# Letter of Transmittal

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Salutations,

Within the attached Technical Report, *Light electricity conservation in work and personal spaces* written for the date of agreement on March 9th, 2021, the document will cover the feasibility of saving electricity through the Electrip Inc. interfacing and our general recommendations on economizing electricity usage.

From Electrip Inc.’s end, we have provided research on the electricity market usage across the globe and the success of the market using our product in different environments ranging from personal to professional. Our team at Electrip has gathered data and insights into how our technology can help conserve the electricity used for versatile purposes such as a University.

“Thank you for trusting us to complete this market research for you. We appreciate your business and look forward to working with you. Please review the official report and respond with your thoughts.” [14]

If you have any questions regarding the attached report, please contact me at [janesmith@my.yorku.ca](mailto:janesmith@my.yorku.ca) or (123) 456-7890. “I look forward to speaking with you further on this project”[14].

Sincerely,

Jane Smith

Electric Light Conservation in Work and Personal Environments

Electrip Inc.

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# Executive Summary

## Overview – The Quick Pitch

Electrip is a company that focusses on integrating new technology from the 21st century into existing technology present in many homes that maybe limited in technology or follow older household guidelines, such as the classic light switch.

## The Problem

Currently “55% of the world’s population lives in urban areas, a proportion that is expected to increase to 68% by 2050” [15] consequently, electric light is increasing in demand as more individuals move closer to urban areas. With light consumption projected to increase in households and eventually corporate usage, electricity consumption is becoming a serious concern affecting individual health, finances and economic expenses and the environment.

## The Solution

There are many viable solutions readily available but with the existence of smart technology it would be the most sustainable solution which can be integrated into current technology using a sensor-actuator based interface.

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# 1. Introduction

This report will describe current issues facing light pollution and potential solutions dealing with the UN sustainable goal that “ensures access to affordable, reliable, sustainable and modern energy for all” [18]. The potential solutions will not only describe the cutting-edge technology that Electrip Inc. provides but will also include other solutions that can also improve the electricity consumption through light usage. The document will provide research that will help convince the user to save electricity by describing the feasibility of doing so. The report will cover the human involvement and environmental (human health, conditions, corporate and personal financial significance, atmospheric impact, ecosystems, migration pattern, wildlife life cycles) involvement in light pollution and excessive consumption. Furthermore, other topics such as simple solutions that can be achieved form personal initiative (Psychological techniques and energy efficient light investments), along side smart technology that Electrip Inc. has to offer. Additionally, the mechanism will be described in terms of logistics and technology involved (Sensor/actuator interface with AI). The scope of the report will mainly cover the need for Electrip Inc. the personal/home environment as well as workspaces and technicality of the sensor/actuator interface and how the AI will interact with the currently integrated technology present in current spaces. It will explore ultra wideband wireless connection, frequency and concepts of data domains utilized by the AI. The document will not cover the installation processes and the specific costs for technology integration as technology integration methodology will vary across different environments due to infrastructure of the building’s circuitry.

# 2. Background

Some technical specific language will be used when describing the smart technology that Electrip Inc. has to offer in the business and personal environment.

Sensor

A sensor is a component of an embedded system that detects changes in an environment of physical and/or logical relation between two or more objects for the microcontroller to interpret [9].

Actuator

An actuator is a component for an embedded system that will take care of moving and controlling a particular part based on instructions provided by the microcontroller [10].

Artificial Intelligence

AI or artificial intelligence a form of technology that uses combination of machine learning and deep learning that will mimic human intelligence.

Ultra-wideband

Ultra-wideband or UWB is a technology that uses radio waves at a relatively short range (80 metres) with a high bandwidth of communication [11].

Circadian Rhythm

A 24-hour internal “clock” process which takes place in the body which can help regulate functions and processes. One common application that the circadian rhythm regulates is the sleep and wake cycle [21].

Melatonin

A hormone produced in response to darkness [22].

Light Pollution

Artificial light or anthropogenic light present in the night environment that affect surroundings such as human beings, the ecosystem, and ability to observe space [23].

# 3. Main Topics

## 3.1 Health

Although direct exposure to light may not affect someone directly, it can take a toll on other's health due to residual light pollution. The American Medical Association reports that blue-white light is “associated with reduced sleep times, dissatisfaction with sleep quality, excessive sleepiness, impaired daytime functioning and obesity” [4] making the effect of light pollution detrimental. Furthermore, a Harvard study found that artificial lighting cuts melatonin levels affecting circadian rhythm [4]. Knowing that 68% of the world's population lives in urban areas, light pollution has become a source of preventable health issues with irreversible effects. A human eye is equipped with cones and rods, one of which that is responsible for black and white and the other is responsible for color vision, respectively. Within the cones that are present in the human eye, a type of the cone is responsible for melatonin productions, and when exposed to blue light, it disrupts the “regular” human cycle. Disruptions can lead to serious illnesses that could affect human health greatly, such as “insomnia, stress and increased risk for a wide range of medical maladies and even cancer” [19]. The issue with light emission becomes more detrimental because longer wavelengths from red and green light tend to have the ability to travel into space while the shorter wavelengths do not have the ability to travel beyond the atmosphere, leading the sky above the city to become saturated with blue light [19](Figure 1).

Figure Wavelength of each type of light color. Light waves in red to green tend to have longer wavelength.

## 3.2 Finances

The impact of being conscious about habits concerning light consumption can lead to savings in household utility bills. For instance, “leaving [the] lights on an extra 8 hours a day adds up to a waste of $900 a year”, knowing many adults pay their own household utility bills, making a shift in habit could save in areas that could be used to better cost of living. There are a variety of different types of lights that operates at different efficiency levels; with the following examples given consider that each type of light has been left on for one hour in a day. An incandescent light can cost $24, a halogen light can cost $16, a CFL light can cost $6, and a LED light can cost $5 (depicted in Figure 3). Although the cost of incandescent light and an LED light vary greatly, such a cost can amount to high expenses that could have been avoided. Furthermore, all four of the types of lights do not last forever but leaving them on mindlessly further deteriorates their life, which will lead to extra cost of investing in replacement bulbs. For reference, in Great Britain around 14 million brits leave the lights on when leaving for work which can amount to carbon emissions that could fuel up to 45 flights in one working day [20], eventually piling up to a cost of $1247.48 in wastage.

Figure Comparing types of lights with efficiency over time (left) and cost over time (right)

Figure Types of lightbulb

## 3.3 Environment

The environment suffers the most from light pollution and despite the method of energy production, it still causes damage to the environment. According to the Imperial College London, “the power stations that supply electricity vary in their carbon dioxide emission rates, depending on the fuel they use: those that burn fossil fuels (coal, gas and oil) have higher emissions than those driven by nuclear power and wind” [1]. A total new redesign of infrastructure and urban areas would require the use of many resources, finances, and time which would be counter productive to combatting the issue efficiently. For example, light bulb disposal also contributes to landfills and toxic chemicals like mercury being detrimental to the environment. The impact on Earth from light pollution is so significant that it is not only contributing to the greenhouse gasses but is also affecting the ecosystem. Thus, mere replacement of light bulbs can be a costly effect on the environment so the effects of replacing whole infrastructures could be exponentially more expensive cost wise, and for the ecosystem.

Figure 4 shows the light pollution visible from space displaying the magnitude of brightness that can be found more densely populated areas. Artificial light pollution near water ecosystems can disrupt the food chain by attracting insects away from their water habitats [4]. Moreover, light pollution can affect the migration pattern by distracting aquatic animals that require the moonlight for navigation [4]. Overall, light pollution greatly affects wildlife specific to parts of the world like species present in tropical and temperate zones which would be subject to “shortened, bright nights” [17]. Species in polar regions are also subject to being affected by light pollution but they are less affected since they can adapt to solar schedules annually. Furthermore, light pollution takes a toll on plants leaving them budded early and vulnerable to colder temperatures [4]. Light emissions affect wildlife behaviour by causing to become disoriented due to beach front lighting and streetlamps found in urban areas, further affecting nocturnal animal rhythms and early life. For example, the sea turtles that emerge from beaches which traditionally use moonlight to navigate towards the sea from the darkness of the beach. Although, due to beachfront lights the turtles have left to become disoriented and lost. Consequently, artificial light has resulted in reproductive issues becoming more prevalent due to the latter discussion of disorientation in species. For example, birds have shown patterns of making poor choices when it comes to choosing places for their nests and some species of frogs have shown tendencies of being less selective with their mates. Other aspects of ecology hindered by artificial light pollution are communication, competition, and predation.

Figure "Up to 1% above the natural light (black); from 1 to 8% above the natural light (blue); from 8 to 50% above natural nighttime brightness (green); from 50% above natural to the level of light under which the Milky Way is no longer visible (yellow); "[16]

## 3.4 Potential solutions

Potential solutions can range from psychological techniques to smart technology.

### 3.4.1 Psychological Techniques

There are methods that can be used to psychologically make someone more aware of their surroundings (Figure 5). According to a study conducted by the University of Victoria, found that "lights off" signs made individuals 8 times more likely to turn off the lights, which showed to be very effective [2]. The most popular example of this application of signage being effective was for “pro-environmental” [2] signage which substantially reduced littering. Although, signage is very effective, placement has also shown to be effective. Thus, putting “phrased prompts” in convenient places increases reactance [2]. Consequently, placing appropriate signage in bathrooms for lights to be turned off, was studied in a university washroom which showed improvement in increased frequency for lights being turned off [2].

Figure Example of appropriate signage that can influence individuals to turn off the light. Signage can be put in staff bathrooms, offices, schools, factories, and homes.

### 3.4.2 Energy-Efficient Lights

As mentioned under finances, it is evident that being mindful of one's finance can play as an incentive to influence the types of light bulbs purchased. Frequently the government offers rebates and helps fun environmental programs ranging from general household usage to large building workspaces. A household example would be the government program for EcoBee thermostat systems. A government program run on large workspaces would be the LEED-credited recognition program that rates the efficiency of building based on infrastructure, present in the Bergeron Center for Engineering Excellence. CFL (compact fluorescent lights) and LED (light-emitting diode) bulbs are the most common types of energy-saving bulbs that cost more to buy initially, although they consume less energy and have a longer life span. In contrast, incandescent bulbs use more energy and 90% of the energy is put towards heat which is considered as "waste" energy rather than light (Figure 7). When investing in electric devices, it can be good practice to look for devices labelled with an "EnergyStar" sticker [12] (Figure 6), that is tested for proven efficiency in electricity consumption and longevity of product.

Figure EnergyStar sticker fund on electric devices.

Figure Graphic organizer comparing the incandescent, LED and CFL bulb with efficiency, cost, and lifespan.

### 3.4.3 Smart Technology

It is estimated that over 5 billion people possess a smartphone [13] and with the wide variety of technology available, apps and embedded systems can interact with each other to provide information on the user's presence in the room using infrared sensors or proximity sensors that measure distance and time like Electrip Inc (Figure 8).

Figure Technology in depicted "house" is controllable technology by a smart phone. Such as light, temperature, computers, etc.

# 4. Discussion

## 4.1 Mechanism

Based on the solutions discussed in the latter section, two unique solutions involving smart technology have been posed. Smart technology is a readily available technology that can be readily integrated into present technology. The most prevalent technology which uses smart technology with readily available technology would be the EcoBee thermostat which uses smart technology and current furnace systems available in homes. The technology updates the thermostat control and allows individuals to keep their current furnaces giving users the ability to control their systems remotely, vacation scheduling, etc. Using a similar application, lights can be controlled remotely with the integration of AI, like the mechanism of EcoBee thermostat-furnace systems. The following technologies have been developed by Electrip Inc. to mimic smart home integration with current technology available in home and office-work spaces.

### 4.1.1 Household usage

Electrip Inc. uses an embedded system that uses sensors and actuators(hardware) to interact with the software installed through an app on a smartphone(Figure 8). The hardware component (sensors and actuator) [3] installed in a light switch that uses Bluetooth technology that emits UWB signals accurate to 5cm to 10cm that will track the distance between the smartphone and the switch. Using a wireless connection, the installed device sends out a signal(pulse) to the smartphone "the distance between two UWB devices can be measured precisely by measuring the time that it takes for a radio wave to pass between the two devices" [3]. With each installed switch the app can track what lights are on in each room based on how they are labelled by the user. The software will essentially monitor the distance and the time of the user and will turn off according to the time preference that the user chooses to be "away" for.

Figure Ultrawide band capacity range comparison. The UWB range expands greatly(200m), enough to cover the are of an average household, which is 95.4 square meter[24].

### 4.1.2 Office/commercial usage

Electrip Inc. also produces an integratable technology for commercial and business spaces. This form of technology will mainly be using a form of AI that will monitor and track times of usage in different spaces and how the building is being used. The AI will check specific components such as timing and manipulate lights to turn on and off according to the patterns of usage in each room. In a typical office space, there is usually meeting areas, kitchen area/lunch area, corridors, references library, individual desk spaces and offices. For the meeting room the AI would track when someone comes into the meeting room and the last person to leave. For the corridor, the AI would track when someone uses a specific hallway for different purposes such as coffee breaks or bathroom usage. For the desk usage, the AI may track when the individual is reading on paper versus when the individual is working on their computer. The AI will collect information based on the individuals pattern usage and it will responsively learn to dim the lights according to their usage or turn them off [5]. After some time has passed on the usage of the AI, it will adapt to the work environment and become autonomous to functions. The main admin will have access to manual control as well in case there is out of the ordinary activity.

Figure Example of Electrip Inc. implementation in an office setting, where the AI will "learn" behaviour of employees and individuals that attend workplace through a camera.

# 5. Conclusion

It is evident that with the potential solutions that there can be great improvement in terms of finances when it comes to homes/personal and company space but can greatly improve the other aspects being discussed such as human health over time and the environment. The combination of the potential solutions and the posed solution that Electrip Inc provides can be used to improve the electric consumption through light further.

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# 7. Appendix

## 7.1 Peer 1

|  |  |  |
| --- | --- | --- |
|  | Advice taken | Advice not taken |
| Peer review taken directly from peer scholar | * The only change I would suggest is putting a bit more space between your address information and the recipient's so that it is clearer to differentiate the two. * In the overview section of your executive summary you wrote "That maybe limited". The maybe should be two words "may be". Besides that everything looked great. * - In your introduction and background in the third line you wrote "trough light usage" but I think you * potentially adding some figures to help readers better understand topics. | - For the rest of your report my only suggestions would be too add more information to your sections like Possible Solutions which only has one sentence in it |
| Commentary on each advice | * I took this advice by adjusting the spacing between the two addresses because I noticed that it could be confusing for the reader to differentiate between the two addresses being referred to in the letter of transmittal * I took both grammatical suggestions because I recognize that it could be complex sentence structure, could be simplified and couldimprove the coherency of what is trying to be communicated. * I added more images to help convey the message better as I understand that there could be an understanding barrier for the reader and visual elements could help improve the clarity of the message I am trying to convey | * Under “possible solutions” I do discuss more solutions in detail and I only wrote one sentence in that main section because I wanted to remain ambiguous before going into more detailed solutions. I think the reviewer was not able to tell the hierarchy. I feel that the reader didn’t notice the difference between font sizes of the heading and subtitle. |

## 7.2 Peer 2

|  |  |  |
| --- | --- | --- |
|  | Advice taken | Advice not taken |
| Peer review taken directly from peer scholar | * Besides, the Letter of transmittal should not be included in the table of contents. * Mechanics: The overall mechanics of the report is pretty neat. However, the are some small spelling issues that could be founded like "trough"->"through", "lightemitting" -> "light-emmiting" or "light emmiting". There are some ambiguous sentences as well like:" Although the cost of incandescent light and an LED light vary greatly such a cost can amount to high expenses that could have been avoided." which can be solved by putting a comma in the middle of the sentence.  In a technical report, it is better to write as simple as possible. The use of long sentences is not preferable. * Visual: There is no visual element in this report. * Logic: the UN SDG goal should be clearly specified. I hope this review is going to be helpful. | * Structure: There is no major problem with this part. There are just some minor issues. For instance, it is better to write "solutions" as heading and "Psychological Techniques", "Energy-Efficient Lights", "Smart Technology" as subheadings to be more organized. |
| Commentary on each advice | * I took this advice because upon revision of the handout I recognized that adding the letter of transmittal to the table of contents would be pointless * I took the suggestions on the mechnics to improve the clarity of the message I am trying to convey * I increased the number of visual elements because I recognize that it could have been difficult for the reader to understand what I was trying to convey, I also added caption s and references to the figure in the text * I added the UN SDG goal into the introduction section so the reader know of the research topic in the start | * Under “possible solutions” I do discuss more solutions in detail and I only wrote one sentence in that main section because I wanted to remain ambiguous before going into more detailed solutions. I think the reviewer was not able to tell the hierarchy. |

## 7.3 Peer 3

|  |  |  |
| --- | --- | --- |
|  | Advice taken | Advice not taken |
| Peer review taken directly from peer scholar | The only part where the technical report was lacking was the proper labeling of the figures and also their sources. |  |
| Commentary on each advice | * I added visual elements and their sources with appropriate captions to describe them that can be informative for the reader. I also added more references in text so the reader can make connections to the text the visual elements. |  |