LITHIUM ION POWERED BY SOLAR WILL OBSOLESCE GASOLINE

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Abstract

Traditionally the global economy has been fueled by oil, and oil companies have dominated the lists of the world's largest companies by revenue for decades. They have generated trillions of dollars by drilling, refining and making oil based products. Even though applications of oil such as gasoline for vehicles are being replaced by electricity (as in electric powered vehicles), the electric charge required to fuel these vehicles is still majorly produced by fossil fuels such as oil. Renewables have been an alternate source of generating electricity for decades but have suffered from the fact that the options to store the generated electricity have been prohibitively expensive especially compared to the ease of storing oil. However, renewables now have a material for storage – Lithium Ion - that has made it economically feasible to store their generated electricity. Also, with the world increasingly turning to renewable energy sources, demand for electrical storage and lithium is projected to boom and Governments around the globe are making legislation and regulations to enforce the use and purchase of electric vehicles to reduce the carbon footprint created by gasoline powered vehicles. Therefore, a renewable energy based electric vehicle (EV) charging value chain is expected to gradually displace the oil based gasoline value chain in the coming years. This is especially true for a solar based EV charging value chain which will shift the value from upstream to downstream processes (energy generation/storage/charging) as demonstrated in this paper.

1. Introduction

In this paper we draw an analogy between the gasoline value chain and the solar powered Electric Vehicle (EV) battery charging value chain and we compare the value added at each stage of the two. We also consider the projected global growth in electric vehicles and the resulting demand for Lithium Ion batteries, and make a case for solar powered EV charging stations by explaining its benefits which will drive this shift from gasoline to solar based charging. This paper also estimates the solar capacity that will be required to power these vehicles assuming that the bulk of the electricity produced in the near future will be powered by solar instead of fossil fuels.

2. The case for solar based EV charging

The global market for EVs (Electric Vehicles) is expected to grow rapidly *(figure 1)* to 10 Million vehicles per annum by 2025 and 42 Million vehicles per annum by 2040 thereby driving demand for batteries *(figure 2)*. Among battery technologies, Lithium Ion is most preferred due to its high energy density and cost efficacy. However, the purpose of electric vehicles (to lower carbon footprint) is defeated if the electricity used to charge the vehicle is generated using power from plants that burn fossil fuel.

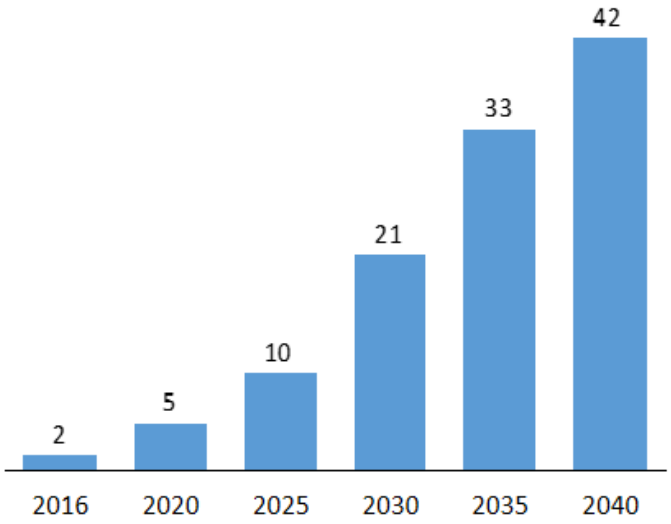

Figure 1: Estimated global Electric Vehicle sales. [1]

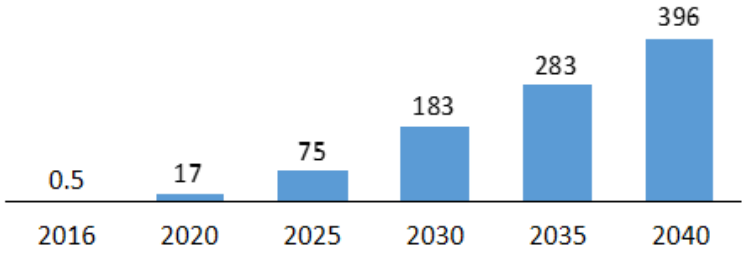

Figure 2: Estimated global EV battery demand (GWh). [1]

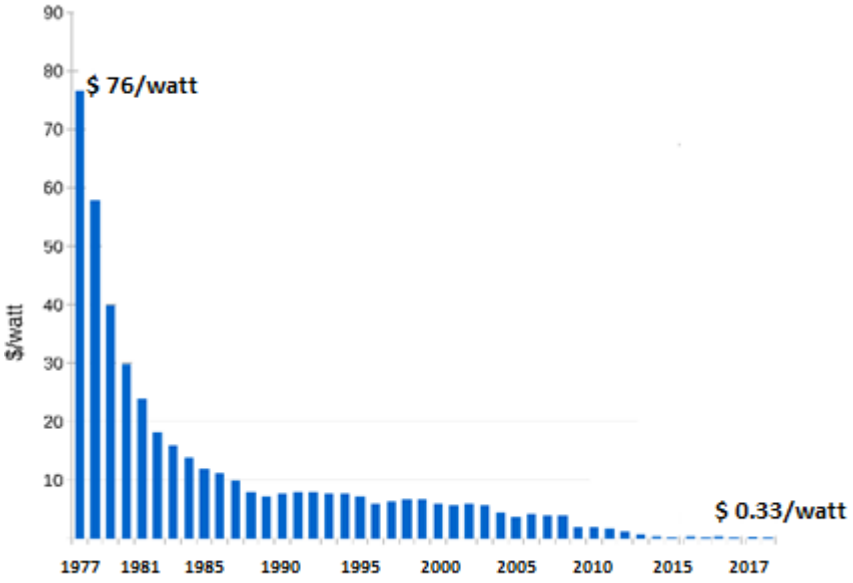

Figure 3: Price history of Silicon PV Cells. [1],[2]

The falling prices of solar cells *(figure 3)* has led to the rapid adoption of distributed solar PV systems. EV charging with solar presents a highly compelling value proposition for the rapidly growing EV market. The many benefits offered by solar based EV charging are:

- Directly charging an EV with Solar power is a complete zero emission solution, which will ensure that the EV revolution does not simply shift the pollution from the car's tailpipe to the coal plant smoke stack. Simply increasing number of EVs on the road without a simultaneous migration of electricity generation to clean sources such as solar will not achieve the core purpose of shift to EVs
- Ability to store electricity or charge vehicles using distributed generation assets minimizes the losses related to electricity transmission.
- EV owners can set up their own charging points according to their convenience. Many households already utilize distributed solar to generate energy, portion of which if unused is exported to the grid for credits, which can instead be used to charge EVs.
- It also acts as shade for parking in open spaces. People park their cars at office parking lots during the day, which is the perfect setup for this proposition.
- Solar can enable direct DC charging for a fast charge supported by a stationary battery at the charging station. Use of fast chargers can help during peak hours. It can help meet peak demand that occurs during the periods maximum customer inflow

3. Value chain comparison

To compare the gasoline value chain with the solar based EV charging value chain, an analogy has to be created choosing a suitable metric for each chain. Cost/litre is the metric for the former while cost/kilo watt hour (kWh) is the metric for the latter. We will also need to establish an approximate equivalence between litre and kWh ie how many kWh could produce the same mileage for an EV as one litre of gasoline can produce for a gasoline powered car. Based on simulations run for mileage of different gasoline and electric car types in Indian road conditions , one litre of gasoline was found to roughly produce the same mileage for a gasoline powered car as 5.2 kWh of charge would produce for an average Electric Car. Therefore to compare the solar powered EV charging value chain with the oil value chain on a per litre basis, we will need a 1 kW PV system and a 5.2 kWh battery.

3.1 The gasoline value chain

Crude oil is the raw material for gasoline in its value chain and the price of crude fluctuates regularly making it is the most important variable in the price of gasoline that consumers pay. The upstream portion of the gasoline value chain (production of crude) accounts for over 60% of the total value in the chain *(excluding taxes)*. The next process which is refining of crude to

create products such as gasoline accounts for over 25% of the total value. The downstream portion of the value chain which is transportation/distribution/retail of final product accounts for a little over 10% of the total value. Therefore, most of the value in the gasoline value chain lies in the upstream processes.

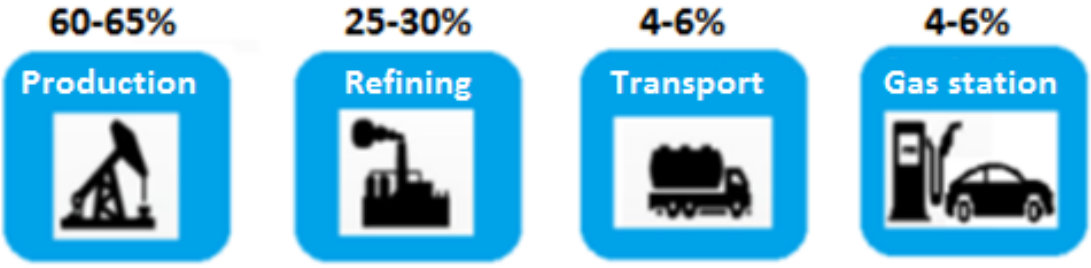

Figure 4: Breakup of cost of gasoline at pump (excluding taxes) [3]

3.2 Solar powered Electric Vehicle charging Value Chain

To charge EVs using solar power, we will have to analyse two value chains – the value chain of the solar PV system used to generate power for charging, and the value chain for the battery used to store this power. The consolidated value chain (PV and battery) along with a final step, which involves adding balance of systems (wiring, switches and structure) and charging infrastructure (plugs etc) for the assembly and installation of the charging station, forms the complete value chain for a solar powered EV charging station.

In the solar PV value chain, polysilicon has to be extracted from sand, which is then melted and shaped into ingots which are then sliced to produce wafers. In the next step these are coated to produce solar cells which are then put together to form solar modules where most of the value is created in this chain.

In the battery value chain, several raw materials are used to manufacture cells. Electrolytes such as Lithium, and materials for electrodes such as cobalt and graphite. Next electrodes are manufactured and they are stacked against each other using a separator and placed in the electrolyte to form cells. In the last step ie Packaging, cells are stacked together to form modules which are finally placed in battery packs to form the battery. This step also includes addition of thermal management system and battery systems and this is the highest value step in the chain.

When we combine both the value chains, (considering the first two steps in each value chain as one to classify them as inputs), and adding the final step as described previously; the breakup of value for the solar powered EV charging station is as shown below *(Figure 5)*. When compared with the gasoline value chain, most of the value in this chain lies in downstream processes which are electricity generation, storage, and charging.

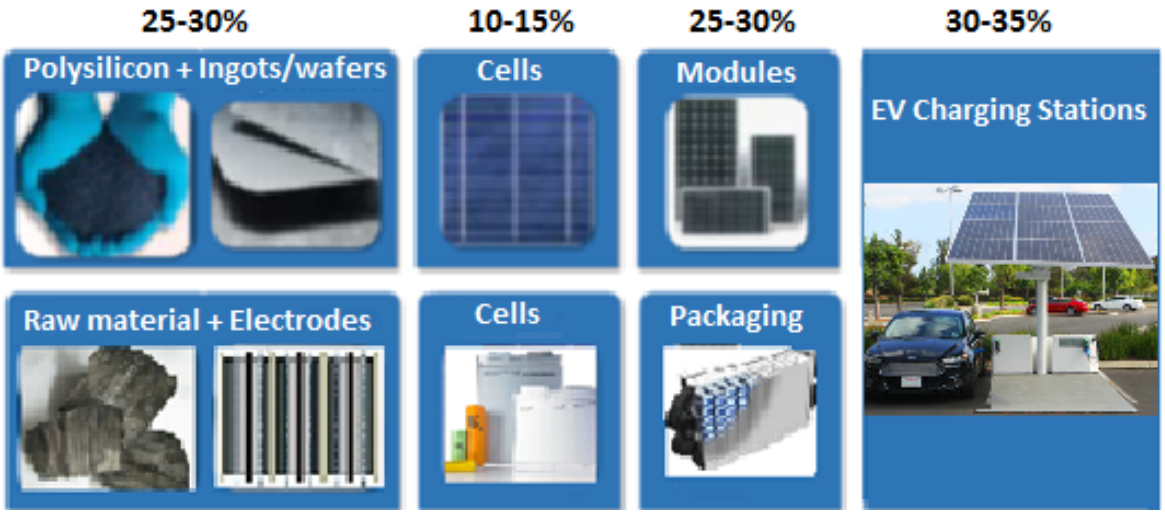

Figure 5: Breakup of solar powered EV charging value chain

4. Conclusion

Most of the value in the EV dominant world would be in the downstream solar electricity generation (distributed and centralized), storage and charging solutions. This will create a huge market for solar companies as well as battery manufacturers. Assuming 80% of vehicles shift to electric power, then based on current numbers the size of the market in kilo Watt hours will be ~ 9.1 trillion kWh/ year. [4],[5] If another 80% of this is powered through solar (Distributed solar + Large Centralized Power Plants), then solar capacity required would be 4.8 TWs just to power EVs.

References:

[1] Bloomberg New Energy Finance (BNEF)

[2] PV Energy Trend

[3] Commodity HQ

[4] British Petroleum, Statistical Review of World Energy 2017

[5] Center for Climate Change & Energy Studies, Total Energy: Monthly Energy Review