3DS by Harmony

HACK OKSTATE

Fall 2022

Team #3

Members:

Emma Cooley (Mechanical Engineering)

Abhilash Minukuri (Computer Science)

Pouria Moghimi (Mechanical Engineering)

LEAN TECHNIQUES

OSU

Baker Hughes

What is the Challenge and our response to it?

The word is making a transition from fossil fuels to sustainable energy. This transition is forecast to take upwards of 25 years according to the United Nations. What products, Business plans, legal terms, or applications can we make or exploit to expedite the energy transition?

It is well understood that Renewable Energies are playing a significant role in the transition to sustainable energy. However, it is worth mentioning that 100% RE could not be achieved without deliberated Energy Efficiency measures:

"With increased global focus on carbon emissions and climate change, Energy efficiency and Renewable Energy measures have significant potential in the race towards meeting sustainability and climate goals. RE measures alone cannot meet existing demand in its entirety. EE measures need to be adopted simultaneously to reduce energy demand, with part or whole of the remaining demand then met by RE. Synergy between EE and RE can be achieved by designing policies that promote their joint implementation, with new policies aimed at simplifying this process. This also has to go hand in hand with technology innovation and sufficiency strategies, both essential to accelerate the growth in acceptance of EE and RE measures." [1]

So, we do care about energy efficiency measures.

Who are we?

Harmony

We are a knowledge-based company that provide energy efficiency solutions for buildings. Our mission is to make it as easy as possible for people to live in harmony with the environment. Our vision is that of people continuing with their everyday lives, without having to think about their carbon footprint. This is because our technology adjusts to them, not the other way around.

"We have intelligent solutions for your home"

Why do we care about residential building sector?

Let the statistics show our "why". The retail sales of electricity to major consuming sectors and percentage share of total electricity retail sales in 2021 in the US were [2]:

38.9%	34.9%	26.0%	0.2%
1.48 trillion kWh	***1.32 trillion kWh***	***0.99 trillion kWh***	***0.01 trillion kWh***
residential	commercial	industrial	transportation (mostly to public transit systems)

Indicating the potential of this market with the highest share of total electricity retail sales. Our solutions work for both new construction projects and home retrofits!

What is our solution?

Our Solution is our innovative service: 3DS

"Let's see how it is going to make the transition possible"

What?

*"**3DS** is an intelligent service that uses **3 D**imensional **S**ensors connected to a central controlling unit to control and optimize lighting and temperature distribution in the building using a machine learning based App."*

It is imperative that we reduce our emissions across the globe as quickly as possible. This will reduce the amount of carbon in the atmosphere and reduce negative impacts on the planet, including reducing extreme weather events, floods, and pestilence among other things.

Since 1990, household energy consumption in the United States has increased from 924 billion kWh to 1.46 trillion kWh. Although significant progress with renewables has been made (in the first half of 2022, 24% of energy was generated by renewable sources), carbon-intensity is still a major issue [3].

Our product 3DS, once installed, allows the occupant of a home to turn their house into a dynamic environment that adjusts to them without any effort on their part. 3DS optimizes a home's usage of light, cooling and heating systems through optimum monitoring of your envelope.

"Calibrate your home's lighting and HVAC usage"
Harmony

How?

We have developed an intelligent platform that measures temperature distribution, lighting and occupancy using multiple sensors in optimum locations in the envelope. It monitors your behavior and health indicators, once connected to your smart watch, in the building and asks for your feedback as well! Then, using some mysterious machine learning algorithms! it optimizes your comfort and energy usage. Here is what the costumer has to do:

1- Install 3DS App.

That's free!

2- Scan your building through camera

Enjoy our user-friendly App!

3- Let the App do its work

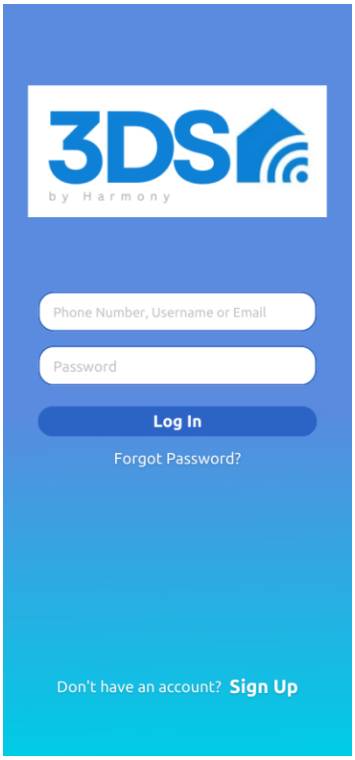
It will spot number and location of the 3D sensors required based on your envelope characteristics and application and estimates the cost to help you with your harmony!

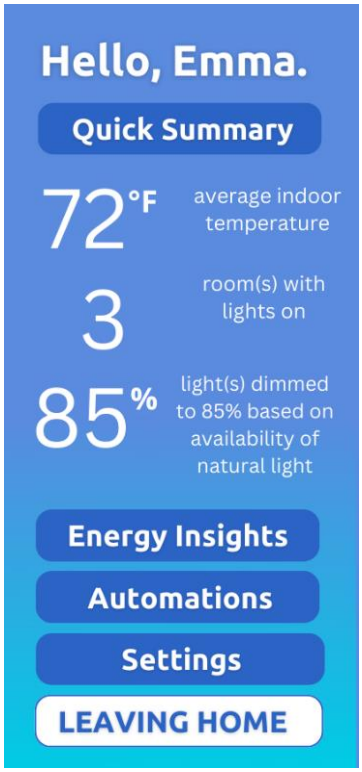
4- Our customer service will take care of installation

We offer free lifetime services for installation and maintenance of our products.

5- Let the App monitor you and harmonize your life!

Our magic algorithm will do that.

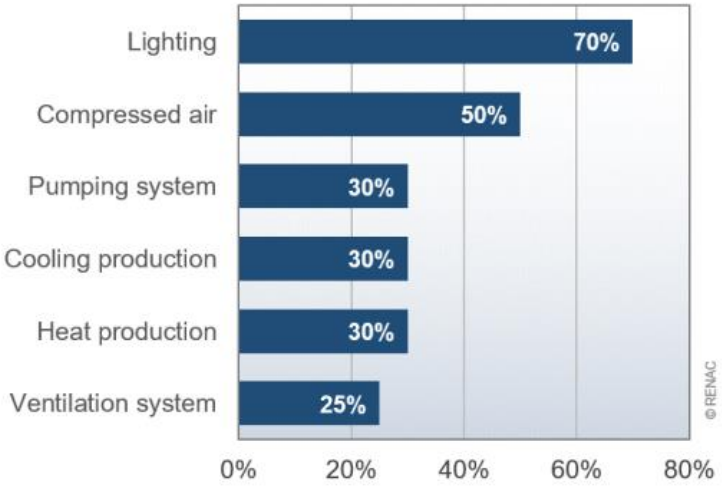




"Let the App Harmonize your life"

Why?

Why do we care about lighting and temperature?



Relative energy efficiency potential of the cross-sectoral technologies (Data source: German Energy Agency DENA 2014)

Because they have high energy efficiency potentials that could be addressed with the lowest cost possible in comparison to compressed air and pumping system.

3DS is not only named for using three sensors (Lighting, Temperature and Occupancy), but also for taking into consideration 3 aspects of sustainability:

1- Your Health and Comfort Matters

Light impacts human health and performance by four main mechanisms [4]:

- Controlling the body's circadian system
- Affecting mood and perception
- Facilitating direct absorption for critical chemical reactions within the body
- Enabling performance of visual tasks

How can we have the optimum lighting inside different zones of the building based on standards?!! Let 3DS do the work.

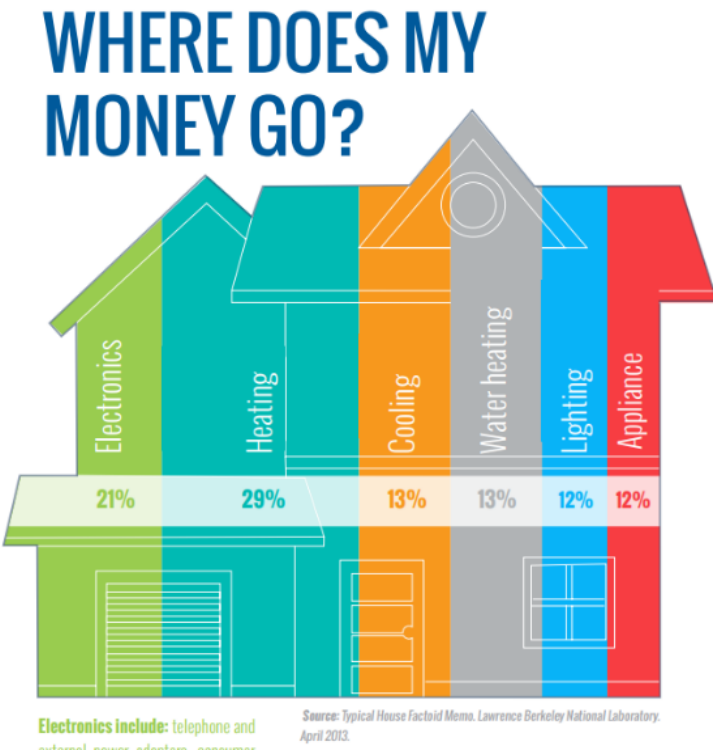
Temperature distribution inside the room impacts human comfort and health:

- Direct health effects: Even small differences from seasonal average temperatures are associated with increased illness and death. Temperature extremes can also worsen chronic conditions, including cardiovascular, respiratory, and cerebrovascular disease and diabetes-related conditions [5].
- Indirect health effects: Heat conditions can alter human behavior, the transmission of diseases, health service delivery, air quality, and critical social infrastructure such as energy, transport, and water. The scale and nature of the health impacts of heat depend on the timing, intensity and duration of a temperature event, the level of acclimatization, and the adaptability of the local population, infrastructure, and institutions to the prevailing climate [5].
- Exposure to environments outside a comfortable temperature could help tackle major metabolic diseases, such as diabetes and obesity, and should be reflected in modern building practices [6]

What is the trade-of between comfort and health based on the temperature distribution in the room?!! Let 3DS do the work.

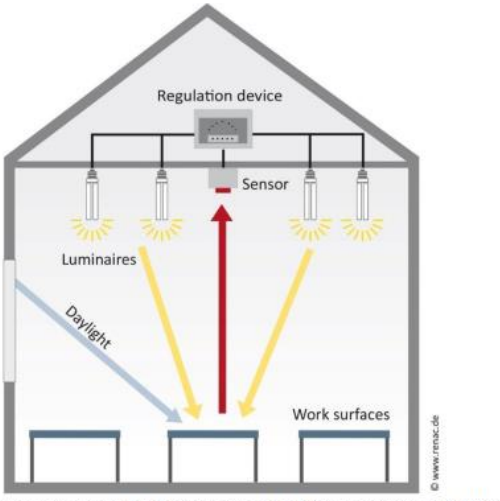
2- Your Wallet Matters

Annual Energy Bill for a typical Single-Family Home is $2,060 [7]

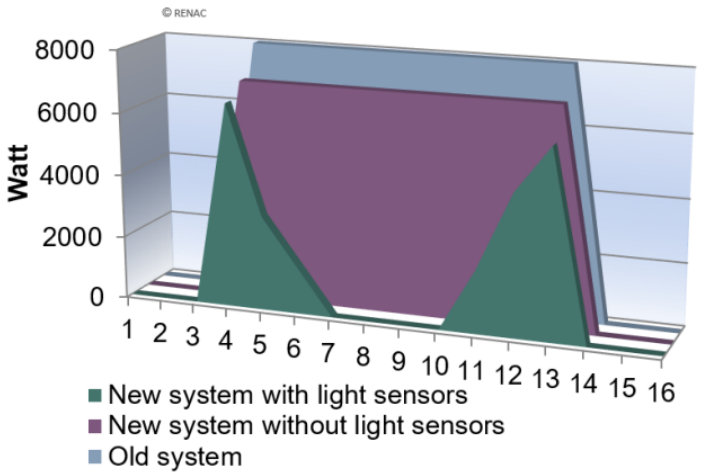


- Excessive light during the day? Shut down/adjust artificial lights.
- No occupant in the zone? Shut down/adjust HVAC and Lightings.

Here are the test results for a sample building with our modified lighting measure. Numbers talk [1]!



Functioning principle of a daylight dependent dimmer (Source: RENAC)



Energy savings using a daylight dependent dimmer (Source: RENAC)

So… How can you save on your bills?!! Let 3DS do the work.

3- Your Environment Matters

Decrease your carbon footprint by reducing your electricity usage.

Residential energy use accounts for roughly 20% of greenhouse gas (GHG) emissions in the United States. Lighting accounts for around 12% of an average home's electricity use, whereas heating and cooling make up 29% and 13% respectively. The standard single-family home is trying to reduce their carbon footprint as much as possible. But this is difficult at times. It can take an immense amount of effort and mental energy to adjust your purchasing habits, driving habits, light and electricity usage.

Do your share with Us. Let 3DS do the work.

Is it going to work?

Strengths

- ✓ Educated and experienced team (Programmers, marketing specialists, health specialists, etc.)
- ✓ Rising investment in renewable energy.
- ✓ Established infrastructure
- ✓ Increased adoption of energy efficient technologies

Weaknesses

- High capital cost
- Reliance on customer interaction for training the machine learning algorithm

SWOT

Opportunities

- ✓ Low pay back period for the customers.
- ✓ Increased tax incentives for energy efficient buildings
- ✓ Shift to commercial building sector as the potential future target market

Threats

- Subsidized energy prices
- Long time duration for justifying homeowners
- Fear of privacy concerns
- Implementation by elderly

Refs:

[1] RENAC, The Renewables Academy, 2018.

[2] https://www.eia.gov/energyexplained/electricity/use-of-electricity.php

[3] https://www.eia.gov/tools/faqs/faq.php?id=99&t=3

[4] Anjali Joseph, Impact of Light on Outcomes in Healthcare Settings, *The Center for Health Design,* 2006.

[5] https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health#:~:text=Even%20small%20differences%20from%20seasonal,has%20important%20indirect%20health%20effects.

[6] Major health benefits linked to indoor temperature variation, study finds, *Taylor & Francis Group*, 2017.

[7] Typical House Factoid Memo. *Lawrence Berkeley National Laboratory*. April 2013.