

Mid-term Design Project

Team Delta-

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EXECUTIVE SUMMARY

Understanding energy consumption challenges at a residential level

PART 1

What We've Learned

During our research on the challenges in the energy consumption space, we discovered invaluable insights into people's energy consumption habits and usage behavior. We tried to understand diverse approaches to how people view energy consumption as individuals and what the motivations and influencing factors can be behind deciding to transition to renewable sources. Throughout our study, we have acquired an understanding of the challenges individuals encounter when monitoring and managing their household energy consumption, as well as the innovative approaches they employ to address these challenges at a personal level.

We found that many people aim not only to lower the electricity bill but also to help the environment. One of the interview participants expressed "My ultimate goal is to not only reduce costs but also contribute to a cleaner environment for my kids". Many people also perceive renewable energy sources as costly. One participant pointed out "I expect significant advantages when I invest a considerable amount, or it doesn't seem worthwhile."

We also studied people's approach to energy conservation in common areas. We conducted our observations in various common areas of an Apartment building where we observed the unnecessary operation of lights and appliances, even in well-lit and unused areas, which suggests a need for increased awareness and energy-conscious behaviors within the community.

Identifying the Problem

The problem majorly revolves around the price of energy consumption, particularly the major dissatisfaction among participants about the current status of their energy consumption bill, and the high costs associated with switching to renewable energy sources. Despite frequent innovation and growing avenues of sustainable energy sources (e.g.: Green banks, Solar energy Co-op, and multiple government schemes that reward the adoption of renewable energy sources), issues such as awareness of the accessibility of renewable energy sources and high upfront costs are persistent barriers avoiding widespread adoption.

Why the problem persists

The challenges are persistent mainly because many users are not informed about the various factors that contribute to their high energy consumption. Behavioral inertia is also a contributing factor, as users are often reluctant to change their energy consumption habits. The transition to renewable energy sources is a big decision and requires consideration of a lot of extensive factors, which is time and effort-consuming. Lack of widespread awareness about financial incentives like net metering, and government incentives also contributes towards the persistence of the problem.

Why is it difficult to address

Addressing these challenges is a complex task as it requires an intricate understanding of users' motivations and driving factors that go beyond the barriers of price and encourage users to put in the time and effort required for the adoption of renewable energy sources.

Past efforts

Existing solutions that try to address these challenges vary in scope and effectiveness. Some of these are:

- **Smart Home Technologies**

Technological advancement has given rise to smart home systems that allow residents to monitor and control their energy consumption more effectively. These systems include smart thermostats, energy monitoring devices, and Smart Grids.

- **Renewable Energy Partnerships**

Some utility companies have partnered with renewable energy providers to offer residents and businesses many different services to go green. AES is currently leading in terms of innovation. AES has partnered with 5B, to deploy 2x more Solar Energy, 3x faster using 50% less land, making clean energy available in places previously thought impossible. AES also partnered with Siemens, to establish Fluence, which offers energy storage products that are optimized for common customer applications.

- **Awareness Campaigns and Educational Challenges**

Numerous energy providers and environmental organizations have started awareness campaigns and education challenges to inform residents about energy-saving practices. These efforts often include workshops, seminars, and online resources to educate people about the benefits of energy efficiency. AES has started an Energy Innovation Challenge which is a competition for graduate students from diverse backgrounds who possess an interest in coming up with new solutions to the problems the energy sector is currently facing.

- **Government Incentives**

Government agencies at the federal, state, and local levels have introduced various incentives to encourage the adoption of renewable energy sources. These incentives include the Federal Solar Tax Credit, rebates, and grants to offset the costs of the installation of solar panels.

Despite these past efforts, challenges such as cost barriers, limited awareness, and complex regulations still persist. The insights from our study underscore the ongoing need for more comprehensive and accessible solutions, as well as continued efforts to raise awareness and provide better incentives for people interested in adopting renewable energy.

Need for Future User Studies

Future user studies must definitely be carried out to acquire a deeper understanding of some of our findings that we only briefly touched upon. We examine the participants' demographics, energy monitoring practices, and levels of satisfaction as well as their knowledge of energy-saving technologies, difficulties in reducing energy use, and motives guiding their energy-saving actions. We can assess participants' perceptions of long-term advantages, and we can carefully track their

energy-monitoring behaviors to learn more. In the end, the policies, educational initiatives, and technological advancements in the fields of energy efficiency and renewable energy can benefit from this research.

PART 2

Design Exploration Avenues

In light of our findings, we suggest a number of design research directions that might be useful in resolving the issues with sustainable energy consumption:

1) Smart Energy Tracking System for Efficient Home Energy Management

- A mobile app for wireless connection to smart meters, offering real-time energy data, usage tracking, goal setting, and alert notifications.
- Additionally, implement data analysis algorithms to identify high-energy appliances, recommend efficient usage, and estimate monthly bills for informed decision-making
- Synchronously integrate with smart thermostats, lighting, and appliances for remote control and automation, optimizing energy consumption.

2) Community-based ownership of renewable energy generators

- Exploring a crowdfunding platform that can be used to generate money for initiatives including community and cooperative ownership
- Access to capital is one of the biggest obstacles that community and cooperative ownership projects must overcome.
- Additionally, it enables flat owners and renters to have access to renewable energy sources.

3) Sustainable energy budgeting platform

- As these renewable energy resources are expensive, for those who are interested in making this switch but want to start small, this platform can take into consideration individual energy requirements and budget constraints to find an ideal fit.
- It can provide suggestions for energy-efficient appliances to replace older, less efficient ones. It can compare the prices and efficiencies of different models, helping users make informed decisions.
- It can also provide updates on current energy-saving trends, government incentives and programs, etc.

02

Observations

Observation 1

Observer: Mohini Yashwant Gaikwad

Location:

Canal Square apartments, Common area, A quiet Monday morning (10:40 AM - 11:15 AM)

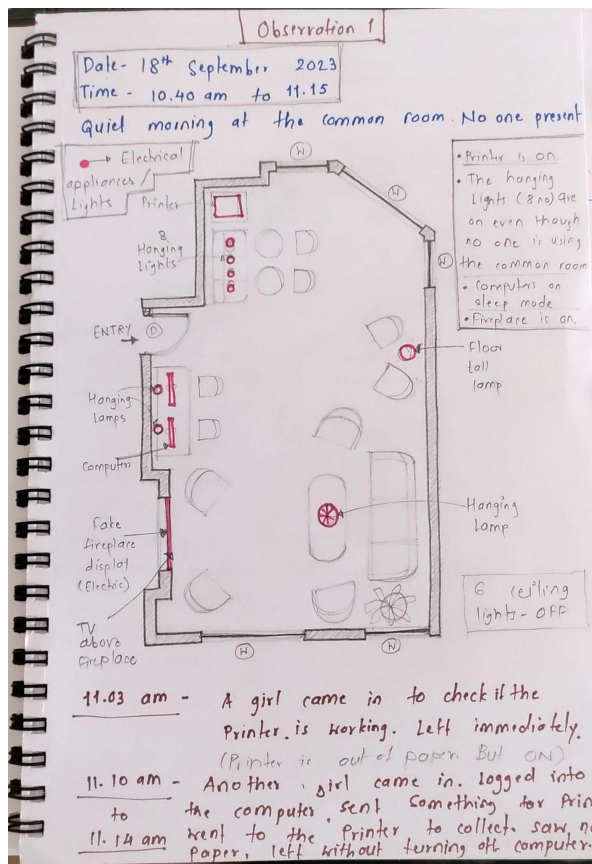
Observation Summary:

Canal Square apartments offer a common room accessible to residents around the clock. I visited this place on a typical Monday morning, not anticipating a significant crowd due to the workweek, but decided to still observe how it functions when very few to no user is using it. As expected, the common room sat empty when I arrived. What struck me was the room's excessive lighting, boasting six ceiling lights, a set of 8 hanging lights, an additional three big hanging lights, and one floor lamp. Moreover, various electricity-consuming appliances were present, including two computers, a printer, a television set, and a faux electric display fireplace.

Throughout the observation period of 35 minutes, the room remained quiet, with only two individuals briefly entering to assess the printer's status. Both left upon discovering it was out of paper. Curiously, despite the lack of people, the computers, printer, and fireplace continued to operate, along with the hanging light set. It became apparent after observing those two individuals, that even when they shared a common purpose, they interacted with and utilized the facilities differently. The first individual promptly checked the printer's status and left immediately after releasing the printer's issue. In contrast, the second individual logged into a computer, spent a few minutes searching for a document to print, sent the print job, and only then approached the printer. Frustrated by the paper shortage, she left without shutting down the computer. This observation led me to speculate that the first individual might have encountered such situations more frequently, prompting her actions.

Notably, the room has an abundance of windows, including some full-sized ones offering views of a central green area. These windows allowed ample natural sunlight throughout the day, illuminating at least half of the space. Consequently, the unnecessarily prolonged operation of lights and appliances in this common room results in wasting a significant amount of energy every day.

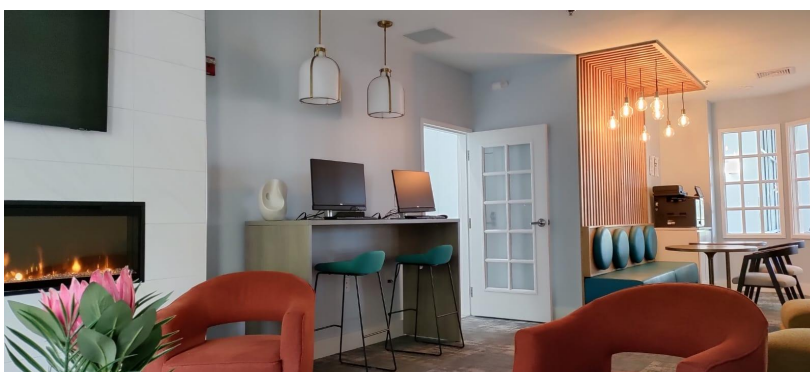
Field Notes:



Photographs:



An empty common room filled with natural daylight.



The lights and faux fireplace display are switched on even when no one is using the room.



One individual who came to get printouts left without turning off the computer or putting it on 'Sleep mode'

Observation 2

Observer: Mohini Yashwant Gaikwad

Location:

Canal Square apartments, Common area, Busy Evening (04:15 PM - 5:15 PM)

Observation Summary:

As my initial observation of the common area in the morning had limited activity, I opted to revisit the location at a different time to gain a more comprehensive perspective. During this second observation, the common area appeared notably busier than it had been earlier in the morning. One group consisting of three students occupied one side of the room, engrossed in collaborative work, while a couple of girls were stationed near the printer, presumably engaged in various tasks. Given the daylight, only the same hanging lights that had been illuminated in the morning remained in use.

The Canal Square apartments house a considerable number of students, and the common room effectively serves as a communal workspace for them. Larger groups often gravitate toward the area with sofas, drawn by the natural light and comfortable seating. In this section, all individuals appeared engrossed in their work, primarily using laptops and occasionally consulting their mobile phones. Notably, none of them availed the power points to charge their devices during this period.

Concurrently, the two students stationed near the printer continued to diligently work on their laptops, intermittently using the printer (which seemed to have been replenished with paper). Their proximity to the printer likely facilitated a more convenient printing process, sparing them the need to vacate their seats.

A noteworthy incident occurred when a young woman entered the common area, switched on a computer, checked the printer's status, and then returned to the computer. She initiated a call while simultaneously using both the computer and her mobile. After several minutes of computer usage, she abruptly closed the window left without printing, and neglected to switch off the computer. Drawing parallels with the morning's observation and observing a similar pattern of appliance and light misuse, I recognized that individuals frequently failed to power down these resources upon concluding their work.

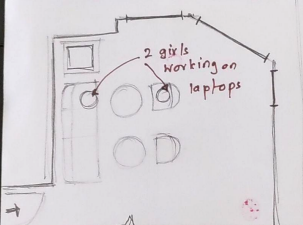
In summary, my observations underscored a consistent tendency among individuals in the common area to overlook the importance of switching off appliances and lights after usage. These findings highlight an area where raising awareness and promoting energy-conscious behaviors could yield substantial improvements in energy conservation within the community.

Field Notes:

Observation 2

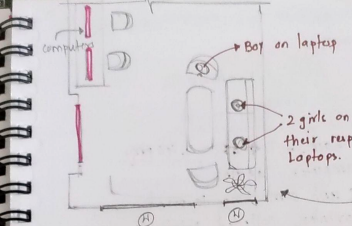
Date - 18th September 2023
Time - 4.15 pm to 5.15 pm.

Place - Canal square apartments - Common room
Place looks busy as compared to it was in the morning.
- No. of people - 5



- Two students working on their laptops
- Not charging any device
- Hanging lights above seating is on
- One of the girl is using the printer without moving from her seat.
- Used printer for 3 times

- other girl is using mobile simultaneously.



- Mostly using natural light.
- No lights are switched on
- Most of the people use this area.
- No lights (artificial on) above their seating.
- 3 people (1 guy, 2 girls)
- All working on their laptops
- Use their smartphones occasionally.
- Discussing about laptops losing battery looking for power points - 4.25

4.28 pm - One girl entered

- Switched on the computer
- Went to the printer to see if its working
- standing in front of the computer
- called someone
- Using mobile & computer simultaneously

4.31 pm - closed the window (comp) suddenly & left

- left without printing
- left the computer on

- One of them started a Google meet /online meet with someone.
- other girl is using her phone
- Guy working on laptop

The girl came back. - 4.35 4.46 pm.

- started the computer again
- still standing & sent something to print
- Went to the printer, collected printouts checked them
- came back to pc computer
- Back to the printer to collect printouts.
- Back to computer
- Browsing through files to find what to print
- sent something to print.
- Back to printer, collected printouts
- Put the computer on sleep mode
- Left - 5.00 pm

- one of the girls working near the printer suddenly remembered something, Packed up & left - 5.02 pm
- Another girl is using mobile.
- Packed up her thing & left as well - 5.05 pm

- Guy went out to get some coffee. - 5.07 pm
- 5.13 pm - One of the girls on the sofa run out of battery on her laptop
- switched Got up to sit near the plug points near computers.

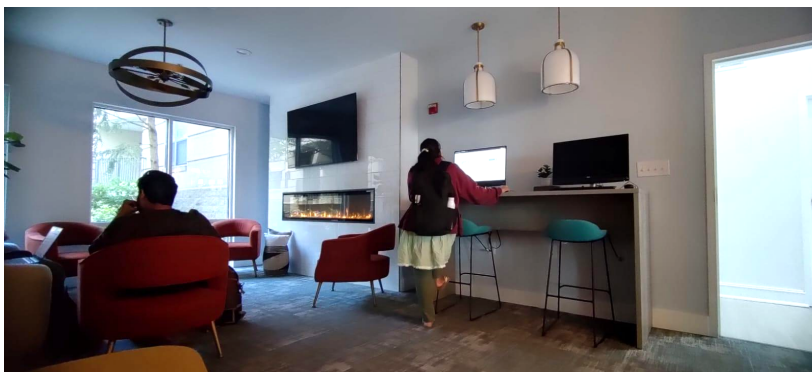
Photographs:



A group of students engrossed in work in an area with ample daylight. Not needing to use any artificial lighting.



The lights above the seating are on near the printing area where artificial light is not required during the day.



People come in only to get printouts and leave the computers on after usage.



A lot of people use the common room only to get printouts.

Observation Reflection (Mohini Yashwant Gaikwad)-

Observations as a design method provided invaluable insights into the people's energy consumption habits and usage behavior among the residents in a common area that might not have been apparent through secondary research or interviews. These two observations, conducted at different times of the day, offered a comprehensive view of how this communal space is utilized.

These observations revealed a prevalent trend among residents to overlook the importance of energy conservation in the common room. The unnecessary operation of lights and appliances, even in well-lit areas, suggested a need for increased awareness and energy-conscious behaviors within the community. The findings underscore the potential for significant energy conservation improvements through education and awareness initiatives, I would not have realized these insights during the secondary review or interviews.

In the future, I intend to broaden my observations by exploring various common spaces within the apartment building, each serving distinct purposes. This will enable me to determine whether the observed behavioral patterns persist consistently across different community areas.

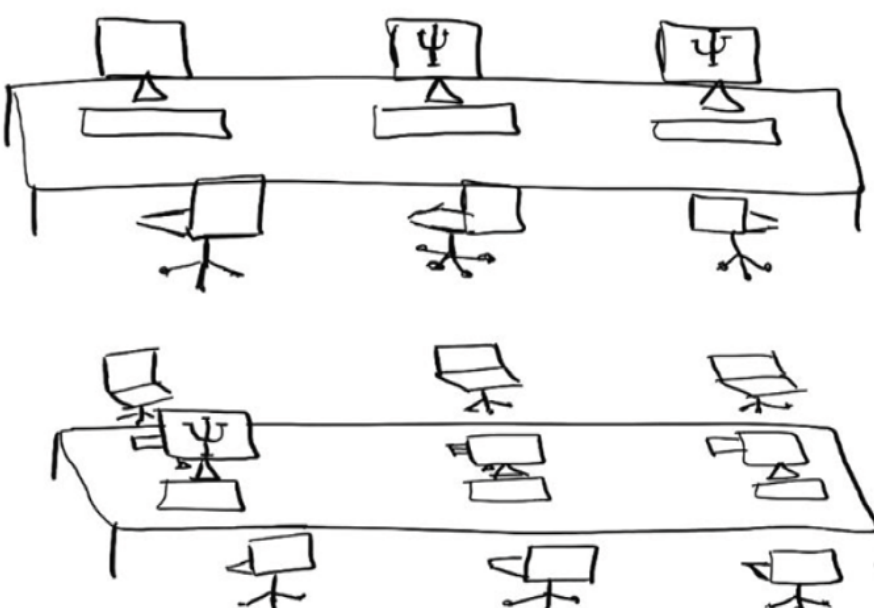
Observation 3

Observer: Elmira Rashidi

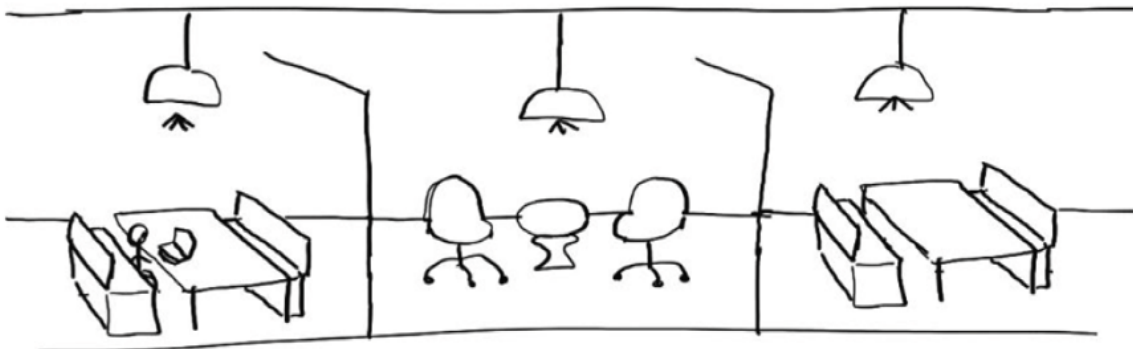
Location: ICTC Student Center – Sep 19, 2023 . 5:45 PM – 6:26 PM

Field Notes:

Time stamp : Sep 19, 2023 5:45 PM
Location: ICTC student center

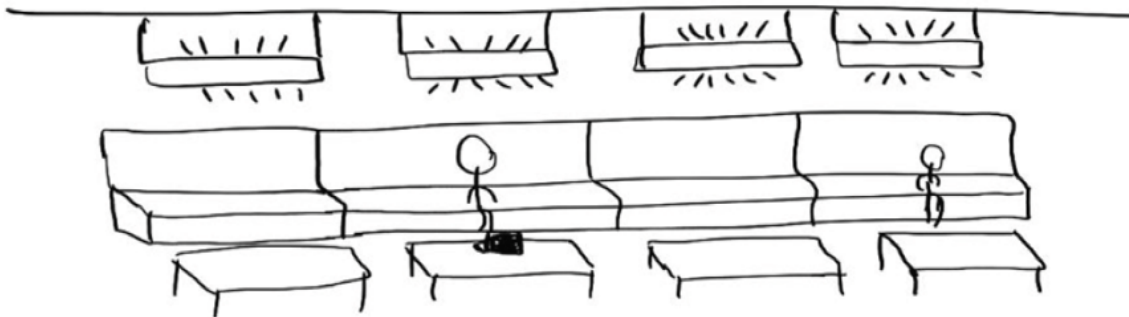


Nobody uses these computers
but some of them are
on!

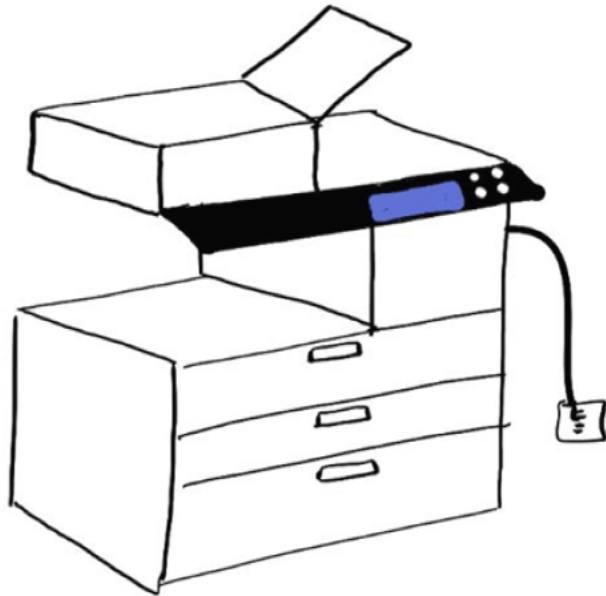


Left side

There are a few students at student center. Not all seats are full but all lights are on.



Right side



There is a printer which is
always on and consumes
energy.

It seems that people (students, staffs,...) are not aware of energy consumption. They do not care about this issue based on my observation.

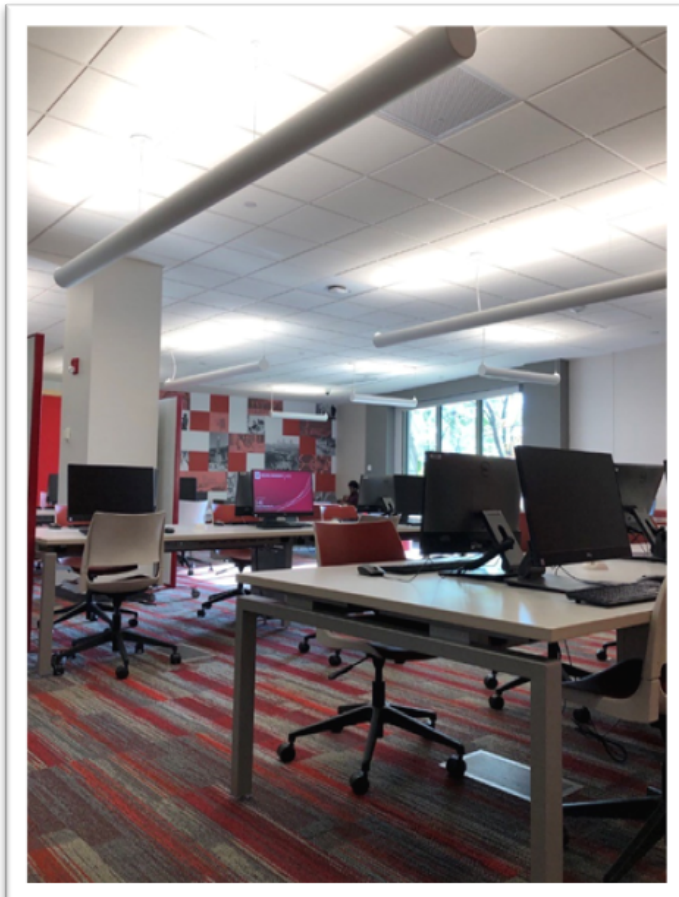
Maybe they do not have enough knowledge of how to reduce energy consumption.

This lack of knowledge cause not to do their best in order to reduce energy consumption.

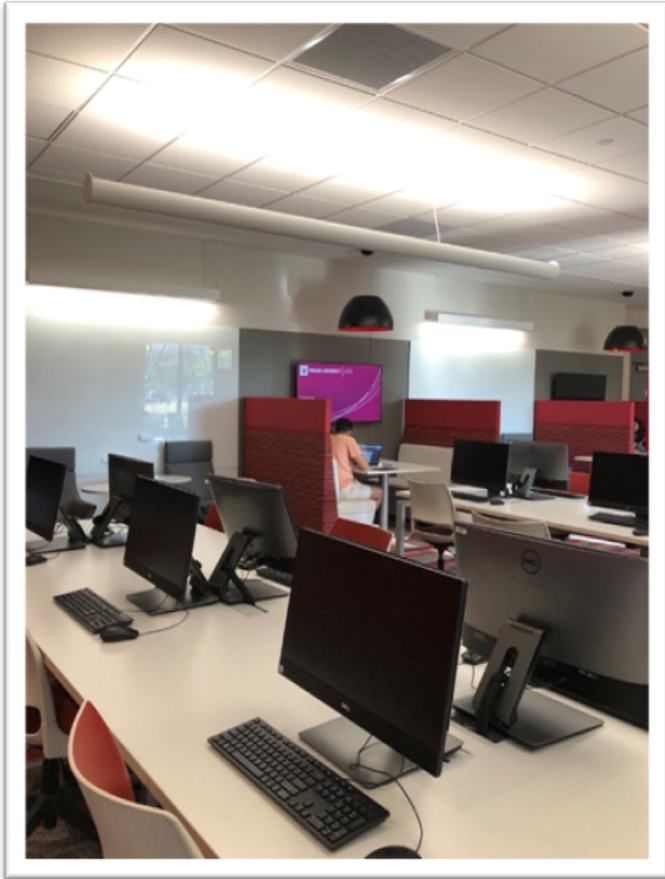
Observation Photographs:



Observation 1-1: A Printer that is Always Plugged In and On – Sep 19, 2023 – 5:47 PM



Observation 1-2: Student Center with a few students sitting there and computers that are on with no users. – Sep 19, 2023 – 5:46 PM



Observation 1-3: After 45 minutes of observing this place, there are still a lot of extra lights on. – Sep 19, 2023 – 6:25 PM



Observation 1-4: After 45 minutes of observing, computers are still on with no users. – Sep 19, 2023 – 6:26 PM

Observation Summary:

On Tuesday, September 19th, I conducted an observation session at the Student Center located in the ICTC building at IUPUI. I spent 45 minutes observing the environment, primarily focusing on energy consumption. During this time, I noticed that there were some students present in the area, primarily engaged in using computers and studying.

Despite the presence of a few students, a significant number of light bulbs and computers were turned on, contributing to a higher energy consumption rate than necessary. The students were primarily occupied with their computer tasks and studying, which seemed to be the main activity in the area.

This observation highlights the potential for energy-saving opportunities by optimizing lighting and computer usage in the Student Center, especially during times when fewer students are present.

Observation Reflection: (Elmira Rashidi)

Conducting the observation at the Student Center in the ICTC building at IUPUI provided valuable insights into energy consumption behaviors and the use of technology in a real-world setting. Observations as a design method have the advantage of offering unfiltered, real-time data that often cannot be obtained through secondary research or interviews. During this observation, I gained a firsthand understanding of how energy was being consumed in the space, specifically through the operation of numerous light bulbs and computers, despite the relatively low number of students present. This direct observation informed my design judgment by highlighting potential areas for improvement in energy efficiency.

One key learning from the observation was the need for better management of energy resources in the Student Center. While students were diligently engaged in their computer tasks and studying, the excessive use of lighting and computers in an unoccupied space presented a clear opportunity for energy-saving measures. This observation underscored the importance of optimizing energy consumption by automating lighting systems or implementing reminders for users to turn off computers and lights when not in use.

In future observations, I would aim to conduct more targeted assessments of energy consumption patterns at different times of the day and week. This would provide a more comprehensive understanding of when energy waste is most prevalent and enable the design of tailored solutions to address these issues. Overall, this observation reaffirmed the value of firsthand data collection in informing design decisions and highlighted the potential for impactful improvements in energy conservation.

Observation 4

Observer: Elmira Rashidi

Location: Campus Center – Sep 20, 2023 . 2 PM – 2:30 PM

Field Notes:

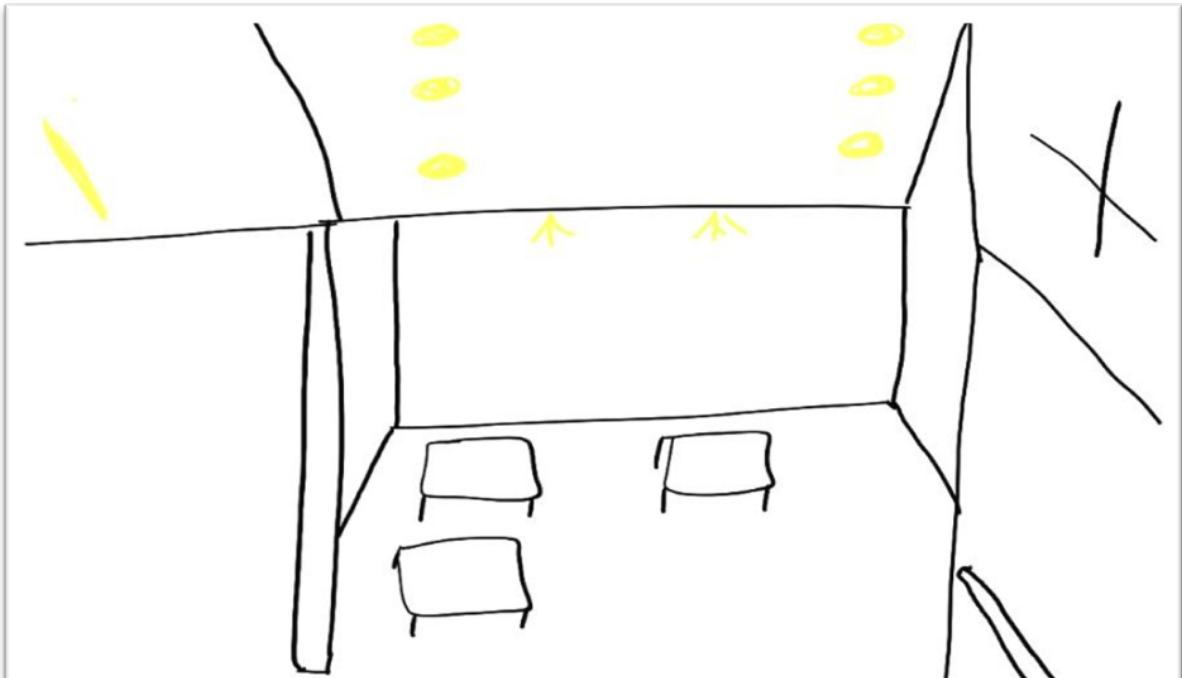
Time stamp: Sep 20, 2023 2 PM

Location: Campus center

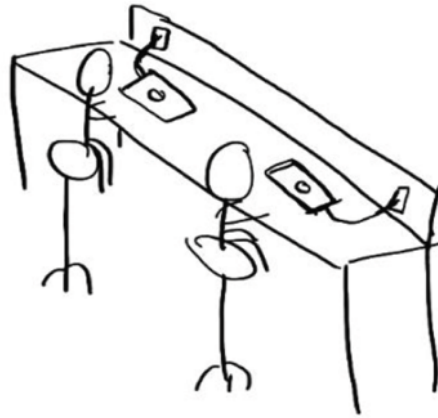
Based on my observation on campus center, all lights are on.

Although it's in the middle of the day and there are enough natural light, all bulbs are on.

Some of those are not really necessary.



Unnecessary lights are on. So the question that comes to my mind is that why nobody cares about reducing the energy consumption.



Some students are here
in food court at campus
center and they don't
use their laptops but they
don't unplug them

Here I don't see any solar panels. Therefore all the devices and bulbs use electricity.

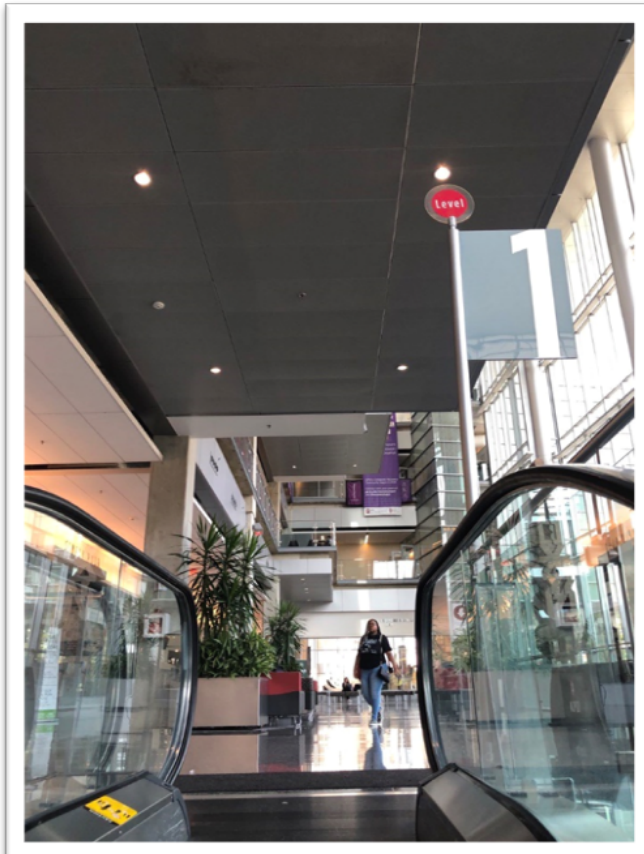
But the bulbs might be LED.

I'm not sure about that but it seems that they are LED which could reduce the energy consumption.

Observation Photographs:



Observation 2-1: Too many lights at Campus Center – Sep 20, 2023 – 2 PM



Observation 2-2: Some lights are on although enough natural light is existed at Campus Center – Sep 20, 2023 – 2:01 PM



Observation 2-3: After 30 minutes of observing – Sep 20, 2023 – 2:27 PM



Observation 2-4: Extra lights, Plugged in devices – Sep 20, 2023 – 2:28 PM

Observation Summary:

On Tuesday, September 20th, I conducted an observation session at the Campus Center at IUPUI, focusing on energy consumption patterns. The observation lasted for 30 minutes. During this time, I observed a significant number of students in the area. Many of them had their laptops plugged in, but they were not actively using them. Additionally, I noticed that a substantial number of light bulbs were turned on, even though there was ample natural light available in the space. While the stores within the Campus Center were not crowded, many electronic devices were plugged in and operational. In some instances, I observed lights in the corners of walls that were not useful.

This observation session shed light on several aspects of energy consumption within the Campus Center. It became evident that despite the presence of natural light and students not actively using their laptops, there was a notable amount of energy being expended on unnecessary lighting and device charging. The observation highlighted potential opportunities for energy conservation, such as implementing better lighting control systems and promoting the responsible use of electrical outlets. The data collected during the observation offered a valuable real-world perspective on energy usage that may not have been as apparent through secondary research or interviews alone.

Observation Reflection: (Elmira Rashidi)

Conducting the observation at the Campus Center at IUPUI was an enlightening experience that significantly informed my design judgment. Observations as a design method offer unique insights that transcend secondary research or interviews. During this observation, I had the opportunity to witness real-time energy consumption behaviors and technology usage in a public space.

One key takeaway was the observed discrepancy between energy usage and necessity. Many students had their laptops plugged in, but they were not actively using them. This highlighted the need for solutions that promote responsible energy consumption, such as smart power management systems or user-friendly reminders to unplug devices when not in use. Additionally, the unnecessary use of light bulbs in areas with ample natural light indicated potential energy-saving opportunities, emphasizing the importance of optimizing lighting systems.

The observation underscored the value of conducting on-site research to gain a deeper understanding of user behaviors and identify areas for improvement that may not be apparent through secondary sources. In future observations, I would aim to collect more granular data on device usage patterns and explore the feasibility of implementing energy-saving initiatives in public spaces like the Campus Center. This experience reaffirmed the significance of direct data collection in shaping design decisions and highlighted the potential for enhancing energy conservation and resource optimization in public environments.

Observation 5

Observer: Atharva Sakharkar

Location: Canal Square apartments, Apartment 281, 08:10 AM - 08:55 AM

Summary

I observed my neighbor's flat to get a better understanding of home energy consumption patterns. A room, a hallway, a kitchen and a balcony were among the elements of the residence that were open to observation. I carefully recorded fascinating details with my iPad during my about 45-minute observation. I started by making a thorough list of all the appliances in the house.

My neighbor graciously offered to make coffee while I was watching, giving me the chance to see how many appliances were utilized for this one simple operation. Notably, I noticed that they connected different gadgets by using switch converters at various points. However, even when there were no connected devices, these stabilizers continued to operate.

One especially intriguing feature of my observation included the balcony, where I discovered a light that stayed on despite no one using it during the observation period. Additionally, I saw that a number of items, including the air conditioner, Wi-Fi, and refrigerator, were used for extended periods of time.

The patterns of energy usage and potential for energy-saving measures in the home were revealed by this observation.

Reflection

It was enlightening to observe my neighbor's apartment's energy usage patterns because it provided important insights into how our daily activities affect our energy usage. Several important conclusions come out as I consider the observations I took in the apartment's various rooms.

The finding confirmed the idea that consciousness is essential to energy conservation. The constant usage of switch converters in the living room and hallway, even when the devices were unplugged, revealed a lack of awareness regarding the energy used in standby mode. This serves as a reminder that enlightening people on the subtleties of energy consumption can result in more informed decisions.

The kitchen, where I saw coffee being made, showed how many appliances may be used for a seemingly straightforward activity. It emphasized how crucial it is to optimize kitchen equipment and procedures to reduce energy waste. It also brought up the possibility of utilizing more energy-efficient kitchen appliances to lower overall consumption.

There were concerns about the necessity of such practices when the balcony light remained on despite no one using the area. It made me consider the value of motion detectors and timers for outdoor lights to prevent unnecessary energy use when not necessary.

The necessity for users to consider whether these devices actually need to operate continually was highlighted by the observation of appliances like the refrigerator, Wi-Fi, and air conditioner running for extended periods of time. The best way to conserve energy is to plan the timing and duration of gadget use.

Overall, this observation served as a reminder that even tiny adjustments to our daily routines and heightened awareness of energy usage can help us all live more sustainably and efficiently. It reaffirmed the value of technology-driven approaches and education in tackling issues related to energy use. Going forward, I'm motivated to impart these insights and think of strategies to promote more sustainable energy practices in my own home and neighborhood.

Photographs:



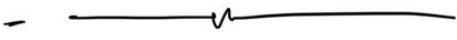
Even though the balcony wasn't being used at the time of the observation, the lights were always on.



Monitoring several kitchen appliances that are constantly consuming power.

Room 1

Bill - 98 | SQFT - 1097

- 2 bulbs - ask megan
- Double bulb lamp - 1
- No Fan
- Thermostat
- Converter plugged to an extension is consuming power
- 
- Participants find it annoying that their switches are on at all times
- They switch off their lights while sleeping, they also close it in the morning.
- They sometimes leave their closet lights on
- The thermostat doesn't turn on - but they prefer it that way as it helps save energy.
- Hall lights are switched on in the evening
- The vent is kept on for many days at times - as they forget to switch it off.

Kitchen

- Kitchen lights are on from evening to night till sleeping = 1 bulb
- Balcony lights are on often at night by mistake
- Door light is on at all times except at night and morning when there is plenty of light
- Fan is never used only the fan lights are used occasionally.
- Wifi is on at all times 24/7
- Fridge also on
- The microwave & stove top is on standby.

Observation 6

Observer: Atharva Sakharkar

Location: Canal Square apartment, Resident gym, 11:30 AM - 11:45 AM

Summary

The observation was done at a late hour—specifically, 11:30 PM—which is not usually a popular time for the gym. This time period was chosen to assess how energy resources were used while there was little gym use. I made a crucial discovery as soon as I stepped into the gym: every piece of exercise equipment was in use. Treadmills running continuously, air conditioners running, and overhead lights on were all examples of this.

The most striking finding was that all energy-intensive equipment ran continuously, even during late hours when there were no active gym patrons. The air conditioning system was running, the treadmills were still turned on and ready for use, and the gym was well lit. This demonstrated that, regardless of demand, gym management kept equipment operating as usual throughout the night.

This observation highlights the problem of energy waste in the gym of the apartment complex. Keeping all equipment running all the time, even when it's not in use, results in extra energy use and higher utility bills. It also prompts questions about how such practices affect the environment.

After giving this remark some thought, it becomes clear that the management of the apartment complex has a chance to put energy-saving measures in place. Installation of occupancy sensors, equipment timers, and user education campaigns encouraging responsible energy use are a few examples of these approaches. The gym may support resource conservation and sustainability by matching energy use with actual demand and encouraging inhabitants to adopt energy-efficient behaviours.

Reflection (Atharva Sakharkar)

The late-night gym observation around 11:30 PM revealed an uncomfortable truth: even though the gym was nearly completely deserted, all energy-consuming equipment ran continuously. This inefficient behaviour resulted in higher energy use, higher electricity bills, and environmental issues.

Upon contemplation, the management of the apartment block has a rare chance for improvement. Aligning energy use with demand and encouraging responsible consumption can be accomplished by putting in place measures like occupancy sensors, device timers, and user education campaigns. These actions support sustainability while also lowering costs.

This event emphasises the possibility of significant change through straightforward actions and stresses the significance of resource-conscious behaviours for a more promising environmental future.



Continually running treadmills, even while not in use.



Television sets that are functioning 24/7

Observation 7

Observer: Avishkar Shinde

Observation Summary:

I observed the AES Indiana Office Lobby on September 15th, 2023 from 11:30 AM to 12:00 PM. I decided to visit the Monument Circle Office. Just before I entered the premises, a few students from IUPUI left. I could identify them due to the IUPUI merch on them. I then sat in the lobby to start my observations. When I tried to click pictures, I was asked to stop by the security guard. He said public photography is not allowed inside the premises as it is a corporate office and they have to adhere to certain protocols. I then sketched two rough sketches of the front lobby. I observed some equipment coming in, but overall the footfall on Friday was less. I then observed two people come in and inquire about the security deposit for AES. It was then I came to learn that the AES Customer Service Office is currently closed until further notice and only email communications and online payments are accepted.

Later on, I had a group of students come in and inquire about the AES Innovation Challenge. It was then that I learned that there's gonna be an informative session on this Innovation Challenge on 17th September. The students were asked to contact Kelly Young, Director of Public Relations at AES Indiana, through email, as she was not present on that day at the office.

I was done with my observation after this and decided to leave the lobby. The security guard was interested in what I was doing, and also gave me Kelly Young's email to gain more insights from her to help with my project.

Field Notes:

11:28 am: Saw three students from IUPUI leave. Indians.

11:31 am: Stopped by the guard
[X] No photos allowed [X]

11:35 : I then started sketching the lobby
and ~~room~~ main room.

The main room is guarded by a keycard gate.
Saw multiple employees leave and enter
through there.

Not a lot of people came to office on Friday

For some reason, front desk was unattended.

11:39 Some equipment came in. Looked very heavy

11:42 Two people came in inquired to security
guy about the deposit payment.

11:43 Apparently their customer office is
closed until further notice. They only
rely on emails and online payments.

11:48 ~~I'm~~ I'm done with my lobby sketch

11:51 Three students ~~are~~ here. They
want to know about aes challenge.

Apparently, there's a webinar about
this challenge day after tomorrow.
I should attend.

11:52

11:52 The security guy refused to contact Kelly
Young to them. I don't know who that is.

11:54 I finished my second sketch around.

11:59 I started packing. The office was quiet.

12:00 The security guard approached me
so I kept my notes with me.

12:05 He was interested in what I was doing
and often explained it to him, he
also asked me to mail Kelly Young.
She was the Director of PR and
can help me with insights. I thank
him and leave.

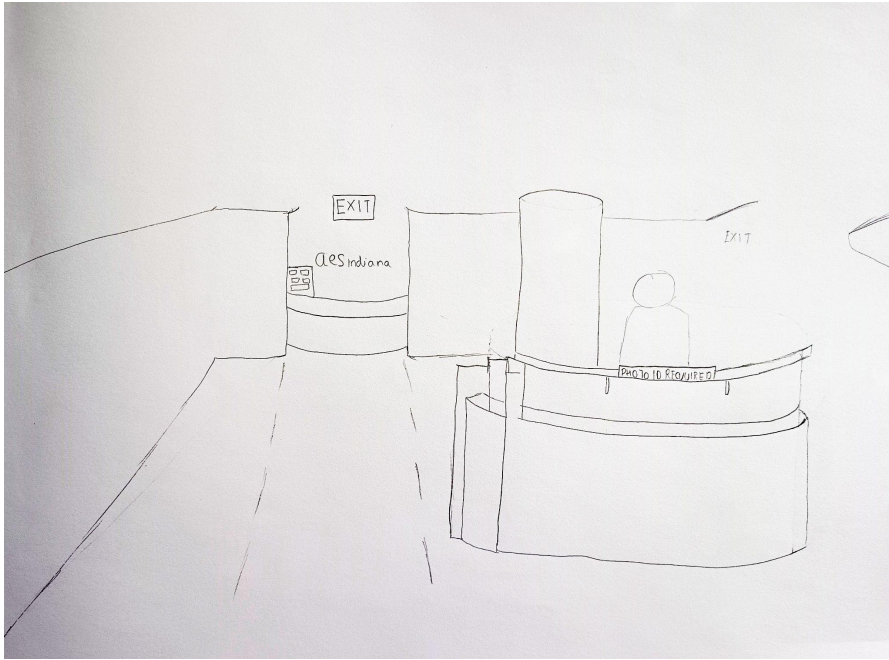
End.

Photos and Sketches:



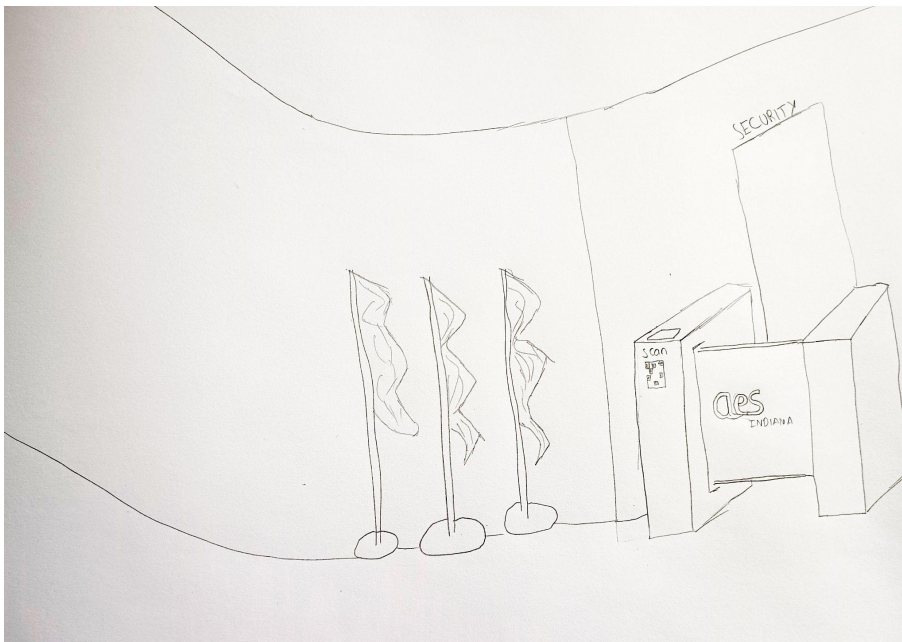
Outside, AES Indiana, Monument Circle

The main corporate office of AES Indiana.



Lobby, AES Indiana, Monument Circle.

The footfall was very less on Friday, with a total of four interactions here.



Main Entrance, AES Indiana, Monument Circle.

The main entry for the office. A key card is required to open the gate. I wasn't allowed near it.

Observation 8

Observer: Avishkar Shinde

Observation Summary:

I observed the AES Innovation Challenge webinar on September 17th, 2023, from 1 PM to 3 PM. The webinar took place on the Microsoft Teams platform. During the webinar, I saw a diverse group of participants, including AES representatives, graduate students, and likely other stakeholders in the energy industry.

The webinar primarily focused on the AES Energy Innovation Challenge, which is a competition aimed at graduate students from various backgrounds who are interested in proposing innovative solutions to current challenges in the energy industry. The event provided valuable insights into the competition's goals and objectives. It emphasized the importance of universities and college students in driving the transition to renewable energy solutions and how the challenge serves as a platform for them to contribute to this transformation.

AES is an energy company with 30GW in operation and 5,000 megawatts under construction, operating in 14 countries and serving 2.4 million customers. They have developed innovative technology, including the Atlas solar robot, designed to enhance the speed, efficiency, and safety of scaling solar installations. Atlas complements the workforce by performing heavy lifting and attaching solar modules while creating new high-tech jobs. AES also partners with 5B to enable faster solar deployment with reduced land requirements. Their technology offers plug-and-play modular systems, rapid deployment, and the ability to install anywhere, including remote and harsh conditions.

Additionally, AES is a world leader in solar innovation and battery energy storage, offering 24/7 carbon-free energy solutions. They recognize the importance of green hydrogen in achieving a net-zero future, especially in sectors that are challenging to decarbonize, such as metals, chemicals, shipping, and aviation. AES emphasizes the growing industry momentum and alliances, as well as strategic national roadmaps for green hydrogen adoption. They also highlight the falling costs of renewable energy and electrolysis, making green hydrogen production more feasible. AES's commitment to innovation extends to their subsidiary, Fluence, which is driving the transformation of the energy landscape through energy storage products, renewables, and cloud-based software.


Furthermore, the webinar highlighted the success stories of previous winners, showcasing the innovative solutions they proposed to address energy-related challenges. These included ideas such as indoor farming powered by solar and battery storage, producing green hydrogen for steel furnaces, and utilizing gravity storage and recycled wind turbines. The event demonstrated AES's commitment to fostering innovation and sustainable energy solutions through collaboration with young, talented minds in the field of energy.

Field Notes:

AES INTRO

- Energy company
- 30 GigaWatt in operation
- 5x MegaWatt under construction
- 2 million customers
- established in 14 countries

Innovative Technology:

Atlas: Reimagining SOLAR!! 

- A first of its kind robot for solar panels
- Helps to enhance the speed and efficiency and safety of scaling solar



67%

Solar jobs
are installation

+52%

Increase of
employment in
solar installation.

(fastest growing
career)

70%

Can be
automated

Takeaway

- Reliable
- Efficient
- Increase performance
- Safer

900,000

100% clean energy
by 2035

5B x AES

- Partnership
- Together, they deployed • 2x more solar energy
3x faster
50% less land
- Maverick technology

Challenges they solved

- 1) Simple: pre-wired, plug&play
- 2) Fastest: 200 kW per team/day
1 MW installed per week
- 3) Smartest: 2x more energy per area
- 4) Rapid deployment: Portable, move anytime

Green Hydrogen

- Reach net-zero by eliminating emissions from difficult to decarbonize sectors.

Sectors

- Metals • Fertilizers • Chemicals • Shipping
- Trucking • Mining • Aviation • Power Generation







Why Green Hydrogen

- 1) Industry momentum and alliances growing
- 2) Boost hydrogen economy while accelerating decarbonization

Fluence

- Partnership between Siemens and AES
- Brings energy storage products to support modernization.

> Stats

 7	 22st	 47	 20.6
GW of energy storage	Storage projects	Markets	GW of AI-optimized and storage

> Values

- Leading • Agile • Fun • Responsible

AES INNOVATION CHALLENGE

- Graduate students create and present solution to relevant industry problems in energy sector.

Key Insights from previous Challenges.

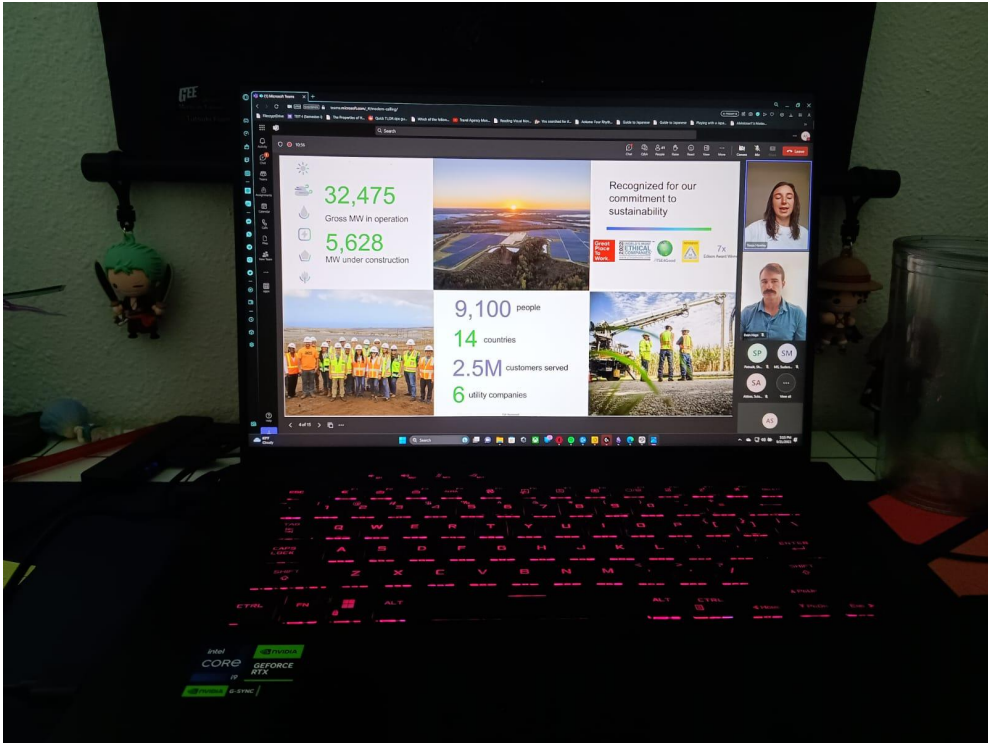
→ University of Dayton:

Indoor farming system powered by onsite solar and battery storage to promote locally grown produce.

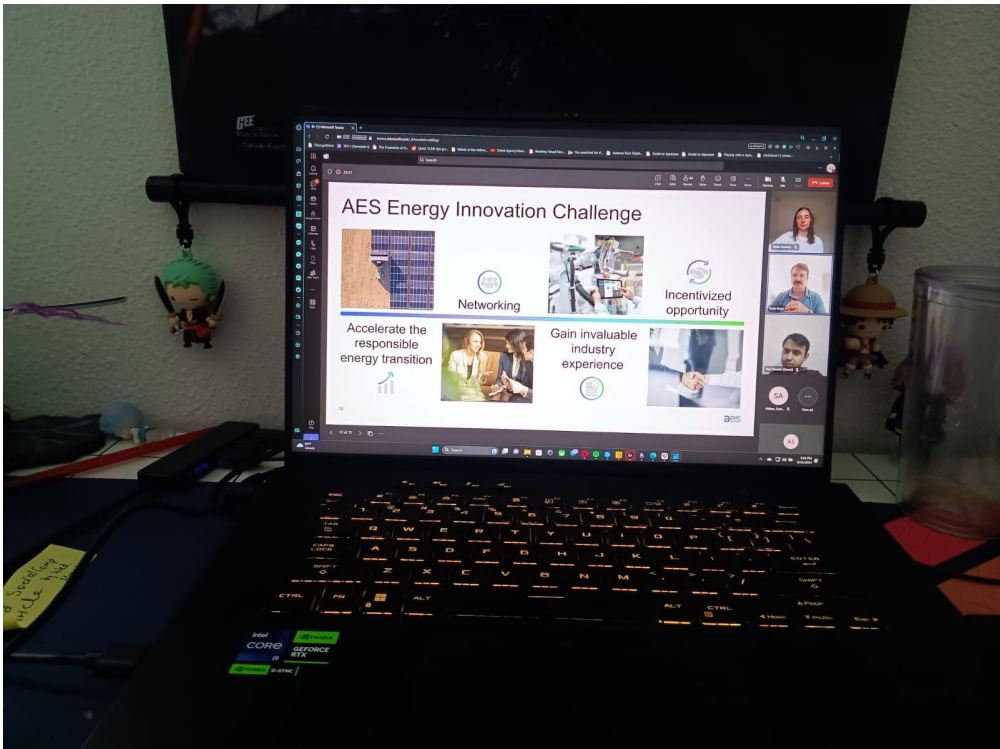
→ John Hopkins:

Deploying additional sources for Green Hydrogen for steel furnaces

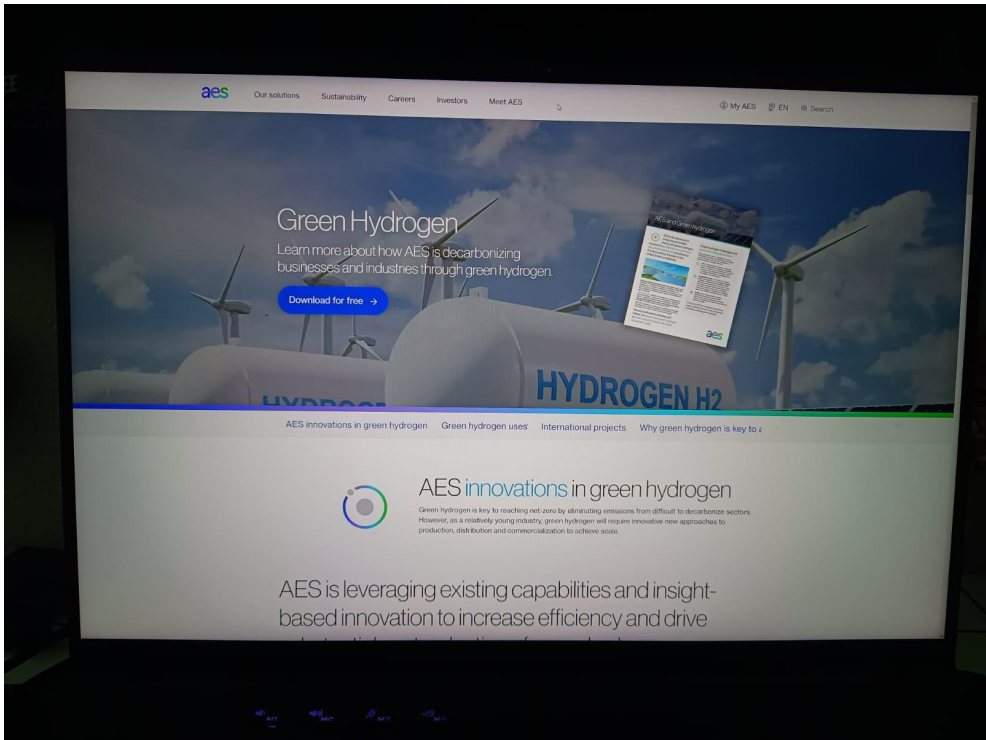
Photos:



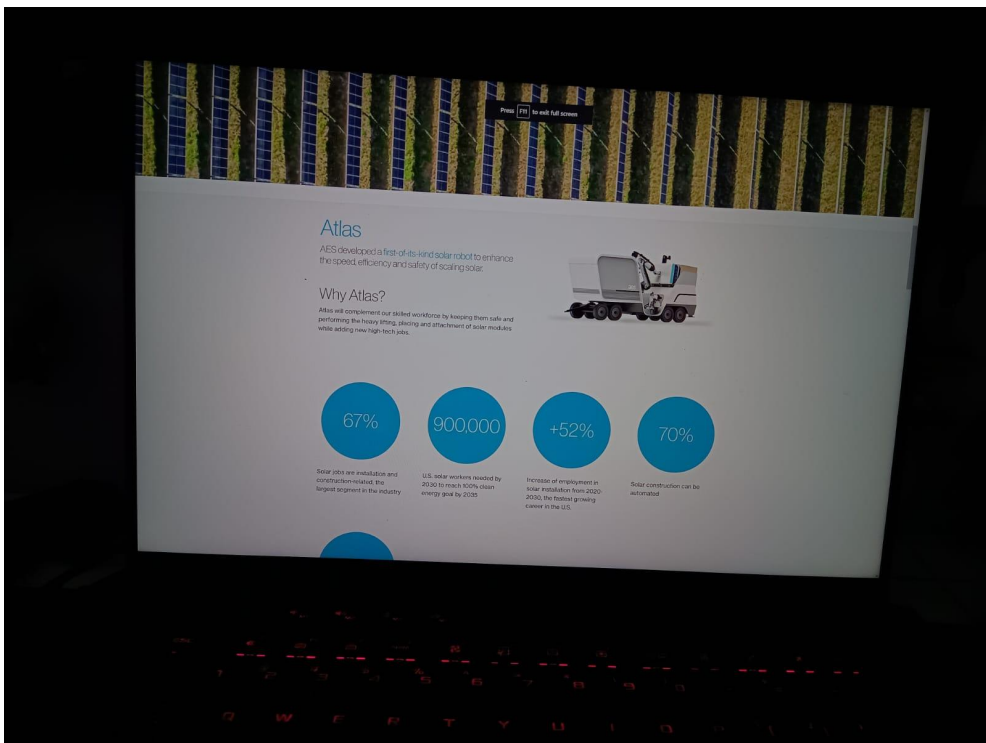
An overview of AES



An overview of AES Innovation Challenge



What is Green Hydrogen



Atlas: Atlas is

Observation Reflection:

My observation of the AES Innovation Challenge webinar and the visit to the AES Indiana Office Lobby provided valuable insights into the energy industry's current dynamics and AES's commitment to innovation and sustainability. It was evident from the webinar that AES is at the forefront of renewable energy and energy storage solutions, with a strong focus on technologies like the Atlas solar robot and green hydrogen production. Their emphasis on collaboration with graduate students and their track record of supporting innovative proposals underscore their dedication to driving positive change in the energy sector. Moreover, the office lobby visit highlighted the impact of COVID-19 on customer service operations, with AES opting for online communications and payments due to office closures. The encounter with students inquiring about the Innovation Challenge further demonstrated the interest and engagement of young minds in addressing energy challenges, with the promise of an upcoming informative session fostering a sense of anticipation and enthusiasm.

Overall, these observations underscore the importance of partnerships between industry leaders like AES and the academic community in fostering innovation and addressing critical issues in the energy sector. It is clear that AES recognizes the role of young talent in shaping the future of energy, and their initiatives like the Innovation Challenge reflect a commitment to sustainability and forward-thinking solutions.

03

Interviews/Contextual Inquiry

For our interviews, we decided to interview 2 user groups, to understand people's approach to energy consumption in their own houses and how apartment deals with their energy consumption which is on a much larger scale. These 2 groups were

1. An Individual house owner who has been living in the USA for the least a few years and owns a house.
2. A Manager of an Apartment building who manages a large building complex.

Interview Questionnaire for Individuals

1. To help us get to know you better, could you tell me a bit about yourself?
2. How long have you been living in the USA and in your current house?
3. Do you keep track of the electricity/ energy you consume daily or monthly?
4. If yes, How do you do it?
5. If not, are you interested in tracking?
6. What is your average monthly energy consumption in kilowatt-hours (kWh)?
7. Are you satisfied with your current energy consumption and its cost?
8. Do you have any specific energy efficiency measures or practices in place (e.g., LED lighting, energy-efficient appliances, smart thermostats)?
9. If yes, did you find any noticeable changes after using those?
10. How informed do you feel about energy-saving practices and technologies?
11. Have you faced any challenges when trying to reduce your energy consumption? (For ex. cost, lack of information, etc?)
12. Have you considered adopting renewable energy sources?
13. If yes, can you give us details?
14. If not, were there any reasons behind not considering them?
15. What factors would influence your decision to invest in renewable energy sources?
16. Are you aware of the incentives the government provides or local programs that support this transition?
17. Do you want to share anything else regarding your home's energy and sustainability practices?
18. Is there anything else that you would like me to know?

Interview Questionnaire for Building Managers

1. Can you give us an overview of *the apartment building name*?
2. How many people reside in this building?
3. Can you provide us with an overview of the current energy consumption of this building/ building complex?
4. Are there any energy-saving practices/ initiatives currently or previously implemented?
5. How satisfied are you with the current energy consumption of this building?
6. Has the management of the building ever considered the possibility of using renewable energy resources?
7. If yes, Can you provide us with the details?

8. If not, Can you tell us the reasons behind it?
9. Are you aware of the incentives the government provides or local programs that support this transition?
10. What are the main factors that would influence your decision to use these resources? (For ex. Cost, Environmental benefits, Incentives/subsidies, or other)
11. Are the residents encouraged to practice energy-saving measures in their units? If yes, Can you describe them?
12. How do you communicate with your residents generally? About new resources or initiatives or other things?
13. Has anyone staying in the building discussed the possibility of using renewable energy for their own apartment?
14. If yes, was the management supportive?
15. If they have used these energy-efficient resources, is there a possibility of us talking to them and knowing more about it?

Interview 1

Date: September 18, 2023, 3:00 PM

Interviewer: Avishkar Shinde

Interviewee: Participant 1

Background Information:

- **Relationship:** Adam is the Leasing Consultant at Barrett & Stokely, and I am a renter at their complex.
- **Age:** Adam is in his early 20s.
- **Role:** Adam has been serving as a Leasing Consultant for the past year at Barrett & Stokely.
- **Location:** The interview was conducted in Adam's office
- **Duration:** The interview lasted for approximately 30 minutes.

Interview Summary:

I recently had the opportunity to sit down and interview Adam, a Leasing Consultant at Barrett & Stokely. He shared some intriguing insights during our conversation. One of the standout aspects of our discussion was his conscientiousness about energy consumption. Despite currently not tracking his electricity usage, Adam expressed a strong interest in doing so, recognizing the need to reduce waste. He already employs some energy-saving practices, such as turning off the thermostat when leaving home and unplugging appliances, demonstrating his commitment to sustainability.

While Adam is satisfied to some extent with his current consumption and costs, he definitely desires a reduction and is open to exploring energy-efficient measures. His motivation is deeply rooted in his concern for environmental change, a value instilled in him since childhood. Adam also wishes to lower his energy bills, but he acknowledges his limited knowledge of energy-saving technologies and government incentives. He's intrigued by the idea of transitioning to renewable energy sources but is currently constrained by the restrictions in his rental property.

However, if presented with accessible, cost-effective, and portable renewable energy options, Adam expressed a strong willingness to make the transition. He also called for increased government initiatives to promote sustainable energy practices and intends to discuss these options with his parents for their home.

Interview 2

Date: September 18, 2023 9:35 AM

Interviewer: Avishkar Shinde

Interviewee: Participant 2

Background Information:

- **Relationship:** Eva is the Leasing Consultant at Barrett & Stokely, and I am a renter at their complex.
- **Age:** Eva is in her early 20s.
- **Role:** Eva has been serving as a Leasing Consultant for the past two years at Barrett & Stokely.
- **Location:** The interview was conducted in Eva's office
- **Duration:** The interview lasted for approximately 35 minutes.

Interview Summary:

I had the opportunity to chat with Participant 2, a Leasing Consultant at Barrett & Stokely. Ava shared valuable insights about the apartment complex she works for, which comprises over 330 units housing more than 1000 people. She emphasized that energy consumption is managed by AES Indiana, with an average usage of 900 Kwh per unit. Interestingly, Ava revealed that they hadn't previously considered monitoring common area consumption. Despite her overall satisfaction with the current energy consumption, she acknowledged that improvements are possible.

One significant aspect Ava mentioned is the management's consideration of renewable energy sources, such as solar panels. However, the high initial investment and limited benefits made them drop the idea. She also expressed awareness of tax returns but felt that they didn't outweigh the costs. Interestingly, she had not been aware of the potential increase in rent and property value for complexes with renewable sources, which piqued her interest. This newfound information appears to be a potential game-changer in their approach to energy management. Moreover, Ava emphasized that residents at the complex are encouraged to practice energy-saving measures, which include turning off lights, thermostats, and computers when not in use.

Despite limited inquiries from residents about renewable energy, Ava recognized the convenience of having more accessible solutions. Lastly, she mentioned her intention to explore the benefits of renewable sources further and share this information with upper management, indicating a growing interest in sustainability within the complex.

Interview 3

Date: September 19, 2023 11AM

Interviewer: Avishkar Shinde

Interviewee: Participant 3

Background Information:

- - **Relationship:** James Smith is a stranger.
- - **Age:** James Smith is in his late 30s.
- - **Role:** James Smith has been serving as a Quality Engineer for the past 5 years at Brose.
- - **Location:** The interview was conducted online.
- - **Duration:** The interview lasted for approximately 40 minutes.

Interview Summary:

I had a great interview with James, a Quality Engineer who lives in a West Blocton, Alabama townhome with his family of three. He's been in his home for five years and actively tracks his electricity consumption, which currently averages around 950 kWh per month. While James is satisfied with his energy-saving efforts, he acknowledges the potential for further improvement.

James has implemented energy-efficient measures like a Smart Thermostat, LED lighting, and insulation improvements, resulting in noticeable reductions in energy bills and improved comfort. He's considered advanced energy monitoring devices but held back due to a lack of knowledge in this area. Still, James stays informed about energy-saving practices and is open to new innovations, with plans to install a Smart Meter soon.

However, James faces several challenges in his journey towards greater energy efficiency and renewable energy adoption. High upfront costs deter him from investing in renewable solutions like solar panels. The lack of local information on programs and eligibility criteria poses challenges, and the complexity of renewable energy installations can be daunting. Despite these hurdles, James remains committed to reducing energy consumption and hopes for more accessible, cost-effective renewable energy solutions in the future, driven by a desire to contribute to a cleaner environment for his children.

Interview Reflection: (Avishkar Shinde)

Conducting these interviews was an eye-opening experience that allowed me to connect with people on a personal level and gain valuable insights. What stood out to me was the universal concern for the environment, irrespective of age or profession. It's heartening to see that people are actively seeking ways to reduce their energy consumption and embrace sustainability.

One surprising moment was when Ava, the leasing consultant, wasn't aware of the potential benefits of renewable energy for her complex. It highlighted the need for better communication and education on sustainability in the real estate industry. In future interviews, I'll make sure to ensure participants are well-informed to get more comprehensive insights.

Looking ahead, I'd like to explore potential solutions with participants, encouraging them to share their ideas for sustainability. This way, I can better understand their expectations and perhaps uncover innovative design solutions that align with their needs and desires. Additionally, I'll dig deeper into government incentives and local programs to understand the obstacles people face in adopting renewable energy solutions. These interviews taught me that design isn't just about aesthetics; it's about understanding the human aspect of sustainability.

Interview 4

Date: September 16, 2023

Interviewer: Atharva Sakharkar

Background Information:

- **Relationship:** 'Interviewee 1' is a Researcher at Miltenyi Biotec
- **Age:** 'Interviewee 1' is in their early 30s.
- **Role:** 'Interviewee 1' lives in a townhouse in the suburbs of Maryland, they live with their partner and two kids. 'Interviewee 1' is conscious of their energy consumption and makes an effort to reduce their consumption by following various energy consumption measures.
- **Location:** The interview was conducted via video call.
- **Duration:** The interview lasted for approximately 35 mins.

Interview Summary:

In this interview, I had the chance to speak with 'Interviewee 1,' who has implemented various renewable energy-saving measures in their house. These methods were as follows: implementing solar panel lighting for outdoors, using LED lights in most places, and using a smart thermostat. The impact of these methods on energy consumption was discussed during the interview, which took place via a video call and lasted for about 35 minutes.

Several insights were collected from this project. Firstly, 'Interviewee 1' emphasized their motivations and interest in switching to renewable sources due to the favorable sun score in their locality, which made solar energy a highly viable option. However, they felt the need to conduct extensive research before proceeding.

Some of their concerns revolved around how to properly maintain solar panels and the associated costs of maintenance and repair. The primary concern related to switching to renewable energy sources was the perceived cost; they are uncertain if solar panels represent a cost-effective choice in the long run.

Additionally, 'Interviewee 1' discussed their general dissatisfaction with the monthly energy bill and expressed an appreciation for even small ways of saving energy, such as tracking appliance-wise energy consumption.

Interview 5

Date: September 18, 2023

Interviewer: Atharva Sakharkar

Background Information:

- **Relationship:** "Interviewee 2" is a Senior Information Technology Specialist at Montgomery County Government.
- **Age:** "Interviewee 2" is in their early 40s.
- **Role:** "Interviewee 2" is a very active sustainability champion. They are very conscious of their carbon footprint and have implemented many lifestyle changes to reduce it. They are invested in multiple sustainability ventures like soil consumption, organic planting, and water conservation.
- **Location:** The interview was conducted via video call.
- **Duration:** The interview lasted for approximately 1 hour.

Interview Summary:

In this interview, I had the chance to speak with "Interviewee 2," who has implemented several renewable energy consumption practices in their home. Our discussion mainly focused on understanding sustainable energy consumption initiatives implemented by "Interviewee 2" and their insights and experiences with renewable energy sources. The interview took place via a video call and lasted for about 50 minutes.

Through our interview, I gained several insights. Firstly, "Interviewee 2" emphasized the various measures they have taken over the years to switch to renewable energy sources, primarily through solar energy. They also shared several experiences that illustrated the challenges they faced while transitioning to renewable energy sources. Secondly, "Interviewee 2" spoke about the various factors that they needed to take into account when making these significant changes. Some of the important factors were cost, installation complications, and maintenance-related queries. Lastly, "Interviewee 2" stressed the importance of government tax rebates and shared several resources that are freely available to people interested in switching to renewable energy sources.

They also touched upon the satisfying feeling of seeing the electricity meter in reverse and the sense of having an overall impact on the environment. They also actively volunteer and make an effort to share information with interested people.

Interview Self Reflection: (Atharva Sakharkar)

This interview offered multiple insights about the sustainable energy consumption space, concepts that were far beyond the scope of my initial research. The interviewees shared several quick remedies adapted by them to reduce energy consumption. They also shared various avenues of renewable energy, e.g., Green banks, Solar energy Co-op, and multiple government schemes that reward the

adoption of renewable energy sources. The conversations shed light on various opportunities available for building a sustainable future from an energy consumption point of view.

One unique talking point that particularly stood out to me was the existence of the 'Electric Vehicle Association of Greater Washington DC.' The organization offers support and advice to people considering a switch to electric vehicles. This unexpected insight also helped me uncover the existence of various government-led initiatives toward sustainable and renewable energy sources.

In future interviews, I would consider adopting a more open-ended approach, as it provides a lot of useful information to work with. A caveat to this is that it can be a challenge to distill all of this information into insights at times. Additionally, I would aim to conduct more structured secondary research before interviews as they lead to more productive interview conversations. Overall, this interview was a great starting point for delving deep into understanding the sustainable energy space, and I was able to collect many resources from both interviewees.

Interview 6

Interview Notes

Date: September 17, 2023

Interviewer: Mohini Yashwant Gaikwad

Interviewee: Participant 1

Background Information:

- **Relationship:** The participant is a relative of one of my friends.
- **Age:** Participant 1 is in her early 40s.
- **Role:** The participant is working as a Software Engineer at Cisco.
- **Location:** The interview was conducted via audio call.
- **Duration:** The interview lasted for approximately 35 minutes.

Interview Summary :

In this interview, I got an opportunity to speak with Participant 1, who holds the role of Software Engineer at Cisco. She and her family have been living in the USA for the last 20+ years and own a townhouse in Clarksburg, Maryland. Our discussion focused on her opinions about energy efficiency and what they do to save energy in their house. The interview took place via an audio call, and it lasted for about 35 minutes.

During our conversation, I understood her perspective on the topic. Firstly, the participant emphasized that they have been using energy-efficient systems such as LED Lighting, Smart thermostats, kitchen and utility appliances with good ratings for being energy efficient, and a patio light operated by Solar power. Secondly, the Participant mentioned that their house is a 'Smart home' and they use an application by 'Alarm.com' that helps control the thermostats and lights in the house and adjusts automatically according to the weather and temperature. Lastly, she mentioned that they were interested in installing solar panels for their house, and even gotten permission from the management company for the installation, they chose to not go for it as it was not giving them the desired benefits even after investing a substantial amount of money.

The participant also mentioned that she and her family consciously try to reduce their carbon footprint and be responsible citizens along with saving money and driving a fully electric car is also part of their effort to do so. Overall the interview provided insights into their energy consumption habits, energy efficiency measures, and considerations regarding renewable energy adoption.

Interview 7

Interview Notes

Date: September 17, 2023

Interviewer: Mohini Yashwant Gaikwad

Interviewee: Participant 2

Background Information:

- **Relationship:** The participant is a work friend of one of my friends.
- **Age:** Participant 2 is in his late 30s.
- **Role:** The participant is working as a UX Designer at Amazon.
- **Location:** The interview was conducted via audio call.
- **Duration:** The interview lasted for approximately 30 minutes.

Interview Summary :

In this interview, I got an opportunity to speak with Participant 1, who works as a 'UX Designer' at Amazon. He and his family have been living in the USA for the last 5+ years and own a townhouse in New Jersey, USA. We discussed energy efficiency measures and practices they follow to save energy in their house. The interview took place via an audio call, and it lasted for about 30 minutes.

During our discussion, I gained some valuable insights. The participant keeps a monthly track of their energy usage and has concerns about its relatively high consumption. Upon moving into their current house, they proactively upgraded to LED lighting and installed a smart thermostat to optimize energy efficiency. However, he expressed worry about the older kitchen appliances, which consume more energy. The main obstacle preventing them from adopting renewable energy sources is the housing management's restrictions on installations. Another notable thing he mentioned was, that they've integrated all household systems with 'Alexa', allowing them to remotely monitor and control various devices using the motion sensor security cameras.

The participant believes that incorporating an energy-efficient system into their house will enhance its market value when they decide to sell it in a few years. This interview shed light on the challenges they face transitioning to alternate energy sources and the methods they use to save energy in their home.

Interview Self-Reflection: (Mohini Yashwant Gaikwad)

These interviews provided me with diverse approaches to how people view energy consumption as individuals and what the motivations and influencing factors can be behind deciding to transition to renewable sources. What surprised me was that even though both their backgrounds and experiences

differed, there were notable similarities and differences between their approaches to energy consumption and sustainability.

One of the key takeaways from the interviews was the importance of engaging with individuals directly. These conversations revealed the details and everyday issues that people face, which might not be evident in the secondary research. The ability to explore small but significant aspects can lead to more profound insights and a deeper understanding of their perspectives.

As someone like me who is new to conducting interviews, this experience serves as a valuable learning opportunity. It made me realize the significance of balancing having a structured set of questions and training adaptable during interviews. Moving forward, I will aim to incorporate more open-ended questions to encourage participants to share their thoughts and experiences freely.

Interview 8

Date: September 18, 2023

Interviewer: Elmira Rashidi

Interviewee: Karyn

Background Information:

- **Relationship:** Karyn is my neighbor, working at a restaurant.
- **Age:** 38 years old.
- **Role:** Karyn tries to consume less energy. She is very educated in this field.
- **Location:** In-person in her apartment.
- **Duration:** The interview lasted for approximately 15 minutes.

Notes:

Interview 1

Karyn 38 y works at restaurant

born in the U.S

live in Indianapolis

moved this Apt recently

keep track → monthly by company

↓

tell me what I consumed

Ave energy kWh? not sure!

satisfied costs? NO! love for lower costs.

Energy Efficiency? Apartment x thermostats

but pick light bulbs

They are LED but it not change.

bought surge protector

change? Yes, would be better

pretty informed → library / my educated friend

+ Adopt renewable energy sources?

- love to do! own house > use solar panel

factor? 1. own place 2. cost

aware of incentive gov?

↳ Yes, Goodwill > surge protector > cheapest

Also > homeowners → get solar panels → ↓ Tax
but I'm not homeowner.

else? (water / solar / wind / fire) power

Interview Summary:

I conducted an interview with Karyn Black, a 38-year-old who has lived in the United States her entire life, and recently moved into a new apartment. She works at a restaurant. She tracks her monthly electricity

consumption and relies on her power company's monthly statements. She pays attention to using less energy and it is really important for her.

Karyn is open to reducing her energy costs and has taken some energy-efficient measures in her apartment, such as using LED light bulbs and purchasing an energy-efficient surge protector that cuts power to peripheral devices when the TV is turned off. Also, she picked out extra bulbs in order to use less power. If she had her own apartment, she would have used solar panels.

She is well-informed about energy-saving practices and technologies and was informed by her educated friend and by studying. Karyn has plans to invest in renewable energy sources, particularly solar panels, and potentially a windmill, once she owns her own home. Factors influencing her decision include property ownership, costs, and the desire to avoid leasing renewable energy equipment. She's aware of government incentives and local programs that support renewable energy but notes that many of these are more accessible to homeowners and mentioned that they can pay less tax, whereas she is not a homeowner. Additionally, Karyn mentions alternative energy sources, such as harnessing heat from fires for warming seating areas, reflecting her interest in diverse and sustainable energy solutions. This interview provided valuable insights into an individual's proactive approach to energy consumption and her awareness of how to reduce energy usage.

Interview self Reflection: (Elmira Rashidi)

Conducting interviews as a design method was incredibly informative and enlightening. These interviews provided a direct window into the thoughts, habits, and preferences of individuals, such as Karyn Black, that secondary reviews or observations alone could not have revealed. One of the most valuable aspects of the interviews was understanding people's perspectives on their energy consumption habits and how they perceive and interact with energy-saving technologies. For instance, Karyn's disclosure of her monthly energy consumption and her preference for owning rather than leasing renewable energy equipment shed light on important factors influencing decision-making in this domain. This firsthand information allowed me to gain a deeper understanding of user needs and preferences, which is vital for designing effective solutions.

During the interviews, some surprises emerged as well. Karyn's innovative idea of using the heat from fires to warm seating areas highlighted the importance of considering unconventional approaches in sustainable design. It was a reminder that creativity and outside-the-box thinking can lead to innovative solutions that might not be immediately evident through secondary research. Additionally, Karyn's awareness of government incentives and local programs was a valuable revelation, as it underscored the role of policy and external support in influencing individuals' choices regarding renewable energy adoption.

In future interviews, I plan to employ a more structured approach to data collection for a systematic exploration of user experiences. Additionally, diversifying the pool of interviewees will be a priority to capture a broader range of perspectives, considering the variability in attitudes and behaviors related to energy consumption. These interviews reinforced the significance of direct user engagement in guiding design decisions and will inform my approach in future design projects.

Interview 9

Date: September 18, 2023

Interviewer: Elmira Rashidi

Interviewee: Sogol

Background Information:

- **Relationship:** Sogol is a student.
- **Age:** 25 years old.
- **Role:** Sogol knows about energy consumption and wants to do her best in this matter.
- **Location:** In-person.
- **Duration:** The interview lasted for approximately 15 minutes.

Notes:

Interview 2

Sogol 25 student
live in the U.S 2 y
new in the Apt

Tracks monthly
How? careful off light / not all lights
washer & dryer once a week
Ave? Depends → ~\$60-\$70 per month
satisfied? Yes
Here manager decides / previous home
↓
used stuff to reduce
changes? Sure / LED ↓ cost
informed? culture/learn from my roommate
/social media

challenges? Not / sometimes got help
to know how
Renewable? x permission
Plan to use in my own house
factors? cost / efficiency
incentive? Ads / high cost motivate
to save
Else? NO
If all save > can help whole
> save money

Interview Summary:

In my interview with Sogol, a 25-year-old biomedical engineering Ph.D. student who recently moved to the U.S., I gained insights into her energy consumption habits and attitudes toward sustainability. Sogol has been in the U.S. for two years, with just one month of residence in her current apartment. She tracks her electricity usage monthly by being mindful of unnecessary lighting and limiting appliance use, such as washing machines, to control her energy consumption. Her estimated average monthly energy cost ranges between \$60 to \$70, which fluctuates with the seasons.

Sogol expressed satisfaction with her energy consumption practices, citing her use of LED lighting as a successful measure in reducing her monthly electricity costs. She mentioned that energy-saving practices, such as turning off lights when not needed, are part of the culture. Sogol has considered adopting renewable energy sources in the future, acknowledging their initial cost as a significant factor in her decision-making process. She emphasized the importance of factors like setup cost and efficiency when considering renewable energy options and noted that incentives, such as lower energy bills, can be strong motivators for individuals to embrace energy-saving practices.

Overall, her interview highlighted the potential for cultural influences and cost considerations to play a role in energy consumption and sustainability decisions.

Interview Reflection: (Elmira Rashidi)

The interview with Sogol, a 25-year-old biomedical engineering Ph.D. student, significantly enriched my design judgment by providing unique insights that cannot be gleaned from secondary research or observations alone. Sogol's firsthand account illuminated the practical steps individuals take to reduce energy consumption, such as her monthly tracking routine and conscious management of lighting and appliances. These intimate details provided a deeper understanding of user behaviors and the problems they aim to solve in their energy-related habits.

One striking revelation was Sogol's interest in renewable energy sources, despite their initial setup costs. Her emphasis on the long-term cost-effectiveness and efficiency of such technologies highlighted the motivations behind sustainable choices. Additionally, her mention of cultural influences, such as roommates and social media, as drivers of energy-saving practices showcased the importance of peer norms in shaping behaviors.

To optimize future interviews, I would consider implementing a more structured approach to data collection and diversifying the interviewee pool to capture a broader spectrum of perspectives. In summary, the interview with Sogol underscored the value of direct user engagement in shaping design decisions and uncovered the multifaceted factors that influence sustainable choices.

04

Secondary Review

PART 1

Existing remedies for problems highlighted in primary research

1. The problem: Users are dissatisfied with their energy consumption/bill

Key finding:

Energy feedback can be a valuable tool for improving energy bill satisfaction. Energy feedback can help consumers become more aware of their energy use and identify areas where they can save energy.

How existing technologies can be implemented to solve this challenge:

Real-time energy feedback systems can be implemented in homes equipped with smart appliances. These appliances can provide homeowners with a detailed analysis of their energy consumption habits. They can also help owners reduce consumption by sending them alerts when appliances are left unattended and by providing recommendations for reducing energy use.

Citation

- Reay, D. J., et al. (2021). Exploring the role of energy feedback in energy bill satisfaction. *Energy and Buildings*, 253, 111471.
- Darby, S. (2010). The impact of energy feedback on residential energy consumption: A meta-analysis. *Energy Policy*, 38(10), 5665-5678.

2. The problem: People find renewable energy sources to be too expensive

Key findings:

Community and Co-operative Ownership of Renewable Energy Projects can help to make renewable energy more affordable and accessible to everyone, including low-income households and renters.

How existing technologies can be implemented to solve this challenge:

Online crowdfunding platforms can be used to raise capital for community and cooperative ownership projects. This can help to overcome one of the main challenges facing community and cooperative ownership projects, which is access to capital.

Citation

- Community and Co-operative Ownership of Renewable Energy Projects (2021) by the International Renewable Energy Agency
- Making renewable energy more affordable: A review of policies and programs (2021) by the International Renewable Energy Agency (IRENA)

3. The problem: Lack of awareness about the accessibility of renewable energy sources.

Key findings:

Public education campaigns by the government or any other organizations can help raise awareness and address some of the negative stereotypes about renewable energy sources, such as that they are unreliable or expensive.

How existing technologies can be implemented to solve this challenge:

Raising awareness and persuading new individuals to switch to renewable energy sources can be accomplished by communicating with people via emailers, social media posts, and Twitter campaigns that explain the effects of renewable energy sources and the advantages of making the switch.

Citation

- "Public Awareness of Renewable Energy: A Review of the Literature" (2022) by the International Renewable Energy Agency (IRENA)
 - "The Importance of Public Awareness for Renewable Energy Deployment: A Case Study of India" (2021) by the Renewable Energy Policy Network for the 21st Century (REN21)
 - "The Role of Education in Promoting Renewable Energy Awareness and Acceptance: A Review of the Literature" (2020) by the Journal of Renewable Energy
-

PART 2

Persistent challenges

1. Users are dissatisfied with their energy consumption/bill

Challenges faced while addressing the problem:

- **Lack of awareness:** Many users are not aware of the factors that contribute to their energy consumption or how to reduce their energy bills.
- **High upfront costs:** Energy-efficient appliances and home improvements can be expensive upfront, which can discourage users from making these investments.
- **Behavioural inertia:** People are often reluctant to change their energy habits, even if they know it would save them money.
- **Split incentives:** In some cases, landlords or tenants may not be incentivized to invest in energy efficiency, even if it would benefit them in the long run.

Citation:

- **Lack of awareness:**
 - "Public Awareness of Renewable Energy" (2023) by the International Renewable Energy Agency (IRENA)
 - "Renewable Energy and Public Attitudes" (2022) by the Pew Research Center
- **High upfront costs:**
 - "The Energy Efficiency Gap: Market Barriers and Solutions" (2021) by the American Council for an Energy-Efficient Economy (ACEEE)
 - "The Cost of Renewable Energy and Fossil Fuels" (2022) by the Renewable Energy Policy Network for the 21st Century (REN21)
- **Behavioral inertia:**
 - "Energy Efficiency and Behavioral Economics" (2020) by the National Bureau of Economic Research (NBER)
 - "Behavioral Barriers to Energy Efficiency: A Review of the Literature" (2019) by the Energy Policy journal
- **Split incentives:**
 - "Split Incentives and Energy Efficiency: A Review of the Literature" (2018) by the Energy Research & Social Science journal
 - "The Role of Energy Efficiency in Multifamily Buildings" (2017) by the American Council for an Energy-Efficient Economy (ACEEE)

Addressing these challenges:

There are a number of things that can be done to address the challenges of addressing user dissatisfaction with energy consumption and bills, including:

- **Education and outreach:** Governments, businesses, and non-profit organizations can play a role in educating users about energy efficiency and how to reduce their energy bills. This can be done through public awareness campaigns, educational materials, and workshops.
- **Financial incentives:** Governments and businesses can offer financial incentives to encourage users to invest in energy efficiency. This can include tax breaks, rebates, and low-interest loans.
- **Behavioral interventions:** Policymakers and program designers can use behavioral insights to develop interventions that encourage users to adopt energy-efficient behaviors. This can include things like default opt-in programs, social norming, and gamification.
- **Addressing split incentives:** Policymakers and program designers can address split incentives by providing incentives for both landlords and tenants to invest in energy efficiency. This can be done through things like energy performance contracts and energy efficiency portfolio standards.

2. Lack of awareness about the accessibility of renewable energy sources.

- **Lack of information:** Many people are not aware of the different types of renewable energy sources available, how they work, or how to access them.
- **Negative stereotypes:** Some people have negative stereotypes about renewable energy sources, such as that they are unreliable or expensive.
- **Lack of exposure:** Many people have not had the opportunity to experience renewable energy sources firsthand.

Citations:

- **Lack of information:**
 - "Public Awareness of Renewable Energy" (2023) by the International Renewable Energy Agency (IRENA)
 - "Renewable Energy and Public Attitudes" (2022) by the Pew Research Center
- **Negative stereotypes:**
 - "Public Perceptions of Renewable Energy Technologies: A Review and Meta-Analysis" (2022) by the Renewable and Sustainable Energy Reviews journal
 - "Barriers to Renewable Energy Deployment: A Review of the Literature" (2021) by the Energy Policy journal
- **Lack of exposure:**
 - "Public Awareness of Renewable Energy: A Review of the Literature" (2020) by the Journal of Renewable Energy

Addressing these challenges:

There are a number of things that can be done to address the challenges of addressing lack of awareness about the accessibility of renewable energy sources, including:

- **Public education campaigns:** Governments, businesses, and non-profit organizations can launch public education campaigns to raise awareness of renewable energy sources. This can be done through things like social media, advertising, and community events.
- **Media coverage:** The media can play an important role in educating the public about renewable energy sources. This can be done through news stories, documentaries, and other educational programming.
- **School curricula:** Schools can incorporate renewable energy education into their curricula. This can help to teach students about renewable energy sources and their benefits.
- **Site visits and tours:** Renewable energy projects can offer tours and site visits to the public. This can help people to learn about renewable energy sources firsthand.

By addressing these challenges, we can help to increase public awareness of renewable energy sources and their accessibility. This can lead to increased adoption of renewable energy sources, which can help to reduce greenhouse gas emissions and improve air quality.

Here are some additional things that can be done to address the challenge of lack of awareness about the accessibility of renewable energy sources:

- **Make renewable energy more visible:** Renewable energy projects can be made more visible to the public by installing them in high-traffic areas and by using public art and other creative elements to highlight them.
- **Provide opportunities for people to experience renewable energy firsthand:** This could include things like offering free electric vehicle charging stations, hosting renewable energy festivals, and allowing people to volunteer at renewable energy projects.
- **Support community-based renewable energy projects:** Community-based renewable energy projects can help to build local support for renewable energy and raise awareness of their accessibility. Governments and businesses can support these projects by providing financial and technical assistance.

3. People find renewable energy sources to be too expensive

- **High upfront costs:** The upfront costs of renewable energy systems, such as solar panels and wind turbines, can be high. This can be a barrier for homeowners and businesses that are considering switching to renewable energy.
- **Lack of access to financing:** Some people may not have access to affordable financing for renewable energy systems. This can make it difficult for them to afford the upfront costs of renewable energy.
- **Lack of awareness of financial incentives:** Many people are not aware of the financial incentives that are available for renewable energy systems. These incentives can help to reduce the upfront costs of renewable energy and make it more affordable.

Citations:

- **High upfront costs:**
 - "The Energy Efficiency Gap: Market Barriers and Solutions" (2021) by the American Council for an Energy-Efficient Economy (ACEEE)
 - "The Cost of Renewable Energy and Fossil Fuels" (2022) by the Renewable Energy Policy Network for the 21st Century (REN21)
- **Lack of access to financing:**
 - "The Role of Finance in Renewable Energy Deployment" (2020) by the International Renewable Energy Agency (IRENA)
 - "Financial Barriers to Renewable Energy: A Review of the Literature" (2019) by the Energy Policy journal
- **Lack of awareness of financial incentives:**
 - "Public Awareness of Renewable Energy Incentives" (2018) by the National Renewable Energy Laboratory (NREL)

- "Barriers to Renewable Energy Adoption: A Review of the Literature" (2017) by the Renewable and Sustainable Energy Reviews journal

Addressing these challenges:

There are a number of things that can be done to address the challenges of addressing the high cost of renewable energy sources, including:

- **Provide financial incentives:** Governments and businesses can offer financial incentives to make renewable energy more affordable. This can include things like tax breaks, rebates, and low-interest loans.
- **Promote community-based renewable energy projects:** Community-based renewable energy projects can help to make renewable energy more affordable by sharing the costs among multiple participants.
- **Support research and development:** Governments and businesses can support research and development to reduce the cost of renewable energy technologies.

By addressing these challenges, we can help to make renewable energy more affordable and accessible to everyone.

05

Problem Synthesis

Key User Requirements

The main difficulties and challenges in the field of sustainable energy usage are outlined in this document.

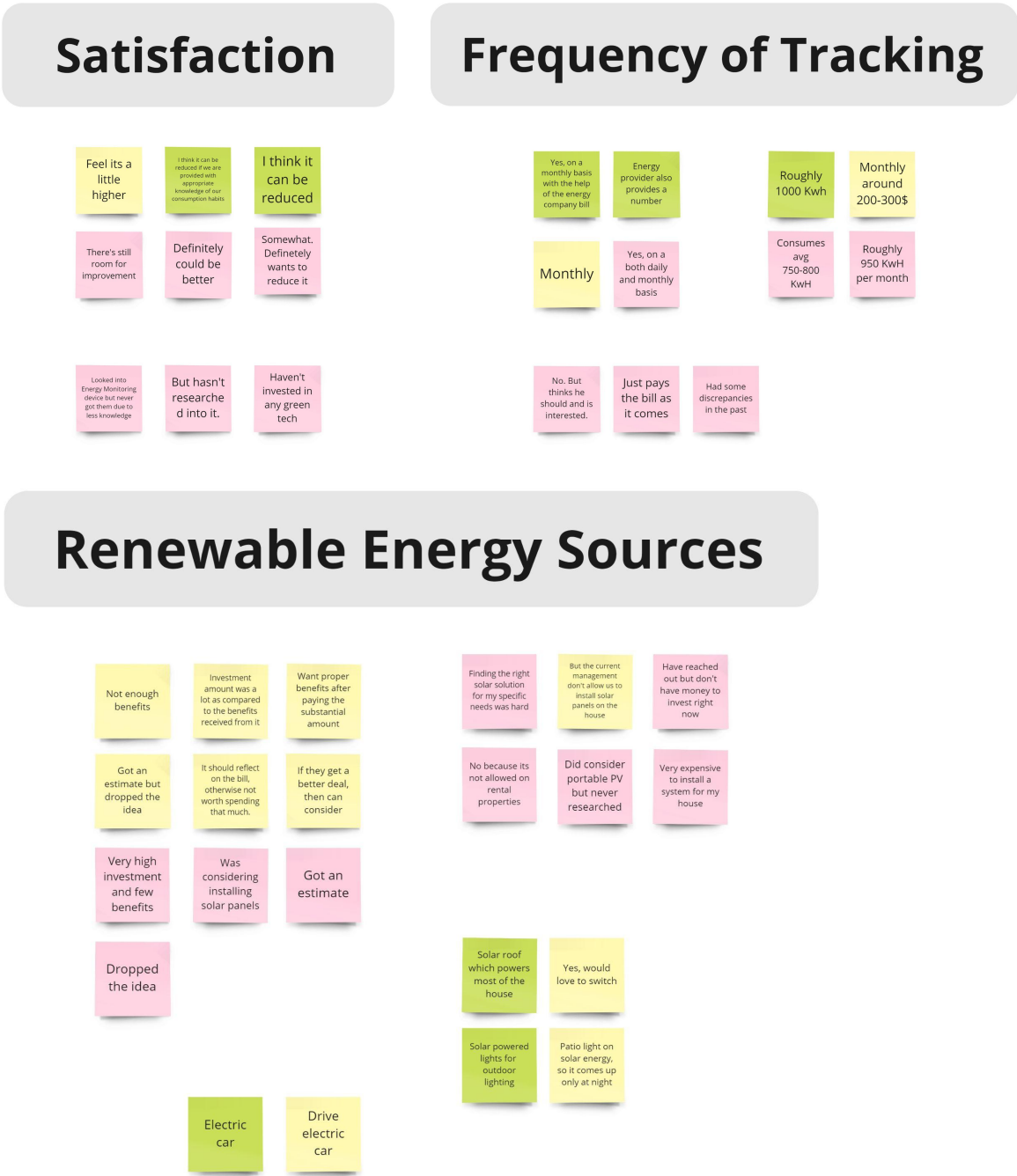
- **Challenge 1:** Users are dissatisfied with their energy consumption/bill
 - **Rationale:** Many users are not aware of the factors that contribute to their energy consumption or how to reduce their energy bills.
- **Challenge 2:** People find renewable energy sources to be too expensive
 - **Rationale:** The upfront costs of renewable energy systems, such as solar panels and wind turbines, can be high. This can be a barrier for homeowners and businesses that are considering switching to renewable energy.
- **Challenge 3:** Lack of awareness about the accessibility of renewable energy sources.
 - **Rationale:** Many people are not aware of the different types of renewable energy sources available, how they work, or how to access them.

These three user requirements, dissatisfaction with energy consumption/bill, renewable energy sources being too expensive, and lack of awareness about the accessibility of renewable energy sources, are vital for the success of any solution aimed at improving energy consumption. Meeting these user needs will enhance user satisfaction, awareness, and the overall adoption of renewable energy sources, ultimately reducing energy consumption through non-renewable energy sources.

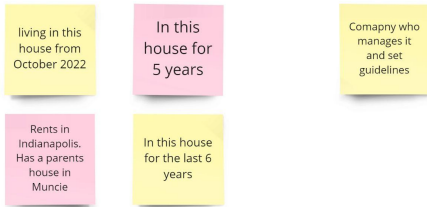
Affinity Mapping:

This package includes a picture of the affinity diagram that was produced during a group exercise to group and evaluate the problems with sustainable energy use, as well as another diagram that the group decided to use to further investigate problems.

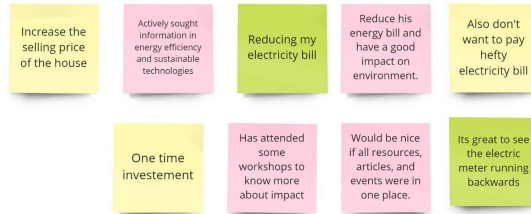
Project file: https://miro.com/app/board/uXjVMjh3zoM=?share_link_id=589723011240



House Type



Motivations



Energy Efficiency Measures



Influencing Factors



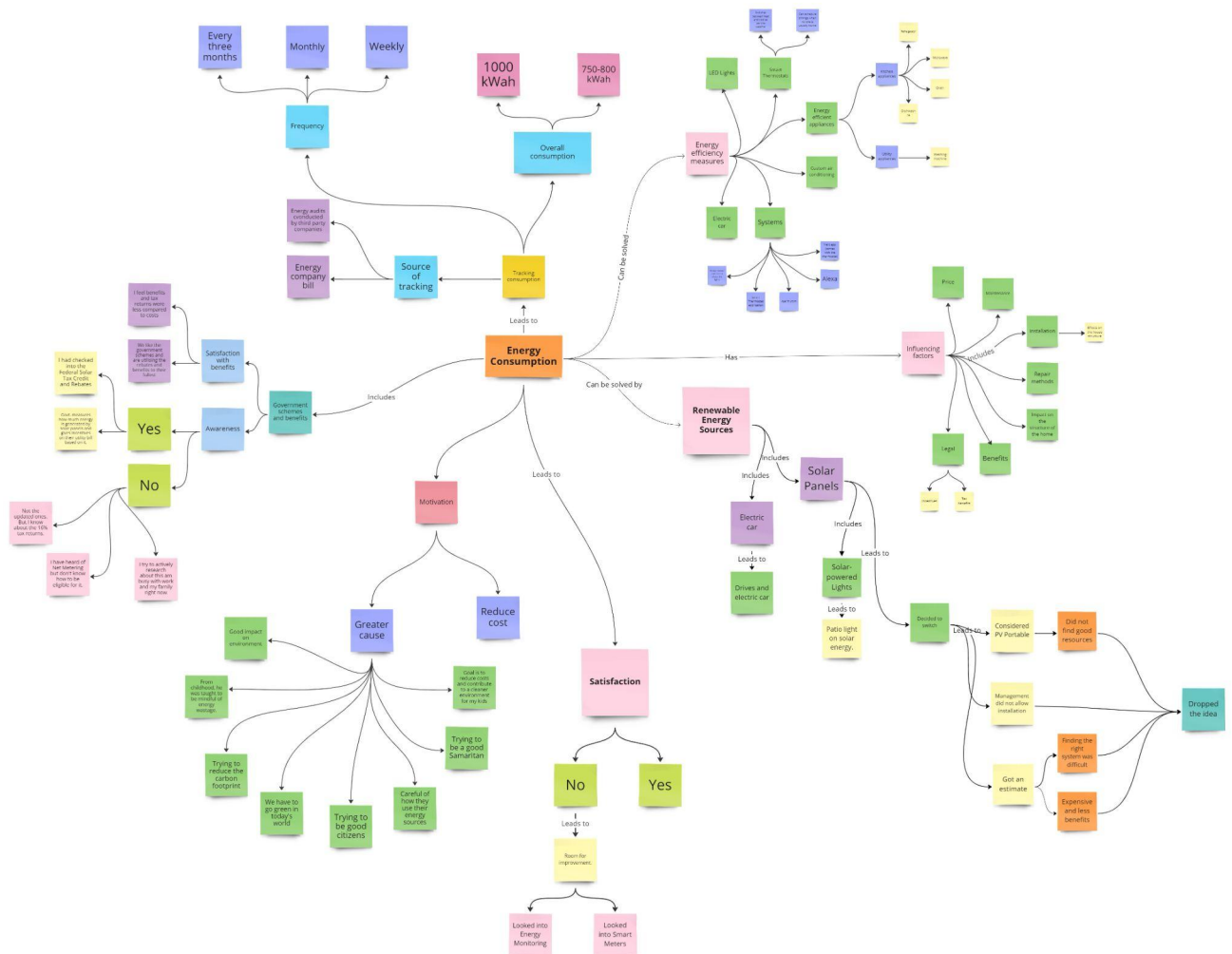
Government Incentives



Concept Mapping

Atharva Sakharkar, Avishkar Shinde, and Mohini Gaikwad participated in the diagramming activity. Each individual brought different key findings to the table and we spent an hour on making it.

Project file: https://miro.com/app/board/uXjVMjh3zoM=?share_link_id=589723011240



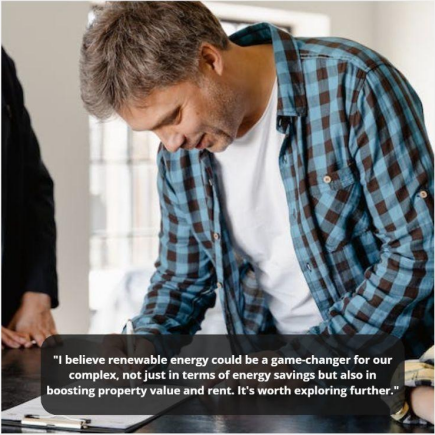
- We opted for Concept Mapping as our preferred method of data representation due to its ability to better encapsulate our findings and we were able to include all our insights easily in concept maps. We were able to convey large amounts of information, clearly and succinctly. It also encouraged us to think out-of-the-box, after we did affinity mapping.
- In affinity mapping, we were categorizing and organize ideas or information into related groups. During concept mapping, we represented the hierarchical relationships between concepts or ideas. It is a more structured way to showcase information. It aided us in visualizing relationships between variables in the study.

User Personas

This package includes personas that represent important users or stakeholders in the field of sustainable energy use, offering insights into their problems, requirements, and viewpoints.

Persona 1 - Property Manager Persona

A Property Manager



"I believe renewable energy could be a game-changer for our complex, not just in terms of energy savings but also in boosting property value and rent. It's worth exploring further."

Motivations

Environment	●●●●●●●●●●●●●●●●●●●●
Cost	●●●●●●●●●●●●●●●●●●●●
Efficiency	●●●●●●●●●●●●●●●●●●●●
Benefits	●●●●●●●●●●●●●●●●●●●●
Investment	●●●●●●●●●●●●●●●●●●●●

John Anderson

52 Indianapolis Property Manager Divorced, 1 Kid

Bio

John, a Property Manager at Avix Complex, aims to boost energy efficiency in his apartment complex but faces cost challenges with green solutions. He's keen on finding affordable, eco-friendly options and sees the potential for increased property and rent value as well as reduced energy wastage as a win-win.

Behaviors

- Actively monitors energy consumption in the apartment complex.
- Implements energy-saving practices within the office and encourages colleagues to do the same.
- Recognizes the potential value in increased rent and property value for complexes with renewable sources.

Goals

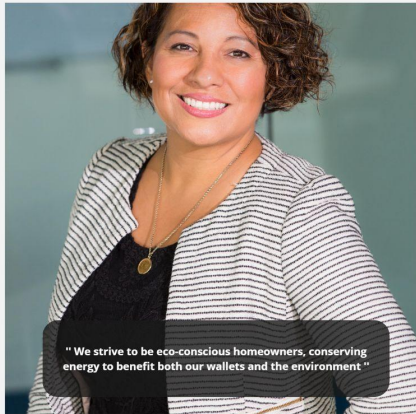
- Improve energy efficiency within the apartment complex to reduce costs.
- Stay informed about local incentives and programs related to energy conservation and green technology.
- Increase demand for renewable energy sources within the complex to potentially boost property value and rent.
- Enhance communication with residents regarding energy-saving practices and renewable energy options.

Pain Points

- Dissatisfaction with current energy consumption management.
- Concerns about the high upfront costs of renewable energy solutions and slow returns.
- Limited awareness of local incentives and programs.
- Lack of accessible solutions for residents interested in renewable energy.
- Challenges in communicating effectively with residents.
- Potential missed opportunities to increase property value and rent through renewable energy.

Persona 2 - Individual House Owner Persona

An Individual House Owner



Motivations

Environment	●●●●●●●●●●●●●●●●●●
Cost	●●●●●●●●●●●●●●●●●●
Efficiency	●●●●●●●●●●●●●●●●●●
Benefits	●●●●●●●●●●●●●●●●●●
Investment	●●●●●●●●●●●●●●●●●●

Jessica Lee

37

Maryland

Software Engineer

Married, 2 Kids

Bio

Jessica is a Software Engineer, who owns a townhouse in Maryland and lives with her husband and 2 kids. They are trying to reduce their carbon footprint and be good citizens by taking a few energy efficiency measures at their house. They want to switch to renewable energy resources if they come across any efficient technology providing good benefits.

Behaviors

- Keeps track of his energy consumption monthly using the electricity bill.
- Drives a fully electric car to reduce carbon footprint.
- Checks if all the lights and appliances off before leaving the house.

Goals

- Make sustainable choices to minimize their carbon footprint.
- Access detailed information about energy consumption to enable better monitoring.
- Gain knowledge about effective energy saving practices and technologies.
- Explore cost effective renewable energy options.
- Track appliance consumption to track their individual energy consumption and replace if necessary.
- Stay informed about government's incentives, programs and tax benefits related to renewable energy.

Pain Points

- The electricity bill is higher than expected.
- Lack of detailed information provided by the billing company for monitoring electricity consumption.
- The initial investment cost required to transition to renewable energy sources outweighs the benefits and the cost savings if offers in the long run.
- Limited awareness of energy saving practices and technologies.
- Concerns about new technology installations affecting the structure of the house.