Original Research Article

Bharat's Solar Energy : An analysis using Porters Diamond Model with a brief on Ancient Past for Environmentally Sustainable Competitive Advantage

ABSTRACT

Objective of this paper is to analyze solar energy as environmentally sustainable area of competitive advantage for Bharat using diamond model with a brief on its ancient past. Bharat is time tested philosophy and culture. Ancient genesis of Bharat was scientifically strong, economically prosperous and socially enlighten with Sun being the centripetal force. Bharat's solar energy industry is in developing stage. Its ancient vedic school system explored "Pancha Bhuta" (five elements) as sun, space, water, air and earth giving knowledge to conduct life cordially in coexistence with these elements. Upon analyzing environmentally sustainable areas using diamond model it is found that Bharat is in advantageous position in area of solar energy.

On solar energy front it is found Bharat has taken big leap with an objective of achieving 175 GW installation by 2025 of which 100 GW was achieved by 2020. Technological factor conditions PV and CSP of Bharat are highest in world and it stood second in 2017 on "Renewable Energy Attractiveness Index". Geographical condition of four to seven kWh/m^2 per day of solar energy is very favorable. Huge demand growth of 1118 Mtoe by 2025 to 1921 Mtoe by 2040 is driven by large solar energy corporations as front runners. Challenges to be addressed are grid connectivity, de-centralized production and consumption. To counter the perils of global warming, exploring solar energy as one of the environmentally sustainable areas is mandatory. Bharat can lead this race by creating competitive advantage derived from active support of government, innovation of low-cost solar technologies, present technologies and vedic history footing towards a sustainable future.

Keywords: Bharat; Diamond model; sustainable environment; competitive advantage; solar energy; vedic.

1. INTRODUCTION

1.1 Environmentally Sustainable *Competitive Advantage of Solar Energy f*or Bharat

The danger bells have already begun, summer 2021 temperatures amazingly reached 50 degrees Celsius at some places in Canada and USA, heavy floods in Europe and Asia,

prolonged drought in Australia, snow fall in Brazil, record melting of ice sheets in North Pole. NASA forecasts average rise in sea levels to 3 feet by 2040 bringing disaster to scores of cities across globe. Presently the challenging task for governments is to work on environmentally sustainable society under the conditions of vast industrialization and urbanization. Carbon emission is a major issue being pursued by United nations framework convention on climate change by Kyoto Protocol. The key areas of concern are greenhouse gases, non-renewable energy source emissions, industrial process/wastes and modern agriculture practices [1, 2, 3] view China, India and USA are major contributors. Coal in particular is widely used for power production in Bharata [4, 5] also across world [6], hence governments should continue aggressive solar energy policy. In the pretext of hue and cry on carbon footprint, many experts suggest minimizing use of electricity, phased shifting to solar energy production, subsidies and incentives, technological innovations, people and community awareness. [7] presented views of both pro urbanization-environment and only pro-environment.

[1] view worldwide there is awareness among governments for climate change, [8, 9] confirm similar view. [5] say several nations have designed environmentally friendly policies and practices. Keeping this in view Bharat is committed to address these issues at top of the mind [4] with a pledged to reduce carbon emissions approximately 35% by 2030 [9]. In the latest development at G20 summit in Rome, global leaders agreed to limit global warming by 1.5 Celsius. In Glasgow climate change conference 2021, prime minister of Bharat Narendra Modi had promised the country to achieve net zero carbon by 2070.

[7] highlighted definition of sustainable development given by World Commission on Environment and Development, 1987 *as* "development that meets the needs of the present without compromising the ability of future generations to meet their own needs", [2] discussed this definition from the perspective of controlling pollution of a tannery unit. From the point of resource utilization of nations [10] discussed sustainable development as "nation competing for limited resources to raise their standard of living and improving their

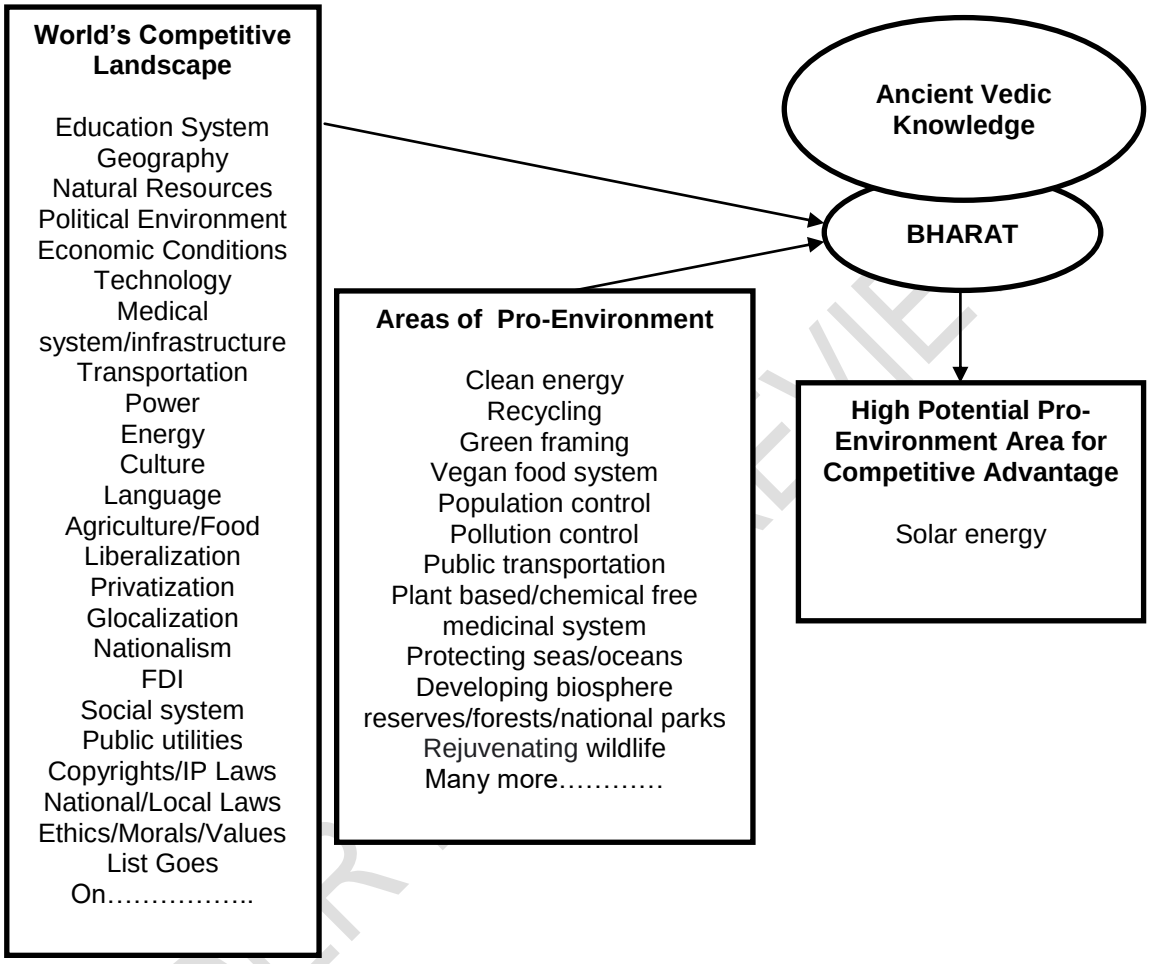
economy". Present study balances between these two definitions and defines sustainable development as, "conducting business by preserving environment for future generations alongside gaining competitive advantage over other nations". See figure 1.

In his book "The Competitive Advantages of Nations" Michael Porter gave "Diamond model"/ "National model" with five factors via firm strategy, structure and rivalry; factor conditions; demand conditions; related and supporting industries; government. This model was criticized since its publication in 1990 [11], but still, it holds solid ground for big nations like Bharat. This discussion starts with government policy triggering business progress, additionally its regulation expected to be compatible and friendly to business organizations. Government policy is ranked on "Ease of doing Business". It also suggests government to play the role of catalyst to speed up the business growth by opening more opportunities. Further the diamond model talks about primary resource factor conditions of a nation; natural resources like oil, coal, water, arable land, minerals and metals, which act as raw material. Resources like capital/manpower as inputs combined with technical/scientific know-how and machines for industrial and service output. Supporting industries play an important role in the success of the large industries. Abundant domestic market gives opportunity for the companies to access customer base to gain hands on experience with the products and services. As the experience curve improves, export market is targeted. As industries reach growth stage, new competitors enter the market to intensify it, companies re-design their strategies for gaining edge. Chance factors; disruptive technologies, natural/man-made disasters will affect industries randomly.

Presently Bharat also faces critical problems as higher carbon emission, depleting coal reserves, dangerous chemical release due to coal energy, lifestyle and health issues leading to unsustainable future. In light of these issues, this paper discusses present policies, troubleshooting strategies initiated, extent of achievements and future plans in solar energy, also it discusses how Bharat should mine back knowledge from its ancient past to achieve

environmentally sustainable competitive advantage and contribute at global level to be "Viswa guru" (global teacher).

Figure 1. Environmentally sustainable development for competitive advantage of Bharat



Important contribution of this study is explore solar energy a contemporary environmentally sustainable area, analyzing it using "Diamond Model" which is a fit for Bharat's case and advocating gain of competitive advantage. Discussion in successor sections analyzes how Bharat is performing presently on solar energy industry using diamond model; on how it can progress in future course and a brief on glorious ancient past related to sun and solar energy.

1.2 Ancient Past of Bharat and Importance of Sun

From ancient past “Sun” is considered as one of the important gods in Bharat. Everyone in Bharat does morning and evening salutation to Sun known as “Suryavandanam and Sandyavandanam”, [12] informs about the description of power of Sun useful to humans in Rigveda. Following are the select areas whose centripetal force is Sun.

Astronautics - [12] discussed propulsion, solar electricity and chemical reaction being reported in “Vaimanika Shastra” (astronautics compendium) dating back to the period of Ramayana. “Tripura vaimana” is a theory which explains how a large aircraft works on the principles of solar rays [13].

Domestic use - According to [14] there are numerous evidences of Sun being considered as a sign of heat, light, energy, power, soldier, and energy from Sun was used for various everyday life activities like cooking food, drying and heating [13].

Medical treatments – [15] have found heat and light rays from Sun used in Bharat for various medical treatments. For skin disorders various plant treatments of Ayurveda along with sunlight are used.

Calendar system – [16] discussed the ancient calendar system of Bharat developed based on movement of Sun, further they reveal it is divided into Uttaryana(northwards movement of sun/winter solstice) which is first half of the year and Daksinayana(southwards movement of sun/summer solstice) which is second half.

Buildings architecture – [17] discussed Vastu sastra (science of architecture) an ancient science of Bharat from Atharva Veda to design cites, multiplex buildings and individual homes in confluence with natural elements Tejas (fire), Jal (Water), Vayu (Air), Prithvi (Earth) and Ambar (sky). Sunrise(Uttarayan) and Sunset(Dakshinayan) have great importance and influence on directions and placement of components in architecture.

Temple architecture – Sun is worshiped as an important god from ancient times in Bharat. There are many temples with rich ancient architectural designs dedicated to Suryanarayana(Sun). Prominent among them are Konark Sun temple in the state of Oddisha

got accredited by UNESCO as world heritage site, Dakshinaarka temple in Bihar, Modhera sun temple in Gujarat, Surya Pahar sun temple in Assam, Suryanar sun temple Tamil Nadu, Surya narayana sun temple in Andhra Pradesh, Bhramanya Dev sun temple in Madhya Pradesh, Mortand sun temple in Jammu & Kashmir, Gwalior sun temple in Rajasthan. There are many other temples with Sun as the deity. The architecture of all temples in general is based on Uttaryana and Daksinayana principle giving maximum exposure to sun rays.

To date ancient principles are followed in areas such as Ayurvedic medical treatments for variety of chronic diseases; calendar system for dates of festivals, ritual related to birth, marriage, death; Vastu sastra for building architecture and Agama sastra for temple architecture.

This rich ancient past related to Sun should be considered for spreading awareness among people and communities to adopt Solar energy solutions in many walks of life.

2. MATERIAL AND METHODS

2.1 Solar Energy Industry of Bharat - Diamond Model Analysis

This section presents analysis of Bharat's solar energy industry using diamond model factors viz government policy, factor conditions, related and supporting industries, demand conditions and firm strategy, structure and rivalry.

2.1.1 Government Policy

Presently Bharat generates much of its power from non-renewable sources [5]. Coal is the major source with 55% contribution in energy production [13]. Globally renewable energy initiatives and production have increased by 5% by the end of 2017 with a major contribution by solar at 35% [18]. Government of Bharat has aggressive solar energy policy with many programs launched to increase the production and utilization in both rural and urban markets. It has initiated "National Solar Mission", "International Solar Alliance" and also coined "One Sun One World One Grid" and "World Solar Bank" [19, 22]. In 2013 created an independent ministry under the title "Ministry of New and Renewable Energy [18]. Set an

objective of achieving 175 GW of renewable energy of which 100 GW solar by year end 2022 [4].

2.1.2 Factor Conditions

[20] found the factors of Solar energy to be very significant. Similarly, [21] found copious Solar sources in Bharat with four to seven kWh/m^2 per day [22], tapping this huge potential is a challenge. Economies of scale will help address this challenge to bring down cost of production per unit, and rest will fall in place. [23] view a stronger performance can be achieved with availability of abundant resources giving competitive advantage, similarly [24] discuss utilization of abundant resources gains successful competitive advantage, a similar argument is presented by [25]. According to one study by [26] the projected installed capacity of renewable energy will be 275 GW by 2026-27, which is 24.2% contribution in the overall power need with major contribution of Solar by 243 GW. Another estimate reported by [5] put renewable at 175 GW of which solar with 100 GW by the end of 2022, a similar projection is given by [6]. At the end of year 2018 the total Solar energy installed capacity was 27000 MW across 47 solar parks, similar data is made available by [4]. As per Renewable Energy Country Attractiveness Index 2018, Bharat stands top in the world on technology specific score of 57 and 34 on Solar PV and Solar CSP respectively. By the end of 2017 Solar sector generated 3.37 million direct jobs in the country. One of the big hurdles is acquisition of land for solar projects [9].

2.1.3 Related and Supporting Industries

When an industry become highly competitive within, it gains competitive advantage on many fronts like technology, employees, capacity, supply chain [20]. Bharat has many solar power companies with excellent expertise and global operations. Top 10 Solar energy companies are Waaree, Tata Power, Vikram, Adani, Indosolar, Moser Baer, Microtek, EMMVEE, RenewSys and Icomm. Aditionally the market is supported by organizations like CEL, CELCO [19, 21].

2.1.4 Demand Conditions

Domestic demand is primary for an industry to gain economies of scale, alternatively [20] argues that Porter advised quality rather than quantity of demand. Energy consumption of Bharat is drastically increasing [19] and in consumption it ranks fourth in the world [13]. It is expected to increase by four folds in next two decades. By the end of 2019 the total power generation from all sources reached a whooping 362 GW. Certainly, there is huge potential for clean energy in Bharat [5] but due reachability, availability and encouragement people are not adopting. Companies in power sector opine vast portions of rural areas are not financially viable for distribution and supply of solar power due to distorted demand needs [19]. As migration to urban cities is growing roof top solar program has a huge potential to tap [18]. According to one study by [26] Bharat's primary energy demand is projected at 1118, 1365 1624, 1921million tons oil equivalent(Mtoe) for 2025, 2030, 2035 and 2040 respectively with an average annual growth of 4.2%. (1 Mtoe = 1163000 Mega watt per hour). Renewable energy is projected as 86, 133, 191, 256 Mtoe for 2025, 2030, 2035 and 2040 respectively with an average annual growth of 12%.

2.1.5 Firm Strategy, Structure and Rivalry

For competitive advantage natural energy resources play an important role [20]. Though the other alternative energy sources like biomass, wind, nuclear, hydro, and thermal are available, either sustainability or feasibility of these sources is an issue in terms of production and distribution [22], hence there is ample opportunity for solar energy. According to [4] the country faces a herculean task in renewable/solar distribution as the system is plagued by gird connectivity and losses due to power transmission. To address this issue companies in Bharat have innovated localizable low-cost solar solutions for rural population for regular electricity needs, they already made some inroads into villages [19]. Intangible resources like employees give competitive advantage [24], expertise of manpower in solar industry has achieved great heights and availability is quite impressive.

2.1.6 Takeaway for Foreign Investors

In the renewable energy sector including solar energy, 100% FDI is permitted. Electricity is basic necessity hence it was added in the Constitution of Bharat, hence needed amendments were done to accommodate private participation. Though there is cent percent FDI allowed in solar energy, in order to minimize the investor risk union government has to work with state governments to address issues like land acquisition, tariff's, transmission glitch's, guaranteed agreements with local state power companies and other minor issues.

3. RESULTS AND DISCUSSION

3.1 Discussion - Future of Solar Energy in Bharat

Bharat can play contributing global role in next two decades by gradually progressing on solar energy to create an environmentally sustainable competitive advantage for 22nd century taking inspiration from its rich ancient past and present opportunities.

3.1.1 Government Policy

Government of Bharat is on right track, its leadership is trying to play a contributing role to save planet Earth by continuing with an aim of producing clean energy [26]. It is well-known non-renewable energy sources are creating great amount of carbon footprints, coal in particular is widely used for power production in Bharat [4, 5] also across world [6], hence government should continue aggressive policy on solar energy to become world's largest producer. A bankable policy is needed to penetrate solar energy concept by taking up small segments of geographical location as single unit, Bharat presently has few such segments but needs a full-scale approach. [21] discussed a similar strategy being implemented in Guinea Bissau, Senegal, Namibia and many more countries by companies of Bharat. The RPO (Renewable Purchase Obligation) is expected to be scaled up to 8% from the current 3%. Also need to opt for alternative technologies like solar hybridization, with biomass which is available in abundance, which otherwise mostly goes as waste [22]. Enhance investor

friendly environment to attract foreign direct investment (FDI). FDI can bring both financial and technological capital. The present FDI policy is attractive to the investors.

3.1.2 Factor Conditions

From the point of technology innovation, global environment is dynamic making competitive advantage a lot uncertain due to tight competition and regulations, alternatively some have turned this to sustainable competitive advantage [23]. In an industry, knowledge transformation to innovation which are economically viable will help in driving competitive advantage [25]. On technology front Solar PV and CSP scores are the highest for Bharat. According to Ernest and Young on "Renewable Energy Attractiveness Index" the country stood second position in 2017 [9]. Given this edge it should move forward with continuous innovation and increase solar energy generation capacity to 200 GW and extend the number of solar parks to 100 by year 2030 leading to sustainable competitive advantage. Availability of renewable energy sources are abundant, the challenging task is to maximize utilization [26], which lessens dependence on non-renewable sources like coal, nuclear, diesel, gas and renewable hydro source which are exerting high pressure on environment. There are enormous sources of biomass in Bharat, according to [22] approximately 400 million tons of biomass is available which is potential raw material for hybridization of solar energy. Availability of plain land is an issue in Bharat [9], alternatively land can be explored from rivers. There are nine important rivers which are interconnected by 400 tributary rivers with a total length of 20000 kilometers, this is abundant land space to be utilized for placing solar panels on shores as well on water to float. In urban areas on building tops with large spaces can be used for solar panels.

3.1.3 Related and Supporting Industries

Bharat has many big corporate solar energy companies with reputed credentials but small-scale enterprises (SME's) bring in faster innovation, mitigation of risk and dynamic capabilities leading to competitive advantage [25]. To improve solar industry reach in society, SME's need to be developed as ancillary units for solar panels, charge controllers

and batteries [18, 19] to support the market expansion process, as the country is vast, large firms alone cannot handle. As grid and transmission loss are major problems areas [4], solar industry should invite companies which can run these areas productively. Limited availability of funds with people in rural to large extent and urban to little extent is playing the spoil sport [18]. Through micro financing, financial institutions can play a major role in solar technology adoption faster among rural areas along with government subsidy [6]. In urban places much of the cost is afforded by people with post adoption incentives like percentage reduction in regular electricity bills, which is being offered in the city of Bangalore. [24] found marketing activities as one of the top five factors of competitive advantage, [19] identified need for strong marketing to spread sufficient knowledge among people on how solar technology will help them in cost reduction and improve efficiency. Similar to SEZ concept, green or solar energy corridors can be created which gives exclusivity [26].

3.1.4 Demand Conditions

The present demand conditions for power are very high, coupled with an aim for increasing GDP to $5 trillion. The forecast of power for next two to three decades is trending super north with a maximum projection of 1200 GW by 2050 [5] which is a great concern of CO2 emission, in view of this boost to solar energy production, distribution and adoption by people is inevitable.

3.1.5 Firm Strategy, Structure and Rivalry

Intense competition, substitutes and entry of new technologies, will swipe off resources based competitive advantage [23]. The days of non-renewables is coming to end replaced by renewables. At the start of 21st century importance of renewable sources shook to limelight due to global warming leading to their adoption. Inter competition among renewable sources is negligible, primarily competition is between non-renewable and renewables. By the end of year 2016 China, Japan and United States of America topped the list of solar power production [6]. Technological innovation gives sustainable competitive advantage

[23]. Time and again power companies adopted new energy technologies as they were innovated for gaining competitive advantage. Among renewables, solar energy takes major bite, hence for competitive advantage building up of managerial competence is crucial [24], research and development (R&D) is needed for cost-effective innovations to penetrate deep for acceptance and adoption by people [19], also have to work on affordable tariffs [26]. Solar hybrid energy solutions in combination with biomass are being used in Europe, China, Mexico for heating systems, boilers and other applications [22]. [26] also reported start of solar hybrid initiatives. Bharat has large number of villages with biomass material, hence biomass propelled solar energy can be used for basic needs of home lighting, fans, mobile charging and also street lighting, [21] research case highlighted on solar solutions relevant to this. The important factors of solar adoption in each country are different USA-social influence, China-demographics, Germany-aspirations [18], but for sure in Bharat, financial incentive/subsidy is the most important factor. Presently government has limited subsidy schemes [6], which need to be increased to thousand-fold. Solar companies need to design pricing strategy taking into account people sensitivity and negotiate with government for provision of subsidies to people. There are very high chance of Renewable Generation Obligation(RGO) targets to be put in place [5], hence power generation industry should keep their organization's structure flexible to meet this.

4. CONCLUSION

Bharat's rich ancient scientific vedic knowledge empowers it to be "Viswaguru" to lead world in saving mother earth alongside gaining competitive advantage. It made good progress and on the path to progress in solar energy sector. Given the technological and geographical factor advantages Bharat has pointed its guns to nothing less than to be numero uno by 2050 in clean energy generation with major focus on solar energy.

Bharat at large is affected by air, water and land pollution due to rampant use of non-renewable sources for power production, automobiles, mass manufacturing, public transport,

domestic electric and electronic appliances and many others. People and governments are raising concern for long at various platforms in Bharat and globally. Government of Bharat recognized the awaiting catastrophe knocking the door, initiatives are taken to develop infrastructure for generation of clean energy majorly solar energy for future needs. Considering the present and forecasts of demand for power, Bharat is following a there is three-pronged strategy used, one – mass scale production of solar energy through solar parks for industrial, commercial and domestic purposes; two – urban terrace spaces for common area and home lighting, fans, water geysers and other uses; three – village level units to produce for household consumption. Research and development are underway to innovate cheaper, reliable and affordable solar technologies in Bharat. There is also need to work on building solar community organizations to build social belief and faster acceptance among population. In the state of Gujarat work is under progress on solar hybrid solutions in combination with biomass, results are encouraging but this have to be validated for expanding such initiatives to achieve the solar energy target. For bio-crop production Bharat has around 130 million hectares of degraded land, which will help sufficient supply of raw material for hybrid solar initiative. Support of government, financial and research institutions will play a pivotal role in achieving the solar mission.

4.1 Limitations and future research

Bharat's foreign direct investment (FDI) policy of solar energy is presented with a glimpse in order to give maximum scope for future studies to explore an in-depth FDI policy in this area. There may be other environmental areas which are sustainable and give competitive advantage, this study did not put thoughts in that direction, which is open for future research. Present study explored environmentally sustainable area with Diamond model, either additional factors can be added to model for future probe or alternative model can be considered.

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