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LED Lighting Product Development and Marketing Strategies: A Business Plan for Energyled Corporation

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ABSTRACT

Energyled Corporation has been doing well in low temperature LED lighting for the past several years. But due to competition and the decline in the low temperature lighting market in particular, the penetration of a second niche market is needed for the company to continue to grow even further. Deep research of the LED industry was completed and found the UV LED market would be a potential market to pursue. Therefore, a business plan is proposed for developing high quality UV-B and UV-C LED light tubes and lamps, targeting the medical phototherapy and medical sterilization of the UV lighting market. Starting from research, design and prototype making to various testings of the new product, the development of the first product is estimated to take six months to complete. Total expected cost will be NTD 1,555,000 and is expected to break even five years after product launch.

Keywords: UV, LED lighting, niche market, product development, marketing

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CHAPTER I EXECUTIVE SUMMARY

Energyled Corporation is a LED lighting company that creates high quality products based on their solid background in the LED industry. As the subsidiary company of Ledtech Group that has more than 40 years of expertise in the industry, the company is most known for its dominance in the LED low temperature lighting market with its low temperature LED light tubes. That was the first niche market they conquered starting in the mid-2000s. Some successful cases include a chain convenience store company and some supermarkets in Taiwan, big supermarket refrigerators and soda vending machines from the United States of America (USA), and many more from Southeast Asia countries. However, as competition has been growing over the years, this particular market is now slowly declining. Energyled has been developing and selling many other products for other markets, such as indoor lighting, spotlight lighting, flood lighting, street light and industrial lighting, but has not yet succeeded in developing a second popular product. Therefore, to aid in this situation, interviews were conducted with Energyled's sales and engineering teams to understand their experience, expectations and thoughts on improvement.

The company has a strong research and development (R&D) team but is slightly weaker in product marketing. Engineers are always looking out for products on the market, improving and developing new products for the company. Sales team helps bring back information from what they see or find from the market or from their customers. Yet, this is not enough for the company to develop a product in advance of any other competitors. The company needs to have a more devoted marketing team to do research and plan with the engineer team to develop unique new products. With such product, Energyled will then be able to penetrate and lead in a second niche market with improved marketing methods.

The purpose of this business plan is to find a second niche market for Energyled to build upon. From numerous competitors in the continuously growing LED industry, the fairly new ultraviolet (UV) LED lighting market is a good choice as a target market. Detailed research in UV market and competitor analysis were conducted. Although UV LED is already mature in some areas, such as curing and disinfection systems, but there are still other applications that can be approached, namely the fields of medical phototherapy and medical sterilization. The creation of high quality UV-B and UV-C LED light tubes and lamps is the

solution to penetrate such fields, along with carefully planned marketing strategies based on the 4Ps and 4Cs.

A great deal of investment is needed in order to proceed in developing UV LED lighting products, including human resource, testing equipment, purchasing of competitor products for comparison and marketing. Total expense is distributed in a six-year period, totaling NTD 1,555,000. Profit is expected to be made starting in the fourth year and break even in the sixth year.

CHAPTER II GENERAL COMPANY DESCRIPTION

Energyled Corporation (below stated as “Energyled”) was established in 2007 in New Taipei City, Taiwan. It is a LED lighting solution company with exceptional knowledge of the LED industry and designs its own products to fulfill market needs. The company has already dominated in the LED low lighting market and has also penetrated into many other markets since then. With its technological advances and goal of creating better products for the public, it has been growing greatly. Its background and experience all came from its parent company, Ledtech Electronics Ltd., which has more than 40 years of experience in the industry.

Ledtech Electronics Corporation (below stated as “Ledtech”) was founded in 1977 as one of the earliest Light Emitting Diode (LED) companies in Taiwan. Began in a small office in Banqiao City, Ledtech started manufacturing and selling LED components such as LED lamps and LED displays. As sales grew and more new products were developed, new factories were built at other locations in order to fulfill sales requirements. It was until 1996 when both the office and factory moved to Xindian District of New Taipei City, and has remained at this location since then.

Other than domestic expansion, Ledtech also expanded internationally. In 1990, Ledtech officially became Ledtech Group when its first subsidiary company, Gelwin, was established in Kowloon, Hong Kong. Hong Kong is known to have one of the busiest ports in the world where countless of imports and exports are handled. Therefore, the establishment of Gelwin is not only to expand on its sales, but it also has a warehouse for which products are stored and ready to be shipped when needed.

Business picked up both domestically and internationally so that an increase in production was needed in order to fulfill all the purchase orders in time. A new manufacturing plant was then built in Zhaoqing City, China, in 1992, as the second wholly owned subsidiary company of Ledtech Group. Beside the plant, there are separate buildings for office work and employee dormitories. Two additional offices were later established in Qingdao City and Dongguan City for taking care of sales from China. After the expansion in China, a sales office was created in California, Los Angeles, USA in 1996. This office mainly focuses on promoting the products in both USA and Mexico. Other than these offices under Ledtech Group, Energyled also have authorized dealers around the globe to expand the footprint of its products.

After 25 years of hard work, surviving the Asian financial crisis, and increasing competition in the LED industry, Ledtech was officially listed in the over-the-counter (OTC) market in 2002. While working for the next step to Initial Public Offerings (IPO) in the Taiwan Stock Exchange (TWSE), Ledtech continued to grow in the direction of the LED industry, developing finished LED lighting products, where LED components are the source of light inside light tubes and lamps. After a few years of working on finished lighting products, in 2007, Ledtech Group established another subsidiary company, Energyled, in order to distinguish product focus from its parent company so that Ledtech focused on components and Energyled focused on finished products. Then in 2008, six years after OTC, Ledtech Group officially IPO in the TWSE.

Today, Energyled is doing well. Although revenue has been slightly decreasing in the past few years, but it still has a promising future. New products are being developed to fulfill customer and market needs every year. A dedicated factory for manufacturing finished products was built last year in Zhaoqing City, China. Similar to the old factory of Ledtech, there are also separate buildings for office work and employee dormitories. With such investment and preparedness, Energyled will need to increase its revenue for upcoming years by using its strength in research and development expertise and sales, and also build on its marketing strategies.

CHAPTER III PRODUCTS AND SERVICES

The product and services provided by Energyled are always customer satisfactory such that quality and responsibility are the core competences of this company. Only the best quality is found in their products, which is one of the factors why loyal customers repeatedly place orders despite the slightly higher price than other competing companies because they trust Energyled's products. Even if there is a five percent increase in the price, there are customers who are still willing to purchase from Energyled if they believe the amount increase is worthy of what they get, which is usually the case. Behind all the trust of quality is the technically advanced experts from the R&D team, who continuously develop new reliable products. Energyled does not have a great assortment of products but all the ones offered are definitely trustworthy. It is the same to be said for the services provided.

Product Diversification

Energyled products are separated into three main categories: indoor, outdoor and low temperature. Of these categories, there is a total of 17 different types of products, one of which includes customization for customers.

Indoor products are used in offices, stores, panels, signs, indoor parking lots, showcases, green houses and many more applications. Basically any lighting that is needed indoors, LED products are available as replacements of the traditional ones. Energyled currently has ten types of indoor products, including light tube, plant tube, yellow tube, signage tube, meat light, AR111, MR16 (multifaceted reflector), down light, light bulb and panel light (Appendix A-1). Some of these types consist of sub-types and each may have different series. For light tubes, there are T5, T8 and sensor type in general. These are the tubes with same size and shape as fluorescent tubes except the choice of the cover of the tube can be either clear or matte. Clear covered tubes allow individual LED lamps to be seen easily even when illuminated. Whereas the matte covered tubes are most similar to the traditional tubes where individual LED lamps are not as visible. If customers want a further complete solution with light fixtures, Energyled also offers them in forms of overhead sharp lights, surface mounted lights, T-bars, AR111 round and square fixtures, and track lights (Appendix A-2). Other types of tubes include plant tubes, yellow tubes, signage tubes and meat lights. Plant tubes generally emit pink light to

stimulate plant growth for photosynthesis, and are used in horticulture, plantation, green houses and general plant lighting. Yellow tubes are used in exposure rooms, semiconductor and PCB (Printed Circuit Board) industries. The uniqueness of the color can also be inside green houses to repel insects. Signage tubes can be used in billboards, advertisement signs, and cooler signs. Meat lights also emit pink light and are used in restaurants or supermarket refrigerators to enhance the pinkness of the meat, making it look more fresh. It also comes in LED PAR (parabolic aluminized reflector) bulbs that can shine onto the meat as a spotlight. All types of light tubes are produced in different lengths, ranging from two to five feet, with two and four feet being most popular.

The remaining indoor products provided by Energyled are the AR111, MR16, down light, light bulb and panel light. Similar to the tubes, each product may have different series by means of using different LED components. AR111 and down lights are considered as recessed lights and both replace the traditional metal halide lamps. MR16 are smaller in design and usually used as spot lights or track lights. The LED light bulbs replace incandescent light bulbs. They are similar in shape but slightly different in design such that only half of the light bulbs are illuminated. This is due to the flat design of the LED chips which are placed horizontally above the screw base and the need of additional space for heat sink. Lastly, panel light is as the name suggests. It is a big board with LED lighting inside. All these can be applied basically in any way where its original traditional products would be used in. Examples include office, interior design, store front, restaurant, hotel, supermarket, and so forth.

Outdoor products are categorized by its IP-approved waterproof feature to differentiate from indoor products. These include high bay light, street light, spot light, flood light, wall light, and bollard light (Appendix A-3). All of these products are either IP65 or 66, except for bollard lights which are IP54. High bay lights are largest in structure that can project light from highly elevated ceilings of factories, warehouses, exhibition centers or big box stores (superstore, super center, megastore). Although this is generally used indoors, but since these are IP 65 and 66 approved, they can also be used outdoors as well. Street lights are as the name suggests used on the streets and city roads. Outdoor spot lights are much bigger and higher in power consumption as compared to indoor-use ones. They can be used in plazas, wharfs, athletic fields, warehouses and container terminals. Flood lights are opposites of spot lights in which it is set on the ground to shine upwards against the wall. These can be found illuminating for signs, buildings, landscapes, pathways and parking lots. Wall lights are, as the name

indicates, products that can be attached to exterior walls. Bollard lights are lightings that are placed on the ground or grass for landscapes or sceneries.

The last category of products is the one that Energyled is most known for: low temperature. As the forerunner and winner of this niche market, many generations of T8 light tubes have been produced to fulfill this market such that standard designs are established for different types of refrigerators, namely open refrigeration display case, glass door refrigeration and sliding door reach in refrigerator. As different countries may have different size refrigerators due to spacing availability, a wide variety of tubes shape, size, wiring and connector solutions are available for customers to customize into their refrigerators. One of the top priorities for Energyled is to fulfill customers' requests to the best possible way.

Services Provided

Excellent customer service is another key value of Energyled. They provide the best service to satisfy customers' need with full responsibility, whether it is to arrange for local product installation or to help train electricians from outside companies. When working with large firms, additional requests are usually within the negotiated terms, such as taking the responsibility of installing the products or quick response to emergency situations. For example, when Energyled started working with a convenience store company, trial installations of low temperature light tubes were organized at a few designated locations. Engineers from Energyled went to those locations and personally installed the light tubes. If any tube suddenly had a slight defect, the customer would call Energyled's sales person, who would then react quickly by bringing an engineer and a replacement tube to the store to confirm the issue and, if necessary, change the tube. There were a few instances when such emergency support was needed on the weekends and Energyled was there as well. After the success of the experience with the installations, more stores were going to change to LED lighting. This increase of workload was no longer able to be handled by Energyled engineers so they found reliable electrician companies and trained them on how to install the products since LED was not as prominent in the early 2000s. These companies would then install all the light tubes for all the existing and new convenience store locations. Likewise, if the customer has its own preferred electrician company to cooperate with, Energyled would help train their electricians as well.

Other than training electricians, training authorized dealers with product knowledge is another service provided by Energyled sales and engineering team, helping dealers understand the values of the product and its difference from competitors. And if there are any questions, Energyled will be at service to explain.

Product Distribution

Ledtech Group reports its annual report based on the sales revenue of two major product types: components from Ledtech and lighting solution from Energyled. Each type is then further divided based on different product categories. The trends of the distribution change can be perceived as a reflection of how the LED market is developing from components to lighting solution.

Based on the distribution of components and lighting solutions for the past three years, an obvious trend is identified where the revenue of components has been decreasing while the revenue of lighting solutions has been increasing (Table 1). The gap between the two types has narrowed down from 32.6% to 18.4 %. This is an indication that LED component sales is slowing down due to the development of the industry to finished solution, which is gradually being accepted by the public despite the price range is much higher than traditional lighting.

Table 1

Summary Distribution of Product Type Based on Sales Revenue

	2015	**2016**	**2017**
Components	0.663	0.614	0.592
Lighting Solution	0.337	0.286	0.408

Lighting solution is further dispersed by its product categories: low temperature, indoor, outdoor, light module and others (Table 2). Sales revenue for low temperature lighting has been gradually decreasing over the past three years, representing the slowdown of this niche market. This is true as Energyled has occupied the majority of the industry, and with the long longevity of the products, second orders of product replacement would be a few years after the

first. Hence, Energyled has also been focusing on indoor lighting, but its increase of 3.7% is not enough to meet the decrease of low temperature lighting at 4.7%. As most high bay light orders are sold for indoor industrial lighting, it is counted in this section as opposed to its originally categorized type. Outdoor lighting is a fairly new sector with minimal change in revenue. It has been steady at a low 0.4% for the past three years. The last two categories are not generally described in its product catalogue because they are half finished products, accessories or components of finished products. Light modules are similar to light strips that can be found within the light tubes. Although there is a slight 0.6% drop from 2015 to 2016, but a 1% increase from 2016 to 2017. This states that customers are buying more modules for their own product design. The trend is similar for the 'Others' section of the distribution. Customers are buying more LED drivers, lens, end caps, heat sink, reflectors and so forth for their products.

Table 2

Summary Distribution of Lighting Solution Products Based on Sales Revenue

	2015	**2016**	**2017**
Low temperature lighting	0.653	0.634	0.606
Indoor lighting	0.221	0.25	0.258
Outdoor lighting	0.004	0.004	0.004
Light Modules	0.068	0.062	0.072
Others	0.054	0.049	0.061

Development of New Products

The development of new products is essential for every manufacturing company. It all starts with the most important stage of market analysis, which is to research on competitor products and understanding market needs. Recognizing customer needs is also taken into consideration as the direction provided by them is generally how the market will gradually move towards. However, Energyled is slightly weaker at this stage as the company does not have a marketing team in particular. R&D team engineers collect their information from competitors' online website, product launch, exhibitions, or from the sales team, who provides information from what they found on the market or from their customers. Customer requests

and complaints directly from the sales team allow the engineers to develop and improve the products, and then eventually standardize the product for other potential customers.

Once the research is complete, engineers start to design, develop and evaluate the feasibility of the new product. If the resulting design passes and the cost is reasonable, the first level of evaluation is complete. Prototypes are then made for further testing, such as power consumption, viewing angle, luminous flux, temperature range and so forth. The resulting statistics are reviewed and presented at internal meetings for final discussion and approval. Once approved, trial production is in order. The trial products are tested repeatedly with specialized equipment, namely high and low temperature shock test, high and low temperature accelerated humidity chamber, light distribution photometer (Appendix B), and many more. Quality check is the second most important segment in product development and production. Near the end of quality check, when the statistics are admirable, the product is ready to be sent out for external certification and patent application.

External certification is also conducted. All products are at least CE certified and some are RoHS approving to be lead-free. Outdoor products are IP approved with IP 54, 65 or 66. The two digits after "IP" explains different levels of protection. The first digit indicates the protection from different levels of solids such as dust. The second digit indicates the protection from water spray or pressure from any direction. Other certifications obtained also include ISO-9001, ISO-14001, PSE and TÜV.

For different countries, there are different approval standards. Taiwan has an Energy Label certification that is supported by the government, who sets the energy efficiency standards. Many businesses look for this certification in products before purchasing the LED products. Energyled's T-bars, panel lights and generation IV high bay lights are examples that fulfill this standard. To sell in the USA, products are expected to meet UL safety standards, in which Energyled's low temperature light tubes do so. These tubes are also DLC approved for its energy efficiency (See definitions of certifications in Appendix C).

While sending the products for approvals, patents are also applied if there is a new unique technical or structural design that needs to be protected. Applications take quite long to process that the approval is sometimes obtained after the product has launched. Currently the entire Ledtech Group has more than 185 patents. When all essential tests and certifications have passed and been approved, the new product is ready for launch.

CHAPTER IV DEFINITION OF THE MARKET

LED industry

Market Analysis

The first sense of LED light emission was discovered in 1907 by a British experimenter, H.J. Round, but the actual creation of the first LED was by Russian inventor Oleg Losev in 1927. It was not until 1962 when the first commercial LED lamp was ready to be sold on the market by Texas Instrument (TI) ("Light-emitting Diode," 2018). Since then, continuous discoveries and development are made, from different colors to shapes, including LED display, backlight, based LED, LED strips, surface mounted device (SMD), chip on boards (COB) and so forth. These can be found in cashiers, automobiles, radio display, electronics, and many other types of applications.

As the industry continues to grow, LED components are designed into lighting solutions in the 1990s. At that time, due to the fact that LED is more expensive than traditional solutions, it was not widely accepted. It was not until the 2000s when energy efficiency is strongly taken into account, especially by the government and businesses, that LED lighting is becoming a consideration. Products are developed to replace traditional incandescent and fluorescent light for different markets, including store lighting, office lighting and street lighting. Today, LED lighting solution is rapidly growing. For manufacturers, products are more standardized and costs are lowered. For customers, either businesses or the general public, the traits of energy efficiency, long longevity, high light quality and low maintenance cost are some of the reasons that grabs their attention. And also the fact that larger well known manufacturer brands, such as Phillips, Osram, Edison Opto, and General Electric (GE), have been attracting attention on a global level with their product release ("LED Lighting Market to Drive Speedily," 2018). The only, and probably the most important, disadvantage is the cost of installation of the LED lamps. Nevertheless, based on a report by Zion Market Research ("LED Lighting Market to Drive Speedily," 2018), the global LED market is growing at a compound annual growth rate of 13% between 2017 and 2022, expecting to reach USD 54.28 billion by 2022 (Figure 1).

Figure 1. Estimated global LED lighting market growth from 2016 to 2022. Adapted from *LED Lighting Market to Drive Speedily and Reach USD 54.28 Billion by 2022*, by *Zion Market Research*, September 11, 2018, retrieved from https://www.zionmarketresearch.com/news/led-lighting-market. Copyright 2018 by Zion Market Research.

LED has been replacing most of the traditional lighting applications that almost all the possible application has been occupied. To find a new lighting market to penetrate and evolve in is a deep search especially with the vast amount of competitors in the industry. If to follow the popular trend of connecting LED products with IoT (Internet of Things) technology such that it can connect to Google Now or Amazon Alexa, the product would need to be reachable to the general public in super stores or super markets. However, this is possible for Energyled is a B2B company, so selling to the general public is not within its distribution channel. Not to mention, bigger brand manufacturers with more research funds have already developed a full system for it. Hence, it is not wise to join such a market when competitors are already way ahead in that particular market. Possible choices as a target market is one that is starting to grow or has not yet been fully developed. For example, the ultraviolet lighting market.

Competitive Analysis

The LED industry has been around for more than five decades. Competition continues to grow yearly with many new LED companies sharing a piece of the market. From competitors, domestic to abroad, the more well-known brands occupy a large part of the share. While the other smaller brands share the remaining portion with its own qualities. Major competitive factors include products and service, quality, reliability, distribution channel and more, that varies in importance for different customers.

The big branded companies all started from developing LED components and evolved into the lighting sector. The most known international brands are Cree, Osram, Philips, Samsung and Nichia, and some local Taiwan brands include Everlight, Liteon and Edison. They all have front guard innovative technologies, such as connecting LED lighting products to IoT or complete sensor systems. But in areas of technical expertise, they do not fully dominate. It is rather the smaller companies that have their own R&D teams and work on quality more than marketing. In contrast, similar in any industry, there are companies that produce low quality products based on copying and low cost. These companies can be found in any country, where a vast majority are found in mainland China. Customers without much knowledge about LED are more likely to be attracted by their price.

A competitive analysis is shown in Table 3 of Energyled with four competitors: Edison and Everlight from Taiwan, Philips and Osram from abroad. The factors listed are ones that customers would care about and compare when considering which company to do business with. By comparing products, quality, selection, service, reliability and expertise, Energyled is as good as competitors. Whereas, it is in brand recognition, global distribution and advertising that it is weaker at. Edison although is better than Energyled in area of marketing, but not better in products and its selection. This is similar for Everlight, which is a big brand in Taiwan but not as popular as Philips or Osram on the international level. Philips and Osram can be said as the biggest competitors for Energyled, excelling in all areas.

Table 3

Competitive Analysis of Energyled with Two Domestic (Edison, Everlight) and Two International (Philips, Osram) Companies

Factor	Energyled	Edison	Everlight	Philips	Osram
Products	5	4	5	5	5
Price	3	4	5	4	4
Quality	5	5	5	5	5
Selection	4	3	3	5	4
Service	5	5	4	4	4
Reliability	5	5	5	5	5
Expertise	5	5	5	5	5
Brand Recognition	1	3	3	5	5
Global Distribution	2	2	3	5	5
Sales Channel	B2B	B2B	B2B & B2C	B2B & B2C	B2B & B2C
Advertising	1	3	4	5	5

UV LED Market

Market Analysis

In LED general lighting, it is known that no UV rays are emitted, but studies have proven that white LED with 400nm or shorter wavelengths do emit UV rays, so called UV LEDs (Muramoto, Kimura & Nouda, 2014). The UV LED market started since the early 2000s and has been gradually emerging. Based on a study by Yole Développement ("UV LEDs," 2018), the UV LED market has grown from 8.3% to 25.3% out of the total UV light source market over the past decade (Figure 2). With this continued growth and the worldwide ban on mercury vapor lamps in year 2020, the global UV LED market is forecasted to reach USD 1,163.5 million by 2023 ("Global Ultraviolet LED Market Analysis and Forecast 2017-2023," 2018).

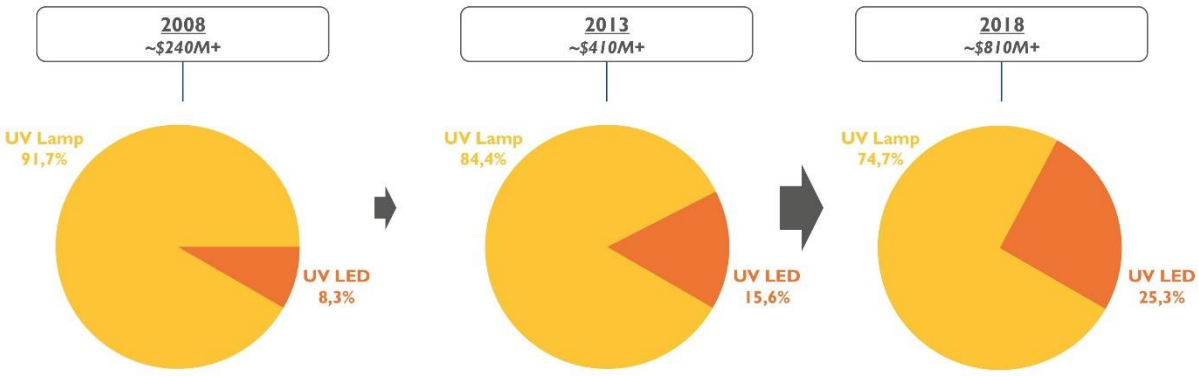

Figure 2. Evolution of UV light source market: 2008-2013-2018. Adapted from *UV LEDs – Technology, Manufacturing and Application Trends 2018*, by Yole Développement, May 2018, retrieved from https://www.i-micronews.com/mages/Flyers/MEMS/YD18017_UV_LEDs_May_2018_flyer.pdf. Copyright 2018 by Yole Développement.

UV rays are divided into three types based on their spectrum wavelength: UV-A, UV-B and UV-C ("Ultraviolet Radiation and Health," n.d.; "UV LEDs," 2018). They can be used in various applications in replacement of UV light sources, including air and water disinfection, sterilization, curing, medical, biotechnology, and security (Muramoto et al, 2014; "Uses of Ultraviolet LED Lights," n.d.), based on their wavelengths (Table 4). UV-A rays has wavelength band spectrum of 315nm to 400nm and is found most commonly in UV applications. It contributes greatest to the increasing growth within the UV market, particularly the curing system. Its success even contributed to the gaining popularity of air and water disinfection systems ("Global Ultraviolet LED Market Analysis and Forecast 2017-2023," 2018). Other applications with UV-A rays include the printing system, banknote detection, tanning and photocatalytic purification ("UV LEDs," 2018). UV-B ray's spectrum ranges from 280nm to 315nm. It is used mainly in medical phototherapy and plant growth. In phototherapy, also known as light therapy, deals with treating skin diseases, such as psoriasis, eczema or other skin diseases, where UV-B light is used to treat the affected area. Dermatology clinics and hospitals around the world have this type of treatment, using either a small lamp or in full body cabins ("UV-B Lamps," 2018). Another type of phototherapy treatment is to transform cholesterol into vitamin D3 by exposing the skin to UV-B light ("UV-B Lamps," 2018). Normally, this is not a necessary treatment if exposure to natural light is available, but in Northern European countries where daylight is scarce, pregnant women may receive such treatment in order for their babies to have enough vitamin D3 when born. This is also used in

herpetology where indoor reptiles need UV-B to produce vitamin D3 and strong bones ("UV-B Lamps," 2018). The last type of UV light is UV-C, with a band spectrum of 100nm to 280nm. It is mostly used in air, water or surface disinfection systems, biotechnology or sensing. Disinfection where the UV-C light is used to kill microorganisms or bacteria ("Ultraviolet Germicidal Irradiation," 2018). Such systems are the recent contributing factors to the growth of the UV LED components market, so for LED lighting manufacturers can focus on the bigger picture on life science and medical sterilization.

Table 4

Band Spectrum and Supported Applications for the Three Types of UV Light

	UV-A	**UV-B**	**UV-C**
Wavelength (nm)	315-400	280-315	100-280
Applications	- Curing system - Printing system - Security, Banknote detection - Tanning - Photocatalytic air/water purification	- Medical phototherapy - Plant growth	- Air/water/surface disinfection - Biotechnology / Medical sterilization (research labs, biotechnology labs, equipment sterilization) - Sensing

Based on the various applications for each type of UV light, the UV LED lighting market is quite big to target as a whole. Narrowing it down to a specific UV type and application as the target is a wiser choice to penetrate and make it a second niche market. As the UV-A LED market's curing system is already quite mature, along with the recent growth of UV-C LED market's disinfection systems, these two application market are better to avoid for new entrants to the market. Therefore, targeting applications in UV-B's medical phototherapy or UV-C's medical sterilization is a better choice since both UV-B and UV-C LED lighting markets have yet been largely impacted by LED manufacturers due to the fact that LED technology in this two types is more difficult than UV-A LED. Hence, even though the technological barrier to entry is slightly higher, but the market is will eventually mature as UV LED curing market will reach a certain limit ("UV LEDs," 2018).

The market size for both UV-A and UV-B LED lighting together is not as high as UV-A LED. There is currently no market estimate for the UV-B LED medical phototherapy in particular but the overall light therapy market is forecasted to reach USD 980 million by 2024 and it includes LED lighting ("Light Therapy Market Size," 2016. As for medical sterilization, Figure 3 represents the market estimate growth of UV-C LED module by revenue from 2014 to 2020 (Shih, 2015). It shows that the medical sterilization market has been slowly growing over the years and by 2020, the estimated revenue will reach USD 110 million (Shih, 2015).

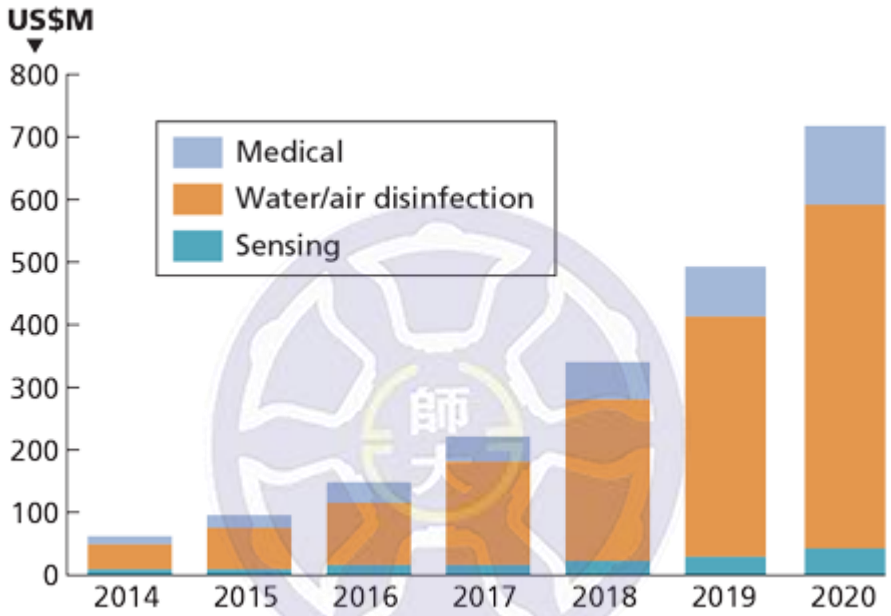

Figure 3. UV-C LED module revenue forecast from 2014-2020 for disinfection. Adapted from Emerging Applications for UV LEDs Drive Broad Interest, in *LEDs Magazine*, by M. Shih., December 4, 2015, retrieved from https://www.ledsmagazine.com/articles/print/%20volume-12/issue-11/features/strategically-speaking/emerging-applications-for-uv-leds-drive-broad-interest.html. Copyright 2007-2018 by PennWell Corporation.

Despite the smaller market size of UV-B and UV-C LED lighting market, there are still worthy reasons for targeting the medical phototherapy and sterilization markets, and marking it Energyled's second niche market. Related technology to produce UV LEDs is not as complicated as starting something completely new since its engineers definitely have enough skills for developing new and better UV LED products. Whereas finding new potential customers is slightly more challenging due to the fact that this is a new area where Energyled

has yet to approach. Potential customers would be in the medical field, especially in the dermatology area for light therapy. This would include not only hospitals but also independent dermatology clinics. Other clients include biotechnology labs and companies with their own research labs that require medical sterilization. These potential customers span around the globe, which means that there are a lot of opportunities for Energyled to expand into. Therefore, the main objective is to find companies that use light tubes and lamps in their phototherapy or sterilization environment, with a target benchmark of ten percent of the potential market starting in Taiwan in the first year. Then in the following years, the benchmark will gradually increase when the products are being promoted internationally.

Competitive Analysis

The differences between traditional and UV LED lighting defines its advantages and disadvantages for which customers would consider whether or not to make changes to LED products. Acknowledging the growth in the LED industry in the past years, an increase of more than six times the number of original manufacturers has joined the industry in the past decade ("UV LED Market to Grow," 2015).

UV LED products are almost exactly the same as general LED ones except the presence of UV ray. As shown in Table 5, LED does not contain mercury, or any hazardous item, in comparison to the mercury vapor composed traditional UV light. This defines its character as environmentally friendly, which is what governments drive for and hence the ban of mercury vapor lights by the year 2020. LEDs have a special design with heat sink that allows the heat to be dissipated quickly out of its confined shape. A good heat dissipation design saves unnecessary additional energy consumption. With the fact that it consumes low power wattage, it can be described as very energy efficient and guarantees lifetime. LED lights have long lifetime of up to 50,000 hours, much higher than traditional UV light's 16,000 hours. Such long hours mean lesser number of times that the lamp need to be changed; hence its low maintenance cost. Yet, despite all the advantages, there are still two disadvantages, both related to cost. The first is the product cost. UV LED products is still considered to be in the early stage that there is no standardized specification so the cost can be lowered to nearly the same as traditional UV light. The second disadvantage is the installation cost. Installing or changing to LED products is not simply a direct replacement due to the difference in the end caps on both sides and the need to use adaptors.

Table 5

Comparison Table of Traditional and LED Types of Light

	Traditional Light	**Traditional UV**	**LED**	**UV LED**
Light source type	Florescent, incandescent	Mercury vapor	LED	LED
UV ray	Yes	Yes	No	Yes
Mercury	Yes	Yes	No	No
Heat Dissipation	Low	Low	High	High
Power Consumption	High	High	Low	Low
Energy Efficiency	Low	Low	High	High
Lifetime (hrs)	7,000~15,000 750~1,000	8,000~16,000	50,000	50,000
Maintenance Cost	High	High	Low	Low
Installation Cost	Low	Low	High	High

In the beginning of 2000s when UV LED development started, only a few companies were involved. They were companies from Japan, Korean and USA (Figure 4). Then with the success of UV LED curing systems over the years, more manufacturers entered the market, now with more than 60 companies ("UV LED Market to Grow," 2015). All these companies manufactured LED components, or packages, for equipment developers. Of these companies, Nichia, Nitride Semiconductors, Seoul Viosys (or Crystal IS), LG Innotek and USHIO/Epitex take up bigger shares of the market (Figure 5) (Wu, 2017). Nichia is one of the earliest companies that researched and developed UV LEDs and has remained to be the leader in the market. Only Seoul Viosys has UV LED incorporated insect trap, air purifier and sterilizer. Information on global UV LED lighting market is limited.

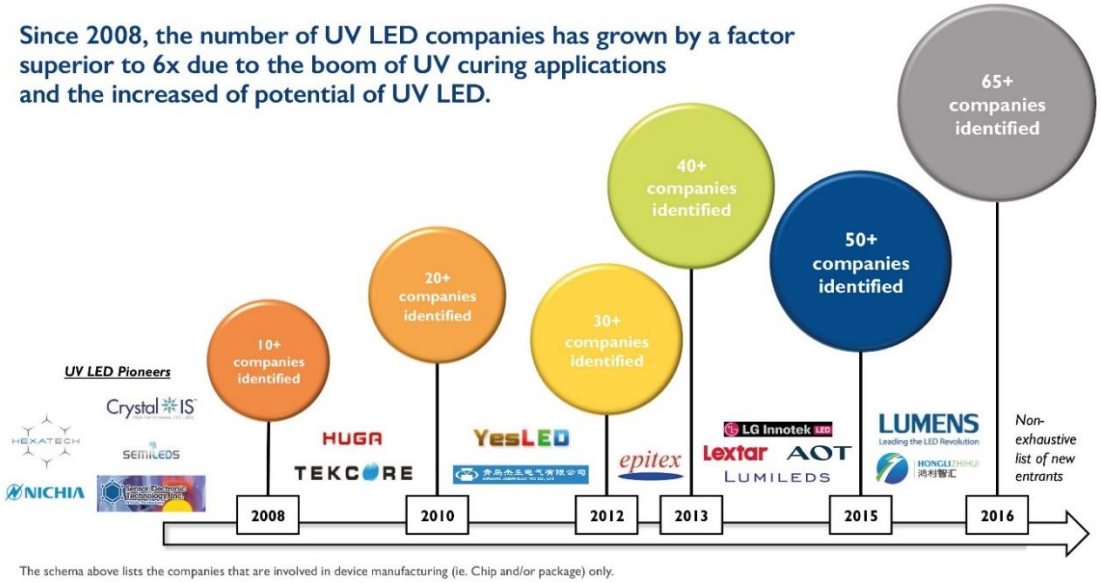

Figure 4. Evolution of the industrial ecosystem. Adapted from "UV LED Market to Grow from $90m to $520m in 2019," by *Semiconductor Today*, *10*(1), 80-81, retrieved from http://www.semiconductor-today.com/features/PDF/semiconductor-today_february2015-UV-LED.pdf. Copyright 2018 by Semiconductor Today.

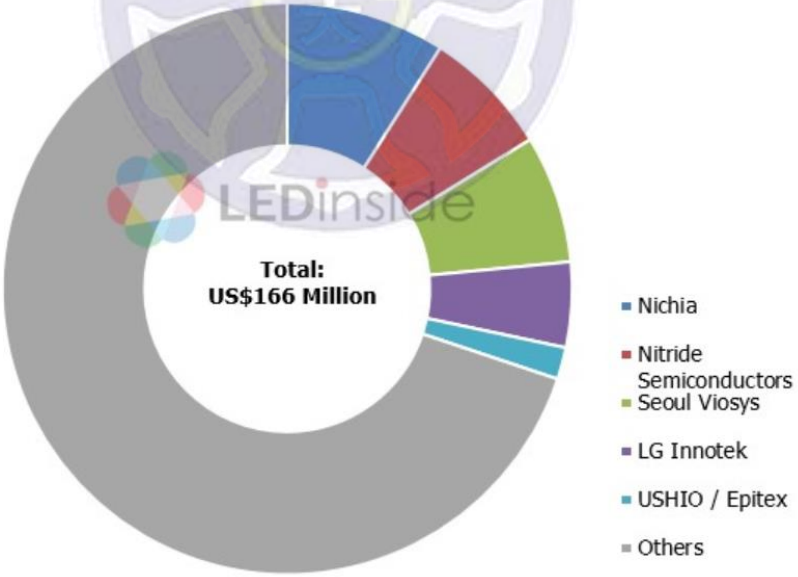

Figure 5. UV LED suppliers by revenue, 2016. Revenue is referred to on the components level. Adapted from TrendForce Says Global UV LED Market to Expand at a CAGR of 34% From 2015 to 2020 as Applications for Related Solutions Emerge, in *TrendForce,* by J. Wu, June 13, 2017, retrieved from https://press.trendforce.com/press/20170613-2880.html. Copyright 2018 by TrendForce Corp.

Most companies in the UV LED market only produce LED packages and not much of lighting products. Hence, a competitive analysis with UV LED companies that produce mainly components are conducted, as shown in Table 6. Although Energyled has not yet started to produce any UV LED products, the information provided is based on their target UV LED products and application market. And the rest of the factors from quality to advertising are the same as Table 3, which is based on the products and services that Energyled provide and its current situation in the area of marketing. Four companies that originated from three different countries around the world are chosen based on its brand, expertise and similarity in UV LED products. Of these four, two pioneer companies are compared to. One of which, SemiLEDs, originated from the USA but is headquartered in Taiwan. The other is one is the big brand Nichia, famous in the industry for its research and expertise in their products. Both companies focus purely on developing UV-A LED components and targets very similar markets. The main difference is their brand recognition and global distribution. The third company is the later joined LG Innotek which produces not only UV-A LEDs but also UV-C LED for sterilization purposes. With LG as its mother company, its quality, service and recognition is equally as good as Nichia, except the fact that it has more selection in their product line. Its quality and technical specifications of UV-C LED components are what Energyled need to compare and compete with most. Lastly, the fourth company, RayVio, is the only company that produces all three types of UV LED products and also sells modules. Although it is not a company that is much heard of, it seems to have the sole focus on the UV LED market such that it is already targeting all possible applications, including the medical phototherapy and sterilization fields that Energyled is approaching. This may be the main fact that RayVio will be the main competition for Energyled since Energyled also have other product lines to develop and support. Luckily, its weakness in the marketing area is similar to Energyled, so if Energyled improve greatly in this area, it can surpass RayVio in the UV LED market.

Table 6

Competitive Analysis of Energyled with Major UV LED Manufacturing Companies

Factor	**Energyled**	**SemiLEDs**	**Nichia**	**LG Innotek**	**RayVio**
Origin	Taiwan	USA	Japan	Korea	USA
UV Support	UV-B, UV-C	UV-A	UV-A	UV-A, UV-C	All types
Product	Light tubes, lamps	Components	Components	Components	Components, modules
Application	- Medical phototherapy - Medical sterilization	- Curing - Counterfeit detection - Tanning - Air purifier	- Curing - Counterfeit detection - Fluorescence excitation	- Curing - Adhesive coating - Tanning - Sterilization	- Curing - Phototherapy - Disinfection - Personal health
Quality	5	5	5	5	5
Selection	3	2	2	3	5
Service	5	5	4	4	5
Reliability	5	5	5	5	5
Expertise	3	4	5	5	5
Brand Recognition	1	2	5	5	2
Global Distribution	2	3	5	5	2
Sales Channel	B2B	B2B	B2B	B2B	B2B
Advertising	1	3	5	5	2

CHAPTER V ORGANIZATION AND MANAGEMENT

Energyled is a growing company with a complete organizational structure. With the chairman/CEO and general manager at the top of the structure, there are five divisions and two departments below. The divisions include R&D, business and marketing; and the two departments are administration and finance & accounting (Figure 6). As Energyled is wholly owned by Ledtech, human resource is supported when necessary.

The chairman of the company is also the CEO. He and the general manager hold the same position as in Ledtech. They are also two of the few founders of Ledtech that built up the Group from a single company over the past 41 years. Other founders are general managers of other subsidiary companies, mainly for different locations.

The two most important sections of the company are the R&D and business divisions. R&D division is where all the products are planned and designed, and business division consists of promoting and sales. There is a total of three business divisions. Business division one includes both domestic and export sales departments. Departments in division two is distinguished by Southeast Asia, Europe and Oceania areas. Greater China is separated into a third division since Ledtech Group has subsidiaries there as well. The remaining marketing division is established but mostly depend on the sales people from the business divisions. Top managers believe that sales department is a part of marketing in which competitor information can be obtained during customer visits or from authorized dealers. Therefore, the R&D division works in close relation with the business division who brings customer request and market information to the engineers for ideas of developing new products. Lastly, administration and finance & accounting are the remaining departments, taking care of matters as the title states.

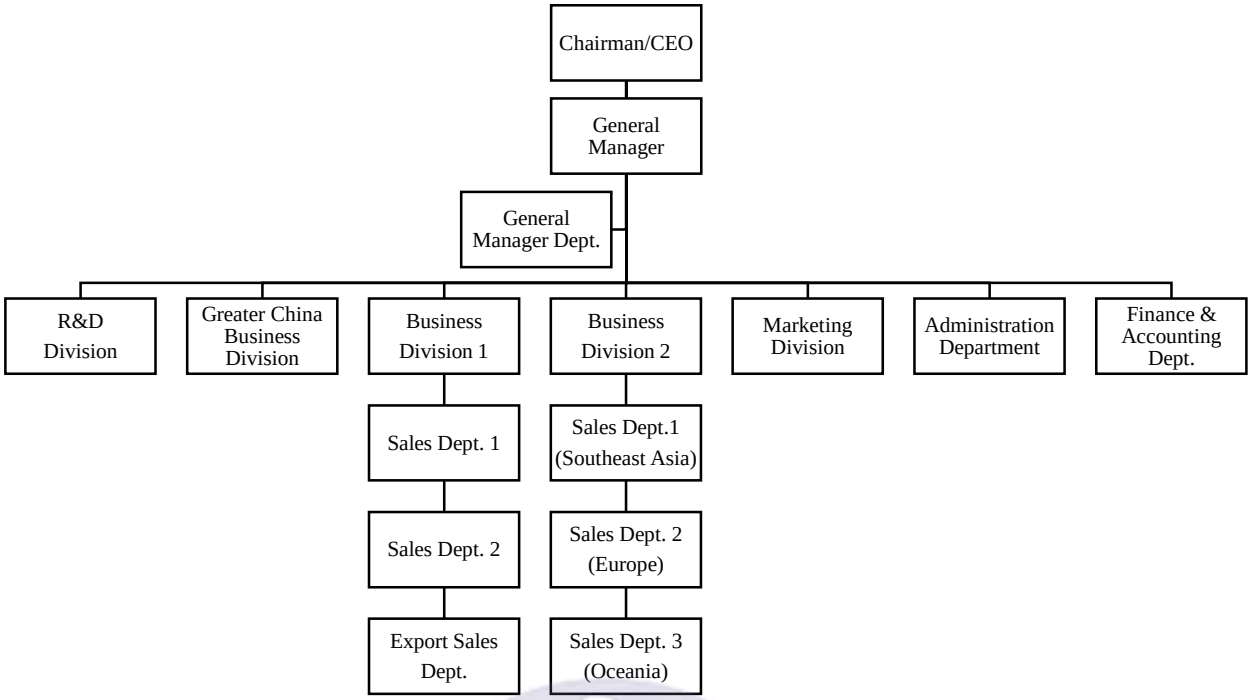

Figure 6. Energyled's organizational chart. Adapted from *Organization*, by Energyled Corporation, 2018, retrieved August 16, 2018 from http://www.energyled.com.tw/en/%E7%B5%84%E7%B9%94%E6%9E%B6%E6%A7%8B/. Copyright 2018 by Energyled Corporation.

CHAPTER VI PRODUCT DEVELOPMENT AND MARKETING STRATEGIES

Product Development

With the UV LED market as the target, especially in medical phototherapy and medical sterilization, additional investment in human resource, product research, designing, planning and testing equipment will be needed. To be more specific, the target application should be the ones that use UV light tubes or lamps in such markets, such as sun tanning booths, herpetology, air sterilization in medical environments, light therapy and so forth. Product roadmap is to be drawn to set goals and deadlines.

The choice of designing light tubes or lamps is not only for the purpose of the target applications but also due to the fact that Energyled already has experience in the structural design of it. UV lighting in sun tanning booths and air sterilization in medical environments mostly use light tubes, and herpetology and light therapy use lamps. Therefore, the goal is to make adjustments to the existing structures as opposed to creating something completely new to start off. Once entry to the market is a success, further development of the subsequent generations or possible new products will be added to the roadmap.

The entire product development roadmap is estimated to take six months with various check points along the way (Figure 7). Before project kickoff, R&D team will need to create a dedicated engineering team to focus on the development of UV LED lighting products. Once settled, they will start from research on the standard and requirements of UV lighting and types of tests to pass for the product to launch. As well as, target light tubes and lamps on the market to study and identify the uniqueness of them. The findings are then reported, a month later, with an estimation on cost for purchasing the necessary testing equipment and competitors' products to top management for authorization to proceed. Once approved and the competitors' products are purchased, detailed technical analysis and component break down analysis are to be processed to understand the complete structure. With the basic knowledge of competitors' products, Energyled is able to design its own distinctive product.

Planning and designing of the new UV LED product is estimated to take around two months, including feasibility testing. Prototypes are made to conduct necessary tests. If the results are not feasible, then modifications are made until the product is at its possible best.

Once with a prototype is finalized, further tests including all internal basic testing, external safety testing and the fulfillment of all UV lighting related requirements, are processed for the next two months. Results are confirmed for each testing, continuously making modification when necessary.

Shortly after halfway through the development progress when the design is finalized and initial testing shows promising results, the engineering team would make an official internal announcement about this new product to all department heads. Prototype design and technical specifications are presented with a hands-on experience to have a better understanding of the product. At this point, sales and marketing teams will join to start working on the marketing plan and contacting potential customers. Updates are reported on a weekly basis, until final approval is made by top management to launch the product onto the market, which is estimated to be six months since project kickoff.

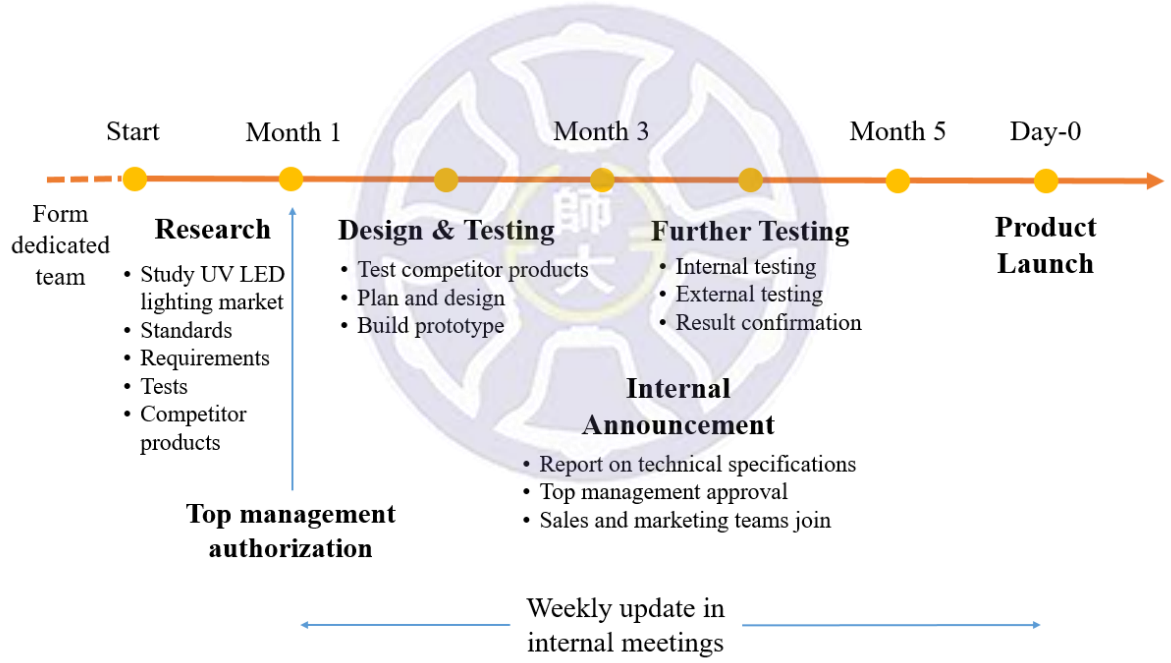

Figure 7. UV LED lighting product development roadmap.

Marketing Strategies

Successful penetration of a new market will require quite an amount of time if the company's brand is not that well-known to the general public. The quickest way to build up a reputation within the UV LED lighting industry is to cooperate with a big business on a successful project. Providing an assortment of products to meet customers' need at an

acceptable price is offered through different distribution channels is the basic considerations for marketing strategies. Most importantly is the promotion method that Energyled will need to work more on in order to increase customer's knowledge of its brand and products. Thus, the 4P's based on Energyled's standpoint are considered in relation to the 4C's of customer views.

Product – Customer Need

Generic UV LED products are provided to customers in forms of light tubes and lamps, with the core value of providing best quality. Light tubes are in various shapes and sizes from T5 to T8 and from 2 to 5 inches. Lamps can be made in forms of MR, PAR or bulbs. With such assortment, Energyled is also open to customized requests from customers to fulfill their special needs.

Price – Cost

The price of the new product would very likely be higher than the average price of the competitors, but quality is guaranteed. Once the customers see and experience the product, they will see the worthiness of the cost. They will be satisfied enough to continuously purchase from Energyled and become a loyal customer. One thing to note is if the purchase order is large enough to reach certain thresholds, price can be lowered.

Place – Convenience

As a B2B company, there is only two possible channels for customers to purchase the product. The first channel, which is to directly order from the company. Once the sales team receives contact via phone or e-mail, they will respond at the quickest. If the inquiry is domestic, a salesman can visit to discuss face-to-face at the customer's convenience. The second channel is directly from Energyled's authorized dealers. Through them, customers in different areas around the globe can be serviced at a faster pace due to accessibility.

Promotion – Communication

First and foremost is to let the LED lighting association know about Energyled's new product in the UV LED market and release articles regarding this great achievement. Product information are to be added onto the company's website, including news release. And to increase the likelihood of the product to show up on the first result page of search engines, adding some search words to the coding of the website is a necessity. Search words including "UV," "ultraviolet," "UV LED," and the product name itself. To further increase exposure, Energyled can continue to build up its access through social media, such as LinkedIn, Instagram and Facebook. These are also ways for customers to communicate with the company.

As per Table 3, Energyled is weaker in the area of brand awareness. Other than increasing its brand recognition on social media, it is also critical to let other businesses be aware of this company. Ways to do so may include attending exhibitions, LED meetings and lighting events. It would be good idea to join events outside of the lighting associations and into the targeted application associations. For example, when trying to find potential customers in the UV lighting industry, sales people can attend UV association events and present oneself. Other good options to increase brand awareness include sponsoring events where the brand logo is widely shown or collaborating with bigger companies to have its name exposed beside the famous brands.

CHAPTER VII FINANCIAL FORECAST

Financial statements for Energyled is not available for release as it is not yet a public company on the Taiwan Stock Exchange. However, as a subsidiary of Ledtech Group, its revenue and net profit data are listed in the Ledtech Electronics Corporation (2015, 2016, 2017) annual report book for their shareholders' meeting.

Energyled's growth has not been steady. As seen in Table 7, both revenue and net profit had increased from 2015 to 2016, and decreased in 2017. The main reason of the decrease was due to the slowdown of low temperature lighting market. But even so, the company still have enough profit for continuous investment for product development and marketing.

Table 7

Energyled Financial Information from 2015 to 2017

	2015	**2016**	**2017**
Revenue	186,095	229,168	194,880
Net Profit	6,931	18,224	8,310

Note. In thousands NTD. Data for 2015 Annual Report from Ledtech Electronics Corporation, for 2016 Annual Report from Ledtech Electronics Corporation, and for 2017 Annual Report from Ledtech Electronics Corporation).

Expected cost is estimated for human resource expense, purchase of competitor products, testing equipment and marketing for the new product (Table 8). As the development of the new product is estimated to take 6 months. Within this period, total human resource is distributed over the six years, along with total equipment expense. Competitor products and marketing expense are based on yearly budget base. The latter years have lower budget than in the beginning because the number of competitor products that is needed to buy is expected to decrease since Energyled has its own products. As well, marketing budget is higher in the beginning because extra focus will be emphasized on the new products and then slowly decrease as it will share the cost with other products altogether. Total expense is summed up to NTD 1,555,000.

Sales income is estimated from 2019, the year that the product is expected to launch, over a five-year duration to 2023. The beginning few years will have a lower income but will gradually pick up starting in the third year. Profit is expected in the 2021, but the overall breakeven point from overall investment is expected in 2023, six years after the start of the new product development.

Table 8

Estimated Revenue and Cost from 2018 to 2023

	2018	**2019**	**2020**	**2021**	**2022**	**2023**
Revenue						
Sales	0	100	200	500	700	1000
Cost						
Human Resource	(40)	(40)	(40)	(40)	(40)	(40)
Competitor products	(20)	(10)	(5)	(5)	(5)	(5)
Equipment	(200)	(200)	(200)	(200)	(200)	(200)
Marketing	0	(20)	(15)	(10)	(10)	(10)
Subtotal	(260)	(170)	(60)	245	445	745

Note. In thousands NTD.

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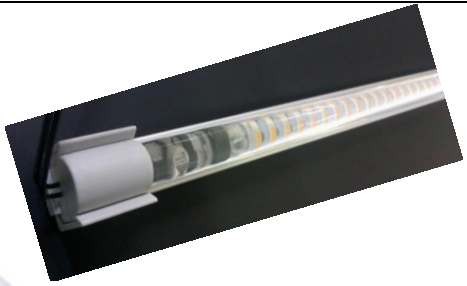
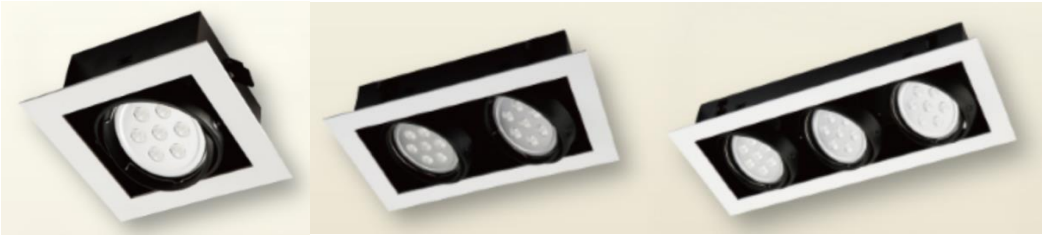
APPENDIX A-1: PRODUCTS for Indoor Lighting

<table>
<tr><td rowspan="3">Tubes</td><td>  </td><td>  </td></tr>
<tr><td>T5</td><td>T8 AC</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Sensor Type</td><td>Canopy</td></tr>
<tr><td>Yellow Tube</td><td colspan="2">  </td></tr>
<tr><td>Signage Tube</td><td colspan="2">  </td></tr>
<tr><td>Plant Tube</td><td colspan="2">  </td></tr>
</table>

Meat Light		
	Tube Series	PAR Series
AR111		
	Economy Series	Power Series
MR		
	MR16	
Light Bulb		
Down Light (4”, 6”, 7”, 8”)		
Panel Light		

APPENDIX A-2: PRODUCTS for Indoor Lighting with Light Fixtures

Products with Light Fixtures		
	Overhead Sharp Light, single tube	Overhead Sharp Light, double tubes
		
	Surface Type, single tube	Surface Type, double tubes
		
	T-Bar, 2ft x 4pcs	T-Bar, 4ft x 3pcs
		
	AR111 Light Fixture, Round	Track light
		
	AR111 Light Fixture, Square	

APPENDIX A-3: PRODUCTS for Outdoor Lighting

<table>
<tr><td rowspan="4">High Bay Light</td><td>  </td><td>  </td></tr>
<tr><td>Gen III</td><td>Gen IV</td></tr>
<tr><td colspan="2">  </td></tr>
<tr><td colspan="2">UFO</td></tr>
<tr><td rowspan="4">Spot Light</td><td>  </td><td>  </td></tr>
<tr><td>COB Series</td><td>COB Series with Lens</td></tr>
<tr><td colspan="2">  </td></tr>
<tr><td colspan="2">CSP Series</td></tr>
<tr><td rowspan="2">Flood Light</td><td>  </td><td>  </td></tr>
<tr><td colspan="2">COB Series</td></tr>
</table>

		
	High Power Series	
Street Light		
	COB Series	High Power Series
Wall Light		
	9683 Series	1651 Series
		
	Beam Light	1390 Series
		
	1018 Series	1621 Series

Bollard Light		
	1541, 1542 Series	1722 Series

APPENDIX B: TESTING EQUIPMENTS

High & Low Temperature Shock Test

High & Low Temperature Accelerated Humidity Chamber

Light Distribution Photometer

APPENDIX C: DEFINITION OF CERTIFICATIONS

Abbreviation	Full Name	Definition
CE	Conformité Européenne	A certification on health, safety and environmental protection standards for products sold within European Economic Area (EEA) ("CE marking," 2018).
RoHS	Restriction of Hazardous Substances	A compliant that restricts the use of specific hazardous materials found in electrical products. It is a necessity to sell in the European Union ("What is RoHS and why is it important?" 2013).
IP54	International Protection	5: limited dust ingress protection 4: protection from water spray, limited ingress protection ("IP enclosure ratings & standards explained," n.d.).
IP65		6: total dust ingress protection 5: protection from low pressure water jets, limited ingress protection ("IP enclosure ratings & standards explained," n.d.).
IP66		6: total dust ingress protection 6: protection from high pressure water jets from any direction, limited ingress protection ("IP enclosure ratings & standards explained," n.d.).
ISO-9001	International Organization for Standardization	Certification for meeting standards for quality management system ("ISO 9001:2000," n.d.).
ISO-14001		Certification for meeting standards for environmental management system ("ISO 14001:2004," n.d.).
PSE	Product Safety Electrical Appliance & Material	A mandatory Japanese law that governs electrical appliance safety. It must be passed in order to sell in Japan ("Act on Product Safety of Electrical Appliances and Materials," 2018).
TÜV	Technischer Überwachungsverein	Product test and certification based on international standards for leading quality and safety ("Testing," n.d.).
Energy Label	Energy Label	A Taiwan government supported program for setting standards for energy performance (efficiency) of products ("What is Energy Label," n.d.).
UL	Underwriters Laboratories	Globally known safety solution testing and certification, especially used in the United States ("About UL," n.d.).
DLC	DesignLights Consortium	Tests and promotes high quality and energy efficient products in the commercial sector ("About Us," n.d.).

APPENDIX D-1: INTERVIEW QUESTIONS for Sales

1. What are the core competences of your company?
2. Please describe the profile of your loyal customers?
3. Why do your loyal customers repeatedly place orders from us?
4. Compared with non-loyal customers, please describe your loyal customers' unique demands or unique characteristics?
5. What unique value of your products or services do your loyal customers appreciate most?
6. Why are you (company) able to create and deliver the unique value your loyal customers appreciate so much and your competitors are not able to match?
7. a) What are the sources (i.e., core competences) for you to create the unique value?
   b) How sustainable are the sources (core competences) identified in the above question?
   c) Is it easy for competitors to imitate or copy your sources (core competences) of unique value creation?
8. If you raise the price by 5%, will your loyal customers still be willing to place orders from you? Why or why not?
9. Do your customers also purchase LED lighting products from other companies? If so, from which companies and what products? And why?
10. Do you know why your customers choose to order products from your company as opposed to other LED lighting product manufacturers?
11. a) What are the top five profitable products that you sold last year?
    b) For these top profitable products, if you raise the quotation price by 5%, will these customers still be willing to place the order? Why or why not?
12. a) Can you describe the profile of customers who are willing to place orders even after a price increase of 5% and contribute high profit margins?
    b) Are there other potential customers who may share the similar profile and needs? Can your business expand by approaching these potential customers?
13. How do you find new customers?
14. What are the biggest challenges of finding new customers?
15. What potential markets do you think you can penetrate?
16. Do you think there are ways you can improve on marketing and promoting your products? Why or why not?

17. How does your company plan and design new products?
18. a) To your knowledge, are there any highly growing or promising markets or industries (such as medical equipment) which may best fit the unique value your company may serve the core competences mentioned earlier?

    b) How should your company better capture the market opportunities out of the boundary of the existent customer base?
19. What is your role? (eg. sales, R&D, etc..)
20. How many years have you worked at the company?

APPENDIX D-2: INTERVIEW QUESTIONS for R&D

1. What are the core competences of your company?
2. What is the main difference between the products you developed and your competitors?
3. How does your company plan and design new products?
4. What kind of market research do you do for designing new products?
5. What are the biggest challenges of developing new products?
6. What kind of unique value does your products bring to the company?
7. What potential markets do you think you can penetrate (with your products)?
8. Do you think there are ways you can improve on marketing and promoting your products? Why or why not?
9. a) How do you plan for your company's technology road map and product road map?
   b) How can you make sure that the aforementioned technology road map and product road map are superior to your competitors' offerings and able to contribute to the company's profitability and sustainability?
10. What is your role? (eg. sales, R&D, etc..)
11. How many years have you worked at the company?