working with athletics. Housing, housings a little more strict on what they can pay for but they're still more willing.	Participant
00:38:42.7	00:38:43.4	Mhm	Interviewer
00:38:43.4	00:38:52.1	Uhm, they're great. When I go looking at a general fund building, there's no money there to make up that difference.	Participant
00:38:52.1	00:38:53.1	Mhm	Interviewer
00:38:53.1	00:39:00.3	So, keep in mind, general funds, you know, the largest piece, the largest square footage for our entire campus.	Participant
00:39:00.3	00:39:00.7	Right	Interviewer
00:39:00.7	00:39:05.5	So I don't like that seven to ten year {LG} constraint on my funding.	Participant
00:39:05.5	00:39:06.5	Mhm	Interviewer
00:39:06.5	00:39:10.5	Uhm, especially when the state of Colorado allows up to twenty five years.	Participant
00:39:10.5	00:39:11.7	Okay, so..	Interviewer
00:39:11.7	00:39:13.8	And the reason, I'm sorry what?	Participant
00:39:13.8	00:39:15.3	Go ahead, go ahead	Interviewer
00:39:15.3	00:39:41.8	The reason most entities will say a five year payback, a seven year payback, a ten year payback is required, is because they don't intend on being in a building for any longer than that. Prior to coming here I was in the commercial real estate industry. We leased a lot of the buildings that I managed for energy. It made sense, if I only had a ten year lease on the building I wasn't going to do a project that paid back in twenty years. Because we'd never get our money back.	Participant
00:39:41.8	00:39:42.6	Mhm	Interviewer
00:39:42.7	00:39:47.7	But here at the University we, we, well, we're a University, it's not like we can pick up and go anywhere.	Participant
00:39:47.7	00:39:48.7	{LG}	Interviewer
00:39:48.7	00:40:18.2	We own all these {LG} buildings {LG}, uhm, and you know, even a fifteen year payback would allow me to fund so may more projects than general funds only. So, you know, it it just doesn't make sense to me. I I don't, I know its a financial decision from our finance group and our chief financial officer, which is Kelly Fox also. Uhm, but to me it doesn't make sense, because these buildings will be here for a hundred more years, you know, hopefully. {LG}	Participant
00:40:18.2	00:40:19.1	Right, yeah, yeah	Interviewer
00:40:19.1	00:40:37.3	Uhm, so that, that constraint, you know, is is a little discouraging. But like I said, I have other customers on campus that they're they're willing to take that risk and go above that seven year ten year payback, and then I can help fund them, and we can do more work that way.	Participant
00:40:37.3	00:40:59.6	Okay, so if you could see that change, you said fifteen, and	Interviewer

		then you said the state of Colorado has a twenty five year payback. Would you rather see the twenty five or, if you could push everyone to fifteen do you think that would be XXX.	
00:40:47.4	00:40:48.7	Yep.	Participant
00:40:59.6	00:41:04.3	If I could even just push everyone to fifteen I could use up all my funding every year pretty easily.	Participant
00:41:04.3	00:41:05.1	Okay	Interviewer
00:41:05.1	00:41:32.8	I struggle sometimes, you know, and and in the end I have over million dollars, because I have both of my funds, well, minus our expenses for my team. {NS} But then, uhm, I have some funding available that goes into a rebate pot pot of money. So when we do projects just like these projects there'll be money that comes back. I'll split that rebate money uhm, by the percentages of what was paid in to do the project with the rec center.	Participant
00:41:21.5	00:41:21.9	Mhm	Interviewer
00:41:32.8	00:41:33.4	Mhm	Interviewer
00:41:33.4	00:41:41.4	They'll get some of that money. I also have, the, get some of it that goes into a fund. So in the end I have over million dollars every year to spend.	Participant
00:41:41.4	00:41:42.2	Right	Interviewer
00:41:42.2	00:41:49.6	It's already March, my year ends in June. I'm down to getting people to say hey, why aren't we doing these projects. So..	Participant
00:41:49.6	00:41:49.7	Right	Interviewer
00:41:49.9	00:41:58.1	And its because of that payback requirement. Uhm, if we could even go out to fifteen years, I would love to say twenty five years, I'd love to say twenty years.	Participant
00:41:58.1	00:41:58.7	Mhm	Interviewer
00:41:58.7	00:42:06.0	But, even if I could get out to fifteen years, there's a lot more work I could do. Particularly in general fund buildings that right now I can't do.	Participant
00:42:06.0	00:42:28.3	Okay, that's good to, good to know. Uhm, so I have made it through all of the questions that we had. If there's anything else that you wanted to touch on, at all, related to this project then we can do that.	Interviewer
00:42:28.3	00:42:38.7	Uhm, I don't have anything in particular with this project. This was a pretty, pretty straight forward uhm, easy one for me. The calc weren't difficult. {LG}	Participant
00:42:38.7	00:42:39.5	Mhm	Interviewer
00:42:39.5	00:42:44.0	Uhm, lighting upgrades are probably the easiest to do on campus, it's pretty straight forward.	Participant
00:42:44.0	00:42:44.7	Right	Interviewer
00:42:44.7	00:42:45.4	You know	Participant
00:42:45.4	00:42:46.3	And XXX	Interviewer
00:42:46.3	00:42:51.0	Just take out a high wattage and put in a low watt LED, it's pretty, pretty straight forward math.	Participant
00:42:51.0	00:42:51.9	Mhm	Interviewer
00:42:51.9	00:43:00.3	Some of our other projects, some of the ones that involved air	Participant

		change rates, or major pieces of equipment that effect an entire system	
00:43:00.3	00:43:00.9	Mhm	Interviewer
00:43:00.9	00:43:15.7	Or adding chilled water to a building and taking out the uhm, individual building services. Those are more difficult for us to manage? And then fund.	Participant
00:43:15.7	00:43:16.8	Okay	Interviewer
00:43:16.8	00:43:44.1	Because they involve larger groups of people. Uhm, who are then involved in the decision making process. If I have to get PDEC involved where the engineers are looking at design, it's going to cost me a whole lot more money, because I have to actually pay our own facilities management group for their time and services. And certain projects, certain scope, have to be reviewed by them, approved by them	Participant
00:43:44.1	00:43:44.7	Mhm	Interviewer
00:43:44.7	00:44:09.1	managed by them. And I pay them for every hour they work on my projects. And, my payback, I do have to include all labor costs. It's not just material costs in that calculation. So if I have to pay, you know, our engineering group ten thousand dollars to do some engineering for me, that goes into my payback calculation.	Participant
00:44:09.1	00:44:09.9	Mhm	Interviewer
00:44:09.9	00:44:14.9	And it could push uh an ROI out beyond what I can afford too.	Participant
00:44:14.9	00:44:17.5	Right	Interviewer
00:44:17.5	00:44:35.9	So that's another caveat really, you know, the size of the project will determine, or or the complexity of the scope could determine whether I have ancillary expenses that that that don't even go into the basic, buy a piece of equipment, change it out. You know, our contracts costs involved there.	Participant
00:44:35.9	00:44:36.0	Mhm	Interviewer
00:44:36.2	00:44:44.0	Internal costs, we try to estimate around ten percent for the, when we're just doing high level estimates, which you'll see in the spreadsheet I send you.	Participant
00:44:44.0	00:44:44.4	Okay	Interviewer
00:44:44.4	00:44:50.8	But I've done projects where our internal costs exceeded forty percent of the project's job costs, full cost.	Participant
00:44:50.8	00:44:53.6	With the design, and engineering?	Interviewer
00:44:53.6	00:44:57.8	Reviews, yes, all of that is included in that cost.	Participant
00:44:57.8	00:44:58.3	Mhm	Interviewer
00:44:58.3	00:45:19.3	And I pay them by the hour. How many hours it takes for them to do something I've got to pay them. Uhm, so, like I was saying, larger projects, more complex scope uhm, all of those things can play into it. Now, not all universities include that cost in their ROIs. I've talked to other energy managers	Participant
00:45:19.3	00:45:20.2	Mhm	Interviewer
00:45:20.2	00:45:28.6	at other facilities, other places, who tell me, we don't include an of our internal costs when we do a calculation for ROI.	Participant
00:45:28.6	00:45:29.4	Hmm.	Interviewer

00:45:29.4	00:45:31.3	Here, I am required to.	Participant
00:45:31.3	00:45:32.0	Okay	Interviewer
00:45:32.0	00:45:35.5	Because the way our funding is set up, and finance is set up.	Participant
00:45:35.5	00:45:36.1	Mhm	Interviewer
00:45:36.1	00:45:42.2	So whoever else you're going to talk to, I think I saw on there, Shannon and Joe, there are some other engineers that we work with.	Participant
00:45:42.2	00:45:43.0	Mhm	Interviewer
00:45:43.0	00:45:55.1	You know, they can do a very high level, very simple ROI and say it'll payback in seven years, and then when I add in all their costs, all our internal charges, all of our contingencies, it exceeds that.	Participant
00:45:55.2	00:45:56.4	Right	Interviewer
00:45:56.4	00:46:15.3	So, that's a piece of the whole decision process. And then once again, I can only fund up to a certain point. If we can find funding from some other source? Uhm, if its not a a, you know, a customer like the rec center, who has their own budget, its just general funds, there's no other source to help fund that.	Participant
00:46:15.3	00:46:15.9	Right	Interviewer
00:46:16.1	00:46:19.0	Yep.	Participant
00:46:19.0	00:46:26.1	Okay, well you've been very helpful, and thank you for taking the time to talk to me.	Interviewer
00:46:26.1	00:46:28.1	Any time!	Participant
00:46:28.1	00:46:28.2	about the project.	Interviewer
00:46:28.4	00:46:30.0	Hey, and I'm going to send you an email	Participant
00:46:30.0	00:46:30.8	Okay	Interviewer
00:46:30.8	00:46:46.0	Uhm, with a link to those uhm, to, maybe to our standards, to our, and then to our recycling uhm materials recycling. I'll send you the uh, original estimate. But, like I said, once again please redact any uhm vendor information off of it for your report.	Participant
00:46:46.0	00:46:46.7	Mhm	Interviewer
00:46:46.7	00:46:52.5	And I will send you my spreadsheet that I did uhm to determine how much I could fund.	Participant
00:46:52.5	00:46:53.5	Okay	Interviewer
00:46:53.5	00:46:55.7	Alrighty	Participant
00:46:55.7	00:47:04.5	Do you have any uh questions for me about this interview process or what I'm going to be doing that I could answer now?	Interviewer
00:47:04.5	00:47:10.2	No, but when you're done with your report, I've always asked students if I could get get to see it. Send me a copy	Participant
00:47:10.2	00:47:11.1	Okay, I can do that.	Interviewer
00:47:11.1	00:47:13.0	I collect them. I have a folder full of them {LG}	Participant
00:47:15.3	00:47:18.9	Okay, well, thank you again for all of your help.	Interviewer
00:47:18.9	00:47:21.2	No problem, good luck.	Participant
00:47:21.2	00:47:23.5	Yeah, thank you.	Interviewer
00:47:23.5	00:47:26.6	If you do need anything else, just let me know.	Participant

00:47:26.6	00:47:28.8	Okay, thank you very much.	Interviewer
00:47:28.8	00:47:30.3	Alright, bye Interviewer.	Participant
00:47:30.3	00:47:30.9	Have a good day	Interviewer
00:47:32.5	00:47:32.6	You too, bye bye	Participant
00:47:32.5	00:47:34.0	Bye	Interviewer

Interview 03-02-03-12a

Start Time	End Time	Transcript 03-02-03-12a	Speaker
00:00:00.0	00:00:01.9	Okay, can you hear me?	Interviewer
00:00:01.9	00:00:04.2	Yes, sure can.	Participant
00:00:04.1	00:00:21.8	Okay, umm, so, let's start with the questions about the system upgrade. So, your, can you tell me just a little bit about the project that happened in the engineering center, just kind of as a..	Interviewer
00:00:19.8	00:00:21.1	Yeah	Participant
00:00:22.0	00:00:32.0	Sure, so this is the, uhm, it was formerly known as Chemical Engineering, but now they call labeled it Environmental Sciences engineering.	Participant
00:00:32.0	00:00:32.7	Okay	Interviewer
00:00:32.7	00:01:05.0	and, uhm, I think I put the square footage down there and the number of people roughly in there. But again, that's kind of a transient number. Uhm, so, the project came to be because there was a programmatic needs for uhm a better, better lab environment, and also more laboratory space. And then, we were also upgrading it for safety reasons. Uhm, due to indoor air quality.	Participant
00:01:05.0	00:01:06.0	Okay	Interviewer
00:01:06.0	00:01:12.2	And then we were also upgrading it for uh, end of life, deferred maintenance.	Participant
00:01:12.2	00:01:13.8	Mhm	Interviewer
00:01:13.8	00:01:20.1	Uhm, so pretty much it was an entirely gutting of the whole facility, and then like a whole re-do.	Participant
00:01:20.1	00:01:36.7	Okay, so, uhm, could you tell me a little bit specifically about the HVAC system that was selected as the replacement and which, if there were alternatives that you considered.	Interviewer
00:01:32.8	00:01:34.4	Yeah.	Participant
00:01:36.8	00:01:51.8	Uhm, yeah, I guess, uhm, so a standard baseline system the industry would have used would be let's say, at a constant vol.. So they're lab spaces.	Participant
00:01:51.8	00:01:53.6	Mhm	Interviewer
00:01:54.0	00:02:09.5	So with lab spaces they need to be a hundred percent outside air and have a cert.. the air change rate is, if people don't study the pragmatic approach to it they make it quite prescriptive and then it wastes a lot of energy.	Participant
00:02:09.5	00:02:10.1	Okay	Interviewer
00:02:10.1	00:02:19.4	So a constant volume system was probably considered for that but we ended up going with a variable air volume	Participant

		system.	
00:02:19.4	00:02:20.0	Okay	Interviewer
00:02:20.0	00:02:24.7	On both the supply, on the supply and the exhaust.	Participant
00:02:24.7	00:02:34.8	Uhm, so, what was, just for the energy usage is why you picked this one? To XXX.	Interviewer
00:02:33.2	00:03:00.2	Uhm, no, there's there's multiple reasons behind it actually. Uhm, so energy consumption was one, safety is another, two, third was, uh, it built resiliency and flexibility into the system. Meaning that we, as renovations needed to happen over the years then it would be easier for us to do that without us having to rebalance the system every time.	Participant
00:03:00.2	00:03:00.8	Okay	Interviewer
00:03:00.8	00:03:34.1	And, and then the other, the fourth piece of that would be, uhm, {NS} the {NS} oh, what was, I lost my train of thought there, sorry about that. We did, uh, energy savings, uhm, resiliency, flexibility, and uhm, it allows us to actually, and the energy, to turn down the system. So there's actually capital ovum component to it as well, uhm	Participant
00:03:34.1	00:03:35.5	Mhm	Interviewer
00:03:35.5	00:03:39.6	There are operation and maintenance variables to that as well.	Participant
00:03:39.6	00:03:40.7	Okay	Interviewer
00:03:40.7	00:04:11.0	So, we, so the other thing is we have these rules as Authorities Having Jurisdiction for the campus as well, so we're able to make, kind of code assessments as well, uhm, with the type of system we're proposing. Uhm, and then myself and another colleague, Tim Lockhart, who's an industrial hygienist, uhm, we pioneered kind of a pragmatic approach to air change rates for campus.	Participant
00:04:11.0	00:04:11.7	Mhm	Interviewer
00:04:11.7	00:04:32.0	Which, uhm, leads to uhm, better performing air change rates. So air change rates are based on performance versus the prescriptive method. And then with that comes the flexibility to actually tune the labs to what's actually going on in the lab, which is the safety component of it	Participant
00:04:32.0	00:04:32.6	Mhm	Interviewer
00:04:32.6	00:04:52.1	Versus, uhm, just saying its twelve air changes per hour all the time. Maybe that's good, maybe its not. Most of the time we're changing a higher air change rate doesn't dictate a safe lab environment, in fact it can be more dangerous. So we actually study the volatility of the chemicals and or hazard in the lab	Participant
00:04:52.1	00:04:52.9	Mhm	Interviewer
00:04:52.9	00:04:55.3	To determine what the appropriate air change rate would be.	Participant
00:04:55.3	00:04:56.3	Okay	Interviewer
00:04:56.3	00:05:04.1	And then that way, depending on what research is going on in there, uhm, the lab air change rate can be tuned in to what is needed.	Participant
00:05:04.1	00:05:38.5	Okay, {NS} so, uhm, how did you consider the different	Interviewer

		kinds of returns that would come from an investment in this kind of system? Whether that's financial or, uhm, if you considered the safety as a kind of return or any of the other elements that you just described. Were there uhm quantitative or like, qualitative weights or measurements or anything that you used in comparing all of those things?	
00:05:38.5	00:05:46.4	So when you say returns, Megan, do mean like, Return on Investment? Or, uhm, do you mean, like, return air or?	Participant
00:05:46.4	00:05:59.4	Uhm, the Return on the investment, but that can be financial, or also, uhm, some of the other things that you mentioned like the safety and those kinds of things.	Interviewer
00:05:59.4	00:06:06.2	Yeah, uhm, I think financial was one of the drivers behind it. Uhm	Participant
00:06:05.4	00:06:06.2	Mhm	Interviewer
00:06:06.2	00:06:21.7	Uh, but also, it, so, financial from my perspective could mean multiple things. It's not just the capital investment into it. It could be like, the programmatic, like, from the campus level.	Participant
00:06:21.7	00:06:22.6	Mhm	Interviewer
00:06:22.6	00:06:31.4	So for example, if we're making better use of the space so that we don't actually have to build another building, there's a return on investment of avoided costs.	Participant
00:06:31.4	00:06:32.8	Okay	Interviewer
00:06:32.8	00:06:34.6	For example, does that makes sense?	Participant
00:06:34.6	00:06:35.2	Yeah, it does.	Interviewer
00:06:35.2	00:06:49.9	Okay, so, there's, I kind of put them into two camps. One is avoided potential cost, and two is just, you can do your straight up return on investment just based on the capital cost alone, based on O and M costs	Participant
00:06:49.9	00:06:50.9	Right	Interviewer
00:06:50.9	00:07:11.9	and energy alone for your your, for your ROI, but I think the reason that our decisions are a little more compounded is we take into account, oh we're avoiding, I don't know, probably another eighty million dollar project to build a new building, reusing an existing structure, and providing more usable square footage.	Participant
00:07:11.9	00:07:12.5	Mhm	Interviewer
00:07:12.5	00:07:31.0	Uhm, which is a huge value to the university because we are limited on square footage, our programs are growing, uhm, so it's a nice way to kind of align all those interests versus having them compete against each other.	Participant
00:07:31.0	00:07:41.0	Okay, that makes sense. Uhm, so I'm just kind of going through this list of questions, I don't know if you're still looking at it, but the, uhm.	Interviewer
00:07:41.0	00:07:47.5	Oh. I probably should I'm sorry Megan, {LG} I mean Interviewer, I'm so sorry, I'm not usually this bad.	Participant
00:07:47.5	00:08:18.1	{LG} Uhm, so I know that you mentioned that there was the safety factor with the indoor air quality, and you were predicting that there would be changes to that based on	Interviewer

		implementing this HVAC system. Have you seen the results of those changes, or have you seen any other performance changes related to energy, or savings for uhm, energy usage, or anything like that?	
00:08:18.1	00:08:22.6	M.. meaning did we get what we expected to see out of it? Is that kind of..	Participant
00:08:22.1	00:08:27.3	Yeah, did you get what you expected or have you gotten something different than what you expected?	Interviewer
00:08:27.3	00:08:32.4	Yeah, we got what it we expected, we actually piloted this strategy on a different building	Participant
00:08:32.4	00:08:33.1	Okay	Interviewer
00:08:33.1	00:08:39.8	Uhm, yeah. And so we actually, this is a longer story, but Tim and I kind of went national with it.	Participant
00:08:39.8	00:08:40.5	Mhm	Interviewer
00:08:40.5	00:08:51.7	And uhm, like, the Department of Energy in other jurisdictions are kind of using our approach now, because it is, it kind of addresses all those things that we just mentioned in the previous question.	Participant
00:08:51.7	00:08:52.5	Okay	Interviewer
00:08:52.5	00:09:18.2	So, uhm, yeah. It it's a good recipe, uhm, that we've, uhm, so far. I I think the other cost, just to kind of lead into that as well is uhm, {NS} the avoided cost of injuries, which is a huge, could be a huge issue for places for what they call on OJI or on the job injury claims	Participant
00:09:18.2	00:09:18.7	Mhm	Interviewer
00:09:18.7	00:09:25.4	Or indoor air quality claims. So, uhm, we're kind of that, that'd be kind of more in the avoided cost pot	Participant
00:09:25.4	00:09:26.2	Okay	Interviewer
00:09:26.2	00:09:28.0	of that consideration	Participant
00:09:28.0	00:09:29.0	Yeah.	Interviewer
00:09:29.0	00:09:51.8	and then we uh, the result typically is uhm, people's comfort is increased, we've got less calls coming in to the, uhm, o.. what they call the operations center, which does, like, on calls for, you know, responding to too hot, too cold, there's something wrong with my lab, air ch.., whatever's going on.	Participant
00:09:48.0	00:09:50.0	Okay	Interviewer
00:09:52.2	00:10:24.2	Mhm, good. That's good. Uhm, okay so, I kno.. it sounds like you guys kind of created this system for the needs that were there. But were there any specific financial limitations that you got from the university or from other funding sources that effected this investment decision?	Interviewer
00:10:25.2	00:10:29.8	M.. meaning were there, like, criteria placed on that payback analysis or?	Participant
00:10:29.8	00:10:49.5	That, or, did you have money coming from a source that specified the ways that you had to use it, or how much was necessary, like, were there any limits or criteria gen.., like, at all, on the financial end of everything?	Interviewer
00:10:49.5	00:10:55.3	Oh. Yeah. So we're obligated to state funding protocols	Participant
00:10:55.3	00:10:56.1	Mhm	Interviewer

00:10:56.1	00:11:15.2	I guess that's the right way to put it. So we did have some, most of it came from different pots of money within the University, so, are you.. I guess I just want to make sure that I'm answering the questions correctly. Is it, external to the university funding sources? Or within the University funding sources?	Participant
00:11:14.1	00:11:20.2	Oh. Uhm, just any funding sources that were related to this project.	Interviewer
00:11:20.2	00:12:04.8	Ah, okay, uhm, yeah. So in general, uhm, for all, uh, construction projects on campus we're, we're obligated to follow the state, state uhm, kind of, legislative procurement, they kind of dictate how the money is spent, and what codes we need to follow, and, uhm, {NS} how it can be spent uhm, and then also, there's also from a capital construction perspective a payback that needs to be met as far as for the decision factor. So for example, we wouldn't select something that had, like a, a hundred year payback, like, a	Participant
00:12:04.6	00:12:05.1	Mhm	Interviewer
00:12:05.1	00:12:37.8	Or something crazy like that. I think it's something close to sixty or.. The energy's also limited to a seven year payback. So the way we work with that is, we do, we do the payback analysis based on energy, deferred maintenance, or O and M costs, and then uhm, capital investment typically for that straight up payment for return on investment, and that's usually where we meet the sweet spot of those, those kind of requirements dictated by the state.	Participant
00:12:37.8	00:13:00.1	Mhm. Okay. Uhm, so being on, being on a college campus and like in one of the academic buildings, were there any time limitations that had an effect on this project?	Interviewer
00:13:00.1	00:13:18.4	Uh, always, {LG} uhm, it.. most of the time it it has to do with the the academia year and then also the ability to colocate people that would be using the space or were using the space	Participant
00:13:18.4	00:13:19.2	Mhm	Interviewer
00:13:19.2	00:13:25.6	and just how we shift the people around the campus so that they can get in back in space, in their spaces	Participant
00:13:25.6	00:13:26.0	Mhm	Interviewer
00:13:26.0	00:13:38.7	and then, of course, following any other con.. jobs that are lined up that also need to use what we call a flux space, uhm, where people kind of cohab.. cohabitate until their facility is done.	Participant
00:13:38.7	00:13:39.5	Okay	Interviewer
00:13:39.5	00:13:48.4	There's a cost associated with that. It'll drive kind of the schedule, but al the budget because it impacts the larger capital construction	Participant
00:13:48.4	00:13:49.1	Mhm	Interviewer
00:13:49.1	00:13:49.8	Portfolio	Participant
00:13:51.3	00:14:25.2	Okay, so, I, it sounds like you guys have considered a lot of different things in your decision making process. But,	Interviewer

		specifically were there any, uhm, Total Cost of Ownership or Life Cycle Cost Analysis sys.. like, financial systems or otherwise that you used to kind of compare the things that you were looking at for this process to make the decision?	
00:14:25.2	00:14:31.1	Yeah. so everything I just described to you is is how we look at our total life cycle cost analysis.	Participant
00:14:31.1	00:14:31.5	Okay	Interviewer
00:14:31.5	00:14:39.6	So, a lot of times your private sectors won't look at the avoided potential cost, but we do, but we actually don't include that as part of the life cycle cost	Participant
00:14:39.6	00:14:40.4	Okay	Interviewer
00:14:40.4	00:14:58.2	So Life Cycle Cost would really be your energy, your O and Ms, and then your capital, and they would very, most likely wouldn't take into account the real estate asset value and what that compounding factor means, and or the avoided cost. So typically that wouldn't be part of it.	Participant
00:14:58.2	00:14:59.0	Mhm	Interviewer
00:14:59.0	00:15:03.1	But we do do both. Uhm, to make the decision.	Participant
00:15:03.1	00:15:03.7	Okay	Interviewer
00:15:03.7	00:15:09.4	I don't know if that, if that was clear or not, but you keep asking me..	Participant
00:15:06.4	00:15:12.2	Yeah, you've already, you've already described the process pretty well I think, so	Interviewer
00:15:12.2	00:15:13.2	Okay	Participant
00:15:13.2	00:15:21.3	Uhm, to what extent were occupants of the building involved in this decision making process?	Interviewer
00:15:21.3	00:15:26.9	Uhm, have.. well, so the occupants, that's a, a hard one	Participant
00:15:26.9	00:15:27.6	Mhm	Interviewer
00:15:27.6	00:15:30.1	Uh, primarily because they change all the time. {LG}	Participant
00:15:30.1	00:15:30.7	Mhm	Interviewer
00:15:30.7	00:15:34.1	So we actually had the Dean of the College involved	Participant
00:15:34.1	00:15:34.5	Okay	Interviewer
00:15:34.5	00:15:35.8	and the Assistant Deans	Participant
00:15:35.8	00:15:36.2	Mhm	Interviewer
00:15:36.2	00:16:15.3	as part of the core committee. Uhm, mainly because they were probably the most stable people for that because, physically the, what they call the principle investigators, or the teachers, or the professors, uhm, they may or may not be in the department by the time the project is done. So, uhm, anyway eh, that, that one's a little tricky on the university side because its not always consistent. So, the choice has been made to incorporate the users primarily being, like, the Deans of the colleges, which kind of look out for their total inventory of spaces.	Participant
00:16:15.3	00:16:35.9	Mhm. Okay, uhm, so do you have data regarding the initial cost of the project or any returns resulting from that investment that you'd be able to share? Or have you done any energy models?	Interviewer
00:16:35.9	00:16:45.4	Yep. We do have some energy models, uhm, the project is	Participant

		wrapping up right now still, so I think we have two more months left on it.	
00:16:45.4	00:16:46.4	Okay	Interviewer
00:16:46.4	00:16:59.8	Uhm, and then uhm, what we could do is talk to our project manager and see if they can share the schedule of values with you. Uhm, the energy bills will not, I'm just looking through your objective data collection list.	Participant
00:16:59.8	00:17:00.4	Mhm	Interviewer
00:17:00.4	00:17:21.6	Uhm, so we'll, we'll have first cost, including design, total cost of operation and operational cost, we probably wo.. won't, we'll have an idea, but they're kind of going to be skewed a little bit because we've been spending a lot of time over there, uhm, with what we call commissioning the building.	Participant
00:17:21.6	00:17:22.2	Mhm	Interviewer
00:17:22.2	00:17:31.4	So, uhm, that might be skewed, same with the energy bills, because typically we have to do flush outs and kind of test the systems.	Participant
00:17:31.4	00:17:32.1	Okay	Interviewer
00:17:32.1	00:17:38.7	Uhm, same with the maintenance cost, those will be skewed. But you can see some historic.. like, we have the old building.	Participant
00:17:38.7	00:17:39.6	Mhm	Interviewer
00:17:39.6	00:17:54.5	You can see what those are, and then, I'm going to guess, probably in another, I don't know what your timeline is Interviewer, but like, probably in a six to nine months we'll have better data on the renovation stuff.	Participant
00:17:54.5	00:17:59.5	Yeah, I should be {LG}, I should be finished up before then, but..	Interviewer
00:17:59.5	00:18:00.5	Okay	Participant
00:18:00.5	00:18:01.5	Yeah.	Interviewer
00:18:01.5	00:18:04.3	Are you graduating this Spring?	Participant
00:18:04.3	00:18:06.5	That's, yeah, that's the plan	Interviewer
00:18:06.5	00:18:12.5	Cool {LG} Okay, I'm rooting for you. Yeah, good ch.. {LG}	Participant
00:18:12.0	00:18:12.3	So..	Interviewer
00:18:12.3	00:18:14.7	Alright, well, we'll give you what we have {LG}	Participant
00:18:14.7	00:18:45.6	Yeah, that's, that's all I'm asking for. Uhm, and then this one's kind of, kind of a repeat question, but what kinds of financial computations were made when you were considering this investment, and I guess we can go ahead and look at the next one too, and, uhm, how was this upgrade financed, was it all through internally accumulated funds, or were there some external sources of funding for this project?	Interviewer
00:18:45.6	00:18:58.0	Uhm, yeah. So, it was all primarily, well, i.. internally it it's kind of a a rough, {LG} I don't know how to explain this so..	Participant
00:18:57.9	00:18:59.3	I know it gets complicated.	Interviewer
00:18:59.1	00:19:03.6	It it's really complicated when you deal with {NS}.. {LG}	Participant

		and again, nothing is simple {LG}	
00:19:03.6	00:19:05.0	Mhm {LG}	Interviewer
00:19:05.0	00:19:15.7	I.. I wish it was {LG} uhm, so, depending on how our CFO decides to pay for this project, sometimes she'll take out a bond on it.	Participant
00:19:15.7	00:19:16.6	Okay	Interviewer
00:19:16.6	00:19:25.0	Uhm, but that, that's up to her discretion of whether, so there's kind of like, uhm, like a loan, but it uh call.. called a bond.	Participant
00:19:25.0	00:19:25.4	Mhm	Interviewer
00:19:25.4	00:19:33.0	So, it's, and then she leverages that with her whole portfolio. It's very quite complicated {LG}	Participant
00:19:33.0	00:19:34.9	{LG} Okay	Interviewer
00:19:34.9	00:20:01.3	Uhm, {LG} we may have some donors, and that's the thing is uhm, but it's always seems to feed into one big pot, and it's like a super pot, and then the CFO kind of determines how it's allocated from there, and so for me to really delineate whether, oh, it was like, a endowment, or it was a hundred percent bonded, or loans, that's the part I, I don't know.	Participant
00:20:01.3	00:20:01.9	Mhm	Interviewer
00:20:01.9	00:20:14.3	Uhm, we'll have to punt to somebody else on, uhm, but I'm thinking maybe Rich, our project manager could help out with some of this data and he might know or have a better idea, because he actually has to see the money. {LG}	Participant
00:20:14.3	00:20:27.7	{LG} Okay. Uhm, okay, so, how long is the group expecting for this HVAC system to be functional, like, what's the expected lifetime?	Interviewer
00:20:27.7	00:20:30.6	Oh, probably fifty years plus.	Participant
00:20:30.6	00:20:31.3	Okay	Interviewer
00:20:31.4	00:20:39.2	that's also another issue behind it, like, we don't get money to replace things for like fifty years. It's pretty crazy.	Participant
00:20:39.2	00:20:40.1	Mhm	Interviewer
00:20:42.9	00:20:56.3	Okay, and are there any benefits that you have already seen from this investment? I know its still, you said its still, kind of, in construction, but..	Interviewer
00:20:56.7	00:21:01.0	Yeah. I think we're going to see energ.. the energy savings, reduced O and M	Participant
00:21:01.0	00:21:01.6	Mhm	Interviewer
00:21:01.6	00:21:08.7	and then uhm, {NS}, uh well the lab people are a lot happier, they're not in a dungeon anymore {LG}	Participant
00:21:08.7	00:21:09.5	{LG}	Interviewer
00:21:09.6	00:21:09.7	Uhm, but I'm going to encourage you to like, talk to them about that. I think they seem happier in their labs, but uhm, but uhm, that part of kind of subjective on my part so..	Participant
00:21:20.0	00:21:26.0	Mhm. Okay, so I'm going to jump to the first set of questions.	Interviewer
00:21:26.0	00:21:27.7	Okay	Participant
00:21:27.7	00:21:33.7	And, uhm, so why is this building important to you? I guess..	Interviewer
00:21:33.7	00:21:42.7	Uhm, {LG} oh okay, where do you start? To me	Participant

		specifically, to my department, or to the university?	
00:21:42.7	00:21:49.8	Uhm, I.. to you and your team that's been working on this project.	Interviewer
00:21:49.8	00:21:58.4	Uh, well, uhm, we've had a lot of eh, indoor indoor air quality claims and issues with the system over there.	Participant
00:21:58.4	00:21:59.4	Okay	Interviewer
00:21:59.4	00:22:20.5	So, that's been the primary driver, at least from our perspective, is to to solve problems. Now does the, now does the college get a programmatic benefit out of it, I think, we consider that a win win because then its not just doing, uhm, a behind the scenes upgrade. So its safe, people actually feel like they want to be in their spaces too.	Participant
00:22:20.5	00:22:20.9	Mhm	Interviewer
00:22:20.9	00:22:35.6	Uhm, so, and then they, they, when ah couple.. the two of those things are coupled together they tend to be a a better win for everybody because then people are more happy in their spaces, they tend to complain less, more productive.	Participant
00:22:35.6	00:22:36.0	Mhm	Interviewer
00:22:36.0	00:22:39.5	So once you get that's kind of our core mission, is to support that.	Participant
00:22:39.6	00:22:52.2	Okay. Uhm, so, what kind of, do you interact with the people that are in the labs very often, or do you get to know them at all?	Interviewer
00:22:52.2	00:23:02.8	Uhm, I personally do, yeah. Uhm, quite a bit actually. Mainly because I'm trying to support their research and have a interface with the, with the systems over there.	Participant
00:23:02.8	00:23:03.2	Mhm	Interviewer
00:23:03.2	00:23:07.1	Uhm, so yeah.	Participant
00:23:07.1	00:23:16.2	Okay, {LG} uhm, these questions are kind of to understand the relationship between the decision maker and the the occupants.	Interviewer
00:23:16.2	00:23:17.6	Ah, yeah.	Participant
00:23:17.6	00:23:23.8	Yeah. Just, uhm, because they're, they're very different than the other set of questions. uhm	Interviewer
00:23:23.8	00:23:25.8	Oh. Yeah. Right.	Participant
00:23:25.8	00:23:33.6	But do you, so do you live in Boulder, or, like an area that is close to here at all?	Interviewer
00:23:33.6	00:23:34.9	Yes.	Participant
00:23:34.9	00:23:51.0	Yeah. {LG} Okay. Uhm, so to the last two are, well we'll start with the first one. To what extent do you believe our global climate is changing?	Interviewer
00:23:51.0	00:23:59.4	Uhm, to a very big extent {LG} so I yeah, I guess I personally have a passion for energy conservation.	Participant
00:23:59.4	00:24:00.0	Mhm	Interviewer
00:24:00.0	00:24:15.5	Uhm, and my degree, I I have a mechanical engineering degree, and uhm, I think out of college I was going to do alternative energy generation for, for NREL. That didn't happen because it was unsexy at the time political climate wise	Participant

00:24:15.5	00:24:15.9	Mhm	Interviewer
00:24:15.9	00:24:25.9	and uh, then I ended up with a job at Hewitt Packard, and uhm, I sold all my energy conservation ideas, more under the consumption, uh like, consumption reduction versus	Participant
00:24:25.9	00:24:27.3	Okay	Interviewer
00:24:27.3	00:24:30.9	alternative energy generation and that took off pretty quickly.	Participant
00:24:30.9	00:24:31.5	Mhm	Interviewer
00:24:31.5	00:24:49.8	and then when I came here with Tim and we developed that air change rate reduction program, that's kind of taking off nationally right now. That's kind of where my passion is at the moment because lab's take up twenty three percent of a typical portfolio. That's what we've seen here on campus, and we're kind of a micro climate of a macro climate.	Participant
00:24:49.8	00:24:50.5	Mhm	Interviewer
00:24:50.5	00:24:54.4	But yet it consumes about forty five percent of the	Participant
00:24:54.4	00:24:55.0	Oh.	Interviewer
00:24:55.0	00:25:05.1	the consumption for the campus. So we're targeting labs, and so with our air change rate reduction project we're hoping to see about a nineteen percent campus wide consumption reduction.	Participant
00:25:05.1	00:25:06.1	Oh.	Interviewer
00:25:06.1	00:25:06.2	Uhm, so that'd be another driver.	Participant
00:25:09.1	00:25:24.0	Mhm. Okay, and so then finally, uhm, to what extent do you believe that your personal beliefs are represented in the policies and standards that CU uses for their decision making processes?	Interviewer
00:25:24.0	00:25:26.4	My personal? {LG}	Participant
00:25:26.4	00:25:28.3	Yeah. Yeah.	Interviewer
00:25:28.3	00:25:39.1	Oh, geez, uhm, well, I don't know if they're my personal beliefs because so, being an engineer I'm probably more data driven than the average bear. Uhm	Participant
00:25:37.8	00:25:38.4	Mhm	Interviewer
00:25:38.4	00:26:10.0	So, I don't know if my personal beliefs are too much into it, I kind of come to the table looking for either patterns, or data to help support decisions, and uh, I do influence it a lot through the standards, but its usually based on a payback analysis, of what makes sense from a business standpoint, but also environmentally, our carbon footprint. Uhm, so, we used to work directly for the Energy Conservation Office, that's kind of how our department was built.	Participant
00:26:10.0	00:26:10.8	Mhm	Interviewer
00:26:10.8	00:26:32.0	Uhm, based on that focus. And then, uhm, it's hard to say it tends to be, the University still has a strong commitment, they have the uhm US Pre.., it's like Presidential Climate Commitment, uhm that we signed a while ago for carbon neutrality.	Participant
00:26:32.0	00:26:32.6	Okay	Interviewer
00:26:32.6	00:26:44.4	And I think uhm, so the University kind of has that	Participant

		commitment at a very high level, anyway, th.. that makes it easier just to align with that I guess, my personal goals.	
00:26:38.3	00:26:39.0	Mhm	Interviewer
00:26:44.6	00:26:45.7	Yeah.	Interviewer
00:26:45.7	00:26:46.2	Yeah.	Participant
00:26:46.2	00:26:47.2	Okay.	Interviewer
00:26:47.2	00:26:51.2	Uhm, but whether we get there or not, that depends on finances {LG}	Participant
00:26:51.2	00:27:07.7	{LG} yeah. Uhm, okay, so, I am through with all of my questions, but if you had anything else that you wanted to mention or think that we should talk about related to this HVAC system upgrade, uhm, we can do that.	Interviewer
00:27:07.7	00:27:12.6	Uhm, well, so the lighting was also upgraded with the HVAC	Participant
00:27:12.6	00:27:13.2	Okay	Interviewer
00:27:13.2	00:27:28.0	Uhm, and so, it's LED lighting, uhm we followed the Principles of, uhm, what's it called.. I2SO, and which stands for International La.. Sustainable Laboratories for the Twenty-first Century.	Participant
00:27:28.0	00:27:28.7	Mhm	Interviewer
00:27:28.7	00:27:36.4	Uhm, and it kind of all aligns with what we talked about before, how laboratories are the bigger con.. biggest consumers.	Participant
00:27:36.4	00:27:37.0	Okay	Interviewer
00:27:37.0	00:28:01.9	Of consumption in the US and also on campus. And uhm, so yeah. Uhm. We're, we're also kind of, I the only reason I'm mentioning it is that, is that there is a business case behind a holistic approach to viewing a Life Cycle Cost versus just the capital construction	Participant
00:28:01.9	00:28:02.9	Right.	Interviewer
00:28:02.9	00:28:10.1	And slowly the O and M and energy behind it. I think that's the only thing I would kind of plug for a lot of our projects on campus.	Participant
00:28:10.1	00:28:13.1	Is that you do that kind of holistic..	Interviewer
00:28:13.1	00:28:23.7	Right, whereas a developer, they're kind of looking more at like, and I I really see the luxury of the opportunity we have to make that decision.	Participant
00:28:23.7	00:28:24.4	Mhm	Interviewer
00:28:24.4	00:28:33.6	If you ask developer, they probably look at the investment from a five year standpoint and call it good. Uhm, which is maybe appropriate given how much they change.	Participant
00:28:33.7	00:28:34.3	Mhm	Interviewer
00:28:34.3	00:28:37.2	But at a University, it's kind of a different story, for sure.	Participant
00:28:37.2	00:28:39.1	Okay.	Interviewer
00:28:39.1	00:28:49.9	Uhm, other than that, I don't know, I wish I yeah. If you need anything holler {LG}. It sounds like a fun project and good luck on it.	Participant
00:28:49.9	00:28:55.4	Yeah. Thank you. And thank you for your time. I'm sorry again about the confusion at the beginning.	Interviewer

00:28:55.4	00:29:02.8	No, uh, it was probably my fault {LG}. I think I get time warped when the time {LG}	Participant
00:29:02.8	00:29:03.4	{LG}	Interviewer
00:29:03.4	00:29:06.1	I don't know what's up from down {LG}	Participant
00:29:06.1	00:29:09.3	{LG} Okay, well thank you for your time.	Interviewer
00:29:09.3	00:29:13.4	Yeah. And good luck on your project Interviewer, let me know if you need anything.	Participant
00:29:13.4	00:29:14.9	Okay, thank you.	Interviewer
00:29:14.9	00:29:16.2	Okay, bye.	Participant
00:29:16.2	00:29:18.4	Bye.	Interviewer

Interview 03-02-03-12b

Start Time	End Time	Transcript 03-02-03-12b	Speaker
00:00:00.0	00:00:02.1	Okay, can you hear me?	Interviewer
00:00:02.1	00:00:05.1	Uh, yes.	Participant
00:00:03.7	00:00:15.6	Okay. Uhm, why don't we start by just, can you describe kind of the project that you chose to work.. to talk about for this?	Interviewer
00:00:15.6	00:00:57.1	Okay. Yeah, the the the project, uhm involves replacing an existing boiler for the uh continuing education building. Uhm, which is kind of located on main campus uh near the north side. Uhm, near the heel, Hill and Boulder Creek. Uhm, essentially the building had a uh, an existing gas fired boiler that was beyond its uh useful life, or service life, uhm so it needed to be replaced. Uhm, so the the the scope of the work was mainly uh just for replacing the boiler within that mechanical room, and we did a couple of other upgrades in that uh room while uh we were in there.	Participant
00:00:57.1	00:01:16.1	Okay. Uhm, so, what other, were there any other alternatives that you chose, uhm, when you were looking at, like, what type of boiler or what other kinds of systems you were going to incorporate with this?	Interviewer
00:01:16.2	00:02:04.7	Yeah. With, during the uh initial the thought, design phase, uhm we kind of ana.. {NS} we kind of uhm analyzed a kind of a couple of different technologies. Uhm, the old boiler was called a noncondensing boiler. Uhm those boilers uh operate at uh higher temperatures to prevent uhm the fuel gas from condensing, which forms an uh an acidic condensate which can damage boilers. Uhm, but those, that technology operates at lower efficiencies, so we were looking at uhm, using a more current technology, uh, like the condensing boilers, or a uhm, a heat pump to see if we could uh kind of get a higher efficiencies out of the heating systems and kind of lower the energy cost for the building.	Participant
00:02:04.7	00:02:21.9	Okay. So, uhm, what were some of the returns that you considered when looking at this investment? And that could be financial, that could be the energy savings, just kind of the return on the investment in different aspects.	Interviewer
00:02:21.9	00:02:58.6	Mhm, uhm, {NS} for most projects, uhm, I typically look at	Participant

		uh first uh the first cost. You know, how much is this piece of equipment or system uhm going to cost uh relative to others. Uhm and then I evaluate the energy costs or or efficiencies uhm because some mechanical systems or equipment may have uhm a really low energy costs, or their efficient, but they may have very high first costs. You know, this this piece of equipment may be two hundred percent more than the other piece of equipment even though its more efficient, you're going to pay a lot more money up front uhm to purchase that.	
00:02:58.6	00:02:59.2	Mhm	Interviewer
00:02:59.2	00:03:38.0	Uhm, so that that's always pretty critical since we have, you know, limited budgets here on campus, you know, limited funds. So we have to kind of pick a a design or system that uh will meet that budget constraint. Uhm, another important uh metric uh I use is always the Operations and Maintenance Cost. Uhm, because the amount of maintenance that uh pieces of equipment have can vary greatly. Uhm, so some equipment, you know, can be very robust or durable, uhm, so you don't have to rea.. spend a lot of effort or money trying to maintain it whereas other equipment uh, you may have to spend a lot of time a year to maintain it. You know, spend, you know maybe forty man hours	Participant
00:03:38.1	00:03:38.4	Mhm	Interviewer
00:03:38.4	00:03:55.8	uhm to do routine maintenance throughout the year. Uhm, so that's always uh a critical component to consider since, you know, we also have limited resources on campus with our maintenance technicians, uhm, so we always try to pick systems that have a lower uhm, kind of operations and maintenance cost.	Participant
00:03:55.8	00:04:06.9	Okay. Uhm, so you mentioned that this system that was chosen was an energy efficient system.	Interviewer
00:04:06.9	00:04:36.9	Yes. So after evaluating a couple options uh we decided to go with two two boilers instead of one because the, the existing building only had one boiler, so we realized that you know, if that boiler were to fail during winter, you know, the the building could have freezing issues. Uhm, so from a resiliency aspect we decided, you know, we should probably put in two boilers. Uhm, then the issue was was uh space constraints. We didn't have enough room in the mechanical room to put in uh two of the same type boilers.	Participant
00:04:36.9	00:04:37.3	Okay	Interviewer
00:04:37.3	00:05:06.9	So our designer proposed using these kind of wall mounted boilers, uhm, that kind of look like a big panel, uhm and you can mount those on the wall, and they have a slim, you know, uh profile, and they were also the condensing type boilers with higher efficiencies. Uhm, so, it wor.. it met the budget, it provided the multiple boilers for the resiliency and it fit within the mechanical room, so we decided that was the best option. So we went with that one.	Participant

00:05:05.1	00:05:09.7	Okay, when did, when was this project uh completed?	Interviewer
00:05:09.7	00:05:16.8	Uhm, let me look here, I think.. I believe it was summer of two thousand and seventeen, I can pull it up	Participant
00:05:16.8	00:05:17.8	Okay	Interviewer
00:05:17.8	00:05:18.8	here.	Participant
00:05:18.8	00:05:33.1	{NS} So my follow up question to that is uhm, have you seen the changes that you were expecting, or have you seen other kinds of changes related to putting in these, this two boiler system?	Interviewer
00:05:33.1	00:06:21.3	Uhm, well since we installed those boilers, uhm, we haven't had any issues, we haven't come acrost any uhm operations or maintenance concerns. You know, none of our techs have came back and said, you know, these things are difficult to maintain. Uhm, I haven't evaluated the the building energy performance since then, uhm, but now that we've gone through at least two winters, yeah, I think we've got some historical data that I could probably pull up. Uh in fact I could probably pull it up right now it won't take very long, to see if we're, if we're using less energy than uh before. Uhm, you know, and of course it satisfied our our de.. our desire to have two boilers, uhm. {SIL}	Participant
00:06:21.3	00:06:31.3	Okay, I'll give you a minute to look at that stuff. {SIL}	Interviewer
00:06:31.3	00:07:23.4	Uh, if there hasn't been any issues with the building heating system, so, uhm, I guess, that, you know, so there hasn't been issues with that technology, or any concerns that that type of boiler would uh would meet heating requirement for that building, so that that's a plus. Uhm. {SIL}	Participant
00:07:23.4	00:07:26.6	Are you still looking at data?	Interviewer
00:07:26.6	00:07:46.9	Uh, I just pulled it up, so, oh! So yeah. It looks like the natural gas consumption has declined so in two, so the fiscal year two thousand sixteen, which essentially would be uhm June of two thousand fifteen to June of two thousand sixteen.	Participant
00:07:46.9	00:07:47.7	Mhm	Interviewer
00:07:47.7	00:08:13.4	So essentially the two thousand fifteen winter and the following winter we used eh about seventy six hundred to nine thousand therms. And then we replaced the boiler, and now looks like we're spending, or using only forty six hundred to fifty five hundred therms, so, that's a pretty good reduction. Yeah. So that's a a reduction of at least three thousand therms.	Participant
00:08:13.4	00:08:23.9	Mhm. Was that something that uhm, you used in your decision making process, or is that kind of just a happy coincidence?	Interviewer
00:08:23.9	00:08:46.9	Oh no, that that was used, because we knew that the, the old boiler was very inefficient, so we knew this boiler was going to lower the energy cost for the building. So we we expected that kind of to happen. Uhm, so this isn't really a surprise, but it does confirm that the the new boiler is saving, you know, a couple thousand dollars a year on energy for that facility.	Participant

00:08:46.9	00:08:57.5	Mhm. So could you describe any specific financial limitations that were involved in this decision?	Interviewer
00:08:57.5	00:09:25.9	Yeah. Uhm, {NS} so when we we uh started this project, uhm, the original scope was simply to just replace the boilers, and then, uhm, {NS} we realized that there, there was also an existing water heater in that mechanical room, uhm, that uh, was also in need of replacement as well as some other uhm piping, appertinences and some other equipment.	Participant
00:09:25.9	00:09:26.1	Mhm	Interviewer
00:09:26.1	00:09:55.8	Uhm, but we already had our budget fixed because that budget was was uh built on uhm, simply just replacing the boilers, kind of a like for like replacement. It didn't account for that additional work. Uhm, so when we did the design we realized that we were going to have issues replacing the other equipment in the mechanical room besides the boilers, so uhm, we had to uh kind of change the design a little bit so that we could, uh I guess lower the cost so that we could still replace the boilers and still replace uh those other pieces of equipment.	Participant
00:09:55.8	00:09:57.0	Okay	Interviewer
00:09:57.0	00:10:02.5	Uh, uhm {SIL}	Participant
00:10:02.5	00:10:06.8	But you got everything figured out to replace everything, right?	Interviewer
00:10:06.8	00:10:31.3	Yeah. for this project we did manage to do that. Uhm, even though that's, that's not typical on a lot of projects, sometimes you have to either cut things out of the scope, you know reduce the scope of the project, or you have to make uh changes, design changes, uhm, yeah, so you may have to alter the design e.. significantly in order to uhm build something within your budget.	Participant
00:10:31.3	00:10:41.6	Okay. So, along with the budget limitations, were there any timescale limitations for this project?	Interviewer
00:10:41.6	00:10:55.7	Uhm, yeah, there's always time limitations. So, since this involved replacing the heat the boilers for the heating water system, uhm, we had to do it during the the summer, you know, before the temperatures in Colorado started to drop down at night.	Participant
00:10:55.7	00:10:56.3	Mhm	Interviewer
00:10:56.3	00:11:31.6	Uhm, but by the time they had a a contractor on board to start the work I think it was already in June or July uhm, so the contractor really had uh to kind of scramble to get the boiler the new boilers replace and up and running before it got cold. And I think, I think they had it up and running in September, but we did get a couple of cold night, you know, during that month, you know, do there was some complaints when people, you know, wal.. came into the building in the early morning. Uhm, so yeah, we did have that concern to get the heating system uhm, operational before we got our first, you know winter freeze uhm here in Colorado.	Participant
00:11:31.6	00:11:32.0	Mhm	Interviewer

00:11:32.0	00:11:53.1	Uhm, so that's usually the time constraints for replacing boiler, there there's you usually try to do it during the cooling season so you don't impact the heating season. And kind of vice versa, if you're doing a project to replace the cooling system for a building you would do it during the winter, and not during the the the summer, so you always have kind of that that window uhm, to do the project.	Participant
00:11:53.1	00:12:04.0	Okay, yeah. That makes sense. Uhm, were there any other external factors that played into the project?	Interviewer
00:12:04.0	00:13:05.4	Uhm, I'm trying to think. For external, yeah, besides, you know, schedule, budget, uhm, I'm trying to think if there was any unique factor or something that we didn't account for that kind of occurred. {SIL} I, yeah, I gue.., the the one, one thing that uh came up was uhm, the old boiler, uh it, uh the flue gases dumped into an existing chimney uhm that went up, you know, went up the building. And when we decided to go with the two boiler option, uhm we realized that the existing chimney was not big enough. We couldn't use it, and we couldn't run any boiler flues up the chimney. Uhm, so we had to find an alternative path outside of the building so we just ran the flues outside of the mechanical room and had to position those so they weren't located next to any windows or doors, you know, so the flue gas wouldn't get	Participant
00:13:05.4	00:13:06.1	Okay	Interviewer
00:13:06.1	00:13:08.3	entrained or, you know, kind of sucked back in the building.	Participant
00:13:08.3	00:13:08.8	Right.	Interviewer
00:13:08.8	00:13:24.3	Uhm, so th.. that was something that kind of popped up during construction that we uh didn't anticipate and had to eh had to, you know, come up with a solution. {SIL}	Participant
00:13:24.3	00:13:47.8	Okay, so did you guys in this decision making process, use any TCO or Life Cycle Cost, uhm, processes, or was First Cost the main consideration? Kind of, where were you coming from using some of the the methods that are out there?	Interviewer
00:13:47.8	00:14:44.2	For this, for this particular project I would, I would say first cost was the main uhm governing factor, uhm, and then I would say we probably evaluated most of our options based on energy costs, you know, because we, whenever we do these projects on campus, you know, we try to, uhm, improve our sustainability, or, you know, lower the energy cost for our buildings. Uhm, so that's usually always pretty high on the list. But the first cost was, was the main, the main uh important factor. Uhm, we didn't we didn't do li.. any life cycle cost uhm, for the boilers, uhm, we don't, we don't usually do that on a lot of s.., uh on most small projects because it costs a lot of money to do that and and effort. Uh, we usually only do life cycle cost for, you know, pretty large projects. Uhm, so for this one, I guess we're just using our engineering judgement, uh, we we we assume that, you know, this system hopefully would have a pretty uh low life	Participant

		cycle cost.	
00:14:44.2	00:14:54.9	Mhm. Uhm, so, were there other, like, financial computations that were made?	Interviewer
00:14:54.9	00:15:03.2	Uhm, in terms of kind of, kind of like, return on investment, or anything like that? Or, like, simple payback?	Participant
00:15:03.2	00:15:04.2	Those kinds of things.	Interviewer
00:15:04.2	00:15:22.3	Uhm, I I I guess I don't have an answer for that. I I did not, CU did not do that. Uh, it could have, the design engineer who did the project may have done some of those calculations. Uhm, I don't believe they ever presented that information to us. So I guess I, that's an unknown.	Participant
00:15:22.3	00:15:39.3	Okay. Uhm, and then, how, if you can answer this, how was the upgrade financed? Was that all through internally accumulated funds or were there outside sponsors? Uhm, what kinds of money were you working with?	Interviewer
00:15:39.3	00:16:07.4	Yeah. So of the funding came from our deferred maintenance program on campus. So that's uh, essentially a uhm a mo.. monies that are set aside to specifically address deferred maintenance. So that's replacing equipment, uhm, that's failed, or nee.. or that or that's old. Uhm, so all the, all the budget, or all the funds came from that budget, uhm so there was no any other funding source.	Participant
00:16:07.4	00:16:22.2	Mhm. Okay, uhm, to what extent, if you know, were the occupants involved in making any decisions about this boiler replacement?	Interviewer
00:16:22.2	00:16:39.3	Uhm, for this particular project, uh I would say there was no building occupants that were involved. Uhm, because all of the work was really contained to the mechanical room so we weren't, we weren't going to do any work inside people's offices.	Participant
00:16:39.3	00:16:40.1	Mhm.	Interviewer
00:16:40.1	00:16:54.1	Uhm, or, you know, the the occupiable spaces. Uhm, so for this project there was no input from the occupants, but when we do projects where we are in people's spaces then then you probably would have that type of input.	Participant
00:16:54.1	00:17:02.5	Okay. Uhm, and how long do you expect the, this new boiler system to be functional?	Interviewer
00:17:02.5	00:17:31.6	Uh, well, well hopefully it lasts a long time. Uhm, hopefully, I would, I would say we hopefully we get, you know, fifteen to twenty years out of it. Uhm that that can vary a lot based on eh different boilers and their their technologies. I mean, we've got some boilers on campus that last, you know, thirty to forty years, and some that don't last fifteen years. Uhm, so, I I hope that that these will last at least ten or fifteen years, so	Participant
00:17:31.6	00:18:01.9	Okay. Uhm, I'm trying to make sure I hit all my, all the questions that I had prepared. So, were there, uhm, any non monetary benefits that you considered when you were deciding on this alternative for this replacement and upgrade?	Interviewer
00:18:01.9	00:18:19.6	{NS} uhm, yes. The, I said the biggest non monetary benefit	Participant

		was the extra space that we gained in the mechanical room by going with these boilers, uhm, we freed up a lot of floor space. Because the old boiler kind of sat in the middle of the mechanical room,	
00:18:19.6	00:18:20.1	Mhm	Interviewer
00:18:20.1	00:18:28.3	and by using these boilers we we now have extra space, uhm, for floor maintenance, and it kind of frees up, you know, space for storage, so	Participant
00:18:28.4	00:18:38.6	Okay. And other than that, have you seen any benefits resulting from this investment?	Interviewer
00:18:38.6	00:18:46.7	Uhm, I said the the probably the big benefit I've seen is the loads, uh reduction in energy consumption or energy cost for the building.	Participant
00:18:46.7	00:18:59.0	Mhm. Would you be able to send me the data related to uhm, the energy models or any cost evaluations that you've done for this project?	Interviewer
00:18:59.0	00:19:01.2	Yes. Yeah, I can do that.	Participant
00:19:01.2	00:19:21.0	Okay. So, I think, we can move on to my second set of questions, which is more about understanding where the decision maker is coming from. So, uhm, why is this building important to you and your team?	Interviewer
00:19:21.0	00:19:54.6	Uhm, uh, so thi.. this building, the continuing education building, you know, houses uhm several departments on campus. Uhm, you know, it's regularly occupied, uhm, they've got offices in there uhm, you know, so, that was one of the reasons why we went with two boilers, because, you know, if the boiler, if we only had one boiler and it failed, you know, not having heating in that building would be bit of an issue. Uhm, so that's why we wanted to uhm, kind of improve the resiliency of that building for for all of the occupants in there.	Participant
00:19:54.6	00:20:05.1	Okay. So do you often, or what kinds of interactions do you have with the building occupants in the continuing ed building?	Interviewer
00:20:05.1	00:20:13.7	Uhm, my my myself personally, or, like, other groups within facilities management?	Participant
00:20:13.7	00:20:15.7	{NS} Uhm, both.	Interviewer
00:20:15.7	00:20:26.9	Okay. Uhm, myself, uhm, since I'm a member of the planning, design, sonctruction group. Uhm, the engineering group, we oversee all design construction activities on campus.	Participant
00:20:26.9	00:20:27.3	Mhm	Interviewer
00:20:27.3	00:21:07.2	Uhm, so, if the occupants in the building, or the building proctor had a project they wanted to do like a renovation, I would have to, or I oversee the design of that uh to make sure that its code compliant, uhm, so I I usually meet with the occupant, sometimes uhm during uh meetings, uhm, and then I also help kind of troubleshoot any uh technical issues or technical problems that uh occur in the building too. So a lot	Participant

		of times uhm, meeting with the occupants, getting their uh feedback on uhm, what issues have come up. Uhm, so that's probably kind of my typical uhm interaction with uh building, the building occupants.	
00:21:07.2	00:21:07.6	Okay.	Interviewer
00:21:07.6	00:21:12.4	Uhm. {SIL}	Participant
00:21:12.4	00:21:21.2	{NS} Okay. So, would you say that you live in a similar area as the typical building occupant there?	Interviewer
00:21:21.2	00:21:22.5	Uhm	Participant
00:21:22.6	00:21:25.8	In the Boulder area?	Interviewer
00:21:25.8	00:21:26.7	Yeah, I'm in, our office building is located on East Campus. Uhm, so it it uh, it can, the Continuing Education building is in on main campus uhm near university Avenue, so it's kind of a a different location but	Participant
00:21:41.7	00:21:42.1	Mhm.	Interviewer
00:21:42.1	00:21:46.2	Uhm, I usually, you know, just hop in the car, and head over there, so	Participant
00:21:46.2	00:21:57.3	Okay. Uhm, so, {NS} the typical building occupant, that's including, like professors, and students, right?	Interviewer
00:21:57.3	00:22:10.7	Yeah. for this building it's it's uh, I think mainly faculty uhm, staff, uh, there might be some students in there. Uhm, I believe they do have uhm, {NS} a call center in there.	Participant
00:22:10.7	00:22:11.6	Okay.	Interviewer
00:22:11.6	00:22:15.6	Uh, so the CU call center, or, there's a call center in this building as well.	Participant
00:22:15.6	00:22:17.5	Okay. Uhm	Interviewer
00:22:17.5	00:22:20.1	Yeah. It's, I mean, it's it's mainly an office building, so	Participant
00:22:20.1	00:22:31.3	Okay. So, do you, I would imagine that most of the faculty and people live in the Boulder area? Do you think that's a good assumption?	Interviewer
00:22:31.3	00:22:41.8	Uhm, I I would, some of them yeah. {LG} A lot of people commute to Boulder though. But yeah, I would say, I would just say most of them probably live in Boulder, or nearby Boulder.	Participant
00:22:41.8	00:22:46.4	Okay. And what about you and your team?	Interviewer
00:22:46.4	00:22:50.7	Uhm, so, our facility, or do we, or do we live in Boulder?	Participant
00:22:50.7	00:22:55.9	Yeah, do you live in Boulder, or Boulder County, or the area?	Interviewer
00:22:55.9	00:22:59.2	Uh, I do not, I live in Broomfield, so, it's close.	Participant
00:22:59.2	00:23:03.1	Mhm. That's a, that's not a bad commute in the morning.	Interviewer
00:23:03.1	00:23:04.9	No. It's not too bad.	Participant
00:23:04.9	00:23:14.6	Uhm, okay, so, to what extent do you believe that our global climate is changing?	Interviewer
00:23:14.6	00:23:56.3	Uhm. I guess, uh, I think it'd be hard to put a a value on that. I think it is changing, but I think it's kind of hard to assess, like, how much. Uhm, I know there's a computer simulations and, you know, there's a lot of computer models. But from my background, you know, computer computer simulations or models can't can't really be trusted very well. Uhm, so it's,	Participant

		so I'm always kind of skeptical of those. Uhm, but, I mean when you see the the news, you know, there's a lot of evidence that, you know, we've got a lot of storm, or or weather events happening, you know, and melting in the polar ice caps. Uhm.	
00:23:56.3	00:23:57.0	Mhm	Interviewer
00:23:57.0	00:24:02.3	But I think that it'd be very dif.. very difficult to determine exactly how much the climate is changing.	Participant
00:24:02.3	00:24:22.8	Okay. So uhm, and then my final question is uhm to what extent do you believe that your personal beliefs are represented in the policies and standards that CU uses for their decision making processes?	Interviewer
00:24:22.8	00:24:27.6	{NS} So, can you repeat that one more time?	Participant
00:24:27.6	00:24:47.6	Yeah. And this can be related to finance, it can be related to energy, however you want to interpret it, but, to what extent do you believe that your personal beliefs are represented in the policies and standards that CU uses in their decision making process?	Interviewer
00:24:47.6	00:24:54.4	Well, I'm I'm a pretty firm believer in, you know, lowering energy costs, energy conservation.	Participant
00:24:54.4	00:24:54.8	Mhm	Interviewer
00:24:54.8	00:25:35.3	Uhm, given our limited fossil fuel resources, you know, so I I always try to find uhm solutions, or or try to approach projects on, you know, how can we improve this existing uh system or building. And, so, you know, a lot of times when I give my feedback to Project Managers, or or clients, or design engineers, uhm, you know, I usually try to uhm, frame things in that mindset. And I think, a lot of times, uh, you know uhm my message does kind of get a.. get across a lot. So I think a lot of uh, the policies that the University pursues are kind of built around uhm that uh, the image of, you know, of being sustainable, and uhm energy conservation.	Participant
00:25:35.3	00:25:35.6	Mhm	Interviewer
00:25:35.6	00:25:46.6	uhm, I always, I always try to find the best value that we can out of projects too. You know, we always have, there's always a limited amount of money too, uhm, we never have infinite resources.	Participant
00:25:46.6	00:25:46.9	Right	Interviewer
00:25:46.9	00:25:53.2	Uhm, so, I I try to be creative and try to propose solutions that will meet the objectives of the project, but also, uhm, work within our, our uh fiscal constraints.	Participant
00:26:02.9	00:26:03.5	Mhm	Interviewer
00:26:03.5	00:26:17.3	Uhm, and, I I I think uh, I I've been pretty successful uh on many fronts with, you know, working with other people here on campus to kind of push those, those goals and initiatives.	Participant
00:26:18.7	00:26:40.4	Okay. That sounds good. Uhm, so I have made it through all of the questions that I had, but if there's anything else that you wanted to discuss related to this project, or kind of, your decision making process, we can do that.	Interviewer

00:26:40.4	00:27:16.3	Uhm, no I, uhm, I'm pretty good. I guess I don't have any questions. Uhm, now as I mentioned for my decision making process. I mean usually the big factors are, you know, first cost, energy cost, and operations maintenance cost too, because uhm a lot of people don't, who don't work for uh a big university, and have to manage, you know, hundreds of buildings. A lot of times they don't uhm factor in all three of those, you know. So we get a lot of engineers who propose systems that may, uhm have a very low first cost, but that may require a lot of money to maintain.	Participant
00:27:16.3	00:27:16.7	Mhm	Interviewer
00:27:16.7	00:27:52.1	And, you know, I tell them well, you know, this will work within the budget, but you've just increased the life cycle cost of of the campus, you know, by by this X amount of dollars, you know, so it's actually a a a negative impact. Uhm, so I always try to make sure that we're kind of taking a holistic approach to projects and evaluating those three main things rather than, rather than just first cost, because first cost tends to kind of govern many decisions. So. {NS}	Participant
00:27:52.1	00:28:02.9	Okay then. Well, I think that we're finished. So thank you for sitting down and talking with me.	Interviewer
00:28:02.9	00:28:21.4	Yep. No problem. And, I will send you uhm, yeah that energy data that I have uhm, for the the building. Uhm, and if there's any other, I guess, analy.. uh analyses, or anything that we did regarding the the the cost, or the energy.	Participant
00:28:21.4	00:28:38.1	Okay. And if you need a reference, again, there's a list of objective data that if you have it then we would just like to to know that, in the Case Study Protocol Summary that I sent. And I can send you that again. If you need me to.	Interviewer
00:28:38.1	00:28:39.7	Okay	Participant
00:28:39.7	00:28:41.8	So.	Interviewer
00:28:41.8	00:28:41.9	Okay.	Participant
00:28:43.1	00:28:45.7	Okay, well thank you again. Have a great day.	Interviewer
00:28:45.7	00:28:49.0	Alright, yep, thank you Interviewer. Alright.	Participant
00:28:51.2	00:28:51.8	Bye.	Interviewer
00:28:51.8	00:28:53.5	Bye.	Participant

Interview 03-02-03-13

Start Time	End Time	Transcript 03-02-03-13	Speaker
00:00:00.0	00:00:06.0	{SIL} Okay, can you hear me?	Interviewer
00:00:06.0	00:00:08.1	Yes, I can.	Participant
00:00:08.2	00:00:16.3	Okay, so, uhm, I'm going to start with the {NS}	Interviewer
00:00:16.3	00:00:20.5	XXX {NS} Okay. Hang on.	Participant
00:00:20.5	00:00:24.3	{SIL} Uhm	Interviewer
00:00:24.3	00:00:26.1	Yeah, I've got to turn my phone off here.	Participant
00:00:26.1	00:00:27.3	{LG} Okay.	Interviewer
00:00:27.3	00:00:29.2	Okay.	Participant
00:00:29.2	00:00:41.0	Okay, so, uhm, just to make sure that we're on the same page	Interviewer

		before we get started. Do you have a specific lighting project in mind? That you were working with?	
00:00:41.0	00:00:44.9	Sure. Uh, let's take the engineering center.	Participant
00:00:44.9	00:01:02.4	Okay, uhm, can you kind of give me some of the back ground information like, what all you were considering when you were considering when you were upgrading that lighting, and why did the lighting need to be upgraded, and why did you pick the alternative that you did?	Interviewer
00:01:02.4	00:01:28.8	So, this was a new project. The engineering center where we are, uhm it has not, the lighting in there has not been upgraded, to my knowledge anyway an.., since it's uhm, was built. So, all the new projects that I do here on campus now, since two thousand and eight, we do LED.	Participant
00:01:28.8	00:01:29.9	Okay	Interviewer
00:01:29.9	00:01:31.5	Okay	Participant
00:01:31.5	00:01:32.1	Mhm	Interviewer
00:01:32.1	00:01:49.8	Uhm, LED is much more efficient as you know, uhm, energy conservation wise, and when you add the O and M with it, then it just, it's head and shoulders above fluorescents or anything else, any other light source.	Participant
00:01:49.8	00:01:52.6	Okay	Interviewer
00:01:52.6	00:01:53.6	Okay?	Participant
00:01:53.6	00:02:04.8	Yep. Uhm, so, what kinds of returns were you considering when you were looking at this investment?	Interviewer
00:02:04.8	00:02:30.5	Uhm, so, the you would have to talk to the project manager, he can give you a, uhm, rate of return and everything that we had on there, and uh, for these LEDs, but typically it, it's a three to five year payback, is what they come down to, to where, it's a no brainer, that's what we do.	Participant
00:02:30.5	00:02:31.2	Okay	Interviewer
00:02:31.2	00:02:40.3	Uhm, they're fluorescent, o.. one fixture, you can imagine there's thousands of these fixtures in the en.. engineering center.	Participant
00:02:40.3	00:02:41.1	Mhm	Interviewer
00:02:41.1	00:02:58.3	One fixture is is typically, let's see. I'm gonna turn this, I keep getting phone calls, sorry. Uhm. Must be some kind of fire, fire drill going on in the old.	Participant
00:02:58.3	00:02:58.7	{LG}	Interviewer
00:02:58.7	00:03:09.4	Electric shop calling me. Uhm, but, typical light fixture has three fluorescent lamps in it. Uh, or or four. Uhm,	Participant
00:03:09.4	00:03:09.8	Mhm	Interviewer
00:03:09.8	00:03:23.8	Any ea.. each lamp is thirty two watts. Uhm, so, y.. you know, that's basically almost a hundred watts per lamp.	Participant
00:03:23.8	00:03:24.6	Right	Interviewer
00:03:24.6	00:03:41.6	When you put an LED in there, their typically around twelve to fifteen watt range, so you can see what the e.. the difference. Uhm, in a poor lamp fixture they might go up to twenty-two watts. {SIL}	Participant
00:03:41.6	00:04:16.9	And then, you know, the LEDs last, the LED itself will last to,	Participant

		uhm, fifty to a hundred thousand hours. Uhm, typically they're, in those fixtures there around a hundred thousand, or seventy five thousand hour range, where a fluorescent is around ten thousand. So, you can see there's a big O and M issue there also, where, maintenance people don't have to touch them for anywhere from ten to twenty years. Obviously depending on how many hours they're operating.	
00:04:15.5	00:04:16.1	Mhm	Interviewer
00:04:16.1	00:04:18.7	Yep.	Participant
00:04:18.7	00:04:32.8	Okay, and you, would you describe this this project is something that, like, those lights needed to be replaced? Or, the University kind of just decided that they were going to take right now?	Interviewer
00:04:32.8	00:04:52.3	Uhm, so, yeah. They could uhm, it's a it's a step I guess, I guess the answer to that is to take the step now. Uhm, any time we're replacing the lighting now, we, we replace them with LEDs.	Participant
00:04:52.3	00:04:52.9	Mhm	Interviewer
00:04:52.9	00:05:00.8	Again, for the reasons I told you, about O and M, and also the uh, the energy efficiency that you get out of them.	Participant
00:05:00.8	00:05:08.3	Right. So, is this a project that is completed? Or is this one that's still..	Interviewer
00:05:08.3	00:05:10.6	It's just about complete, right now. Yep.	Participant
00:05:10.6	00:05:23.0	Okay, uhm, what were some of the predicted changes that you expected, related to this upgrade, and have you seen the results that you were expecting?	Interviewer
00:05:23.0	00:05:46.9	Uhm, so that would be part of our energy model that was done. And, again, like I said you can talk to Rich Dvorsky on that uh uh to get, get those. But, uh, yeah. They eh uhm, typically, I think for this project uh I'd have to look it back up again, it but it's around point five watts per square foot is what our pre.. we predict.	Participant
00:05:46.9	00:05:47.6	Mhm	Interviewer
00:05:47.6	00:05:55.0	Uh I think it came in around {NS} less, it's less than that, it's around four watts per square feet, so	Participant
00:05:55.0	00:05:57.2	That's pretty close.	Interviewer
00:05:57.2	00:06:09.3	Yeah. But, it, you take uhm, uhm, you know, hundreds of fixtures, and that's quite a, quite a difference between four watts a square foot and five watts so.	Participant
00:06:09.3	00:06:19.0	Okay, uhm, so, were there any specific financial limitations surrounding this investment?	Interviewer
00:06:19.0	00:06:20.3	{LG} Budget of course.	Participant
00:06:20.3	00:06:27.7	{LG} Right. Uhm, was that something that gave you guys any trouble, or?	Interviewer
00:06:27.9	00:06:46.3	Uh, typically no. Like I said for the lighting, the LEDs, the LED lighting has come, the pricing on the LEDs has come to a uhm, a point now come down to a point now where the they are very affordable, very compatible so.	Participant
00:06:45.9	00:06:51.7	Mhm. Yeah. That technology's been around for a little while now, so	Interviewer

00:06:51.7	00:06:59.3	Yes, yes it has. Like I says, I've been doing since two thousand and seven on campus here, and like said since two thousand and eight have been replacing everything with LEDs.	Participant
00:06:59.3	00:06:59.9	Mhm	Interviewer
00:06:59.9	00:07:41.7	Uhm, had a lot of push back in the beginning, especially from, what I consider, uhm, some architects that are, have grown up with the non LED lights and that and all the the pushback I got in the beginning was how much, you know, when you replace uh, when you put a fluorescent fixture, and uhm we go to replace that lamp, that lamp costs you three to five bucks. What is it going to cost you to replace that LED. And I, my pushback was, I don't know, whats what are the going to cost, we're going to change the fixture in twenty years, what are they going to cost then?	Participant
00:07:41.7	00:07:43.2	Right.	Interviewer
00:07:43.2	00:07:48.1	So, anyway, like I says, so.	Participant
00:07:44.4	00:07:56.2	Uhm, so just to, there weren't really any, the school was kind of expecting for the LED change, so the budget	Interviewer
00:07:56.2	00:07:57.0	Yes.	Participant
00:07:57.0	00:07:58.2	was appropriate.	Interviewer
00:07:58.2	00:07:58.3	Yes.	Participant
00:07:58.3	00:07:59.2	Okay.	Interviewer
00:07:59.2	00:07:59.8	Yes.	Participant
00:07:59.8	00:08:15.2	Uhm, and also, was there a time scale for this project? I know for some of the, some things within a school you're trying to work around people and work around students, and, was there anything effecting the project like that?	Interviewer
00:08:13.1	00:08:37.2	Yes. This yeah, this, uh, this project is no different. We put some new lab space in the engineering center there and uh in engineering, and uh, you know, had to work around like I said, students, and that's been going on for over a year now, and that's about to wrap up so. Uhm, tt's going to go into another phase, we're going to remodel the the tower part of it now. So.	Participant
00:08:37.2	00:08:55.0	Okay. {NS} Uhm, were choices in your upgrade limited by any external factors? Like, is there a different bulb that may have been preferred, but you weren't able to use it, or anything?	Interviewer
00:08:55.0	00:09:18.4	No. Not really. Uhm, there is some, obviously there's some uh, uhm, I'm searching for the for the the right word there's some uh, custom I guess would be the right word, custom fixtures that some you put in in certain buildings uhm, that are quite a lot more expensive than the others	Participant
00:09:18.4	00:09:18.8	Mhm	Interviewer
00:09:18.8	00:09:27.8	and it's all for, you know, aesthetics, so pleasing that. But we didn't have any of that in on this project. So.	Participant
00:09:27.8	00:09:48.0	Okay. Uhm, to what extent did you and your team use a Total Cost of Ownership or a Life Cycle Cost Analysis in your decision making process? Or was..	Interviewer
00:09:44.9	00:09:46.3	That, that,	Participant
00:09:46.3	00:09:47.3	Sorry, go ahead.	Interviewer

00:09:47.3	00:09:49.1	No, that's okay. Go ahead.	Participant
00:09:49.1	00:10:00.8	{LG} I just, the rest of the question was or was the decision made primarily based upon first cost considerations and that initial up front cost?	Interviewer
00:10:00.8	00:10:07.6	Well, so, both of them are decisions made concerning both the models so your	Participant
00:10:07.6	00:10:07.7	Mhm	Interviewer
00:10:08.1	00:10:32.8	your primary cost you have to weigh that against your life cycle cost. But everything, you know, the buildings that we put on here. They they typically don't get touched for fifty years so. Fifty to, uhm, the buildings are, the outside is made to last for a hundred years, and and we typically around twenty years or so go in and typically remodel them anywhere from twenty to fifty years so	Participant
00:10:32.8	00:10:33.4	Mhm	Interviewer
00:10:33.4	00:11:00.0	Uhm, a.. again, like I said the LEDs, your life cycle cost is greatly considered in that. Uhm, every every, and not just the LEDs but your your lighting controls as well, that ties into our, to your LED for the efficiency in that. Uhm, it's it's a total life life cycle cost of everything so.	Participant
00:11:00.0	00:11:01.5	Okay.	Interviewer
00:11:01.5	00:11:16.1	Now, if the uh upfront cost were pushing on the budget then we would have to do a little compromise, but we we it would be the total cost of the building. So, I mean that life cycle cost of the materials and that so.	Participant
00:11:16.1	00:11:26.6	Okay. {NS} Uhm, were the occupants of the Engineering Center involved when you guys decided to upgrade all the lights?	Interviewer
00:11:26.6	00:11:37.1	Yes. They were part of the team, I'm not sure uh exactly who it was, but yeah, they were, they were very much involved in all of.	Participant
00:11:37.1	00:11:38.2	Okay	Interviewer
00:11:38.2	00:11:52.3	They had, there was a representation group, you know, that, obviously you can't get everybody that that works in engineering center to agree on everything, so they they'll send, each group sends a representative, and that's who	Participant
00:11:48.8	00:11:49.8	{LG}	Interviewer
00:11:52.4	00:11:53.0	Mhm	Interviewer
00:11:53.0	00:11:55.9	has a voice in the design.	Participant
00:11:55.9	00:12:08.3	Okay. Uhm, so my next question has to do with data, and energy models, but it sounds like I need to get in contact with, I think you said his name was Rick?	Interviewer
00:12:08.3	00:12:10.6	Rich, Rich Dvorsky.	Participant
00:12:10.6	00:12:11.2	Okay.	Interviewer
00:12:11.2	00:12:22.5	Yeah, he's the project manager, he would, uh, you know as part of our, as our lead consultant did an energy model and it has all that data so	Participant
00:12:22.5	00:12:28.9	So I will, I will probably follow up with you to get his contact information after this.	Interviewer

00:12:28.9	00:12:30.4	Okay, great.	Participant
00:12:30.4	00:12:39.8	And then, does he also have data regarding the cost considerations or is that something that I should get from you?	Interviewer
00:12:39.8	00:12:42.2	Uh, he would have that too.	Participant
00:12:42.2	00:13:02.8	Okay. Uhm, so, this maybe on a higher level, you know, when considering this LED upgrade, what financial, what financial computations are made in this process?	Interviewer
00:13:02.8	00:13:11.7	Uhm, so the, obviously the cost of the ownership uhm, of these.	Participant
00:13:11.7	00:13:11.8	Mhm	Interviewer
00:13:11.7	00:13:26.9	Like, I said as well it's it's your your O and M cost, plus your uhm, you know, the first cost of the of the fixtures that, and and again like I said, thats not only lighting, it's also the lighting controls	Participant
00:13:26.9	00:13:27.6	Mhm	Interviewer
00:13:27.6	00:13:57.3	Uhm, that go with it. You, we have aux sensors and vacancy sensors, automatic lighting con.. uh, lighting control system there to actually oh, turn the lights off after a certain amount of time so that uh, uh, so, for instance, let's say the corridors in the engineering there in in the building and the building is normally open from let's say six AM til til midnight. Well from midnight to six AM.	Participant
00:13:57.3	00:13:57.9	Mhm	Interviewer
00:13:57.9	00:14:21.1	Uh an aux sensor will will run those corridors and it'll turn those lights off until somebody walks in there and actually triggers them, then they come back on from midnight to six. And they only stay on for, I think their time, I think it's a thirty minute time. It's a certain amount of time that they stay on and then they, if they don't sense anybody in there they go off.	Participant
00:14:19.5	00:14:20.7	Mhm	Interviewer
00:14:20.7	00:14:43.6	From six AM to midnight, the normal building hours, it's the first person that triggers that then those lights stay on for that amount of time. The other thing that we do is, uh, with our lighting controls is we send a signal to the HVAC uhm let them know if the room is occupied or unoccupied so that they can dial back the HVAC	Participant
00:14:43.6	00:14:44.3	Okay	Interviewer
00:14:44.3	00:14:57.6	accordingly. If nobody's in the room then they they set it back to sixty six degrees or whatever it is, sixty eight degrees. Or, in the summer time the air conditioning is set up to seventy three or four, or whatever.	Participant
00:14:57.6	00:14:58.3	Mhm	Interviewer
00:14:58.3	00:15:07.7	So now you're still with the light lighting controls interact with the HVAC, and now you're saving lots of money there.	Participant
00:15:07.7	00:15:23.8	Mhm. Okay, so {NS} the next question is, how was this upgrade financed? Was it all through internally accumulated funds or did you have any external funding?	Interviewer
00:15:23.8	00:15:32.8	I think it eh all internally, but again Richard Dvorsky can tell you that. Pretty sure, ninety nine percent sure it was all	Participant

		internally funded.	
00:15:32.8	00:15:49.5	Okay, and you mentioned before the hours of the lamps, but overall, including the controls and everything how long to you expect for this upgrade to be functional? {SIL}	Interviewer
00:15:49.5	00:15:59.9	Uh, twenty plus years. {SIL}	Participant
00:15:59.9	00:16:13.5	Okay. Were there any non monetary benefits that you considered when deciding to switch to these LEDs? I know you've mentioned the..	Interviewer
00:16:12.9	00:16:54.3	Oh, absolutely. Uhm, you know, lighting plays a big part in everyone's in demeanor, their health, everything, and so, Engineering Center was well, this part was well overdue to get a uhm lighting upgrade to where it did not feel like a cave when you're walking in there. So, yeah, there's lots of benefits, it will, I think, improve morale, health, uhm, so that that would be a non monetary benefit there.	Participant
00:16:51.4	00:17:01.5	Mhm, yeah. It definitely is. Uhm, have you seen any benefits from this investment already?	Interviewer
00:17:01.5	00:17:09.1	Uh, sure I I've said that just the same benefits that we just talked about over there.	Participant
00:17:09.1	00:17:09.7	Mhm	Interviewer
00:17:09.7	00:17:19.6	They're more happy, they enjoy it, I've talked to a few people, a few users there and they they just uhm they're very excited, they were almost giddy over	Participant
00:17:19.6	00:17:20.2	{LG}	Interviewer
00:17:20.2	00:17:22.8	how much good lighting they have now.	Participant
00:17:22.8	00:17:41.1	Good. I'm sure that's good to hear. Uhm, okay, so I'm going to move on to the second set of questions, which is, less about the system itself and more about kind of the context of the decision.	Interviewer
00:17:41.1	00:17:41.7	Okay.	Participant
00:17:41.7	00:17:48.1	So, uhm, why is this building important to you?	Interviewer
00:17:48.1	00:18:04.4	Have the, uh, they're all important to be, uh, to be, to be quite honest, I mean, this this sounds corny but uh, I I hope I'm making a difference here. In fact I I know I am, I wouldn't be here	Participant
00:18:04.4	00:18:04.8	Mhm	Interviewer
00:18:04.8	00:18:26.8	without trying to make a difference. One building is not more important than the other on campus here. Uhm, Engineering Center may have a little bit of a, since I am an electrical engineer, a little bit of a soft spot in my heart, but not any more than a.. any other building on campus here. I want the students to have a fantastic learning environment	Participant
00:18:26.8	00:18:27.4	Mhm	Interviewer
00:18:27.4	00:18:43.8	and eh., experience while they're here. I'm uhm, uhm alumni, so I'm very proud of this, my, I have a daughter that is graduated from here as well, so uh, very proud of what I do here and this university.	Participant
00:18:43.8	00:18:54.8	Mhm. Okay, so what kinds of interactions do you have with the occupants of the engineering center?	Interviewer

00:18:54.8	00:18:59.9	Uhm, so, you mean for this project or just overall?	Participant
00:18:59.9	00:19:00.9	Both.	Interviewer
00:19:00.9	00:19:18.8	Okay, so, for this project I try and after the project's complete, and like I said and this is getting to be like that there. Uhm, I let them settle in for a couple three weeks, and then I go talk to them. I actually walk through and ask them what they think of the lighting, what what they like, what they don't like	Participant
00:19:18.8	00:19:19.6	Mhm	Interviewer
00:19:19.6	00:19:29.7	so I can get feedback on the next project so we can make sure that we are, you know, doing the due dilig.., like I says, making a difference.	Participant
00:19:29.7	00:19:30.1	Mhm	Interviewer
00:19:30.1	00:20:05.0	whatever's going on over there. Uhm, as far as, the rest of it, I do walk through Engineering Center mm, and interact with students and with the faculty there. I said being an electrical engineer, I interact with the uhm the lighting, uh prof.. head of the lighting professors over there, and uhm, the I teach a class every, I take Moncef's class every year, and, for a day, and I take people like you, the Architectural Engineering students, I think that's what you are Interviewer.	Participant
00:20:05.0	00:20:06.0	Yes. I am.	Interviewer
00:20:06.0	00:20:32.0	Uhm, on a tour of uh I give them a little, uhm, white board demonstration there of how power is brought into campus here and how and distributed and that, and then I actually go and sh.. and on a tour and show them where all these things are are located in engineering center so they've got an idea of what's going on there.	Participant
00:20:26.2	00:20:29.9	That's really cool. It sounds like you're really involved.	Interviewer
00:20:29.9	00:20:33.6	{LG} I try to be! I just want to try to make a difference here.	Participant
00:20:33.6	00:20:49.1	Yeah. Uhm, okay, so, next question. Do you live in a similar area as the typical building occupant? So do you live in Boulder, Boulder County, or one of the surrounding areas.	Interviewer
00:20:49.1	00:20:50.3	I live in Arvada.	Participant
00:20:50.3	00:21:01.4	Okay. Uhm, and to what extent do you believe that our global climate is changing?	Interviewer
00:21:01.4	00:21:05.9	Oh our global climate, we are definitely getting warmer.	Participant
00:21:05.9	00:21:07.1	Yeah.	Interviewer
00:21:07.1	00:21:08.8	If that's what you mean {LG}	Participant
00:21:08.8	00:21:13.3	Well, you can {LG} however you want to answer is	Interviewer
00:21:13.3	00:21:21.0	That, like I said, if that's what you're talking about global climate, eh, I mean look at this winter we just had now. It's moving spring, winter, spring, winter, it's not	Participant
00:21:21.0	00:21:22.0	Mhm	Interviewer
00:21:22.0	00:21:43.0	The temperature is always, it's going up. Uhm, and I think that uhm, the more we can do for sustainability, and the more we can uhm, I don't want to say reduce, the more we can curtail, maybe, that warm.. global warming that we're having.	Participant
00:21:43.0	00:22:02.6	Mhm. Okay, and uhm, to what extent do you believe that your personal beliefs are represented in the policies and standards	Interviewer

		that this that CU uses in their decision making process?	
00:22:02.6	00:22:18.6	Uhm, well, uh, it's impossible not to have my your personal beliefs involved in this, but uh uhm, moreover I doit for the the good of the campus and the state, I follow all their state policies, and rules and that.	Participant
00:22:18.6	00:22:19.4	Mhm	Interviewer
00:22:19.4	00:22:39.0	Uhm, but, yeah. There's a there, like I said, it's impossible not to put some of your personal feelings in there. I says, I'm a very green person. Uhm, drive a prius, I, like I says, I ride a bike to to the park n ride, take a bus to work, and so	Participant
00:22:39.0	00:22:39.4	Mhm	Interviewer
00:22:39.4	00:22:43.0	Uh, I can't help but put some of that into..	Participant
00:22:43.0	00:22:47.3	Yeah, it's impossible to eliminate, so	Interviewer
00:22:47.3	00:23:29.7	Yeah. It's impossible to eliminate my personal beliefs. Anyway, but I, you know, I pride myself, and like you were asking about how much voice the users have. Well I sit down with the users prior to and we go over their lighting needs and, uhm, I sit down with them at least three times during the project before it's even completely built there, and go over the lighting and lighting controls, make sure that we've got everything covered the way they would like it. Uhm, sometimes monetary doesn't let us do what everything they want to do, but we find a a compromise that does make everybody happy. So. I shouldn't say, everybody, you can't make everybody happy.	Participant
00:23:29.7	00:23:30.0	{LG}	Interviewer
00:23:30.0	00:23:31.0	Make the majority happy	Participant
00:23:31.0	00:23:47.3	Right. Okay, well we have made it through all of my questions, so if there was anything else that you wanted to bring up related to this lighting project, then we can talk about that now.	Interviewer
00:23:47.3	00:24:08.4	Uh, no, I don't think so. Like I says, I talked about the controls that we have, uhm, you know lighting controls so, if you look at all the new buildings that are on campus here you'll see that, that in the evening that they are dark. Which is great	Participant
00:24:08.4	00:24:09.4	{LG}	Interviewer
00:24:09.4	00:24:26.8	for the older buildings uh, I mean, yeah. The older buildings on campus there that we're working on getting uh lighting controls to where we don't have to have the lights on when we don't need them. And then, like I said, this is a step towards it when we're doing these types of projects here.	Participant
00:24:26.8	00:24:31.3	Okay, do you have any questions for me?	Interviewer
00:24:31.3	00:24:36.8	So, you're an AE student, did you take Moncef's class?	Participant
00:24:36.8	00:24:42.6	I have taken, uhm, one of his classes. I'm getting my Master's so	Interviewer
00:24:42.6	00:24:43.6	Okay.	Participant
00:24:43.6	00:24:54.3	kind of what they do for the Master's student's who don't have AE undergrad, they have a crash course of lighting, and HVAC, and electrical, so he taught	Interviewer
00:24:54.3	00:24:54.4	Right.	Participant

00:24:54.3	00:24:57.1	a portion of that course for me.	Interviewer
00:24:57.1	00:25:04.3	Okay. Alright. Okay. No, I don't have any other questions for you.	Participant
00:25:04.3	00:25:10.1	Okay, then I think we are finished. Thank you for taking the time to talk to me today.	Interviewer
00:25:10.1	00:25:18.2	You're welcome, any time you need follow up, give me a shout, holler, you've got my email, you've got all my contact information, so.	Participant
00:25:18.2	00:25:22.1	Okay, thank you very much. Have a good day.	Interviewer
00:25:22.1	00:25:22.7	You're welcome, you too. Bye.	Participant
00:25:22.8	00:25:23.8	Bye.	Interviewer

Interview 03-03-03-15

Start Time	End Time	Transcript 03-03-03-15	Speaker
00:00:00.0	00:00:04.0	Okay, can you hear me?	Interviewer
00:00:04.0	00:00:05.3	Yes.	Participant
00:00:05.3	00:00:13.0	Okay, so, to get started with some questions about this specific lighting upgrade.	Interviewer
00:00:13.0	00:00:13.8	Mhm.	Participant
00:00:13.8	00:00:22.4	Uhm, can you just kind of describe the project for me a little bit and set the stage as far as like, location, and the size of the project and those kinds of things?	Interviewer
00:00:22.4	00:00:46.6	Okay, alright. Uhm, this is a this building is a an office building, one of our regional office buildings, here in Oakland, California. Uhm, the project name is eighteen hundred Harrison, uhm, building, interior lighting replacement. Now, the building itself is twenty five stories high	Participant
00:00:46.6	00:00:47.4	Mhm	Interviewer
00:00:47.4	00:01:16.5	I'm not sure what, how many square footage that is, I can take a look really quick, but i.. i.. in essence, uh, what we have before were all fluorescent light fixtures, and so we upgraded all of the light fixtures, replaced them with the uhm, uh, upgrade kits to LED lighting. So that's primarily the project.	Participant
00:01:16.5	00:01:20.3	Mhm. {SIL}	Interviewer
00:01:20.3	00:02:14.8	Oh let me just see, I think you might need the square footage, so let me find that out really quick. {SIL} Okay, here you go. The internal gross area of this building is seven hundred and ninety thousand square feet.	Participant
00:02:14.8	00:02:19.5	Okay. {SIL} Uhm	Interviewer
00:02:19.5	00:02:26.7	Right, and yeah. This is saying nineteen eighty four era building.	Participant
00:02:26.7	00:02:35.6	Okay. That's, so it's time for an upgrade then I guess. Uhm	Interviewer
00:02:35.3	00:02:35.4	Say that aga.. say that again	Participant
00:02:36.7	00:02:40.0	I said I guess it was time for an upgrade then.	Interviewer
00:02:40.0	00:02:48.8	Uhm, yes. {LG} Well the lights certainly were, most of the light fixtures were replaced way back in nineteen ninety	Participant

		nine.	
00:02:48.8	00:02:49.5	Okay.	Interviewer
00:02:49.5	00:03:07.9	But it was fluorescent to fluorescent because uhm, you know, fluorescents, you know, it uh it has a fixed life, you know, and once in a while you have to replace those lamps. But since this is, you know, we we replace them primarily for energy uhm upgrades.	Participant
00:03:07.9	00:03:16.7	Okay. So, why specifically did you se.. why was lighting chosen for this upgrade?	Interviewer
00:03:16.7	00:03:28.5	This one here because fluorescent, uhm, fixtures, although they are more efficient than let's say incandescent, they still consume a lot of energy.	Participant
00:03:28.5	00:03:29.1	Mhm	Interviewer
00:03:29.1	00:03:53.9	And since m.. most lamps you would have to change it anyway, uh, it's up and coming already that they needed to be changed, b.. but it just makes sense to upgrade them to LED so that we can take a look at the energy savings. However, just because they're more efficient, that that doesn't mean that we're just going to replace them.	Participant
00:03:53.9	00:03:54.4	Mhm	Interviewer
00:03:54.4	00:04:36.1	Uh, because LEDs LED lights, about five, or more years ago, were very expensive. Uh, so even if you realize some energy savings, uh it still didn't ma.. make sense because the payback would would be very long. However, the last few years, they have come down in price already. So, we looked at this, they did the calculations, uhm, our consultant did the calculations, and it showed a positive net value, so we were able to fund that uhm, that light fixt.. uhm that lighting upgrade.	Participant
00:04:36.1	00:04:42.2	Okay, and you said that you switched from fluorescent to LEDs, but were there any	Interviewer
00:04:41.2	00:04:41.3	Yes.	Participant
00:04:42.2	00:04:49.1	alternatives in the kinds of lamp or the types of LED that you were looking	Interviewer
00:04:49.1	00:04:52.4	Uhm, no. Actually, not really.	Participant
00:04:52.4	00:04:53.2	Not really.	Interviewer
00:04:53.2	00:05:13.9	Because uh, yeah, uh, their other light sources there that are not as efficient as LEDs and there are light sources that are more efficient than LEDs but they are uhm, kind of new technology, and very expensive.	Participant
00:05:13.9	00:05:24.5	Okay. Uhm, how did you consider the return that you would get on making this lighting investment?	Interviewer
00:05:24.5	00:05:32.9	So what we've done, uhm, is to they did a survey, counted all of the light fixtures in the building.	Participant
00:05:32.9	00:05:33.7	Mhm.	Interviewer
00:05:33.7	00:06:25.7	And, and had an equivalent uh LED retrofit uhm upgrade for each fixture. So what we have done is look at the energy consumption of all of the existing lights using the LED of course, uh using a set number of of hours per year, and then	Participant

		compare it with the same number of hours per year with using LED. That gave us a a a net savings in terms of energy consumption. Knowing the electricity rate we calculate how much energy cost that we are saving in a given year. Then what we have done is, we looked at an IRR uh the Internal Rate of Return	
00:06:25.7	00:06:26.3	Mhm	Interviewer
00:06:26.3	00:06:29.2	and it has to be eight percent or better.	Participant
00:06:29.2	00:06:30.3	Okay.	Interviewer
00:06:30.3	00:06:58.5	So, this yeah. So that is our our uhm, our financial uh uhm, uhm, baseline. So, anything that you're doing for an upgrade especially on energy, has to be eight percent or higher. Otherwise that means, you know, uhm, uh it's not worth doing that. So this particular project {SIL}	Participant
00:06:58.5	00:06:59.5	Hello?	Interviewer
00:06:59.5	00:07:02.1	Yes. I'm looking at this right now, hold on just a second.	Participant
00:07:02.1	00:07:03.5	Okay, sorry, I thought I had lost you.	Interviewer
00:07:03.5	00:07:11.3	So, yeah. And uh, so this particular project they have a ba.. they have an IRR of sixteen point eight percent.	Participant
00:07:11.3	00:07:13.6	Okay, that's like double.	Interviewer
00:07:12.3	00:07:13.6	So, which is pretty good.	Participant
00:07:13.6	00:07:14.2	Yeah.	Interviewer
00:07:13.6	00:07:14.9	Yeah. Right.	Participant
00:07:14.9	00:07:24.9	Uhm, so what were the predicted performance changes that you were expecting with these lights, and	Interviewer
00:07:24.9	00:07:25.5	Okay	Participant
00:07:25.5	00:07:29.8	what have you seen as actual performance changes?	Interviewer
00:07:29.8	00:07:52.0	Okay, alright. Uh the predicted performance in terms of energy was the amount of electricity that the project will save comparing from LED from comparing from fluorescent is two million four hundred and thirty four thousand six hundred and twenty nine kilowatthours per year.	Participant
00:07:52.0	00:07:52.8	Wow.	Interviewer
00:07:52.8	00:07:56.3	So that's well, because this is a big building right?	Participant
00:07:56.3	00:07:57.0	Right. {LG}	Interviewer
00:07:57.0	00:08:21.0	Almost a million square feet, so that's that's why, it's big, and considering, uhm, you have an average of maybe about twelve cents per kilowatthour that you pay. So that translates to a huge amount of of of savings there. That's why the internal rate of return went to sixteen point eight.	Participant
00:08:21.0	00:08:29.4	Okay. And is this, have you seen those changes, was it as efficient as you were ant.. anticipating it to be?	Interviewer
00:08:29.4	00:08:33.1	Uh, that I don't know, I don't have that data.	Participant
00:08:33.1	00:08:33.7	Okay.	Interviewer
00:08:33.7	00:08:39.3	Uhm, yeah. I I yeah. I don't know for that.	Participant
00:08:39.4	00:08:53.2	That's fine. Uhm, so can you please describe any financial limitations that were surrounding this uhm investment decision.	Interviewer

00:08:53.2	00:08:55.2	Uhm, what do you mean?	Participant
00:08:55.2	00:09:08.2	So, was there a strict budget that you were working with? Were you limited in the types of lamps that you could choose based on the cost of each of them?	Interviewer
00:09:08.2	00:09:09.6	Oh. Yes.	Participant
00:09:09.0	00:09:12.5	Especially with the large scope of this project. Uhm	Interviewer
00:09:12.5	00:09:31.5	Yeah, got it. Right. So, one the this project since it's a replacement it's basically a one to one replacement. So, if you have a fluorescent light fixture they replace that in kind, nothing else. Since it's a retrofit it's not brand new uhm because	Participant
00:09:31.5	00:09:31.8	Mhm	Interviewer
00:09:31.8	00:10:09.7	Because labor is expensive, and if you start changing the layout of the light lighting system, then it's going to cost more, so the best cost for this particular project is a one to one. So then that means picking the right light fixture. Now there's certainly other light fixtures that are uh uh expensive and what the consultant has done is to find, uhm, the uhm, the uhm, light fixture that is one that will maintain the illumination and light quality as the existing or better.	Participant
00:10:09.7	00:10:10.6	Mhm	Interviewer
00:10:10.6	00:10:33.7	Second that the cost will not up bring uh that it will not bring down the IRR to less than eight percent. So those are the two issues that they looked at a particular fixture which is by Philips lighting, and they used that, and that's what they installed.	Participant
00:10:33.7	00:10:35.5	Okay. Uhm, so it sounds like there weren't really, other than that IRR, there weren't really many financial limitations. Were you using uh, I guess I'll get to it in a few minutes but uhm	Interviewer
00:10:50.6	00:10:51.4	Okay.	Participant
00:10:51.4	00:10:59.6	So was this a decision that had to be made or implemented within a specific timescale?	Interviewer
00:10:59.6	00:11:08.4	Uh, yes. Uhm, you know, we n.. we needed, of course, everything here is, you need it as soon as possible {LG}	Participant
00:11:08.4	00:11:09.1	{LG}	Interviewer
00:11:09.1	00:11:20.0	and this was uhm, uh completed on uhm, I think December of twenty fourteen. So it's not, not long ago.	Participant
00:11:20.0	00:11:20.8	So did they	Interviewer
00:11:20.8	00:11:21.8	Uhm.	Participant
00:11:21.8	00:11:25.2	I'm sorry, did they do the entire building in one month?	Interviewer
00:11:25.2	00:11:26.2	No.	Participant
00:11:26.2	00:11:27.2	Or was that the finish date?	Interviewer
00:11:27.2	00:11:29.0	No it was finished by December	Participant
00:11:29.0	00:11:29.4	Okay	Interviewer
00:11:29.4	00:11:32.8	or January twenty fifteen. No, they couldn't, yeah they	Participant
00:11:32.8	00:11:33.5	{LG}	Interviewer
00:11:33.5	00:11:34.7	Yeah. They XXX {LG}	Participant
00:11:34.7	00:11:37.2	That would be very impressive.	Interviewer

00:11:36.8	00:11:47.0	Twenty five, yeah, twenty five floors. Remember this is a XXX, you they uh, the building is occupied, so most of the time they would have to do it off hours.	Participant
00:11:47.0	00:12:09.6	Okay. {SIL} Uhm, were there any other external factors that limited your choices with this lighting upgrade? We've talked about the IRR, and you said they picked based on kind of illuminance, and the	Interviewer
00:12:09.6	00:12:10.2	Right.	Participant
00:12:10.2	00:12:16.5	the brightness. But were there any other factors that you can think of, or things that may have come up along the way	Interviewer
00:12:16.5	00:12:18.3	Uhm	Participant
00:12:18.3	00:12:19.7	that had an effect?	Interviewer
00:12:19.7	00:12:37.9	Ye.. well, for for our lighting opera.. not really. You know, n.. uhm, I think that as long uhm a, well, let me put it this way. There's a code by OSHA, you know	
00:12:37.0	00:12:37.9	Mhm	Interviewer
00:12:37.9	00:12:50.4	uhm, you know, for the workers that says you need to have a minimum illumination. And for office environment, that's thirty foot-candles right.	Participant
00:12:50.4	00:12:51.2	Mhm	Interviewer
00:12:51.2	00:13:14.2	In most of our our fixtures are are originally designed anyway for the code. So it should be okay, however, since it's been like, what, twenty years since they have installed this and, uhm, it might not necessarily have that right illumination.	Participant
00:13:14.3	00:13:14.9	Mhm	Interviewer
00:13:14.9	00:13:20.6	Uh, however, for the the retrofits, they have to make that you still meet those, right?	Participant
00:13:20.6	00:13:21.7	Right.	Interviewer
00:13:21.7	00:13:41.5	Which they do. Now, uhm, I think the only drawback were after the fact, uh after after the project was done, so there were some complaints. I don't know if that's what you're asking for.	Participant
00:13:41.5	00:13:46.6	Uhm, yeah, that would be, were people, was it too bright, or were people?	Interviewer
00:13:46.6	00:14:34.3	Yeah, see, yeah. They uhm, there were uh complaints wherein there were some, and it's all over the map too. There were some complaints at first that uh the new lighting were very too bright. then there were some complaints that the lighting was was dim. So, but we've but uhm, this project has done it per all of the applicable codes. So there's nothing wrong as far as that's concerned. Now what, it might be psychological at first because the people who who keep saying that they are too bright were the one were were they were in areas wherein uhm, the existing lights have diminished over the years right.	Participant
00:14:34.3	00:14:35.0	Oh. Okay.	Interviewer
00:14:35.0	00:14:38.1	So the illumination actual degraded right.	Participant
00:14:38.1	00:14:38.5	Mhm	Interviewer

00:14:38.5	00:14:56.3	And so all of a sudden you you provide a new fixture that provides the illumination as originally designed, twenty years prior, and so a person looking at a an old picture would see, wow, all of a sudden it's too bright in here.	Participant
00:14:56.3	00:14:57.0	Mhm	Interviewer
00:14:57.0	00:15:01.8	But those are the complaints. But after a while those complaints subsided.	Participant
00:15:01.8	00:15:26.3	Okay. {NS} To what extent did you or your team use uhm, total cost of ownership, or lifecycle cost analysis in your decision making process? Or was the upgrade decision made primarily based on first cost considerations?	Interviewer
00:15:26.3	00:15:32.1	Uhm, no. This was not on first cost, this was based on IRR	Participant
00:15:32.1	00:15:32.9	Mhm	Interviewer
00:15:32.9	00:16:42.0	for a twenty year period, so, in a way that is that it in.. indirectly that is considering the total cost of ownership, right? Uhm, typically there are ways of of trying to uhm uhm trying to justify a project uhm one way obviously would be to use a life cycle cost analysis so to take a look at the total cost of ownership that is, you know, with the first cost, uh take a look at the ener.. uh the consumption cost, the maintenance, uhm, and then you look at that and then what the best option would be, would would be the uh the least total cost of ownership right? Uhm, so in a way that was was used. However, since this was an energy project, uhm, we had basically to uhm uhm basically a need to justify the internal rate of of return, which was the eight percent.	Participant
00:16:42.0	00:16:45.3	{NS} Okay, uhm, so	Interviewer
00:16:45.3	00:16:46.3	Does that make sense?	Participant
00:16:46.3	00:16:47.0	It does make sense.	Interviewer
00:16:47.0	00:16:47.9	Yeah.	Participant
00:16:47.9	00:17:00.9	Uhm, what data are available regarding the initial cost and any TCO or positive returns resulting from this investment?	Interviewer
00:17:00.9	00:17:43.5	Okay, yeah, so uhm the data that are used here obviously would be the first cost, uhm, the installation, the first cost of the light fixtures, that would be known, uh the labor to install them, that will be known, because uh there's a cost factor to who provides the bid. Uh there is the energy cost rate that is know, uhm, and then so, using the comparison of the energy savings with the rate you would know uhm, uh you would know the the annual uhm uhm consumption cost.	Participant
00:17:43.5	00:17:44.1	Mhm	Interviewer
00:17:44.1	00:17:47.6	So, those are the data that are readily available.	Participant
00:17:47.6	00:17:53.6	Okay, were there energy models that were used for?	Interviewer
00:17:53.6	00:18:04.9	In this case no, it was just a spreadsheet to take a look at uh the energy the energy uh used by A the existing, which is the fluorescent	Participant
00:18:04.9	00:18:05.8	Mhm	Interviewer

00:18:05.8	00:18:12.4	Versus the energy that would be used by the new, which is the LED. But as a model, no.	Participant
00:18:12.4	00:18:13.2	Okay	Interviewer
00:18:13.2	00:18:15.4	It was just strictly the spreadshet.	Participant
00:18:15.4	00:18:30.6	Uhm, so, I think you've answered this, but when considering building investments, what financial computations are made?	Interviewer
00:18:30.6	00:18:32.3	Primarily the IRR.	Participant
00:18:32.3	00:18:33.9	The IRR, okay.	Interviewer
00:18:33.9	00:19:04.1	Yeah. Uhm, the reason being is for us eight percent, that means if if you are making a project uhm other than a maintenance issue, uhm, you know, if its less than eight percent you're better off not doing that and investing that money in a, you know, in an account somewhere, right. So that's basically what it it costs us eight percent to to borrow money.	Participant
00:19:04.1	00:19:10.3	Mhm. Okay, uhm, so how was this upgrade financed?	Interviewer
00:19:10.3	00:20:07.7	This upgrade finance was uhm, a way that we were, a way that uh uh our enterprise is is done. It's, they have a pool of money that they give to the regions and for the Northern California region there is a set money specifically for energy upgrades. Uhm, so from that pool was you know we have to to say that we meet the IRR sixteen point eight, it's a sixteen point eight so it's more than the eight percent and the total uh budget with this was like two million seven hundred thousand. So that was submitted and the money came from that big pool. How they got to that pool I have no idea. If they borrowed it, or if they have on in their coffers for something, so, I don't know	Participant
00:20:07.7	00:20:15.3	Okay. Uhm, and how long are you expecting these LEDs to be functional?	Interviewer
00:20:15.3	00:20:17.3	Ten years, maybe more.	Participant
00:20:17.3	00:20:27.9	Okay. Uhm, to what extent were the occupants of the building involved in the decision making process?	Interviewer
00:20:27.9	00:20:32.8	Since this was a one to one replacement	Participant
00:20:32.8	00:20:33.2	Mhm	Interviewer
00:20:33.2	00:20:41.6	So only the facility operations, the ones who take care of the building, were involved. But not the occupants, so.	Participant
00:20:41.6	00:20:52.1	Okay. Uhm, did, were any non-monetary benefits taken into account when you were deciding on this upgrade?	Interviewer
00:20:52.1	00:20:55.7	You've mentioned energy savings.	Interviewer
00:20:53.9	00:20:54.0	Uh, yes.	Participant
00:20:55.7	00:21:00.9	Yeah. Uh obviously energy savings is one, but the quality of light	Participant
00:21:00.9	00:21:01.5	Mhm	Interviewer
00:21:01.5	00:21:12.1	is also another. That might not be apparent to other, to, you know, most people but the the quality of light produced by the LED	Participant
00:21:12.1	00:21:12.9	Mhm	Interviewer

00:21:12.8	00:21:18.5	is much better than the old fluorescent technology. {SIL}	Participant
00:21:18.5	00:21:27.8	Okay and what kinds of benefits have you seen already in this building from this light replacement?	Interviewer
00:21:27.8	00:21:47.2	Uh, well it's kind of not apparent, I mean, most people won't really look at the uhm light as a {SIL} hm. That's are to uh {LG}	Participant
00:21:47.2	00:21:48.0	Mhm {LG} right.	Interviewer
00:21:48.0	00:21:56.3	Yeah, so from the naked eye, I mean, uhm, there's not much change because a light is a light, you know?	Participant
00:21:56.3	00:21:56.9	Mhm	Interviewer
00:21:56.9	00:22:05.5	After a while it so you you really don't see that much. So its not apparent, basically, that's the answer.	Participant
00:22:05.5	00:22:12.0	Okay. Uhm, okay, so now I'm moving on to a second set of questions that's less	Interviewer
00:22:12.0	00:22:12.3	Okay	Participant
00:22:12.3	00:22:15.2	about the lighting upgrade specifically.	Interviewer
00:22:15.2	00:22:16.2	Alright.	Participant
00:22:16.2	00:22:20.1	Uhm, so, why is this building important to you?	Interviewer
00:22:20.1	00:22:55.4	Uh this is one of the regional uh office buildings that we have in Oakland. Uh, Kaiser is, Kaiser is headquarters here, I mean, Kaiser is based here in Oakland. Uh although this is not where the CEO resides it's uh it houses a lot of the regional functions. So this is very important in order for uh the Northern California and for the whole Kaiser enterprise to function uhm, uh efficient.	Participant
00:22:55.4	00:23:07.7	Okay, so it sounds like you work in this building, but what kinds of interaction or rapport do you have with the building occupants?	Interviewer
00:23:07.7	00:23:22.1	Uhm. {SIL} Well, {SIL} {NS} not much because there are practically hundreds of different departments here.	Participant
00:23:22.1	00:23:22.5	Right.	Interviewer
00:23:22.5	00:23:33.5	Uhm, so we are just one out of hundreds. Uhm, so it's a a little bit hard to uhm to interact that way. If that's what you mean.	Participant
00:23:33.5	00:23:47.2	Okay. Uhm, and would you say that you live in a similar area as the typical building occupant?	Interviewer
00:23:47.2	00:23:49.5	Uh, yes, I would say yes.	Participant
00:23:49.5	00:23:52.4	Okay, and that, is that in Oakland?	Interviewer
00:23:52.4	00:23:53.7	Yes.	Participant
00:23:53.7	00:23:54.6	Okay.	Interviewer
00:23:54.6	00:24:01.9	Wait a minute, hold on. For you are talking lived, uh, uh lived in uhm, off hours you mean?	Participant
00:24:01.9	00:24:03.1	Yes.	Interviewer
00:24:03.1	00:24:19.6	Oh, I see I see okay. I uh, I thought y.. you were talking about my area here in the office would be the same as the other floors. No, it's not. I live thirty miles away, different environment.	Participant
00:24:18.1	00:24:23.3	Would you say that that's typical? Of the people in the building?	Interviewer

00:24:20.3	00:24:26.8	Uh, wow.	Participant
00:24:26.2	00:24:28.0	To commute far?	Interviewer
00:24:28.0	00:24:36.0	That's, uhm, no. It's, you know, this is a million square feet, and there are practically thousands of people here {LG}	Participant
00:24:36.0	00:24:36.6	Mhm	Interviewer
00:24:36.6	00:24:41.3	And, I have no idea. I wouldn't say no, it's not typical.	Participant
00:24:41.3	00:24:42.1	Okay.	Interviewer
00:24:42.1	00:24:46.0	Where all over, uh, I live in a house.	Participant
00:24:46.0	00:24:46.6	Uhuh	Interviewer
00:24:46.6	00:24:57.0	Uh uh a single family home. There are a lot of people also who probably live in apartments or condos in Oakland or in what we call the Bay Area.	Participant
00:24:57.0	00:24:57.6	Mhm	Interviewer
00:24:57.6	00:25:06.5	Uh, I live up north, so my commute is kind of far away so, uhm, I wouldn't say no, it's not typical.	Participant
00:25:06.4	00:25:16.0	Okay. Uhm, to what extent do you believe that our global climate is changing?	Interviewer
00:25:16.0	00:25:59.0	{SIL} To what extent. Yeah, it it's changing. Yeah, I do believe it is changing. Uh there is a lot of uh factors that that you can see for example, you know, there's a lot of uhm, uh there's a lot of icebergs that are that are are breaking out from the Antarctic right, or or the Arctic, and and you can see that from from, you know, from Iceland and Greenland, that that normally you wouldn't, and so that means that that itself is an indication that there is some sort of a global warming there right?	Participant
00:25:59.0	00:25:59.8	Mhm	Interviewer
00:25:59.8	00:26:18.9	Now that is effected by obviously the the uh, you know, uh uhm uh the pollution the carbon that that is uh in our areas right? So, you know it it doesn't, you don't need to be a rocket scientist to kind of look at that.	Participant
00:26:18.9	00:26:20.0	Mhm. {SIL} Okay, uhm and to what extent do you believe that your personal beliefs are represented in the policies and standards that Kaiser uses in their decision making process? And that can be related to finance, it can be related to environmental things or energy savings. Uhm.	Interviewer
00:26:46.3	00:26:58.3	Uh yeah, uhm, well, uh I I do believe that my beliefs are are imbedded in in the policies uh and the codes that this en.. that Kaiser has.	Participant
00:26:58.3	00:26:59.0	Mhm	Interviewer
00:26:59.0	00:27:19.5	Uh, one of the biggest goals that that have that we have done and we're heavily involved was to reduce our carbon footprint by thirty percent from the twenty two thousand and eight uh two thousand and eight baseline by twenty seventeen, which was last year.	Participant
00:27:19.5	00:27:20.3	Mhm	Interviewer
00:27:20.3	00:27:29.8	And we've met that. Now, how does that effect carbon, you know, uhm one of the biggest contributors for carbon is fossil fuel right?	Participant

00:27:29.8	00:27:30.4	Right.	Interviewer
00:27:30.4	00:27:52.2	Uhm, and fossil fuel, you know, in it's most of the electricity that we use, uh are still not renewables, they're from fossil fuel. So, this makes sense that reduce your energy consumption, you reduce the use of fuels, uhm fossil fuels, and as you reduce your carbon footprint right?	Participant
00:27:52.2	00:27:53.0	Mhm	Interviewer
00:27:53.0	00:28:01.9	And so we are doing that. Uh this is a good example that we're doing because we are savings, what did I say? Two million uhm	Participant
00:28:01.9	00:28:02.9	Mhm	Interviewer
00:28:02.9	00:28:11.0	Yeah, I two million four hundred and thirty four thousand kilowatt-hours per year.	Participant
00:28:11.0	00:28:11.4	Right.	Interviewer
00:28:11.4	00:28:19.0	You know, so that's a big amount of of offset in our carbon there. {SIL}	Participant
00:28:19.0	00:28:33.9	Okay. So, those are all of the questions that I had, but if you had anything else that you wanted to say related to this lighting project or if you had any questions for me, we can go over some of that stuff.	Interviewer
00:28:33.9	00:28:49.2	Uhm, okay. Well, no uhm, the only uh I I think I I would just want to say, I I don't have questions but I do want to say that uhm lighting projects, especially replacement of fluorescent light fixtures	Participant
00:28:49.2	00:28:50.0	Mhm	Interviewer
00:28:50.0	00:29:14.2	are pretty straight forward. Now, it's pretty straight forward because you know the fluorescents are are are are are archaic, it contains mercury, uh you have to replace them all the, you know, a.. a.. a.. after two of three years, you know, they because they the amount. Uhm obviously they they consume more energy than the LEDs	Participant
00:29:14.2	00:29:14.8	Mhm	Interviewer
00:29:14.8	00:29:50.5	LEDs with with the technology has come down in price. That was the main things that is the one of the biggest barriers for adopting uhm LED light fixtures was the cost. Uhm, and that has come down in price and so as as we go forward LED prices go down, and their efficiency is going to go up. So as you move, in the future, uhm, you {NS} changing to LEDs would would be a no-brainer.	Participant
00:29:50.5	00:29:51.3	Okay	Interviewer
00:29:51.3	00:29:52.7	Uhm, you know.	Participant
00:29:52.7	00:29:53.6	Yeah.	Interviewer
00:29:53.6	00:30:09.4	Especially for the uh for for big buildings like this. Now, smaller buildings might be a little bit different. Might be difficult to to justify because you might not see those results, but the big building, as as big as uh a million square feet	Participant
00:30:09.4	00:30:09.8	Mhm	Interviewer
00:30:10.0	00:30:20.8	uhm, you can easily see that uh on probably on on uh your	Participant

		utility meter. {SIL}	
00:30:20.8	00:30:37.5	Okay. So, uhm, I ha.. I don't know if you've seen this, but I have a Case Study Protocol that has the questions that we just went through, and then there's a list of some objective data that I am	Interviewer
00:30:37.5	00:30:38.1	Uhuh.	Participant
00:30:38.1	00:30:41.9	trying to collect, and I can send that to you.	Interviewer
00:30:41.9	00:30:42.8	Okay.	Participant
00:30:42.8	00:30:46.6	So that you know what I'm looking for.	Interviewer
00:30:46.6	00:30:54.0	Oh, I see. So, alright, you can send that to me, and then am I supposed to do something on that or? Or you pretty much have	Participant
00:30:52.5	00:31:01.0	If you could provide me any of the information that you would be able to provide me with would be very helpful.	Interviewer
00:31:01.0	00:31:01.9	Uh	Participant
00:31:01.9	00:31:09.1	This is this list is kind of expansive, so if you just don't have some of these things that's okay.	Interviewer
00:31:09.1	00:31:13.7	Okay, got it. Alright, just send that to me and then I'll see what I can do.	Participant
00:31:13.7	00:31:19.0	Okay. Well thank you for taking the time to talk to me today.	Interviewer
00:31:19.0	00:31:24.0	Yeah, you're welcome and good luck on your uh on your thesis.	Participant
00:31:24.0	00:31:25.7	Thank you very much.	Interviewer
00:31:25.7	00:31:28.6	Is that something that you can share to us after you're done?	Participant
00:31:28.6	00:31:34.4	It should be something that is available to the public so I will try to get it to people. Mhm.	Interviewer
00:31:34.4	00:31:36.8	Ah, okay alright.	Participant
00:31:36.8	00:31:40.9	Okay, well, have a great rest of your day.	Interviewer
00:31:40.9	00:31:46.3	Alright, you too. Alright, nice talking to you bye.	Participant
00:31:42.5	00:31:43.4	Thank you.	Interviewer

Interview 03-03-03-22

Start Time	End Time	Transcript 03-03-03-22	Speaker
00:00:00.0	00:00:05.4	Okay, can you hear me?	Interviewer
00:00:05.4	00:00:06.3	Yes.	Participant
00:00:06.3	00:00:15.3	Okay. Uhm, so how about we start by you just telling me a little bit about the lighting project that we're going to talk about.	Interviewer
00:00:15.3	00:00:40.6	Okay, so uhm, we uhm proposed to the region to do a number of uh LED projects throughout the region right. Uh we picked about uh, I think it was about like uh eight of them, uh uh for future projects, but uh, focus on about five buildings. Uhm, you know, to get approval.	Participant
00:00:39.3	00:00:40.1	Mhm	Interviewer
00:00:40.1	00:01:08.9	Uh so, you know, we created a business case uh gathered uhm energy information uh what it costs us to replace uh regular bulbs uh you know, the main power associated with	Participant

		that. Uh, customer uh satisfaction with it the type of lighting that we have now versus the new LED lighting.	
00:01:08.9	00:01:09.9	Mhm	Interviewer
00:01:09.9	00:01:15.7	Uh, and pretty much, you know, created a uh a case for approval.	Participant
00:01:14.5	00:01:24.7	Okay. So, why did you select lighting as the building feature to upgrade?	Interviewer
00:01:23.0	00:01:33.4	Uh, one of the uh factors was that uh some of the lighting was older in these facilities.	Participant
00:01:33.3	00:01:34.1	Mhm	Interviewer
00:01:34.1	00:01:43.8	Uh, require a lot of maintenance, uh we have uhm EVS group that replaces the bulbs uh in addition to my engineers replacing balances uh. And then we also did some newer facilities, and in newer facilities were target uh because of their high uh energy uh usage.	Participant
00:01:58.7	00:01:59.8	Okay.	Interviewer
00:01:59.8	00:02:02.0	Yep.	Participant
00:02:02.0	00:02:08.6	Uhm, so what kinds of alternatives did you consider when you were looking at this lighting?	Interviewer
00:02:08.6	00:02:21.0	Uh, we really didn't have any uh other alternatives because uh the majority of these buildings had aged fixtures that needed to be replaced.	Participant
00:02:21.0	00:02:34.4	Mhm {SIL} Okay, how did you consider the return that you would get on making this investment?	Interviewer
00:02:34.4	00:02:42.8	Uh the uh energy, materials, labor savings.	Participant
00:02:42.8	00:02:43.4	Mhm	Interviewer
00:02:43.4	00:03:01.2	Uh the uh LED uh also promotes employee productivity, collaboration, and improves the mood of our patients, staff, and visitors. So an overall change in the environment per say.	Participant
00:03:01.2	00:03:15.8	Okay. And what kinds of predicted and actual performance changes have you seen? So what were you expecting, and then what did you get when you made the upgrade?	Interviewer
00:03:15.8	00:03:27.9	Uh well, actually they they we're still in the uhm, in the uhm, uhm, uhm, {LG} what is it you call, the uhm assessment period right, because these were done last year.	Participant
00:03:27.9	00:03:28.8	Okay.	Interviewer
00:03:28.8	00:03:35.6	But uh uh we uh we're recognizing a three hundred thousand uh in savings.	Participant
00:03:35.6	00:03:38.2	Already?	Interviewer
00:03:38.2	00:03:41.6	For utilities, that's that's that's the uh that's the target.	Participant
00:03:41.6	00:03:42.2	Okay.	Interviewer
00:03:42.2	00:03:47.7	Yeah, that's the target. So, three hundred K savings on electrical charges.	Participant
00:03:47.7	00:03:48.3	Mhm	Interviewer
00:03:48.3	00:04:00.2	Approximately XXX-one thousand in material savings, and and we're hoping, we're we're targeting, I should yeah, I wouldn't say, I shouldn't say hoping because that won't get me approval.	Participant

00:04:00.1	00:04:01.2	{LG}	Interviewer
00:04:01.2	00:04:09.1	Uh {LG} uh to to achieve this in uh two point nine years. So a little bit less than three years.	Participant
00:04:09.1	00:04:13.9	Okay, and that's spread over how many buildings?	Interviewer
00:04:13.9	00:04:15.7	Uh it's with the five.	Participant
00:04:15.7	00:04:19.8	Five buildings, okay. {SIL}	Interviewer
00:04:19.8	00:04:26.9	I have the answers to your questions I've just got to find them on my sheet. {LG}	Participant
00:04:26.9	00:04:41.0	Okay. Uhm, so, can you describe the financial limitations or context surrounding this investment decision?	Interviewer
00:04:41.0	00:04:43.6	You said the uh limitations?	Participant
00:04:43.6	00:04:49.0	Yeah, or the the con.. the financial context that you're working with.	Interviewer
00:04:49.0	00:05:12.9	Yeah, well, the uh, you know, i.. in order for us to uhm to get any uh funding uh especially capital funding uh, you know, we have to uhm uh really like.. rely heavily on the return on investment, and the in this case, it had to be three years uh and under.	Participant
00:05:12.9	00:05:13.9	Okay.	Interviewer
00:05:13.9	00:05:23.7	So one one of the the problems that we had actually was uh, we we did a retrofit versus uh getting new fixtures right?	Participant
00:05:23.7	00:05:24.3	Mhm.	Interviewer
00:05:24.3	00:05:32.6	When you go into new fixtures, uh that extends the the uhm the return uh on the investment years.	Participant
00:05:32.6	00:05:33.3	Mm.	Interviewer
00:05:33.3	00:05:36.0	So it doesn't make it attractive for uh leadership.	Participant
00:05:36.0	00:05:48.6	Okay, so is that like a simple payback period, or is are there other things that you're including in the return on investment there?	Interviewer
00:05:48.6	00:05:53.9	That's just a simple payback period. {SIL}	Participant
00:05:53.9	00:06:07.6	Uhm, do you, I know you've said it's three year. Is that the, I guess why is that the timescale that was chosen for this?	Interviewer
00:06:07.6	00:06:27.0	That's uhm, uhm that is the uh that is the uh the the the minimum uh uh time that uh leader.. uh leadership will uh allow us to do. So any more than that is not, it's not, it's not worth it, it's not worth the investment.	Participant
00:06:27.0	00:06:27.6	Okay.	Interviewer
00:06:27.6	00:06:30.5	You've got to get your return within the three years.	Participant
00:06:30.5	00:06:31.1	Mhm	Interviewer
00:06:31.1	00:07:03.8	We have uh we have a lot of uh y.., you know, this organization is huge. I'm just one part of it of the uhm process of for the project right? I pretty much gather all the information like the vendor information and, you know, prepare it for approval type thing, but then it goes to our financial gurus that uhm, really really comb it for, you know, to make sure we really get the what what what we're saying.	Participant
00:07:03.8	00:07:04.7	Mhm	Interviewer
00:07:04.7	00:07:05.7	It's a challenge.	Participant
00:07:05.7	00:07:17.5	{LG} yeah. Uhm, so were there other external factors that	Interviewer

		were effecting the decision to make this upgrade to LED?	
00:07:17.5	00:07:18.7	No, uhuh.	Participant
00:07:18.7	00:07:43.5	No, okay. And if you know, uhm, to what extent did you use TCO, like Total Cost of Operation and Life Cycle Cost Analysis in your decision making? Or was it all based on the first cost considerations?	Interviewer
00:07:43.5	00:07:58.2	Well it was uhm, yeah initial cost, return on investment, operational risks. Uh, you know the the, like I said uhm, maybe, maybe about half of the buildings had uh aged uh fixtures.	Participant
00:07:58.2	00:07:59.2	Mhm	Interviewer
00:07:59.2	00:08:10.9	That in time, you know, they they become uh, a risk, you know even when when our guys go to a fixture and replace bulbs, balances, and, you know, the carvers don't fit right, they they could fall.	Participant
00:08:10.9	00:08:11.3	Mhm	Interviewer
00:08:11.3	00:08:13.3	You know, it it becomes a risk.	Participant
00:08:13.3	00:08:26.4	Okay, so I just want to clarify with the ROI that you're talking about. Are you guys looking at the energy savings from switching, and that's your	Interviewer
00:08:26.4	00:08:27.3	Yes.	Participant
00:08:27.3	00:08:31.9	Okay. {SIL}	Interviewer
00:08:31.9	00:08:50.2	The uh uh the this uhm, my company has a uhm, energy and uh carbon reduction target that, you know, expands through out national, our uh national program.	Participant
00:08:50.2	00:08:51.0	Mhm	Interviewer
00:08:51.0	00:09:03.1	So, all of the facilities are uh tasked to reduce certain amount of uh energy uh waste. So this will help us with our goals as well.	Participant
00:09:03.1	00:09:13.5	Okay. {SIL} To what extent were occupants involved in the decision making?	Interviewer
00:09:13.5	00:09:37.9	Uhm, you know, it was uh very uh minute I would say. Uh we did provided a capl.. uh couple of uh fixtures and, you know, we placed them strategically for them to, you know, get a feel of what the new fixtures will uh feel like, and there were a couple of different products, different you know, uh colors of of lighting.	Participant
00:09:37.9	00:09:38.5	Mhm	Interviewer
00:09:38.5	00:09:49.6	Uh, so, you know, we we placed them and we had a conversation with them. We got them involved a little bit so they can help us with uh, you know with the approval of the replacements.	Participant
00:09:49.6	00:09:58.1	Okay. {SIL} Uhm, what, oh go ahead.	Interviewer
00:09:58.1	00:10:03.6	We we can't just buy new stuff and put it in the buildings, these are medical facilities.	Participant
00:10:03.6	00:10:04.2	Mhm	Interviewer
00:10:04.2	00:10:06.8	We have a lot of bosses out there.	Participant
00:10:06.8	00:10:07.5	{LG}	Interviewer
00:10:07.5	00:10:09.6	{LG}	Participant

00:10:09.6	00:10:26.3	Uhm, so what data are available regarding the initial cost, and any positive returns resulting from your investment? And did you guy.. did you guys use any energy models?	Interviewer
00:10:26.3	00:11:31.1	No, we we didn't uh actually uh use an energy model. We did hire a vendor that did uh, uh , they did a cost analysis for us. Uh we provided the uh utility uh uh usage and bills that uh uh you know, we have for all these facilities. uhm. And they did a calculation to see uh what the uhm reduction would be, and, you know, what the length would be for the payback. Uh, and also, you know a bit of the uh maintenance that we do as far as, you know, replacing the bulbs and stuff like that. Uhm, we uhm, we actually ah this this region we create a uhm, an S-bar, is what it's called. Uh and uh it uh described the situation right uhm and uh how uhm what methods are we using to approve and how, you know, we want to achieve that, the reduction in cost and all of that stuff, I can uh, I don't know if you you you want to see some of these documents, I can share uh	Participant
00:11:31.1	00:11:32.0	That would be great.	Interviewer
00:11:32.0	00:11:49.4	For what we prepare actually uh for approval. And this, you know, this this document shows uh, the uh energy savings uhm per building, uhm, and the materials savings per building.	Participant
00:11:49.4	00:11:50.0	Okay.	Interviewer
00:11:50.0	00:12:01.4	I can actually send you this. I'll have to check with staff, but I I don't see a problem because it doesn't have a company name anywhere.	Participant
00:12:01.4	00:12:10.6	Okay, uhm so were there any other financial computations that you can think of that went in to this?	Interviewer
00:12:09.8	00:12:10.7	Mm-mm	Participant
00:12:10.7	00:12:14.2	No. Just the energy and the maintenance?	Interviewer
00:12:14.2	00:12:15.2	Yes. Yeah	Participant
00:12:15.2	00:12:15.7	Okay	Interviewer
00:12:15.7	00:12:21.1	And there there are risk factors, you know, being an aged facility and aged fixtures.	Participant
00:12:21.1	00:12:26.6	Okay, uhm, could you explain to me a little bit what that is?	Interviewer
00:12:26.6	00:12:27.9	What do you mean?	Participant
00:12:27.9	00:12:32.2	The risk factor, I'm not sure what you mean when you say that.	Interviewer
00:12:32.2	00:12:36.7	Oh the risk factor is that uh uh either since the fixtures are so old	Participant
00:12:36.7	00:12:37.5	Mhm	Interviewer
00:12:37.5	00:13:02.1	Uh, you know, we started getting into fixtures falling. Uh, you know, because their age, and, you know the the the employees, my uh engineers have done so much work on these fixtures, right, so there's a potential for fixtures have fallen off the ceiling. Actually, we had uh one building that, the cover just fell.	Participant
00:13:02.1	00:13:03.1	Oh!	Interviewer

00:13:03.1	00:13:06.5	It didn't hit anybody, but {LG} it was close.	Participant
00:13:06.5	00:13:15.9	Yeah, uhm, so is that something that you guys have assigned a monetary value to? Or is it something that you're just kind of aware of?	Interviewer
00:13:15.9	00:13:27.4	No, that, yeah, that's just kind of uh uh uh awareness. The ma.. the the the the monetary value is, you know, what it costs to, you know, for the boss and stuff like that.	Participant
00:13:27.4	00:13:28.0	Okay.	Interviewer
00:13:28.0	00:13:28.5	Yeah.	Participant
00:13:28.5	00:13:40.3	Uhm, so how are you financing this project? Is it all through internally accumulated funds? I know you mentioned capital funding	Interviewer
00:13:40.3	00:13:55.3	Yeah, it was uh yeah it was fu.. financed uh internally, and that's capital investment. And that's a.. that's actually, that was that was key, you know, to prepare this uhm this document that I'm going to send you	Participant
00:13:55.3	00:13:56.0	Okay	Interviewer
00:13:56.0	00:14:02.9	to to get the uh leadership buy in that, you know, it has to be capital, because, you know, the expense, no body really wants to yeah.	Participant
00:14:02.9	00:14:03.0	{LG} yeah.	Interviewer
00:14:05.6	00:14:09.0	Uh, spend you know, millions of dollars operational spending to	Participant
00:14:09.0	00:14:09.7	Mhm	Interviewer
00:14:09.7	00:14:13.1	reduce energy. That doesn't happen.	Participant
00:14:13.1	00:14:19.7	And how long will you expect for the LED lights to be in place?	Interviewer
00:14:19.7	00:14:30.1	That's a, that's a good questions. You know, we have, I have a uh uhm a hundred thousand hours of operational lights.	Participant
00:14:30.1	00:14:30.7	Mhm	Interviewer
00:14:30.7	00:14:36.1	Uh which equates over about a little bit over eleven years.	Participant
00:14:36.1	00:14:37.3	Okay.	Interviewer
00:14:37.3	00:14:43.8	With us really, with with for without maintenance really touching it.	Participant
00:14:43.8	00:14:46.3	Mhm. Okay, and can you think of any other non-monetary benefits that were taken into account in?	Interviewer
00:14:58.2	00:15:15.6	Uhm, yeah, yeah, you know, uhm, I I said this before, but, you know, this this uh this really promotes uh employee productivity. You know, it's it's it's amazing when you come to the, to a building and you're used to it being so dark because the fixtures are, you know, just dated. Uh.	Participant
00:15:15.6	00:15:16.8	Mhm	Interviewer
00:15:16.8	00:15:35.4	And to, and you come into a uhm, in a a new environment it's so, you know, nice, and lit, and everybody's happy. Uhm, it it im.. it improves the mood of the patient, you know, staff come in and it it gives it a a different look to the building.	Participant
00:15:35.4	00:15:50.1	Mhm. Okay, and I know that it just started, but have you seen any benefits from this already?	Interviewer
00:15:50.1	00:16:06.1	Yeah, we're seeing some. Uh it's kind of it's kind of a little	Participant

		bit hard to, you know, uh account account for even though get energy uhm uh bills and everything, but uh it it has, I just can't quantify it right now.	
00:16:06.1	00:16:06.4	Mhm	Interviewer
00:16:06.4	00:16:07.4	I don't, I don't, yeah.	Participant
00:16:07.4	00:16:13.3	Have you, are you at a point where you have like one whole building that's finished or is it?	Interviewer
00:16:13.3	00:16:16.5	Yeah, they they they're all done. Yeah.	Participant
00:16:16.5	00:16:17.4	Okay	Interviewer
00:16:17.4	00:16:26.7	You can actually see it through the uh, through the energy uh uh energy usage uh bills that that we that we have, that we get.	Participant
00:16:26.7	00:16:27.6	Mhm.	Interviewer
00:16:27.6	00:16:28.3	Yeah.	Participant
00:16:28.3	00:16:46.1	Okay, so that's all the questions that I had about the system itself. Uhm, so now I have some questions for you.	Interviewer
00:16:46.3	00:16:47.2	Okay.	Participant
00:16:47.2	00:16:53.1	Uhm, why are these buildings important to you?	Interviewer
00:16:53.1	00:16:57.9	Uh, these are actually uh medical facilities.	Participant
00:16:57.9	00:16:58.3	Mhm	Interviewer
00:16:58.3	00:17:11.9	Uh so, you know, we're a healthcare organization, they're important facilities. Uh, in addition to that actually my fa.. me and my family come visit some of these buildings.	Participant
00:17:11.9	00:17:15.5	I'm sorry, I missed that, you come visit?	Interviewer
00:17:15.5	00:17:20.5	Yeah, in addition to that, you know, we're we're also members of this organization that	Participant
00:17:20.5	00:17:20.9	Oh, okay.	Interviewer
00:17:20.9	00:17:22.8	me and my family come, you know	Participant
00:17:22.8	00:17:23.7	Mhm	Interviewer
00:17:23.7	00:17:30.5	see these uh these facilities. Uh I've also been with this company twenty nine years, so	Participant
00:17:30.5	00:17:31.1	Mhm	Interviewer
00:17:31.1	00:17:34.6	e.. every every building is dear to my heart. {LG}	Participant
00:17:34.6	00:17:44.9	{LG} yeah. So what kinds of interactions do you have with the building occupants?	Interviewer
00:17:44.9	00:17:52.4	Uh, personally, I don't I have I have an interaction with the manager of the facility	Participant
00:17:52.4	00:17:52.7	Mhm	Interviewer
00:17:52.7	00:18:11.7	Uhm, but I have uh thirty two engineers that are uh throughout the uh region that have uh daily interaction with the uh customers and the occupants that uh, you know, bring uh feedback to me	Participant
00:18:11.7	00:18:12.5	Mhm	Interviewer
00:18:12.5	00:18:16.2	as these projects are done, or anything that happens in a building.	Participant
00:18:15.8	00:18:17.5	That's a lot of people.	Interviewer
00:18:17.5	00:18:20.9	I just sugar coated that, you know, they	Participant
00:18:20.9	00:18:21.7	{LG}	Interviewer

00:18:21.7	00:18:26.9	but they they they bring a lot of problems. {LG}	Participant
00:18:26.9	00:18:43.9	Okay, so the it sounds like the typical building occupant would encompass staff, and kind of administrative staff, as long, as well as nurses, and even like hospital patients?	Interviewer
00:18:43.9	00:18:56.3	Yeah, we have doctors, uh yeah, they're they're like uhm, we have like clinics. These are clinics, yeah. We did a couple of buildings that do have uh O.R.s as well.	Participant
00:18:56.3	00:19:06.2	Mhm. So would you say that you live in similar area as the typical building occupant?	Interviewer
00:19:06.2	00:19:24.4	How would I say uh so so you so that that that question right there was a little, I said I said no, but I didn't I guess I didn't understand the question so you you are, am I am I to, if I compare me to the occupants? Is that the question?	Participant
00:19:24.4	00:19:25.0	Yeah	Interviewer
00:19:25.0	00:19:25.4	{LG}	Participant
00:19:25.4	00:19:36.0	We're just kind of wondering if the decision maker is kind of experiencing life in some of the same ways that the people in the building are.	Interviewer
00:19:36.0	00:19:37.6	I would say yes.	Participant
00:19:37.6	00:19:38.0	Okay.	Interviewer
00:19:38.0	00:19:43.3	Yeah, that makes sense. I had it as a no, but changed it to a yes. {LG}	Participant
00:19:43.3	00:19:51.4	Okay, uhm, to what extent do you believe that our global climate is changing?	Interviewer
00:19:51.4	00:19:57.4	Uh, this is another one that I was very uh, a little bit difficult. Uhm {LG}	Participant
00:19:57.4	00:19:57.9	{LG}	Interviewer
00:19:57.9	00:20:04.9	Well, you know, I I think it's well known that, you know, carbon monox.. dioxide is, you know, effecting our our our weather.	Participant
00:20:04.9	00:20:05.8	Mhm	Interviewer
00:20:05.8	00:20:17.2	Uhm, you know, I'm uhm, I'm a I'm a believer of uh the company's uh goal to reduce uh energy consumption and waste.	Participant
00:20:17.2	00:20:18.0	Mhm	Interviewer
00:20:18.0	00:20:37.3	Uh, you know, I uh, I experience it uh very frequently uh, you know, the the global change, the change in temperature. Actually uh I go to uh Orlando a lot, and uh don't don't remember the last time I was there, and I've been there many many years, and the last time I went actually it was, it was thirty degrees	Participant
00:20:37.3	00:20:38.1	Oh, man.	Interviewer
00:20:38.1	00:20:45.7	uh, in Orlando. So uh, yeah, whether you believe it's happening or not, that's up to you, but there's evidence, you know	Participant
00:20:45.7	00:20:46.5	Mhm	Interviewer
00:20:46.5	00:20:47.5	Yeah.	Participant
00:20:47.5	00:21:03.6	Okay, and to what extent do you believe that your personal beliefs are represented in the policies and standards that	Interviewer

		Kaiser uses in their decision making process?	
00:21:03.6	00:21:12.6	Oh I have uh, I believe that in within my job I have the uh a good chance to influence decision makers. Uh	Participant
00:21:12.6	00:21:13.0	Mhm	Interviewer
00:21:13.0	00:21:32.8	You know, by uh providing uh concrete industry uh, you know, standard information that I can, you know, gather, so so I can make my point across. I I think uhm, I I think uhm they they do listen.	Participant
00:21:32.8	00:21:55.2	Okay. That's good. Uhm, okay, so I have gone through all the questions that I had, but if there was anything else related to this system, or anything else that you wanted to mention that we didn't maybe talk about, then we can do that now.	Interviewer
00:21:55.0	00:22:11.2	Uh, not really, uh, the uhm, just curious, you know, on like on your your uhm form that I filled out it asks for the level of education uh	Participant
00:22:09.9	00:22:10.9	Mhm	Interviewer
00:22:10.9	00:22:39.0	You know, and a lot of these decision making in.. uh individuals are, you know, directors and what have you uh. I grew up a little bit, a little bit different, you know, just finished high school, and uhm, I've been uh working in the field all my life. So I have a bit of uh manager experience and the uh foot on the ground, uh boots on the ground uh experience that was myself and the engineers so	Participant
00:22:39.0	00:22:39.6	Mhm	Interviewer
00:22:39.6	00:22:46.8	Uh, yeah. Just a little bit different uhm, don't sit behind a desk, I'm out there.	Participant
00:22:46.8	00:22:47.2	{LG}	Interviewer
00:22:47.2	00:23:04.2	{LG} finding projects to reduce energy and {LG} improve the overall uh appearance and comfort of the uh patients and staff.	Participant
00:23:04.2	00:23:15.6	Mhm. {SIL} Okay, well, I think that we're finished.	Interviewer
00:23:15.6	00:23:16.4	Okay.	Participant
00:23:16.4	00:23:19.9	So thank you. Thank you for taking the time to talk to me.	Interviewer
00:23:19.9	00:23:30.8	No problem uh if uhm, I'm let me, I'm going to ask Jacqui if I can send you this document that we uh put together for the uh LED lighting	Participant
00:23:30.8	00:23:31.8	Mhm	Interviewer
00:23:31.8	00:23:35.7	project, and uh, if she says it's okay I'll send it to you.	Participant
00:23:35.7	00:23:37.9	Okay, that sounds great.	Interviewer
00:23:37.9	00:23:38.8	Alrighty	Participant
00:23:38.9	00:23:41.6	{LG} Okay, have a nice day.	Interviewer
00:23:41.6	00:23:43.0	Hey you too. Thank you.	Participant
00:23:43.0	00:23:45.4	Mhm. Bye.	Interviewer
00:23:45.4	00:23:46.0	Bye bye.	Participant

Interview 03-04-03-14

Start Time	End Time	Transcript 03-04-03-14	Speaker
00:00:00.0	00:00:02.3	Okay, can you hear me?	Interviewer

00:00:02.3	00:00:03.7	Yes.	Participant
00:00:03.7	00:00:10.5	Okay, so, the first set of questions is related to the chiller system specifically.	Interviewer
00:00:10.5	00:00:11.5	Okay.	Participant
00:00:11.5	00:00:19.6	And we can start with, why did you select this building feature to upgrade?	Interviewer
00:00:19.6	00:00:27.0	It was uhm, uhm, life expectancy was almost over.	Participant
00:00:27.0	00:00:42.0	Okay, and you, uhm, can you kind of describe the system that was put in place, and any alternatives that you may have looked at during the process?	Interviewer
00:00:42.0	00:01:29.6	Okay. Uhm, the existing system consisted of three chillers. Two chillers, uhm, one or, t.. two chillers did the building cooling, the third chiller did the lab uh cooling requirement, so almost like a process chilled water system with it for the labs, that are in uh this building. Uhm, they're outdoor units, so they're air cooled uh chiller. Uhm, at the time we can only afford a one for one replacement. Uhm, other things that we could have look as was uhm, more of the uh energy savings, or uhm, with, including a modular system with a some sort of free cooling module.	Participant
00:01:29.6	00:01:30.3	Mhm	Interviewer
00:01:30.3	00:01:39.4	That we have done in the past here at NREL. Uhm, but in this scope it can only afford a one for one replacement.	Participant
00:01:39.4	00:01:50.0	{SIL} Okay. So, the limiting factor was the budget in this case?	Interviewer
00:01:50.0	00:01:51.3	Correct.	Participant
00:01:51.3	00:02:00.8	Okay. And, how did you consider the kinds of returns that you would get on investing in this replacement?	Interviewer
00:02:00.8	00:02:36.0	Uhm, {SIL} well, the returns would be that it's a longer life. Uhm, it's a new equipment, so less maintenance. Uhm, uhm, performance maybe. With uh, with the, oh now a days new chillers are coming out with better, uhm, uh SEER or EER, or uhm, IPLV, uhm if it's uh	Participant
00:02:36.0	00:02:36.5	Mhm	Interviewer
00:02:36.5	00:02:53.3	Its a uh, uhm, not, not fully loaded. They have a better efficiency. So, this was probably twenty or thirty, how old is NREL, uhm nineteen seventy four vintage chiller.	Participant
00:02:53.3	00:02:53.7	Oh	Interviewer
00:02:53.7	00:02:54.1	chillers.	Participant
00:02:54.1	00:02:55.2	Okay.	Interviewer
00:02:55.2	00:02:58.5	So it it was it was about time to replace it.	Participant
00:02:58.5	00:03:18.4	Mhm {SIL} Okay. So what were the predicted performance changes that you anticipated with this upgrade? And then, what are some changes that you have noticed since it's installment?	Interviewer
00:03:18.4	00:03:48.3	Well, the assumption on the building side was that it would not change the load was would be the same. What we found out with the lab side, uhm, not many people are using the ch.. process loop. Uhm, some experiments have shut down, and the	Participant

		chiller is not being used effectively, uh, for the lab process side. So, in essence, it it just uhm, short cycles. And, it's over sized.	
00:03:48.3	00:03:49.5	Mhm	Interviewer
00:03:49.5	00:04:09.0	And so what could have happened, uhm, is a reassessment, uhm, you know, if uh we were to go do it all over again is a reassessment of if this what you need? Is this the right capacity? Uhm, we were just told, uhm, that we just want a one for one replacement. {LG}	Participant
00:04:09.0	00:04:10.0	{LG}	Interviewer
00:04:10.0	00:04:19.1	And, you know, it's one of those that I wish we could have just said, asked the simple question, uhm, is this the right size?	Participant
00:04:19.1	00:04:20.5	Right.	Interviewer
00:04:20.5	00:04:44.9	Uhm, for the the building it's pretty much the right size because it's a it's a consistent load, uhm, and uh, whereas the lab chiller, not knowing that there were has been some uh, remodeling, or uhm, shutting down of certain equipment, that the load was never, was not present. So therefore the new chiller is just cycling on and off.	Participant
00:04:44.9	00:04:55.7	Okay so the way this is set up there there's more than one chiller and one of them serves the building as a whole, and one of them serves the lab spaces? Is that..	Interviewer
00:04:55.7	00:05:05.7	So, uhm, building as a whole in a sense that for labs. So we retrofitted an office space and converted it to lab space.	Participant
00:05:04.6	00:05:05.4	Okay	Interviewer
00:05:05.4	00:05:37.1	With offices uhm, ventilation rate is a lot lower, but with laboratories, they need, uhm a hundred percent outside air. So this chiller would actually provide, uh, the the cooling for the make up air unit that's require in, eh for the different laboratories. So it's a make up air unit up in the fourth floor in in Denver West sixteen. And, you know, uhm when it's hot outside, that's when the chillers are used, for, to cool down the air.	Participant
00:05:37.3	00:05:37.9	Mhm	Interviewer
00:05:37.9	00:05:44.6	So, it's pretty much uh the the size of the unit is based on the size of the make up air unit.	Participant
00:05:44.6	00:05:45.8	Okay.	Interviewer
00:05:45.8	00:06:19.3	Whereas, the lab chiller, which is only one, uhm, goes into individual labs within the building, and usually there's a process load. Uhm, uh researchers like their equipment, and sometimes they need water cooled uhm, equipment, uhm and they use the process loop, or the chilled water loop to help with the, with their equipment that's water cooled. Or, they would use it for uhm HVAC systems, HVAC units	Participant
00:06:19.3	00:06:20.1	Mhm	Interviewer
00:06:20.1	00:06:49.6	That would provide uh cooling for the space. Uhm, that the building could not provide the extra cooling. So, in essence, you know, it's a glorified office, but offices only has certain VAV boxes, and their they don't expect to have a big load if	Participant

		there's an equipment running uhm for an experiment twenty four seven, and th.. this unit would help out with helping with the load inside the space.	
00:06:49.6	00:07:08.4	Okay. Uhm, so you mentioned that the budget called for only a one to one replacement. Were there any other specific financial limitations that came with the project?	Interviewer
00:07:08.4	00:07:19.4	No. Uhm, we did have some cope creep, uhm, where it was a design build type of project	Participant
00:07:19.4	00:07:20.0	Mhm	Interviewer
00:07:20.0	00:07:58.4	Or if you will a turn over key to uhm, we didn't have a designer uhm engineer, it was basically, uhm, a contractor uhm, construction contractor asking uhm, carriers to pro.. to provide the chillers and put it in place. So there was no really engineering design uhm, because they were thinking one for one, it would be uh a lot cheaper that way, but we did find some, uhm. Surprises, at the beginning of the project that we had to pay extra for.	Participant
00:07:58.4	00:07:59.4	Okay	Interviewer
00:07:59.4	00:08:13.2	So, so, really we wanted to get bare minimum cost {LG}, but we didn't. There were some situations on site that, that called for more spending.	Participant
00:08:13.2	00:08:17.4	Okay. Could you tell me what some of those were, or?	Interviewer
00:08:17.4	00:08:26.6	Sure. Uhm, so the three chillers on are on a pad outside of th.. of the office building, our lab building.	Participant
00:08:26.6	00:08:27.2	Mhm	Interviewer
00:08:27.2	00:08:43.1	And, uhm, the the lines were leaking uhm, from outside pad uhm, there's a leak within from the outside pad to the building itself. So, we had to replace the lines.	Participant
00:08:43.1	00:08:44.9	Okay.	Interviewer
00:08:44.9	00:08:52.3	Uhm, underground lines. Uh, we replaced it with new. Uhm, that was a cost that we weren't expecting.	Participant
00:08:52.3	00:08:53.0	Mhm	Interviewer
00:08:53.0	00:08:59.8	Uhm, we were just thinking one for one replacement, but it turns out that, since we're replacing it, now's a good time to replace the lines.	Participant
00:08:59.8	00:09:13.9	{LG} Yeah. Okay, and, was there a specific, excuse me, was there a specific time scale that this project had to fit inside of?	Interviewer
00:09:13.9	00:09:26.5	Uhm, yeah, within the fiscal year was uh usually with a replacement project, uhm, it shouldn't be more than a year.	Participant
00:09:26.5	00:09:27.3	Mhm	Interviewer
00:09:27.3	00:09:37.3	And, so, it kind of, almost reached a year, because of the uhm, the civil work that needed to be done, for the piping.	Participant
00:09:37.3	00:09:38.1	Mhm	Interviewer
00:09:38.1	00:09:41.2	So we had to, it was based on weather as well.	Participant
00:09:41.2	00:09:43.0	Okay	Interviewer
00:09:43.0	00:10:09.7	Uhm, yeah. I think we completed it, uhm, and I would have to look at the project folder on that. But uh, they competed it, they spent about six hundred and twenty one thousand was the budget, I don't know what the total project cost was, including	Participant

		the scope change. Uhm, that's not on this spreadsheet that I have. Uhm, but I can find that out.	
00:10:09.6	00:10:19.7	Okay. Uhm, and were there any other external factors that were limiting at all?	Interviewer
00:10:19.7	00:10:26.7	Uhm, I know, for time crunch, to answer that, the question before	Participant
00:10:26.7	00:10:27.3	Mhm	Interviewer
00:10:27.3	00:10:31.1	We needed the chillers before, uhm, summer.	Participant
00:10:31.1	00:10:32.1	Okay.	Interviewer
00:10:32.1	00:10:33.5	So, uhm,	Participant
00:10:33.5	00:10:34.5	That makes sense.	Interviewer
00:10:34.5	00:10:44.5	So we needed to have it installed, and I think we uhm, we went over that and we had to use temporary cooling in some areas.	Participant
00:10:44.5	00:10:45.3	Mhm	Interviewer
00:10:46.1	00:10:59.3	So, uhm, so that was a limit on time. We needed to get it sooner than later. Uhm, any other limiting factors was maybe, you know, uhm, budget, again, uhm	Participant
00:10:59.3	00:11:00.2	Yeah.	Interviewer
00:11:00.2	00:11:05.5	You know, you can only handle so much uh, you c.. you ol... you only have so much contingency	Participant
00:11:05.5	00:11:06.2	Mhm	Interviewer
00:11:06.2	00:11:25.4	and I think we have exceeded contingency, so, uhm, especially when uh there was some leaks, uhm, there was oh {LG} with an upgrade, a replacement, no one thinks about how the water system, whether it needs filtration, uhm, because it's been sitting there for a while. {LG}	Participant
00:11:25.4	00:11:26.4	Ew.	Interviewer
00:11:26.4	00:11:39.3	So the cost of actually filtering the water was a huge expense as well. So that was another uhm, change of scope or things that we was not foreseen in the budget.	Participant
00:11:37.7	00:11:59.7	Mhm. So, with this decision, were, I know that the budget was a limiting factor, but were you able to use, kind of, Total Cost of Operation, or Total Cost of Ownership, or any uhm Life Cycle Cost Analysis in your decision making?	Interviewer
00:11:45.6	00:12:07.4	Uhm, no, unfortunately not with this. We do have design guidelines of when to use Life Cycle Cost Analysis.	Participant
00:12:07.4	00:12:08.0	Mhm	Interviewer
00:12:08.0	00:12:36.1	Uhm, and for NREL standards, and for building replacement or, sorry, equipment replacement, that's not one of them. Uhm, we do have our own uhm life expectancy on certain equipment, and then that gets on, uhm, that gets assessed, so for equipment replacement, not necessarily we do a life cycle cost analysis, because uhm, it's already at its end of its life it just needs replacement.	Participant
00:12:36.1	00:12:36.5	Mhm	Interviewer
00:12:36.5	00:12:37.5	Does that make sense?	Participant
00:12:37.5	00:12:37.8	Yeah.	Interviewer
00:12:37.8	00:12:45.8	So we don't usually typically use it for equipment replacement projects. Uhm, we do the Life Cycle Cost Analysis basic..	Participant

		basically with new building	
00:12:45.8	00:12:46.6	Okay	Interviewer
00:12:46.6	00:12:58.6	Or uh r.. remodels. Uhm, I think over ten thousand square feet of whether or not we we implement certain uhm energy cost measures. Uhm, that kind of thing.	Participant
00:12:58.6	00:12:59.2	Mhm	Interviewer
00:12:59.2	00:13:15.5	to make our help with the decision making what, how to benefit the design. But for equipment replacement, especially with this type of funding, which is maintenance and repair. Uhm it's just, it's end its life, we need to have it on the books {LG}	Participant
00:13:15.5	00:13:16.3	{LG}	Interviewer
00:13:16.3	00:13:41.7	and then replace it, and then, you know, uhm, look at whether it's it meets all the certain codes that we have like refrigeration, uhm, because they now banned our twenty two uhm efficiency, whether we meet uh the EERE's requirements for chi.. the chillers to meet uhm certain energy efficiency. Uhm, those kind of things that we would look into.	Participant
00:13:41.7	00:13:42.9	Okay.	Interviewer
00:13:42.9	00:13:46.2	But not necessarily Life Cycle Cost.	Participant
00:13:46.2	00:13:46.5	Mhm.	Interviewer
00:13:46.5	00:13:51.8	Like, I know we, we physically did not do it for this, for this particular project.	Participant
00:13:51.8	00:14:10.0	Okay, uhm, so what kind of data is available regarding the initial cost, or any positive returns resulting from the investment. I guess you said it was in a leased building, or it's a leased situation though, so	Interviewer
00:14:10.0	00:14:52.2	Correct. So, uhm, how it works out for us, uhm, because there's we converted offices to labs, and it's in under the Denver West, it's not on our campus. It's just off site, just a five minute drive away. Uhm, we have the maintenance of our equipment done under the lease. Uhm, so they give us a certain rate. Uhm, now that they have a chiller they do prevent.. they do preventative maintenance checks and what not, so, that's part of the contract uhm for the chiller. Uhm, so that helps us out that we don't have to maintain it on our end.	Participant
00:14:52.2	00:14:52.8	Mhm	Interviewer
00:14:52.8	00:15:04.5	Uhm, that way our maintenance guys can focus whatev.. what's on the South Table Mountain site and the wind site. For, as terms of cost, I just want to open up the project folder here.	Participant
00:15:04.5	00:15:05.8	Okay.	Interviewer
00:15:06.1	00:15:24.0	In terms of data, {SIL}. So we had, uhm, initially a cost estimate within within our facil.. uh, within our group.	Participant
00:15:24.0	00:15:24.6	Mhm	Interviewer
00:15:24.6	00:15:41.2	Uhm, to help out with getting the budget. We have a contract proposal, and then, we and then they provided options, and then we picked one. And then I have costs for all the different change orders {LG}	Participant
00:15:41.2	00:15:42.2	{LG}	Interviewer

00:15:42.2	00:16:27.6	I think there's like six, change orders. Uhm, and the documents, let's see. Budget spreadsheet, maintenance cost, we have {SIL} so, our project manager did uhm, contracts, cash flow, design, construction design, build. Uh oh. CBS recharges, XXX charges, contingency. I can give to you, so we spent about, I think budget was six twenty one. Oh, original budget was five eighty one. {LG}	Participant
00:16:27.6	00:16:28.3	{LG}	Interviewer
00:16:28.3	00:16:51.0	And then I think it went up to five eighty eight. Now why would I get six twenty one? Huh? I wonder why that is? Uhm, {SIL} I see two different task numbers, maybe that's why. Okay, so do you need all of this? I don't know if I'm allowed to do this {LG}	Participant
00:16:51.0	00:16:52.6	{LG} Okay	Interviewer
00:16:52.6	00:16:56.5	Is another thing. Uhm, that uh, you know, with	Participant
00:16:56.5	00:17:30.6	Right. Yeah, no, I understand. What we're, what I'm kind of going for with this, the study that I'm doing right now, is wanting to know, uhm, if that data was used so, what, {NS} another, with another project is someone has sent me some of that data, but I everything will be scrubbed if it's used in uhm, any reports that are written or anything like that. Any identifying information will be redacted.	Interviewer
00:17:30.7	00:17:32.4	Okay.	Participant
00:17:32.4	00:17:50.8	So, if you are allowed to, and you would like to, just know that that's, that's what's going to happen. None of it will be directly associated with NREL. But, if you're not allowed to, then, I just needed to know what kinds of data you had access to and if you were using them.	Interviewer
00:17:50.8	00:18:39.5	Ah, use them as part of the project? I mean, what we ha.. received for our project was the bid, the proposal. I mean, those are the datas that we would would look at. Uhm, what could we afford in terms of options. Uhm, and then, when all of these different, six different surprises came about we had to look at the price as well, and what best that we could do in order to uhm make a decision. Uhm, because they gave us several different options for example on the filtering. We have dirty lines, uhm, especially when we had to replace those pipes underground. Uhm, there was no thought of flushing. Uhm, we've done it before in our facility, but NREL did not ask for it in the contract.	Participant
00:17:54.9	00:17:56.5	Mhm. Yeah.	Interviewer
00:18:01.9	00:18:02.4	Mhm	Interviewer
00:18:39.5	00:18:40.0	Mhm	Interviewer
00:18:40.0	00:18:45.7	But it was one of those turnkeys, so the expectation was somewhat hey, they know what they're doing {LG}	Participant
00:18:45.7	00:18:47.3	{LG} Right.	Interviewer
00:18:47.3	00:19:06.1	And, you know, whether, you know, it was one, okay, so, you didn't put it in the price in the contract, fine, how much does it cost. You know, and they gave us different options. Uhm,	Participant

		could we do it ourselves, in house? Uh it was getting closer to summer, everyone's getting hot.	
00:19:06.1	00:19:06.7	Mhm	Interviewer
00:19:06.7	00:19:29.0	So, you know, do we bite the bullet and get the bigger filter in trying to get this all cleaned up? So it was one of those decisions on, uhm, yes. Price was coming in, and whether we had to look at it and say can we eat that cost? Or not? Or was there other ways to help uhm mitigate that cost, by things that we could do in house.	Participant
00:19:29.0	00:19:29.9	Okay	Interviewer
00:19:29.9	00:19:43.9	So, uhm. Because we're only given a tight budget, and all of these uhm, circumstances, outside circumstances attributed to asking for more money,	Participant
00:19:43.9	00:19:44.7	Mhm	Interviewer
00:19:44.7	00:19:53.7	We had to make sure that uhm, we're doing right by just thinking it through and making sure that we're not just handing them money {LG}.	Participant
00:19:53.7	00:19:54.4	{LG} Right.	Interviewer
00:19:54.4	00:19:56.7	In order to, in order for it to go away.	Participant
00:19:56.7	00:19:57.1	Mhm	Interviewer
00:19:57.1	00:20:03.9	Because it's one one of those things where w.. what next? All we wanted to do was replace a chiller. {LG}	Participant
00:20:03.9	00:20:04.9	{LG} Yeah.	Interviewer
00:20:04.9	00:20:17.9	And it's one thing after another after another. Where, it was kind of, uhm, wasn't quite sure if it, the contract, if we were in the right contract for that. Do you know what I mean?	Participant
00:20:17.9	00:20:18.5	Mhm	Interviewer
00:20:18.5	00:21:06.5	If uhm, if we had a time to to establish, is this the right size for the chiller, uhm, what are things that are not in the contract that should be in the contract, and it's a matter of getting the right people to review that contract to make sure that uhm, certain things that they're aware of in terms of replacement of equipment gets in.. included in the contract. Uhm, so. {LG} In hindsight, it would have been nice that we had a better review, instead of hey, I got the funds, let's throw it over the fence to a contractor and could we have prevented some of the cost with proper review? Yeah. Maybe we should downsize the chiller and	Participant
00:21:06.5	00:21:07.3	Mhm	Interviewer
00:21:07.3	00:21:25.6	support other costs. Uhm, that we found associated with, that really needed to be done, like, filtering the whole system, cleaning, flushing it out, making sure that uhm, nothing gets uh, clogged. That kind of thing.	Participant
00:21:25.6	00:21:45.1	Mhm. Okay, so speaking of the, just kind of getting the funding and going with it. How, how was this upgrade financed? Was it all internally accumulated, like, funds through NREL, or is a specific fund?	Interviewer
00:21:42.7	00:21:42.8	So, funding sources through NREL, as uhm, we have a dedicated uhm, maintenance and repair budget.	Participant

00:21:51.8	00:21:52.6	Mhm	Interviewer
00:21:52.6	00:22:22.8	And so, uhm, projects get put together, submitted, uhm, and seeing which is a priority for maintenance and repair. There's other projects, uhm, like for building construction projects, that are not in this, uh pool of money. So essentially, anything that requires any maintenance and repair, gets submitted under this funding. And then it's up to the powers to be gets to decide which is a priority and which isn't.	Participant
00:22:22.8	00:22:23.4	Okay.	Interviewer
00:22:23.4	00:22:30.3	And for this year, er, last year, twenty sixteen, two years ago, it was for the lab chiller replacement.	Participant
00:22:30.3	00:22:40.2	Okay, and since they made that uhm, upgrade, how long do you expect for that chiller to be functional?	Interviewer
00:22:40.2	00:22:45.8	Hopefully after I retire. {LG}	Participant
00:22:45.8	00:22:45.9	{LG}	Interviewer
00:22:45.8	00:22:51.1	Uhm, no. Uh, you know, chillers should last, if well maintained, thirty plus years.	Participant
00:22:51.1	00:22:51.9	Okay	Interviewer
00:22:51.9	00:23:00.9	So, uhm, we expect that if it's not maintained properly that of course the life expectancy of a of any equipment gets reduced.	Participant
00:23:00.9	00:23:02.1	Mhm	Interviewer
00:23:02.1	00:23:11.9	Uhm, so we go with the ASHRAE model, of uh what's the life expectancy of a chiller. And I think it's thirty years, twenty five, thirty years.	Participant
00:23:11.9	00:23:28.0	Okay, so you've mentioned uhm that talking to the building occupants may have been helpful, but were they involved to any extent in the decision making process for this investment?	Interviewer
00:23:28.0	00:23:37.0	No. Uh for the most part it was our facility manager, uhm, they're the almost like the landlord of the building.	Participant
00:23:37.0	00:23:37.4	Okay.	Interviewer
00:23:37.4	00:23:51.1	Uhm, there was a need to replace an old qui.. equipment. Uhm, and we just did an estimate, and never really questioned uhm, whether or not uhm we needed to downsize.	Participant
00:23:51.1	00:23:53.5	Okay. Uhm,	Interviewer
00:23:51.8	00:23:53.5	So.	Participant
00:23:53.5	00:23:55.1	No, go ahead.	Interviewer
00:23:55.1	00:24:00.9	I, you know, uhm, like I said hindsight's twenty twenty and we could have	Participant
00:24:00.7	00:24:01.5	{LG}	Interviewer
00:24:01.5	00:24:10.1	posed the right question and said has there been any changes since the building was up and running and back in nineteen seventy four, or whatever it was, seventy seven.	Participant
00:24:10.1	00:24:10.7	Mhm	Interviewer
00:24:10.7	00:24:11.5	Know what I mean?	Participant
00:24:11.5	00:24:22.4	{LG} Yeah. Uhm, so were there non monetary benefits that were taken into account with this upgrade?	Interviewer
00:24:22.4	00:24:25.7	Non monetary benefits.	Participant
00:24:25.7	00:24:26.4	Mhm	Interviewer

00:24:26.4	00:24:34.4	Like, uhm, no money benefits? {LG}	Participant
00:24:32.3	00:24:47.5	Like if there were any {LG} uhm, so, if there were any benefits that you noticed in the environmental impact, or in the impact to the occupant, or to the building. Uhm	Interviewer
00:24:47.0	00:24:59.5	So I do know that because there's no load, therefore the chiller's not running in does effect, it does effect the environment for the occupants, because they're still hot {LG}	Participant
00:24:59.5	00:25:01.1	{LG} okay	Interviewer
00:25:00.3	00:25:01.9	in in their spaces.	Participant
00:25:01.9	00:25:07.2	Uhm. So, if if anything they know when the chillers down.	Participant
00:25:01.9	00:25:03.3	Yeah.	Interviewer
00:25:07.2	00:25:07.8	Mhm	Interviewer
00:25:07.8	00:25:08.2	Which is sad.	Participant
00:25:08.2	00:25:08.3	{LG}	Interviewer
00:25:09.2	00:25:39.1	Or, what's funny is maybe it's running so efficiently now, that the lines, they didn't see it as much when the the old chiller was operating. {LG} Because, it could have been leaking, it could have been, and that was enough to maintain the operation of the chiller. I don't know if I'm making any sense, it's just that all of a sudden we get this new chiller, and then we up size, or fix the pipe and now it's running too efficient that it has to shut down {LG}	Participant
00:25:39.1	00:25:39.3	Mhm {LG}	Interviewer
00:25:39.3	00:25:40.6	Or there's no load.	Participant
00:25:40.6	00:25:41.2	Right.	Interviewer
00:25:41.2	00:25:42.1	Uhm	Participant
00:25:42.1	00:25:55.8	Okay, and have there, have you seen any benefits or any, what, and results come from this system already, other than the ones that you've mentioned?	Interviewer
00:25:55.8	00:26:06.8	It's a chiller. I mean, so it's, the benefit is providing cool air when uhm, uhm, to the occupant so	Participant
00:26:06.8	00:26:07.5	Mhm	Interviewer
00:26:07.5	00:26:13.1	Uhm, yeah. That's the only benefit.	Participant
00:26:13.1	00:26:13.7	Okay	Interviewer
00:26:13.7	00:26:45.3	But I guess for an operation wise, it's uhm, less maintenance for now. Uhm, so operation, I think, energy cost maybe. We have better efficiency on our chillers, uhm, therefore utilities shift a little bit down on the draw. Uhm, {SIL} so that's operation, maintenance, uhm, user, yep, that's all I can think of.	Participant
00:26:45.3	00:27:06.7	Okay, that that works. Uhm, so my second set of questions has more to do with kind of the process, and the context of it, and less to do with the system. So, number one would be, why is this building important to you?	Interviewer
00:27:06.7	00:27:12.9	Uhm, this building's important because it's still part of NREL.	Participant
00:27:12.9	00:27:13.5	Mhm	Interviewer
00:27:13.5	00:27:41.9	Uhm, it still has lab function that uh is doing some uhm cool research in. Uhm, that researchers need more labs, and Denver West Sixteen, although it's an office converted to labs, it's a little bit not as high in corrosive or toxicity or anything like	Participant

		that like we see here on the South Table Mountain	
00:27:41.9	00:27:42.5	Mhm	Interviewer
00:27:42.5	00:28:03.7	Uhm campus here and the Wind site, but it is still uh, a viable part of the mission. Uhm, with their experiments at building sixteen, so uhm, as a support staff, uhm, we support them in their research for renewable energies. So, it is important to keep them going in order to meet the mission.	Participant
00:28:03.7	00:28:16.3	Mhm. Uhm, and I know we've talked about this, but what kind of interaction or rapport do you have with the occupants of the building?	Interviewer
00:28:16.3	00:28:28.0	Uhm, not too often, uhm only if there's remodel, or if there's a work order uh that required engineering uhm, for their particular lab space.	Participant
00:28:28.0	00:28:28.8	Mhm	Interviewer
00:28:28.8	00:28:33.9	Uhm, and usually we get the I'm too hot calls {LG}	Participant
00:28:33.9	00:28:34.5	{LG}	Interviewer
00:28:34.5	00:29:10.7	So, uhm, we are going through uhm, an assessment of the lab chiller actually this Friday to see what all we can do to keep that operational, uhm, to make sure that it doesn't shut down uhm frequently. Uhm, so. Uhm, I'll be learning more {LG} with the occupants on Friday, but usually I, I only get to see them only if there's a work order, or if there's a really a situation in their their little quester if you will.	Participant
00:29:10.7	00:29:22.3	Okay. And, would you say that you live in a similar area as the typical occupant of the building?	Interviewer
00:29:22.3	00:29:37.8	No. Uhm, they're more uhm, the occupants have more traditional closed offices. Uhm, closed offices on the exterior wall, uh where I reside is in the Research Support Facility.	Participant
00:29:37.8	00:29:38.5	Mhm	Interviewer
00:29:38.5	00:30:12.1	Uhm, kind of like a net zero building. We're open floor concept, uhm, you know, uh what's that to the le.. daylight, uhm, lighting and you know, and our lights turn of during uh, when there's uh, from the daylight, uhm. Uh, they don't have that over at uh Denver West. So Denver West is more of the old school type of office floor layout.	Participant
00:30:12.1	00:30:13.1	Okay	Interviewer
00:30:13.1	00:30:28.3	And where our labs are actually situated on the interior zone, so they have exterior hardwalls uhm offices on th.. they're located on the exterior of the, the perimeter of the building.	Participant
00:30:28.3	00:30:28.9	Mhm	Interviewer
00:30:28.9	00:30:47.2	And then labs are either on the corner, or the corner suite, or even on the interior zone of the of the offices. So here I'm, I'm in the location where it's strictly office. And there it's, over there is it can be a mixture of office and labs.	Participant
00:30:47.2	00:30:57.2	Okay, uhm, to what extent do you believe that our global climate is changing?	Interviewer
00:30:57.2	00:31:03.8	{SIL} Uhm, it changes everyday, so yes, I believe in climate change.	Participant
00:31:03.8	00:31:04.4	Mhm, okay	Interviewer

00:31:04.4	00:31:09.3	To the extent that we need to do something about it.	Participant
00:31:09.3	00:31:10.3	Mhm	Interviewer
00:31:10.3	00:31:14.7	It's man made, if that's what you're asking.	Participant
00:31:14.7	00:31:40.9	Uhm, okay, and to what extent do you believe that your personal beliefs, and that can be about the finance, or the environment, or the indoor environment, uhm, are represented in the policies and standards that NREL uses in their decision making process?	Interviewer
00:31:40.9	00:31:55.3	My own personal beliefs on how the process is being dealt with on decision on finances? Or project management?	Participant
00:31:55.3	00:31:56.2	Uhm,	Interviewer
00:31:56.2	00:32:05.3	I guess I, it's a lot of uhm, so, can, uh, let's repeat that again. {LG}	Participant
00:32:05.3	00:32:20.5	{LG} Okay, uhm, to what extent do you believe your personal beliefs are represented in the policies and standards that NREL uses in their decision making process?	Interviewer
00:32:20.5	00:33:27.5	Uhm, somewhat in line I guess. I mean, I believe in their mission, uhm, I believe in their uhm, their goals for uhm, for renewable energy as a part of the future. Uhm, we do have climate change, uhm policies. Uh, trying to become carbon neutral. Uhm, and being a uh area a facility where people can look to as a role model if you will, or as some sort of a, identify that it can be done. Uhm, in terms of, you know, reducing carbon footprint. So, yeah. {LG} I'm all for the mission, and uh, how they do the decision making, and I mean, there are some that we wish we could requestion {LG}	Participant
00:33:27.5	00:33:28.6	Mhm	Interviewer
00:33:28.6	00:33:43.2	And, and you know, but yeah. For the most part, uhm, the projects are being scrutinized and uhm, prioritized in a way that helps with the mission with at at at NREL.	Participant
00:33:43.2	00:33:52.8	Okay. That's good {LG} uhm, I have made it through the list of questions that I had, but if you	Interviewer
00:33:52.8	00:33:54.2	Awesome. {LG}	Participant
00:33:54.2	00:34:02.8	had anything else that you wanted to to mention with regards to this project, or if you had any questions for me we can	Interviewer
00:34:02.8	00:34:14.7	I just have uhm, how much of a document do you need? Uhm, is it okay if I don't send anything? Is uh, would this be good enough, to help with your, uhm	Participant
00:34:14.7	00:34:17.7	I think that this would be good enough but if I	Interviewer
00:34:17.7	00:34:18.7	Okay good.	Participant
00:34:18.7	00:34:32.9	Uhm, I'll talk to my advisor and a couple of people who uhm, may know better than I do about that, and I can get back to you if it's not, but I think that this will be sufficient.	Interviewer
00:34:32.9	00:34:38.9	Okay, because I do have stuff. {LG} I do have proposals, I have RFPs, I don't, I can inundate you with a lot of paperwork, but.	Participant
00:34:37.6	00:34:39.5	Right, but it's not actually	Interviewer
00:34:44.7	00:35:05.8	Right, and, I'm not actually using the paperwork, in the process that I'm doing, I'm doing more of an analysis of the interviews.	Interviewer

		But, knowing what's available. Sometimes people don't even realize what all is available to them until they they look through it for us, but.	
00:35:05.8	00:35:37.4	So in terms of first cost including design, I have that total cost of operation, I just have, uhm, well I do have the lease to get the lease, uhm, the leasing agent to do the maintenance, we and we've got some energy bills, no, unfortunately it's a lease facility so we don't actually meter uhm because part of the natural gal and the lighting uh elec.. electric is under the lease bill.	Participant
00:35:37.4	00:35:38.4	Okay	Interviewer
00:35:38.4	00:35:58.4	So, we don't have the energy bills, the maintenance cost, again that could be the lease agreement that we have. Labor and materials, that's part of the contract, which was part of the proposal, so I can get that. Repair cost, I think that's probably the change orders that we had. Uhm finance cost, uhm essentially that's just the dollar figure in in a	Participant
00:35:58.4	00:35:58.5	Mhm	Interviewer
00:35:58.7	00:36:29.8	project management plan. Uh financial outcomes, yeah, it's it's a lot bigger than what we expected{LG} expected projections, uhm, didn't really project uhm, the, we thought it was under their their contract but it wasn't. Uhm, actual usage cost, I think that we have. Well, really you can't, with a chiller, unless, if you want to know the kilowatt hours, the actual electrical usage.	Participant
00:36:29.8	00:36:30.6	{LG}	Interviewer
00:36:30.6	00:36:32.2	I don't think we have have that.	Participant
00:36:32.2	00:36:33.3	Okay	Interviewer
00:36:33.3	00:36:48.0	Uhm, if you asked us about that on our site, yes. {LG} Uhm, but we don't uhm, meter our own, or leased facilities. If that makes sense, so in this case, in this in this particular project.	Participant
00:36:48.0	00:36:49.0	Mhm	Interviewer
00:36:49.0	00:36:56.8	So, I I'm just rambling off with all the financial information, uhm I do have some.	Participant
00:36:56.8	00:36:57.5	Okay	Interviewer
00:36:57.5	00:37:10.0	But if it's needed, uh let me know which ones out of that financial information that you need and I'll, I'll even scrub a few things off of there too on our end if it if it meets our requirement.	Participant
00:37:06.8	00:37:11.0	Okay, yeah. okay.	Interviewer
00:37:11.0	00:37:11.1	Okay, that sounds good.	Interviewer
00:37:12.6	00:37:13.0	Cool?	Participant
00:37:13.0	00:37:13.6	Yes	Interviewer
00:37:13.6	00:37:16.2	Alright, good luck with this Interviewer	Participant
00:37:16.2	00:37:18.5	Thank you, thank you for talking to me.	Interviewer
00:37:18.8	00:37:20.8	Yep. Have a good one.	Participant
00:37:20.8	00:37:21.5	Have a good day,	Interviewer
00:37:21.5	00:37:22.6	Bye.	Participant
00:37:22.6	00:37:23.6	Bye.	Interviewer