(the following is as an excerpt from another document)

Powered by Renewable Energy

To understand the provision of renewable energy for the proposed device, it's important to understand the cost structure of the device and the cost of the energy that powers it. The BOM cost for the proposed device is $400. The total annual energy consumption (as cited above) is 3 kWh per year. If we simply take the wholesale price of solar power ($0.0632 per kWh [1]) over the lifetime of the device (2.5 years), that's 7.5 kWh at $0.474. As a percentage of the BOM cost, that's a miniscule 0.12%. This cost would be incorporated into the cost of the device.

The revenue generated for this purpose is used to offset the energy taken from the grid to recharge the device. Options for doing so include a personal solar charging station, construction of large-scale solar energy collection facilities, subsidization of residential solar, or others. Each are explored here.

Personal Solar Charging Station

Development of a solar charging station means the creation of a separate product with its own BOM and R&D costs. The device must be capable of collecting solar energy during the day, storing it, then recharging the user's device at night. Suppose, then:

Table 1 - Personal solar charging station design parameters. Amounts as shown.

Device Battery Capacity	2	Ah
Battery Voltage	3.77	V
Device Battery Capacity	7.54	Wh
Solar Energy Constant	1366	W/m^2
Solar Panel Efficiency	15%	
Daylight Charge Duration	6	hours
Charging Circuit Efficiency	75%	

Based on these assumptions, we can calculate that a solar charging station will need a solar panel with a total area of 0.008177 m^2, and a battery with a 2.67 Ah capacity. The bill of materials is approximately:

Table 2 - Personal solar charging station bill-of-materials. Amounts as shown.

Solar Panel	$10
Battery	$8
Assorted Circuitry	$5
Enclosure	$5

[1] Solar Electricity Costs http://solarcellcentral.com/cost_page.html

Total	$28

At this point, we've deviated far from the goal. The goal was to provide 7.5 kWh at wholesale rates. With a personal solar charging station, we have an additional SKU with its own BOM and associated R&D costs. However, by far the worst aspect of a personal solar charging station is how it's used.

People are accustomed to charging their devices via the wall outlets in their homes. The customer typically charges their device on a nightstand while they sleep. A solar charging station is an entirely different proposition. First, it must be placed in direct sunlight. Then, either a cord must be run to the nightstand, or the convenience of charging on the nightstand must be sacrificed. Worse, if the customer is travelling, they must bring their solar charging station with them. Imagine a bunch of solar charging stations cluttering an airport terminal. It's ridiculous. So, the personal solar charging station is ruled out.

Large-Scale Solar Facility

Let's consider construction of a large-scale solar facility. Assuming a population of a million units that each consume 3 kWh per year:

Table 3 - Large-scale solar facility design parameters. Amounts as shown.

1,000,000	Units
3	kWh/y
3,000,000	Aggregate kWh/y
8,766	Hours Per Year
31.8%	Solar Duty Cycle[2]
2,790.3	Charging Hours
1,075.2	kW Capacity
1.1	MW Capacity

A solar facility with a 1.1 MW capacity would collect enough energy to power the entire population. Assuming a capacity cost per watt of $2, this equates to a per-unit cost of $2.15.

Amortization of Solar Energy Collection

Why have we calculated $2.15 per unit when the wholesale cost of solar was only $0.474 per unit above? The answer is that the wholesale cost of solar is calculated based on the entire lifespan of the collector. For example, let's assume the solar panel is used over a period of ten years. Our design lifespan for the device is only 2.5 years. Our customer is therefore paying for 7.5 years of collection which they don't need. To solve this, we amortize the collection of energy over the ten-

[2] $1 / \pi$, derived from calculating the average of sin(x) over the range of $(0, \pi)$ and dividing by two. This is simply an estimation of the amount of direct sunlight that falls on a given point on the Earth's surface.

year period. Therefore, instead of needing 1075.2 kW of capacity for 2.5 years, we need 268.8 kW of capacity for ten years. As such, the per-unit cost is $0.5375, which equates to $0.0716 per kWh. In line with typical rates.

The device-to-collector lifespan ratio may be adjusted or applied non-linearly over time based on strategic or financial goals. For example, considering the downward price trend of photovoltaics, it may be beneficial to construct capacity later rather than sooner. Alternatively, if collector costs are largely influenced by economies of scale, a large up-front purchase might be prudent. Regardless, it is paramount for marketing purposes that customers are able to verify our efforts to provide renewable energy for their device. Construction of a big ass solar facility prior to product launch would do wonders.

Providing renewable energy by building a large-scale solar facility also has issues. First, the collected power must get to each unit somehow. Obviously, building a separate grid is out of the question. Charging batteries and shipping them to the customer is similarly absurd. We could possibly dump the energy directly onto the grid to offset energy taken off the grid to charge the device. However, while dumping energy onto the grid is technically feasible, accommodation of business arrangements in power distribution is non-trivial. For example, in 2016, the state of California had to pay the state of Arizona to take excess power so as not to overload the California grid.[3] To reasonably dump energy onto the grid, arrangements must be made with utilities to distribute this power. Further, it's critical that any energy added to the grid offsets energy derived from carbon-based sources. If it does not, our efforts will be wasted.

Subsidies for Residential Solar

What if there were a way to provide collected energy nearer to the point of consumption, supplant the use of carbon-based energy, and complement NameBrand Inc.'s other businesses? As it turns out, there is a way. If the revenue generated for creating renewable energy for the device were used to rebate residential solar installations, these things are all achieved in concert. First, the power is generated nearest to the point of consumption; no agreements need to be negotiated with utilities, and carbon-based energy usage is preempted. Second, NameBrand Inc.'s residential solar business is complemented by reducing its price. It should be noted that while device unit sales remain modest (one million units), the per-solar-installation subsidy is very small. However, as the device-to-residential-solar-installation ratio increases, the per-installation subsidy increases.

Table 4 - Residential solar installation rebates vs device unit sales. Amounts as shown.

Energy Cost / Device	Unit Sales	Total Energy Revenue	Solar Instl's	Ratio	Solar Instl Rebate
$0.5376	1,000,000	$537,576	100,000	10	$5.38
	5,000,000	$2,687,879		50	$26.88
	25,000,000	$13,439,394		250	$134.39
	50,000,000	$26,878,787		500	$268.79
	100,000,000	$53,757,574		1,000	$537.58

[3] "California invested heavily in solar power. Now there's so much that other states are sometimes paid to take it" Ivan Penn http://www.latimes.com/projects/la-fi-electricity-solar/

While BOM costs must be strictly controlled to protect profit margin, the component cost of energy per device could be arbitrarily increased to increase the solar installation rebate. 2x-5x could be easily sustained. 10x would be a bold move that would dramatically increase the subsidy. Basically, the pricing power of the device is being leveraged to subsidize residential solar.

About

I am an engineer, inventor, angel investor, and executive producer. I built the most successful products of all time during my career at Apple. I was a team member on the original iPhone and have contributed to every iOS device ever made. I founded Blit It Inc. in 2014 to advance the cause of consumer 3D printing. I am the executive producer of Aubrey Logan's debut album, "Impossible." I am passionate about technology and driven to give meaning to life by making the world a better place.

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