

# Competitive Advantageous Green Energy Technologies - Photovoltaic, Geothermal & Wind

Shiva S. Hullavarad\* and Nilima V. Hullavarad

Advanced Materials Group, Institute of Northern Engineering,  
University of Alaska Fairbanks, Fairbanks, AK, USA 99701, \*[shiva.h@alaska.edu](mailto:shiva.h@alaska.edu),  
[nvhullavarad@alaska.edu](mailto:nvhullavarad@alaska.edu),

## ABSTRACT

Green Energy technologies are now poised to be a great avenue for the economic superiority by developing disruptive technologies to address energy needs. Solar, wind and geothermal are some of the renewables that are being used across the globe for energy production and diversify the existing energy portfolio. However, the cost of energy production from the renewables exceed that of energy produced by coal and gas, thus pushing the users, energy producers, energy explorers and policy makers into a dilemma of renewable energy adoption. This paper provides a materials based study on how the green energy technologies can be advantageous over the non-renewables and key competitive advantages that can be understood on 12 dimension offerings.

**Keywords:** Photovoltaic, wind, geothermal, innovation radar

## 1 INTRODUCTION

The objective of this study is to develop the understanding on how the renewable energy can be distributed over wide dimensions and to identify the changes in trends of non-fossil fuel energy industry demand, growth and opportunities. The study uses the databases such as patents, news events, income/financial statements to assess the company status and the track record of the industry. The research is based on the methodology of Innovation Radar developed by Sawhney et.al [1] to evaluate the placing of the leading company and design in photovoltaic, geothermal and wind renewable energy industry. The study also encapsulates the maintainable competitive returns of some of the successful companies in the energy sector. The correlation of the gains in innovation tripartite (product, process, business) to the corporate competitive advantage is discussed. The companies selected here are based on the innovations leading to improve the process, product and also business aspects.

## 2 APPROACH

This research focuses on photovoltaic, geothermal and wind sectors and maps these industries through innovation

radar. Photovoltaic industry focuses on effective conversion of solar light to electrical power through recombination of electrons and holes in semiconducting materials. The key components for the solar energy sector are increasing the efficiency of solar cells above 45%, cost and power storage. Geothermal sector is focusing innovative approaches that can safely and economically extract and convert heat from untapped geothermal resources. The key components for geothermal sector are identifying the geographical locations to provide maximum thermal gradient, efficient turbines and power transmission. Wind sector focuses on capturing the wind energy through propeller like blades to generate electricity and feed into the utility grid. The key components for wind sector are design of stronger and lighter blades through innovations in materials, efficient wind to electrical conversion systems and installation logistics.

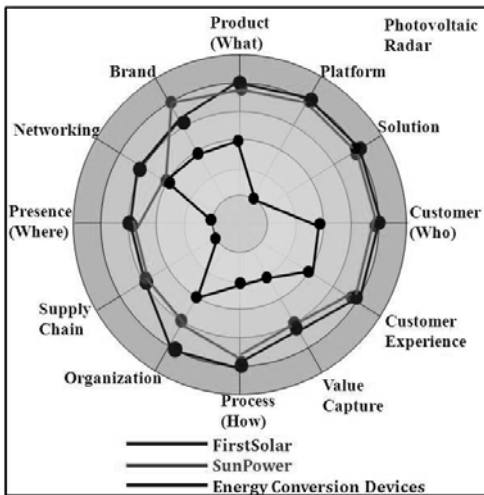
Comprehensive studies were carried out based on innovation tripartite process, product, and business corresponding to efficiency, functionality and value creation, respectively. The important factors in this study are; an overview of each field to figure out the actual level of novelty in each element studied here, influential procedures to understand activities or factors that contribute to the observed level of innovativeness. The innovation radar provides a quick glance on the overall tendency of a company's ability to provide incremental or significant benefits by addressing the 12 key dimensions through innovations. Innovation radar is divided into 5 concentric circles to represent the level of innovativeness and each point (rating on scale 1-5, going outward) represents a particular company's position on a particular dimension. The envelope of these points provides the bird view of company's competitive advantage through innovations in 12 key dimensions.

## 3 ANALYSIS

### 3.1. Solar Nano-Photovoltaic

Photovoltaic (PV) materials when exposed to sunlight creates electron-hole pairs. Since the limitation of using silicon in photovoltaics have reached, there is a need for materials with suitable energy band gap. Nanostructures of different materials exhibit enhanced photovoltaics' properties. The vital parameters investigated in the PV

technology are high short circuit current density and open circuit voltage from the materials that are used as photo conversion materials. The efficiency of silicon solar cell is ~44%, CdTe solar cell is 18% and CuInGaSe and Organic materials is 6% [2]. We have shown in a separate study that efficiency of CdTe, CuInGaSe and Organic materials can be improved by synthesizing nanmaterials. Based on the three broad categories of crystalline Si, CdTe, CuInGaSe and Organic, the PV industry was scanned to identify the technologies focusing using above materials systems. The companies that match well with the methodology and criteria are Energy Conversion Devices, Inc., SunPower Corporation (Si based) and First Solar Inc. (CdTe based). There have not been any PV companies that feature commercialized product in organic PV materials. **Figure 1.** shows the innovation radar detailing twelve different aspects on which the company's progress is dependent on.



**Figure 1:** Innovation radar for the Photovoltaic industry.

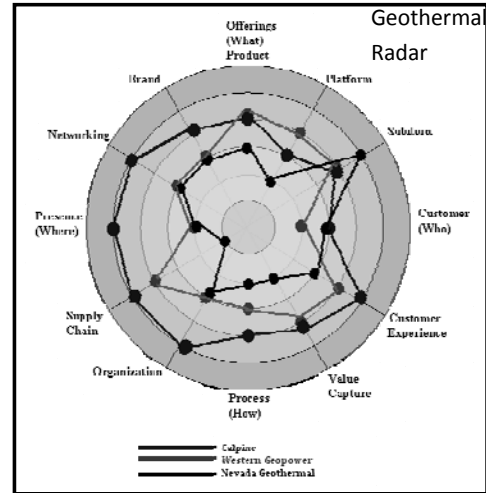
It is clear from the innovation radar that the companies have varied technology focuses and approaches that separate them in some of the dimensions. The competitive advantage the PV industry has to offer is in the areas of supply chain and the value capture.

### 3.2 Geothermal

The major driving force in the geothermal research [3] are; location of reservoirs, power plant's fluid treatment, drilling and maintenance cost, and low temperature efficient power plants. Understanding the heat physics and hydrodynamics of systems are the vital components. Enormous data in mining engineering have contributed to the successful implementation of geothermal plants. We selected three companies Calpine, Western Geopower and Nevada Geothermal for comparative studies. These companies have incorporated efficient geothermal heat utilization for effective diversification of energy portfolio

and have established complimentary assets at their disposal to offset and leverage research and development, exploration and implementation related expenses.

**Figure 2** shows the innovation radar on the geothermal energy. From the innovation radar it is estimated that there is need of consumer awareness and brand equity.

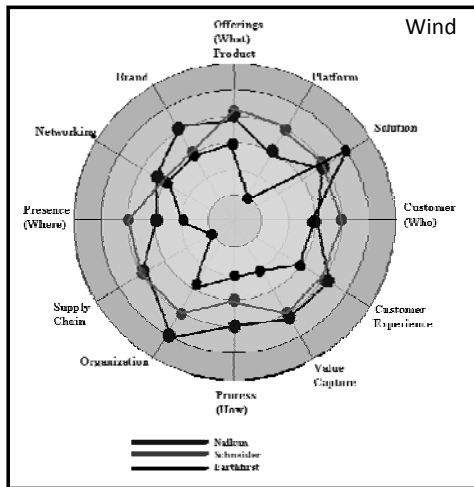


**Figure 2.** Innovation radar for the geothermal industry

The process needs to be more efficient although the product innovation does not have much impact. The industries studied here suggest that there is a need for novelty in establishing the presence of geothermal locations to figure-out the wealth of geothermal resources.

### 3.3 Wind

The major challenges faced by wind energy areas are; installation and maintenance of very large turbines, power transmission and adoptability. Typically, new designs and smart operations involving automatic trouble shooting are crucial to reduce maintenance and repairs cost. New system designs with improved material systems are always in demand for places having less wind. Unbalanced grid voltages influence the induction generators through torque pulsations and irregular currents, thus affecting the installation of wind turbines. From the innovation radar seen in **Figure 3** for the wind energy, it is observed that there are issues with the customer base, platform, and supply chains. Improvements in these sectors would enhance the outcome.



**Figure 3.** Innovation radar for wind industry

### CONCLUSIONS

The studies based on innovation radar for three sectors; wind, geothermal and solar energy suggest that although there are vigorous innovations in non-fossil energy, still there is lot of scope for improvement. PV industry demonstrate discrete competitive advantage over the geothermal and wind sectors. Thus, there is a need for further in-depth investigations in the fields of wind and geothermal energy sectors. The new energy economic policy gives hope for improvement in the green technology.

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