# LED POWER

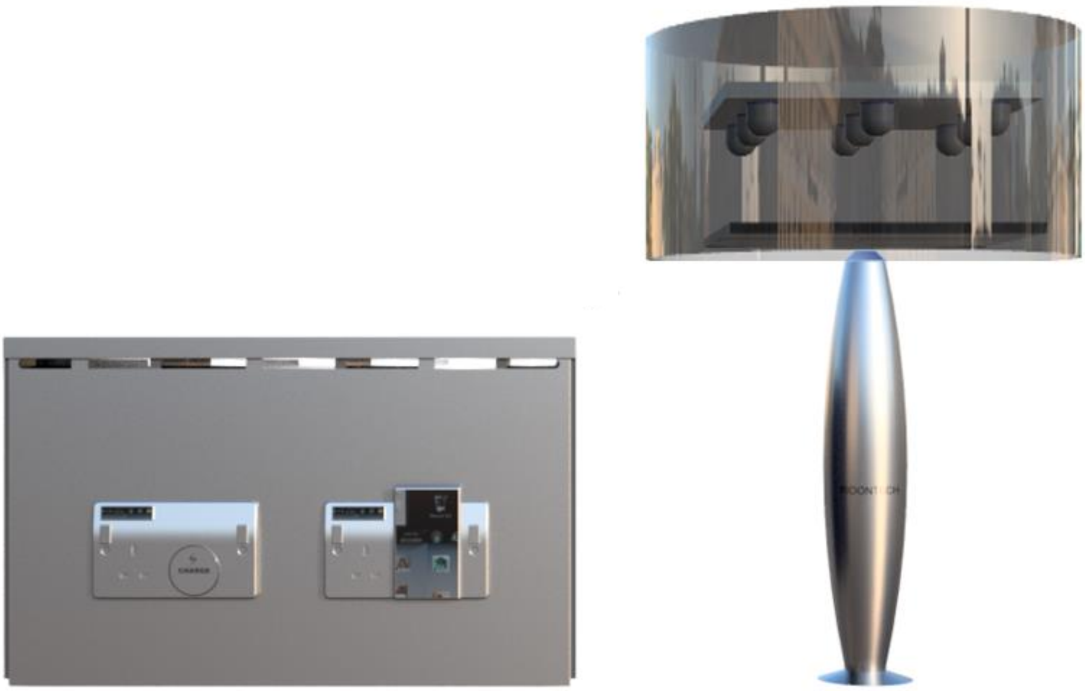

*Figure 1 LED Power Concept*

# PhD Proposal

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# Proposal

This proposal is based upon the research that Light Emitting Diodes (LED's), can be used as a power source. The fundamental basis that this concept is a reality is because LED's produce more lumen power output than electrical power input. This is due to a chemical reaction within the LED known as doping. Doping silicon atoms with Antimony and Boron elements will add electrons and remove electrons from the selected materials. A PN-junction is formed when a doped N-type (negative) material is fused together with a P-type (positive) material, creating a semiconductor diode junction. As electrons pass through this type of semiconductor, it turns into light. The dosage of added impurities and the design method will determine efficiency and lifespan. LED's have huge longevity, operating up to 50,000 hours and surpassing in some advanced cases. (Rooney 2018) (Electronics Tutorials, 2019) (Electronics Weekly, 2009)

# Light Emitting Diode

LED's vary in colour and efficiency, the material of an LED dictates the colour and efficiency, for this project efficiency is a priority. To harness the maximum efficiency an LED can produce we need to select LED's that reflect the blue spectrum of light. The Daylight LED reflects more of the blue spectrum and produces a higher kelvin (K) measurement. Kelvin is the degree measure relating to the colour temperature, the higher the number, the brighter the visual tone of the lamp appears to be. The colour temperature of a lamp is assigned using the basis of correlated colour temperature (CCT). Whilst Lumen (lm), is related to the measurement of brightness. Typically, Kelvin temperatures for commercial and residential lighting applications have a range that falls somewhere in-between 2000K to 6500K, from a scale of 1000K – 10000K. (Westinghouselighting.com, 2019)

For example, if we purchase two LED lamps and compare input wattage of a Warm White to a Daylight, we will find the input wattage to be the same. However, the kelvin measurement of the Daylight is more than twice that of a Warm White. (Westinghouselighting.com, 2019)

- Daylight LED Lamp = 4600K - 6500K
  (Amazon.co.uk, 2019)

- Warm White LED Lamp = 2000K - 3000K.
  (Amazon.co.uk, 2019)

The reason an LED Daylight lamp seems to produce more lumens than a Warm White is because of the design material selected, and Kelvin factor. Selection of material regarding an LED produces the visual colour requirements. LED's come in a range of colours, and all colours produce different amounts of lumen output given the same power input. (Compound Interest, 2016)

Daylight LED lamps are considered for clinical uses, for example, hospitals for maximum vision. Warm White Lamps would be put into home environments as a comforting, less intense lighting solution. Warm White uses more of the red and green spectrum and Daylights typically use blue and yellow which mimics the natural daylight wavelength better than any other type lamp. (Socket Store, 2019)

## Advancement

Big improvements have been made whilst researching and designing LED's, a company called Kyocera in 2014 developed a Daylight LED with a violet LED element that can efficiently replace standard light sources. This unique LED utilises a violet LED element and is able to achieve close to a full spectrum using red, green and blue phosphors. Its spectrum is very close to that of a standard illuminant (CIE) and performance surpasses 90 in all colour render indexes (CRI). Producing a luminance efficiency factor which exceeds 100 lumens per watt (100/lm) (LPW) which is quite impressive. (Onlinelibrary.wiley.com, 2014)

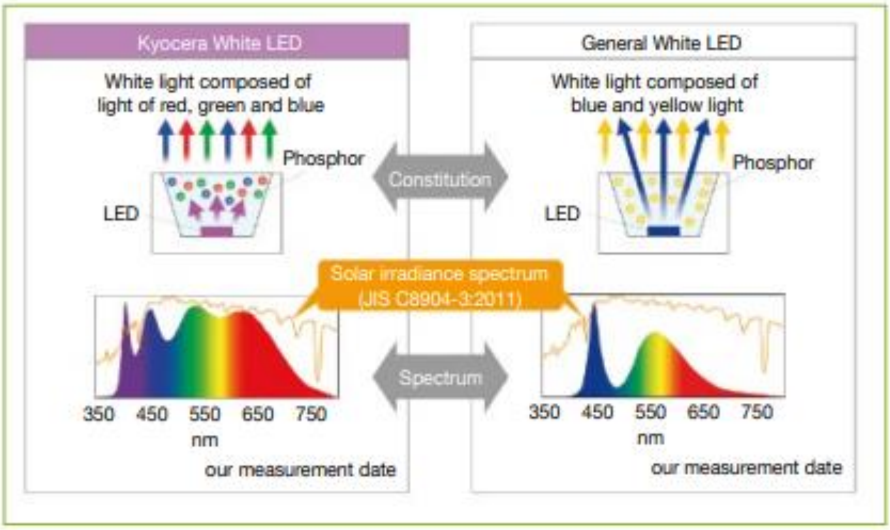


*Figure 2 LED Advancement*

(Onlinelibrary.wiley.com, 2014)

## Further Advancement


*Figure 3 LED Further Advancement*

(Cree.com, 2014)

And then again, in the same year CREE recorded a very significant LED milestone that has a demonstrated ability of producing 303 lumens per watt, from a high-powered Daylight LED. This LED reached the landmark achievement much quicker than to be believed possible. This result surpasses CREE's former research and development industry-best, which was rated at 276 lumens per watt, announced over 6 years ago. (Cree.com, 2014)

## My Thoughts

The Sources I have shown above are dated 2014, when we step into 2020 and beyond, I believe that the advancement in LED will continue, and soon to have LED's that produce 500 - 1000 lumen per watt. When this happens, power capability of an LED, specifically Daylight, will be a used as a significant power source. (Rooney 2019)

# Solar Panel

## Conventional Method

Solar panels conventionally work by converting the suns light into electrical energy, converting photon to electron. They capture the suns energy using photovoltaic cells, commonly called solar cells. A solar panel is made up of many solar cells. (Theecoexperts.co.uk, 2019)

## Solar Panel Efficiency

Solar panel selection is equally important, they vary in efficiency, cheaper solar panels operate between 12-25%, whilst the highest known to date operate at 44.7%.

The Fraunhofer Institute for Solar Energy Systems recently announced the development of a multijunction photovoltaic cell with 44.7% efficiency, breaking its own record of 43.6% in 2013. Gaining a 1 % increase in efficiency, this occurred in a short time frame and that would suggest further improvements will develop quickly. (Lombardo, 2013)

## Unconventional Method

My method is to use solar panels but power them via LED, the more efficient the materials used the better the overall efficiency of the devices I intend to design and build. (Rooney 2018)

# DC-DC Drivers

By using Direct Current (DC) LED drivers, we convert solar panel output direct to a DC driver which then powers LED's. If we maintain the DC method without converting to Alternating Current (AC), we do not lose power and efficiency is maintained. Various DC-DC drivers are available to buy on the current market. The design phase will determine which DC-DC drivers will be used. (Meanwell-web.com, 2019)

# Lumens to Watts

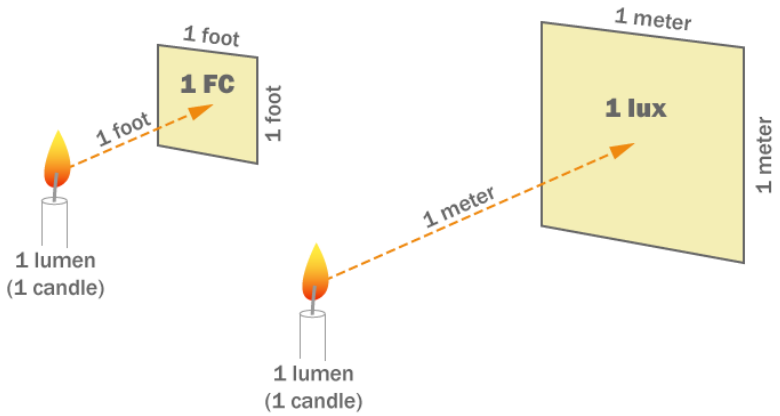


*Figure 4 Measure of Light*

(Systems et al., 2019)

Watts = Foot Candle (1 FC) x 0.01609696, because 10.76 x 0.001496 (1 Lux) = 0.01609696 watts. (Systems et al., 2019) (Steves-digicams.com, 2019)

1 lumen = 0.01609696 watts (FC) = 1 candle projecting light over a distance of 1ft (304.8mm) and hitting a surface area of $1ft^2$. (Systems et al., 2019) (Steves-digicams.com, 2019)

If we shorten the gap by $\frac{2}{3}$ = 101.6mm = 0.01609696 + (0.01609696 x 66.6) ÷ 100 = 0.0268 watts.

1 lumen = 0.0268 watts based on 1 candle projecting light over a distance of 101.6mm and hitting a surface area of $101.6mm^2$.

Cree's 303 lumen per watt = 0.0268 x 303 = 8.1204 watts.

The average solar panel efficiency = 20% (8.1204 x 20) ÷ 100 = 1.62408 = 1.62 watts.

This is why a Cree LED can self-power at close proximity using a 20% efficient solar panel as proven.

Using the best Solar Panel to date, rated at 44.7%.

(8.1204 x 44.7) ÷ 100 = 3.6298188 watts = 3.6 watts.

This is the basis of my Lighting concept and Power Pack. When the efficiency increases over the coming years, and it will, then power can be produced in abundance. Using DC-DC drivers, preventing light from leaving operating systems, and keeping the unit cool. We would lose a small amount of energy through heat; however, we will still gain more than we lose by a long way. (Rooney 2019)

# Methodology

The methodology is simple, to face solar panels towards LED's at the most efficient distance of operation, and not allowing the light to escape. Initial powerup will use either an external solar panel, capacitor, rechargeable battery or mains power. This will supply electricity directly to the first or only DC driver, this method will electrically power the LED's. From this we convert light/photon via the solar panel in range. This absorbs the light/photon energy and converts it back into electrons which is either sent back to the first DC driver or to the next DC driver. By removing the initial power source, the unit powers itself, making this perpetual in effect. To turn the unit on or off a simple switch is put in place before the first or only DC driver. (Rooney 2018)

## Procurement

The design approaching method would be to source materials and equipment's and put those to use. Approaching accredited companies that specialise in the advancement of LED and solar panels would be my primary goal. Secondly, cost. If I can get the same quality equipment at a cheaper price through research then that would determine the companies used. However, I will be looking at the company's methods of production and how wasteful they are producing their products. (BusinessDictionary.com, 2019)

## Testing

I suspect Testing will be a difficult precise application, the correct LED's and solar panels are of high importance, any old LED and solar panel will not work. Precision is a key element alongside the advancement in technology. Testing will commence once I have a working prototype using CT scanners and manual electrical test gear. (Accuenergy, 2019) (Uk.rs-online.com, 2019)

# LED Lighting Concept

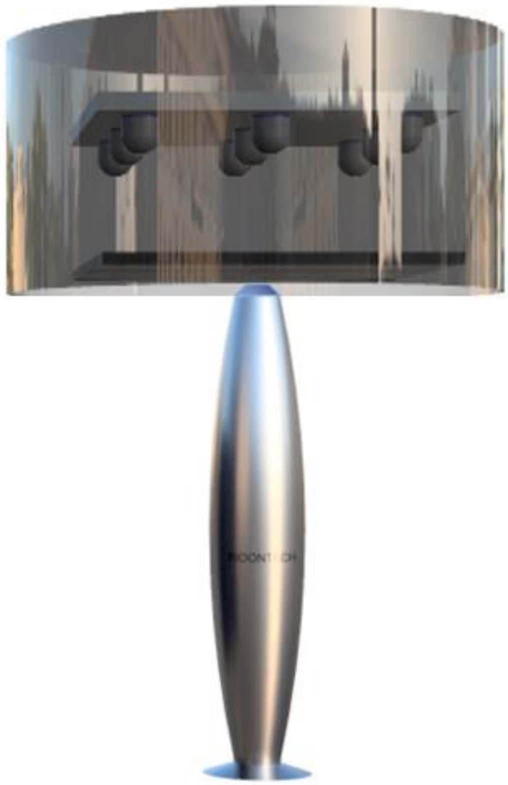

*Figure 5 LED Lighting Concept*

*Figure 6 LED Powered Lighting Methodology*

## Lighting Design Method

To design a luminaire, we need to use the method shown in the pictures and stated prior, it is a simple process and the most basic method of free energy using LED as a power source. This luminaire would use very little external power if any at all, and thus an efficient sustainable lighting concept for the modern world. A rechargeable battery would be a good option for ignition purposes, directly supplied via the solar panel. These luminaires have the potential to re-design the electrical industry on a scale I wish not to declare. (Rooney 2019)

## Luminaire Components

- 1 x 20-watt solar panel 12 Volt (44.7% efficient)
- 9 x 303 lumen LED’s (Daylights)
- Rechargeable battery 12 Volt
- Lamp shade
- Lamp base
- Switch
- DC driver

## Alternative Components

- Capacitor
- Mains power
- 12 Volt transformer
- External solar panel

# LED Power Pack

*Figure 7 LED Power Pack Concept*

*Figure 8 LED Power Pack Methodology*

The LED Power Pack operates similar to the light, the difference is, instead of sending power back to the 1st set of LEDs' we send it to the 2nd LED driver, I call this the 2nd stage of power. It repeats the process of the first stage, and the 3rd stage is the same. Once we power the 3rd stage we send power back to the first. This then makes the unit perpetual in effect, the solar panel that absorbs the total amount of energy supplies DC power to devices via sockets on the face of the unit. (Rooney 2019)

## Initial Design Idea

We start with 3 x 303/lm per watt LED's, powered by either external solar, rechargeable battery, mains or capacitor. The LED's are producing 3.6-watt each in photon energy due to close surface contact using 44.7% efficient solar panels and using formula (lm = 0.0268 watt). We send the photon energy to the next LED driver; at this driver we should have a total of 10.8 watt. Given losses say we have 8.8-watt, we proceed to the next driver which is to power 6 LED's. This driver then powers 6 x 303/lm per watt, therefore, we should accumulate a total wattage of 21.6 watt through conversion to the last stage. Ideal calculations suggest 21.6 watt, allow for efficiency loss, say 4 watt, so we then have 17.6 watt to use. This is then sent to the last stage which powers 9 LED's at 9 x 303/lm per watt. We have enough power for the 9 as we have 17.6 watt, 9 LED's can produce 32.4 watt. Even if we lose a little efficiency and send 3 watts back to the starting DC driver to make it perpetual, we should still have 25 watt to power devices. We could send power back from the 2nd stage or split it between 2nd and 3rd.

Due to the chemical reaction and increase in photon power we can increase electrical power. This basic Power Pack has three stages, once we get to the last stage, we then send power back to the first, this then makes the unit self-powering, perpetual in effect. For prototype purposes we will use Extra Low Voltage (ELV), small power for safety. (Rooney 2019)

## Design Method

We begin with a plastic rectangular box, double insulated for protection, we then add two 5-watt solar panels to each external end, this is enough solar power potential to strike the first row of LED's if we decide to use solar energy, we could use a rechargeable battery.

We then add the first row of LED's, a DC driver and a 10-watt 12 V solar panel, we repeat this process two more times but increase the solar panel wattage to 20-watt at the 2nd stage and

30-watt at the final stage. This will then complete the internal design; we then add two double sockets and a finally a lid to prevent light escaping. By using the natural daylight, we can power the external solar panels, at night you could use a torch, a rechargeable battery or mains for the initial strike up. Once power is executed the unit runs by itself, we can use a switch to turn off the power before the first DC driver to control operation. (Rooney 2019)

## Power Pack Components

- 2 x 5-watt solar panel 12 Volt (44.7% efficient)
- 1 x 10-watt solar panel 12 Volt (44.7% efficient)
- 1 x 20-watt solar panel 12 Volt (44.7% efficient)
- 1 x 30-watt solar panel 12 Volt (44.7% efficient)
- 18 x 303 lumen LED's (Daylights)
- 3 x LED driver
- 2 x socket outlets
- Housing case
- Housing lid
- Wiring
- 4 mm nuts and bolts
- Rechargeable battery 12 Volt
- Switch

## Alternative Components

- Capacitor
- Mains power
- 12 Volt transformer

## Apparatus

- Work bench
- Study area

## Equipment

- CAD software
- Manufacturing
- Tooling
- CT power measurement
- Electrical test meter
- Calculator
- Pen
- Paper

The housing design method and all components are shown in the following picture, they show stage to stage design features and how those feature look but not connect. I have not finalised the following via CAD as the equipment used has to be selected first, at this point I will design the housing and include all nuts and bolt and stanchions.

The design housing does show one important feature, and they are the holes situated at the base and the lid; these are due because heat is an undeniable factor. Keeping LED lamps cool is a priority, heat will rise and escape through the lid. Individually, heat will rise through the sides of the lid, I will design this in such away light cannot escape.

On a large industrial scale of multiple devices, to counter heat, the base holes are in place. These holes would allow a cooling application to be added, working on the same principle of a data hall. Using a raised floor and filling the void with compressed cooled air supplied either by an air handling unit, air conditioning or just a very high RPM fan will be used to keep the unit cool from the base up. this is only valid on a big scale operation. (Rooney 2019)

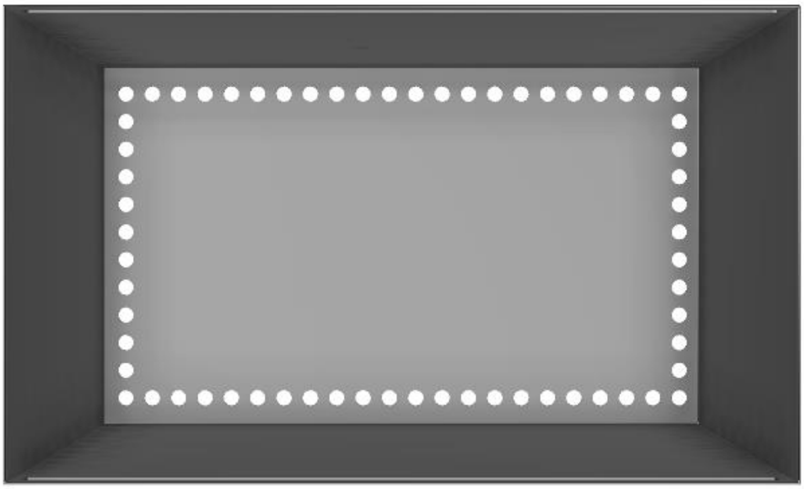

*Figure 9 LED Housing Unit*

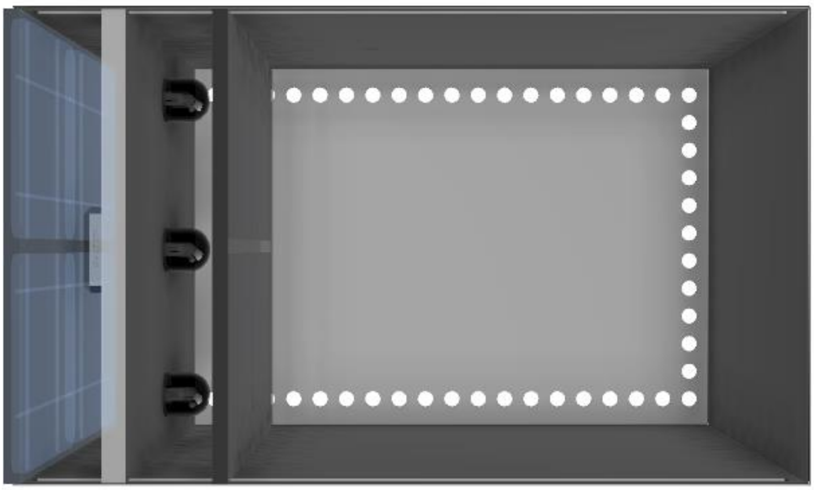

*Figure 10 LED Power First Stage*

*Figure 11 LED Power Second Stage*

*Figure 12 LED Power Third Stage*


*Figure 13 LED Power Socket Outlets*

*Figure 14 LED Power Complete Design*

*Figure 15 LED Power Fully Encased*

The above illustrations show the methodology and build of the LED Power Pack, this will be the initial design build of the prototype and the vision I have had since 2017. The sockets supplied are also of interest, my own design incorporating wireless Magnetic Passive Charging Socket Outlet (MPCSO). This unique socket outlet design allows for a reduction in cabling and port damage to phones/devices and reduces snagging of cables. It will also feature charging capacity of devices, a time clock and a few other smart features that I will not declare to date.

# Furthered Existing knowledge

My research will show others if it is a viable solution to use LED as a power source, using my methodology and techniques. Failure or success, my research is vital information. The cost, quick implementation and power concept will make these devices unique and a very valuable addition to the approach in powering devices and equipment. (Rooney, 2019)

## Failure

It will save time if others decide to undertake such work, if failure is imminent, eras can be learned from without testing. If others believe I have missed valuable information or have overlooked a certain scenario. A mistake on my behalf would still be valid information If others learn from it. Information I have sourced may well be subjected to negativity, and others may see a better way, this does not mean my work is a waste of time, it means I have to readjust and change my path to get it right, or see that others do get it right. The importance of these devices is monumental to the world tech industry. (Rooney, 2019)

## Success

If successful, then this will be a benchmark platform to move forward from, creating industry, jobs and a reduction in utility bills. (Rooney, 2019)

# Previous Work Proposed

The foundation of this concept was developed via Derby University, as part of an independent innovation project, BSc Mechanical Engineering. It was not a mechanical project but electrical. I am a time served electrician, so I understand electricity and I combine that with mechanical knowledge, this allows me to design products based on electrical and mechanical operation.

In that project I stated that I would use Light as a synthetic power source using LED's. Initially the design was based on a standard electrical pendant that had an LED light beam mounted at the base. The LED would power smoke alarms and small ceiling power devices, wirelessly using light/Photon power capabilities. The LED light would be charging rechargeable batteries in the smoke alarm, and devices via a solar panel. However, at the same time I developed the Power Pack method of using LED to ramp up power inside these devices so they could be bigger and produce more power.

After this I realised my pendant was flawed, I did not need a Light Switch at all, but still a nice unique feature and still valid to some degree on the basis that it uncovered my other products. After discovering through research, the power capabilities of LED's. I stated in my report this project is one of two, and I am only talking about one, being the pendant able to charge ceiling devices, including heat and smoke alarms.

The reason was because I wanted to be able to produce a smoke alarm device/s that would never need a replacement battery change, that took its power from local existing lighting circuits. Possibilities included mounting smoke alarms to difficult wiring positions by using wireless light charging capability. This method would also prove to be a health and safety feature, never allowing a battery to run out. Whilst utilizing a tiny amount of power at the pendant which would be used regularly when darkness was apparent in any room, constantly topping the battery in effect. (Rooney 2018)

# Conclusion

Throughout this proposal it is evident that LED's can be used as a synthetic light power source, mimicking the sun in effect. The benefit of this system is that unlike solar it can operate at night with maximum potential of 24 hours a day. LED's can operate efficiently up to 50,000 hours and surpass this figure giving a long-life expectancy. Parts will be manufactured in such a way that they are easy to replace, if faults occur.

Sunlight is roughly 11-13 hours a day around the world, with added cloud cover, rain and storms it reduces efficiency. This design will bring solar power indoor and would be a credit to energy efficiency. A sustainable solution providing free energy and lighting which reduces the use of fossil fuels, and relieves equity of expensive materials, copper being the main one.

The prototypes to be built will use small power and prove the concept works using the correct equipment to do so, at an affordable price. The potential of such devices is astronomical, aiming, not just to power small devices but eventually, charge electric cars at home or we could even house the Power Pack/s onboard vehicles as a constant battery top up. The Power Pack will be relatively lite in weight and can be shaped to suit tight spaces giving thought.

Using the Power Pack like a remote petrol/diesel generator allowing construction workers on remote sites to charge tool batteries for free with no power leads whilst also providing light in darkened areas is just one small idea. Every home, building, and streetlights could be powered by the self-operating lighting concept, for free.

Obviously, this is the starting point and the potential is clearly there for bigger applications later in the future, but small powered devices such as luminaires, radios, smoke alarms, heat detectors, phones tablets, laptops, fit bits, watches etc can all be powered today using the LED Power technique.

This concept would revolutionise the world and the way we think about power, people get confused thinking thermodynamic laws apply quoting "the conservation of energy". Until they realise it is a chemical reaction which creates the photon regarding an LED. And the fact that LED's have passed the 300 lumen per watt mark is an undeniable fact, an LED can produce more output energy than input. (Rooney 2019)


*Figure 16 LED Lighting and Power Concept @ROONTECH*

# Project Timetable

*Table 1 Time period, year 1*

| Time Period | Anticipated Activities |
|---|---|
| Year One<br><br>October 2019 - December 2019 | Research, In-depth Knowledge to be obtained, data collected via Internet, books and experts.<br><br>Revisit work completed on the subject.<br><br>Data Collected. |
| December 2019 - April 2020 | Begin Initial CAD Design Phase. |
| April 2019 - July 2020 | Design Phase Completed. |

*Table 2 Time period, year 2*

| Time Period | Anticipated Activities |
|---|---|
| Year 2<br><br>September 2020 - July 2021 | Select materials, manufacture components, build LED Power Pack and Lighting Prototypes.<br><br>Data Collected. |

*Table 3 Time period, year 3*

| Time Period | Anticipated Activities |
|---|---|
| Year 3<br><br>September 2021 - July 2022 | Thorough testing of Lighting and Power Pack, hand calculations and analysis.<br><br>Data Collected. |

*Table 4 Time period, year 4*

| Time Period | Anticipated Activities |
|---|---|
| Year 4<br><br>September 2022 - July 2023 | Optimisation, tweaking for the best outcome. Organise potential clients and stakeholders.<br><br>Data Collected. |

*Table 5 Time period, year 5*

| Time Period | Anticipated Activities |
|---|---|
| Year 5<br><br>September 2023 - July 2024 | Critical conclusive write up, all scenarios covered, difficulties and self-criticism.<br><br>Win or lose.<br><br>Evaluation, dissertation. |

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