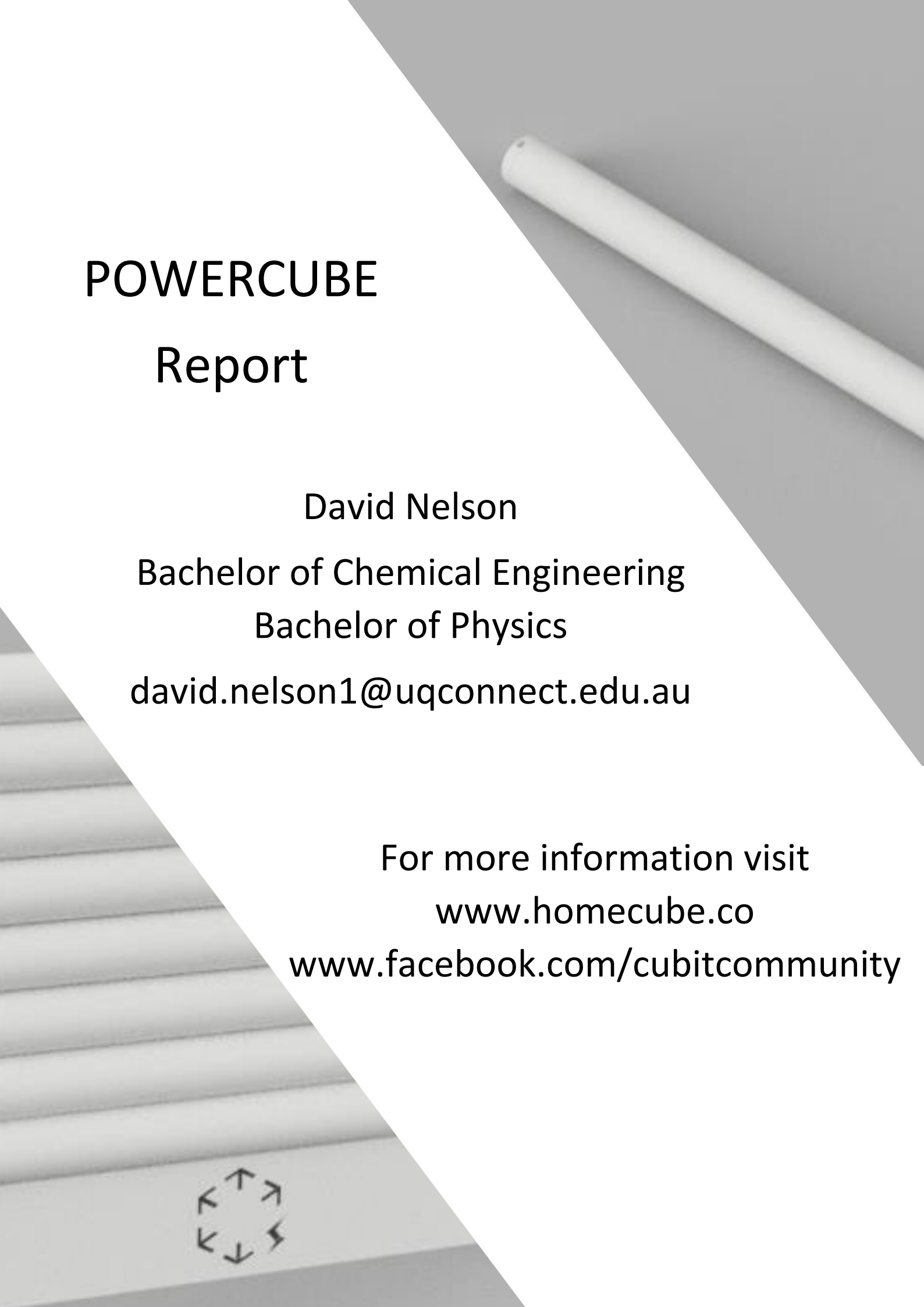

POWERCUBE
Report

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Summary

The POWERCUBE is an affordable, modular solar battery system targeted at the 1.2 billion people in slums without electricity (International Energy Agency, 2018).

The POWERCUBE consists of three main components: the solar panel, the POWERSTICK and the POWERBASE. The solar panel produces the electrical power, the POWERSTICK is a 12V, 33Wh Li-ion battery module that stores the electrical power and they both plug into the POWERBASE which regulates the voltage and has a 12V outlet. The POWERSTICK and POWERBASE are shown in Figure 1.

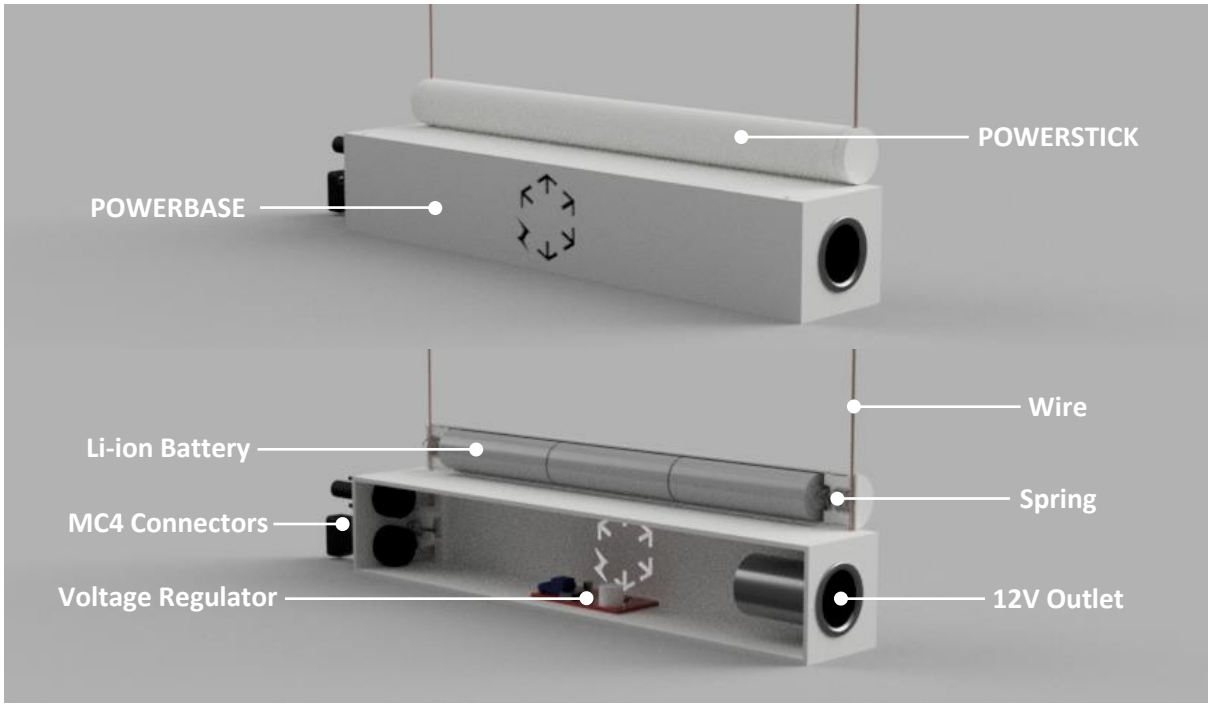

Figure 1: The POWERSTICK and POWERBASE

The world's biggest problems are the greatest business opportunities. This generation is defined by the dual crisis of climate change and global poverty. The POWERCUBE unleashes the potential of the poorest billions by empowering them with the technology of renewable energy. The poorest four billion people represent a US$13 trillion-dollar market (Prahalad, 2004). 1.2 billion of them have no access to electricity meaning there is literally no competition (International Energy Agency, 2018). Which stands in stark contrast to the saturated western home solar battery market. Those who purchase the POWERCUBE will get richer and thus have more money available to spend on upgrading their systems, creating a virtuous cycle.

Finance

The idea is simple. Use the technology of the Tesla Powerwall but make the module size as small as possible so as to make the initial cost affordable to slum dwellers. As can be seen in Figure 2, a two orders of magnitude decrease in initial cost has been achieved against the next closest competitor. However, Figure 2 also shows that the cost per kwh is also cheaper than competing brands such as the Powerwall. The large number of competing products demonstrates that the home battery market for developed countries are a red ocean and it is uncertain that the POWERCUBE's significant differential of lower initial and total cost will enable it to succeed in this market.

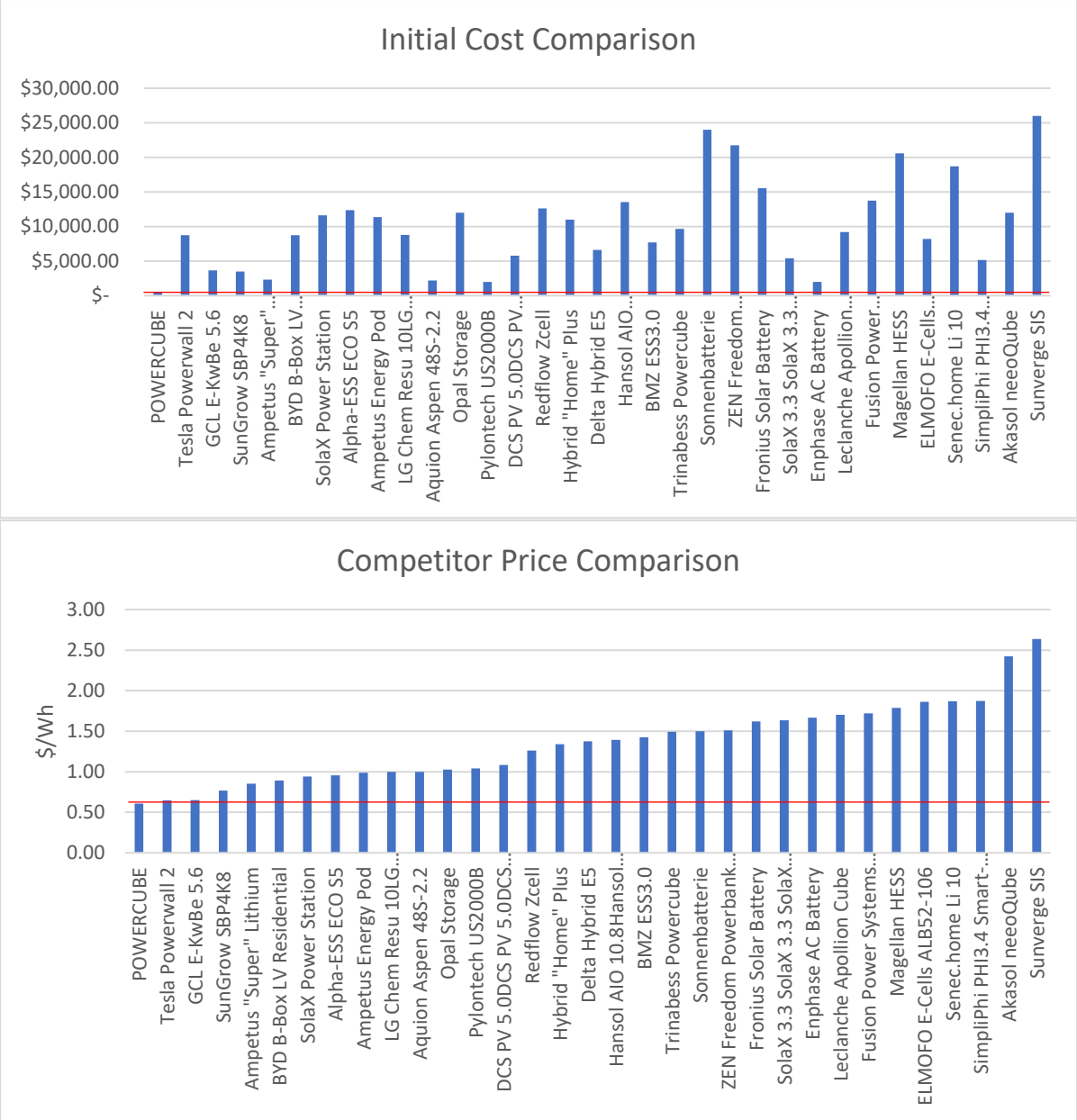

Figure 2: Cost comparison between the POWERCUBE and competitors (Solar Quotes, 2018).

The POWERSTICK and POWERBASE will be sold for $20 each (all prices in this report are in Australian dollars unless otherwise stated). The material cost breakdown can be seen in Figure 3. Note that 95% of the cost of the POWERSTICK is the cost of the Li-ion battery. Two factors will greatly reduce this cost. The first is buying batteries in bulk and optimizing the supply chain. The second is the experience curve for Li-ion batteries shown in Figure 4 which is responsible for the exponential decrease in Li-ion battery price. The experience curve states that the more that something is produced the cheaper it becomes to produce it. For Li-ion batteries every ten times increase in global production results in a 21% decrease in cost.

Also note that the casing cost is significantly cheaper than could be achieved using injection moulding technology. The casing will be mass produced on 3D printers enabling local manufacture and a low capital pathway to developing manufacturing capacity. A Tronxy X1 3D printer costing $165 (Gearbest, 2018) can produce 12 POWERSTICK casings a day resulting in a pay-back period of three days. If the initial profits from sales are used to buy more 3D printers then an exponential

increase in manufacturing capacity can be achieved with a doubling time of three days. To put this into perspective after one month of exponential growth a production capacity of 12,000 POWERSTICK cases a day is achieved. 3D printers also have an experience curve resulting in exponentially cheaper printers in the future (Worstall, 2012).

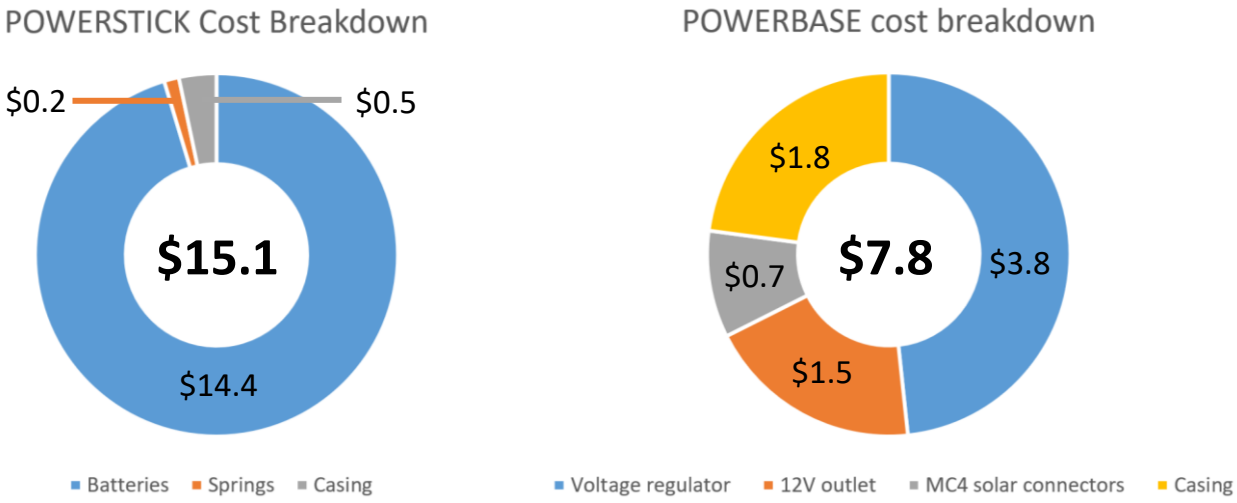

Figure 3: POWERCUBE Component Cost Breakdown (all prices in AU$)

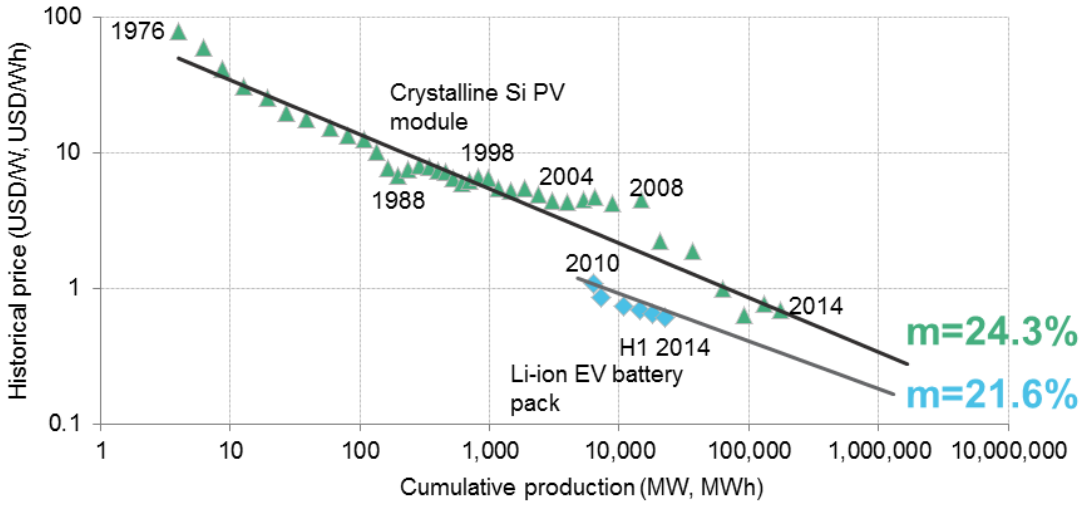

Figure 4: The experience curve of solar panels and Li-ion batteries (Liebreich, 2015).

The Product

The POWERCUBE system runs on 12V. This voltage is safe, enables small module size and has a wide range of appliances. Because it is safe it enables do it yourself installation without the potential for harm. In fact, it is impossible to incorrectly assemble the components, for example if the end user tried to plug the MC4 solar connectors in the 12V plug it just wouldn't work. This reduces costs and avoids the need for written instructions, important considerations for slum communities. Due to the popularity of camping and caravanning an increasing range of 12V appliances are being developed. These appliances cover all the needs for modern living such as led lighting, computer and phone chargers, fans, microwaves and kettles for cooking, etc. These appliances are easily accessible to slum dwellers and will considerably increase quality of life providing significant motivation to purchase the POWERCUBE system. Inverters costing $0.09/W can be placed between the

POWERBASE and the appliance to provide higher voltages (Yueqing Jyins Electric Technology Co., Ltd., 2018).

The POWERCUBE system can be integrated into any existing solar panel installation to provide battery storage. Solar panels use MC4 connectors, which can be plugged directly to the POWERBASE. The capacity of a POWERBASE is enough to regulate the voltage of one full sized solar panel. This means that the POWERCUBE can be sold separately to the solar panel.

The POWERCUBE uses Li-ion batteries because they have a much higher energy density and specific energy than any other battery (Figure 5). The price of Li-ion batteries decreased 80% in the last decade and because of the experience curve this trend is likely to continue (Figure 4). However, it should be noted that if a better battery chemistry is developed, a 3D printed casing can easily be produced to fit its form factor.

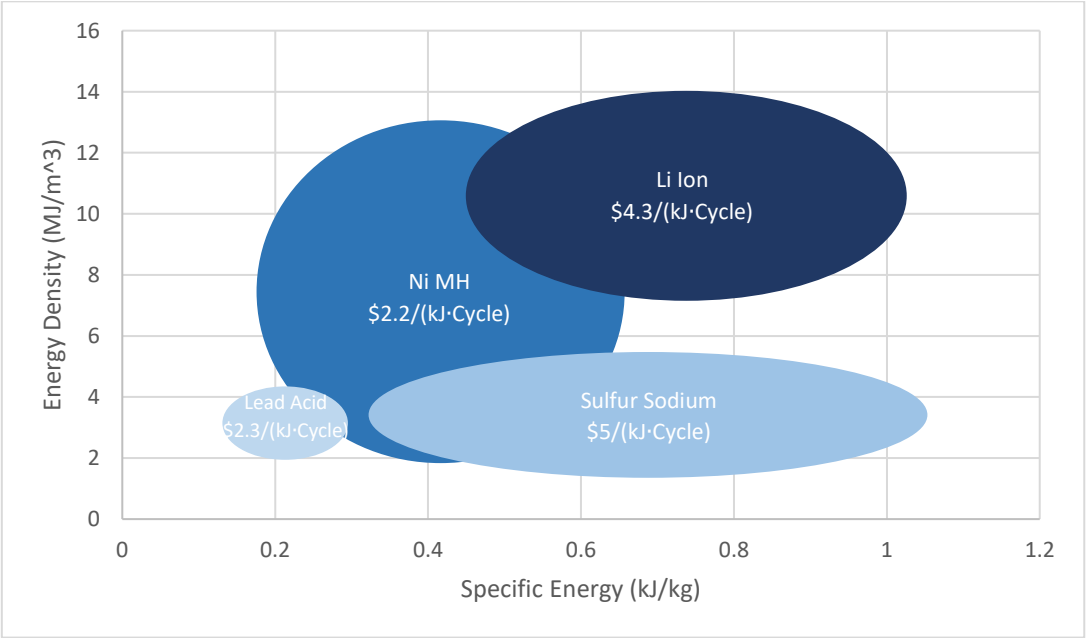

Figure 5 Specific Energy vs Energy Density for different battery chemistries (CES Edupack, 2016).

Out of the range of Li-ion batteries the specific type NCR18650B was chosen. The NCR18650B is manufactured by Panasonic and represents a good compromise between large total capacity (3.2Ah) and high discharge current (4.8A) (Panasonic, 2012). NCR18650B are used in Tesla cars and Powerwalls (Panasonic, 2015). These batteries are bought direct from China through Shenzhen Haiengdi Technology Limited at a price of US$3.80/ea. Recycled batteries from old laptops are a potentially cheaper option if a good supplier could be found.

Suppliers and Distributors

Contact has been made with suppliers and distributors. Components such as the Li-ion battery and voltage regulator chip are bought from Chinese suppliers through Alibaba due to their high quality, low cost products and excellent customer service. I have made contact with Pollinate Energy, who sell solar lights to Indian slum communities, and William Electrical, who installs solar battery systems in the Solomon Islands. Both companies are interested in selling the POWERCUBE product. I completed an internship with Pollinate Energy in 2015 where I had the opportunity to survey over fifty slum communities on their energy situation. I saw first-hand how empowering a simple solar

light could be to the impoverished. This experience was the nexus point for the development of the POWERCUBE.

Future Development

Future development of the POWERCUBE company will proceed in four stages: product development, regulatory approval, product sale and Kickstarter campaign (Figure 6).

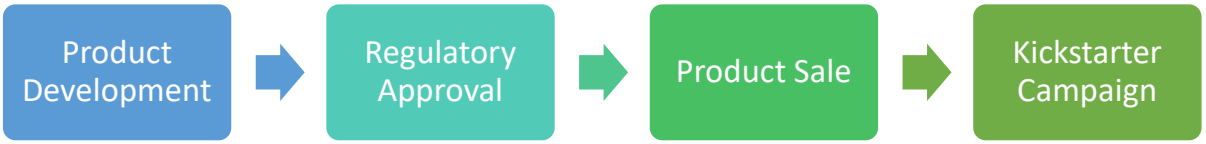

Figure 6: Future Development

1.) Much of the product development has already been completed. To finalise product development, I will personally use the POWERCUBE to power the 3D printers that make the POWERCUBE components. This means I will experience any pain points in the product and will be able to make agile design changes early on. Being able to power 3D printers from POWERCUBEs could be used to gain publicity as well as being an important functionality to reduce manufacturing costs and increase possible manufacturing locations in the future.
2.) Every State and Territory of Australia has legislation requiring electrical products to be approved by the safe electronic products approval mark. To obtain this mark a fee of $660 and a processing time of five days is required. During this time, they test several samples of the electrical product to ensure it passes Australian electrical regulations.
3.) I can make initial sales using contacts that I have already made with Pollinate Energy in India and William Electrical in the Solomon Islands. Initially the POWERCUBE components will be made in Australia and shipped overseas with the exception of solar panels that will be shipped directly from China to the destination country.
4.) The Kickstarter campaign will be launched with the target of campers and the aim of getting global publicity and generating sales. Pollinate Energy is particularly good at producing high quality video and photographic media about their business and could provide media of the POWERCUBE being used in slums which would be very effective in a Kickstarter campaign.

I have no intention of having the POWERCUBE company be a publicly listed company or having the POWERCUBE company be acquired by another company.

Founder Information

I have two degrees, one in Physics and the other in Chemical Engineering that gives me a solid understanding in both the theoretical and practical sides of designing the POWERCUBE. I have also successfully launched a start-up called PRINTORY3D that has sold thousands of mass produced 3D printed products. I've experienced poverty first-hand in both India and the Solomon Islands and I am driven to fulfilling life's purpose of loving God, others and myself by using my entrepreneurial and engineering skills to sell empowering products to those in poverty.

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