Social Cost Benefit Analysis of Solar Power Projects

** P. Natarajan*
*** G. S. Nalini*

Abstract

Social cost benefit analysis provides a scientific base for the appraisal of projects with a view to determine whether the total social benefits of a project justify the total social costs. India is endowed with immense solar energy potential as it is located in the tropical zone of the earth. The Government of India launched The Jawaharlal Nehru National Solar Mission with the intention to be a global leader in solar energy. Since solar power is in the nascent stage in our country, it is mandatory to assess its impact on the society. Solar power guarantees various benefits, including carbon credit, renewable energy certificate, employment generation, rural electrification, curbing global warming, and also ensures overall development. However, the main setback of solar power is its high generation cost. This study unveiled that the social benefits attained in case of solar power are greater than the social cost. However, the high startup capital keeps the customers away from solar power. Thus, necessary measures need to be taken to bring down the cost of solar power to ensure its viability. Also, the government has to initiate the right mechanisms to discard the electronic scraps.

Keywords : **social benefit, social cost, solar power**

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The Social Cost Benefit Analysis (SCBA) is a systematic evaluation of a project in view of social performance rather than economic performance. It is concerned with the possible influences on the social quality of life in place of economic quality of life. The technique is most popular for making socially viable decisions of acceptance or rejection of projects. To make a scientific and systematic social cost benefit analysis of projects, it is indispensable to weigh each project's pros and cons to the society as a whole. Social cost would include, in addition to the private cost, any environmental damage, ecological imbalance, undesirable practices, human services used, monopoly costs, adverse effect on society and so forth. On the other hand, social benefits consist of improvements in environment, availability of goods and services, employment generation, curbing poverty and also the activity contribute to the betterment of the society (Agarwal & Mishra, 2006). Social cost benefit analysis is required when the project has a great impact on society and is usually done by the government (Pollock, n.d). A major gain of a social cost benefit analysis is facilitating investors to systematically and cohesively compare diverse project alternatives (Decisio BV, n.d).

Growing economy, industrialization, mounting population and improved access to power has led to rising demand for power in the country. India is facing an acute power crunch which is hampering its industrial growth and economic development. Setting up of new power plants is undoubtedly reliant on import of highly volatile fossil fuels. Thus, it is necessary to deal with the energy crisis through the utilization of abundantly available

* *Professor & Head,* Department of Commerce, School of Management, Pondicherry University, Puducherry- 605 014.
E-mail: natarajanppu@gmail.com
** *Doctoral Scholar,* Department of Commerce, School of Management, Pondicherry University, Puducherry- 605 014.
E-mail: nalinicomgac@gmail.com

existing renewable energy resources, such as solar energy, wind energy and biomass energy etc. (Srivastava & Srivastava, 2013).

India is endowed with massive solar energy potential. The equivalent energy potential is about 6,000 million GWh of energy per year (Sharma, Tiwari, & Sood, 2012). Solar power has wider application than other energy resources such as power generation, water pumping, heating, chilling, desalination, drying etc. Recent development ensures the solar power systems made available easily for industrial and domestic usage with the added advantage of less maintenance.

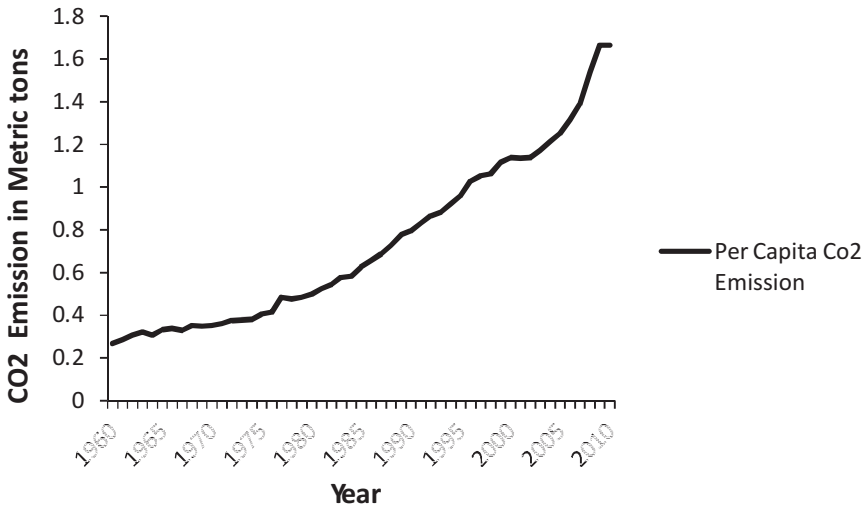
The Government of India launched the Jawaharlal Nehru National Solar Mission (JNNSM) with the intention of to be a global leader in solar power. The Mission has set the ambitious goal of installing 20,000 MW of grid tied solar power by 2022 aims to reduce the cost of solar power generation in the nation (MNRE, 2010). In order to reflect the real value of a project, the impact of the project on society has to be acknowledged. This paper portrays a comprehensive outline of social cost benefit analysis of solar power to ensure the viability of solar power projects.

Need for SCBA in the Power Sector

At present, India is the seventh largest emitter of Green House Gases (GHGs) and fifth largest in case of emission from fossil fuel combustion in the World. It accounts for about 4% of the world's emission. India plays a crucial role in the Copenhagen Accord which emphasizes that climate change as one of the supreme challenges, it is mandatory to bring the carbon emissions down. The greenhouse gases are released during the combustion of fossil fuels, such as coal, oil, and natural gas, to produce electricity. India has made a commitment to reduce its emission per unit of GDP by 20% to 25% on 2005 levels by 2020 (Former Hon'ble PM, Manmohan Singh, NRDC). CO_2 emissions are a major contributor to global climate change, the most serious environmental threat facing the world today.

The Figure 1 shows CO_2 emission per capita in India from 1960 to 2010. It depicts CO_2 emission per capita is gradually increasing year on year. Industrialization and alarming population growth keep the CO_2 emission curve towards upward trend. Escalating the fraction of electricity derived from wind, solar, and small hydro from the present 8 percent to 20 percent by 2020, is the move taken by Indian government to hold back carbon emission. Thus, the government of India looks forward to make renewable as an alternative to curb carbon emission. Solar

Figure 1. CO_2 Emission Per Capita in India



Source: WDI, The World Bank

being a perennial source, both state and central government preferred it as the best alternative thereby framing their own solar power policy. In this context, measuring the social cost benefit of solar is inevitable to make sure of feasibility.

Social Benefits of Solar Power Project

The following are the various benefits offered by solar power to the society:

(1) Carbon Credit : Solar power ensures carbon emission reduction and paves the way for availing carbon credit. Carbon credits are "Entitlement Certificates" disbursed by the United Nations Framework Convention on Climate Change (UNFCCC) to the implementers of the permitted Clean Development Mechanism (CDM) projects (National Renewable Energy Laboratory, 2010). One carbon credit is equivalent to one tonne of carbon dioxide or its equivalent greenhouse gas. Under the UNFCCC, charter any corporation from the developed country can join hands with a corporation in the developing country that is a signatory to the Kyoto Protocol (Prabhakant & Tiwari, 2008). And the company in developing country should implement latest tech-know-how to reduce carbon emission. There are two ways for an obligatory to offset carbon foot prints. They can either use newest tech-know-how to bring down the carbon emission or buy carbon credit in exchanges (Saravanan, 2011).

MCX has become the first exchange in Asia to trade carbon credits. Reliance power is the world's leading carbon offset originator with a CDM registered project portfolio of over 0.012 million MW, with potential to offset 60 million certified carbon credits. Carbon credit projects based on Solar Photovoltaic (PV) technologies support the project developers to cover the project cost related to the technology and equipments.

(2) Renewable Energy Certificate : Renewable Energy Certificates (RECs) are a type of environmental commodity intended to provide an economic incentive for electricity generation from renewable energy sources (Shrimali & Tirumalachetty, 2013). One REC is equivalent to 1 MWh of clean energy and also there is a provision to separate RECs from the solar and non-solar by considering high cost of solar power generation. The floor and forbearance price determined for solar REC for 2012-17 are ₹ 0.0093 million/MWh and ₹ 0.0134 million/MWh respectively.

The State Electricity Regulatory Commissions (SERC) under the Electricity Act, set target for distribution companies of respective states to procure certain percentage of the total power requirement from renewable energy sources. This target is referred to as Renewable Purchase Obligation (RPO). RPO is the key driver for REC market. Renewable purchase obligated entities comprising not only distribution companies but also open access consumers and high tension consumers. REC helps the obligated entities to comply with regulatory requirement.

A power exchange is a platform on which REC is traded. Only the exchange members, who have been admitted by exchange, are eligible to enter into contracts, and undertake transactions relating to such contracts. (IEX, 2012). The Clients can take part in trade through a registered exchange member. REC assists the solar power generator to trade the generated solar power as a commodity.

(3) Employment Generation : Renewable energy technologies are more labour intensive than mechanised fossil fuel technologies, meaning there is a greater prospect to create domestic jobs through the market augmentation (NRDC & CEEW, 2015). The aggressive players of solar market include manufacturers, developer, integrator, engineering and procurement contractor and consultants etc. On-grid solar PV systems are power systems energized by photovoltaic panels which are connected to the utility grid. Off-grid solar PV uses batteries to save and transmit electricity which is an alternative for gird tied system.

The Table 1 depicts the future employment projection in solar PV on-grid based on JNNSM targets. It is estimated that the solar PV on-grid sector would employ 0.039 million employees by 2017 and 0.152 million by

Table 1. Future Projections of Employment in Solar PV On-grid

Year	Estimated Employment (in Millions)		
	Manufacturing	O&M	Total
2017	0.025	0.014	0.039
2022	0.093	0.059	0.152

Source: CII & MNRE

Table 2. Future Projections of Employment in Solar PV Off-grid

Year	Estimated Employment (in Millions)		
	Direct	Indirect	Total
2017	0.047	0.093	0.14
2022	0.075	0.15	0.225

Source: CII & MNRE

2022. It also reveals that solar on-grid is expected to employ 0.093 million for manufacturing activities and 0.059 million for Operation &Maintenance work by 2022.

It is clear from the Table 2 that solar PV off-grid sector would make use of 0.14 million employees by 2017 and 0.225 million employees by 2022. The total proposed employment by 2022 would be 0.225 million of which 0.15 million indirect and 0.075 million direct employment. It is obvious that solar off-grid has greater potential for employment generation than on-grid.

(4) Curbs Global Warming : India is profoundly reliant on fossil fuels for its energy needs. Most of the power generation is carried out by fossil fuel plants which contribute greatly to greenhouse gases emission (Murthy, 2012). Global warming threatens the existence of human society and also countless species. Fortunately, decades of research have led to efficient solar panel systems that generate electricity without discharging green house gases. Therefore, solar is conferred as one of the most important solutions to the global warming crisis.

(5) Rural Electrification : According to the census of 2011, in rural India, more than 44 percent of the households lack basic access to electricity. Even those villages that have been provided with grid power receive less than 6 hours supply in most cases (Ratho, n.d). India is paying huge developmental costs due to its energy poverty such as education, health, and economic development are at a standstill in rural India. Addressing this challenge remains a huge task for the Government of India.

In the last few years, mini-grids have largely been developed by independent developers, non-governmental organizations and social business entities using external funds. To meet the unmet community demand for electricity, standalone rural solar PV power plants with battery storage in a micro grid mode, would be provided ₹ 0.00015 million/Wp of capital subsidy and soft loan at 5% by the Ministry of New and Renewable Energy (MNRE, 2010). Hence, mini-grid using solar power has gained momentum to help the government to achieve cent percent rural electrification.

(6) Reduction in Fossil Fuel Subsidy : Energy subsidy is a direct cash imbursement by the government to an energy producer or consumer to stimulate the production or use of a particular fuel or form of energy. According to the Organization for Economic Co-operation and Development (OECD), subsidies supporting fossil fuels, particularly coal and oil, represent greater threats to the environment. Subsidies to nuclear power contribute to unique environmental and safety issues, related mostly to the risk of high-level environmental damage. Subsidies to renewable energy are generally considered more environmentally beneficial, although the full range of

Table 3. CERC Determined Solar PV Plant Benchmark Cost for 2013-14

Particulars	Capital Cost (₹ in Million/MW)	Percentage of Total Cost
PV modules	32.592	40.9%
Additional module cost as against degradation	0.979	1.2%
Land cost	1.68	2.1%
Civil and general works	9.45	11.9%
Mounting structures	10.5	13.2%
Power conditioning unit	6.0	7.5%
Evacuation cost up to interconnection point	10.5	13.2%
Preliminary and pre-operative expenses	8.0	10%
Total capital cost	79.701	100%

Source: CERC

environmental effects should to be taken into account.

In fiscal year 2012-2013, the Indian Government spent ₹ 962 billion (1.75 percent of GDP) for compensating Oil Marketing Companies for retail under-recoveries accrued in this period. The Ministry of Petroleum and Natural Gas estimates that total under-recoveries could reach ₹ 1.81 trillion in 2013-2014, a year-on-year increase of 12 percent from 2012-2013 (Clarke, Sharma & Vis-Dunbar, 2014). Solar subsidy controls the oil and gas subsidy especially Kerosene subsidy. Unlike other fossil fuel subsidy, solar subsidy is a onetime subsidy. As the government is spending huge amount for oil subsidy, solar power brings down the subsidy burden of the government too.

(7) Overall Development : In India, about 25,000 villages are located in isolated and inaccessible areas so the government found it difficult to electrify through conventional grid. The Ministry of New and Renewable Energy has implemented the 'Remote Village Electrification Programme' (RVEP) to electrify such remote villages by using solar photovoltaic home lighting systems across India. An evaluation study was done by National Council of Applied Economic Research (NCAER) in six states, viz. Assam, Meghalaya, Jharkhand, Odisha, Madhya Pradesh, and Chhattisgarh, indicates that the usage of kerosene has been come down. Nearly 53 to 69% reported that there is considerable progress in their children's education, and 37 to 78% stated that there is improvement in the standard of living after setting up of solar lighting. Beneficiaries now spend extra time on income generating activities. Crime rate has also reduced due to the presence of solar street lights in the villages (Buragohain, 2012).

Social Cost of Solar Power Projects

Solar power offers plenty of benefits than setback**.** The major shortcomings of solar power are given below:

(1) High Generation Cost : The generation cost of solar power is very high when compared to other sources of power generation. Despite decades of research to lower its price, each kilowatt-hour costs roughly two to three times as much as the same amount of electricity produced from fossil fuels.

The Table 3 presents the breakup of benchmark capital cost norm for solar PV projects for the year 2013-14. In view of the above, the capital cost of solar photovoltaic power projects after rounding off arrived at ₹ 80 million/MW considered as benchmark cost of solar PV projects for determining tariff.

According to the report by Photon Consulting, a German research group, reveals the scarcity of silicon result in soaring price of solar panel. The project developers have little faith on local manufacturers. Despite the government favoring local procurement, 70% of solar power projects set up under the National Solar Mission

Table 4. Health Hazards of Solar PV Waste

Pollutant	Outcome
Arsenic	Increased lung cancer risk
Cadmium	Toxic to the respiratory system
Chromium	Provoke asthma and lung cancer
Lead	Affects the kidneys and the reproductive system
Polychlorinated biphenyls	Harm reproductive and immune systems

have used imported modules or cells. Compared to the locally manufactured modules, the imported thin film modules are cheaper. To bring down the cost of solar power, the governments should carry out various researches concerning solar power and also encourage domestic panel manufacturers with different perks. Solar power could be made financially viable with government tax incentives and rebates.

(2) Health Hazards : The potential menaces and consequences of increasing solar photovoltaic cell production are being neglected by most of the producers. Solar energy is an indispensable part of the global move toward clean energy, and it is critical that the growing solar photovoltaic industry is itself truly secure and sustainable.

The Table 4 shows despite solar is a clean energy it has some mild contaminant which can harm social being. The toxicity of the PV cell differs on account of its components. The major pollutants in solar PV are arsenic, cadmium, chromium, lead and polychlorinated biphenyls which can harm the human well-being. Silicon based solar PV production involves many of the same materials as the microelectronics industry and, therefore, creates various health hazards. Solar being an electronic waste, disposal of panel and other sub system becomes a major challenge. Thus, proper recycling measures are required to handle these electronic wastes.

Conclusion

Social Cost Benefit Analysis estimates the social cost and the benefits obtained from a specific project. Since solar power is in the burgeoning stage, it is mandatory to assess its impact on society. Solar power guarantees various benefits including carbon credit, renewable energy certificate, employment generation, rural electrification, curbing global warming and also ensures overall development. But, the main set back of solar power is high generation cost. This study unveils that the social benefit is greater than social cost in case of solar power. However, high startup capital keeps the customers away from solar power. Thus, necessary measures should be taken to bring down the cost of solar power to ensure the viability. And also the government has to initiate the right mechanism to discard the electronic scraps.

Limitations of the Study and Scope for Further Research

This study has taken into account the social cost benefit analysis of solar power projects which could not be measured in real monetary terms owing to non-availability of required data. Thus, the government should compile and furnish the data on contribution of solar in curbing carbon emission and fossil fuel subsidy as well as its magnitude in rural electrification and employment generation.

In future, social cost benefit analysis of solar can be compared with other clean energy. Future research can further probe into each pros and cons of solar power in detail that would give clear picture about solar arena.

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