Evaluation of Solar Photovoltaic Programmes under Jawaharlal Nehru Solar Mission in India

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Biography- *I, Ravneet Kaur have done Masters in subject of Public Administration in 2011 and pursuing doctorate on topic entitled "An Evaluation of Renewable Energy Promotion and Conservation Programmes in Punjab: A Case Study of Punjab Energy Development Agency (PEDA)". My research interest areas are Policy implications related to Renewable Energy, Climate Change and Sustainable Development etc.*

Abstract- The Jawaharlal Nehru National Solar Mission (JNNSM) is an initiative taken by Government of India and State Governments through Ministry of New and Renewable Energy and State Nodal Agencies to promote environment friendly sustainable growth to address India's energy security challenge and meet the needs of approximately 1.30 billion population. The main objective of JNNSM is to generate resources for installation of Renewable energy devices and create favourable environment for the diffusion of solar energy at both Grid and Off- Grid level. The success of the mission depends on the subsidy structure, role of implementing institutions, functioning of the standardised systems and society's awareness and knowledge level. The research paper has evaluated the performance of JNNSM in India regarding dissemination of photovoltaic applications. The paper presents data and develops quantitative metrics to analyse its implementation throughout India.

Keywords: Jawaharlal Nehru Solar Mission, Solar Photovoltaic Application, Off-grid, Renewable energy, Sustainable development

Introduction

Energy plays a significant role in economic development of any nation and in improving the quality of life of society. As per National Sample Survey Organisation on the Household Consumer Expenditure in India (2006-07), 42.3% of rural households and 6.4% of urban households in India still use kerosene (fossil fuel) as a primary source to lighten their homes. This data reflects the status of non availability of power to 72 million households in India. (Deshmukh et al. 2011) There is continuous power cut from energy deficits which has already reached to 9 percent in the electricity sector of India. (CEEW 2012) These statistical figures pinpoint towards energy deficit in India as current energy supply cannot meet the growing demand of society and burning of fossil fuels also leads to environmental pollution.

The best possible alternative available for sustainable growth is to generate power through Renewable energy sources that is solar power. Solar energy is used to generate electricity which is cleaner and promising in comparison to conventional energy sources as they are scarce and emits various toxic gases in environment. As per Estimate measure for Renewable energy, solar energy can reduce the mitigating climate change and will help India in achieving its set target of reducing greenhouse gas emissions from 2005 levels by 20 to 25 percent by 2020. Carbon dioxide is one of the contributing elements in global warming and solar power has the potential to eliminate 95 million tons of CO2 emissions annually by 2022. (CEEW 2012) The promotion of solar energy

is vital as in accordance to the utility scale, solar energy leads to various environmental benefits and it is also expected that inflation will come down with its increased deployment. (Harish and Raghavan 2011)

The systems based on solar energy can play a significant role towards the fulfilment of demand of energy by industry. One of the product of solar energy i.e. Photovoltaic electricity generation is a promising solution to generate climate compatible power with sufficient energy potential which would cover the present worldwide demand for electricity consumption. Photovoltaic system is advantageous as their demand of power is low, can build integrated grid connected systems and can act as standalone systems. In USA and European countries photovoltaic based energy production facilities are already in operation or are under construction.(Sharma 2011)" World solar photovoltaic (PV) market installations reached a record high of 7.3GWin 2009, representing growth of 20% over the previous year." According to latest edition of Marketbuzz 2010, Report from Solarbuzz, "The PV industry generated $38.5 billion in global revenues in 2009, while successfully rising over $13.5 billion in equity and debt, up 8% on the prior year. European countries accounted for 5.60 GW, or 77% of world demand in 2009. The top three countries in Europe were Germany, Italy and Czech Republic, which collectively accounted for 4.07GW". (Sharma 2011)

The policies framed by Indian Government focussed on providing financial and technical assistance towards exploitation of solar energy for power generation through the Ministry of New and Renewable Energy (MNRE). MNRE is the nodal Ministry of the Government of India at the Union level to sustain all matters relating to new and renewable energy. The Ministry has been facilitating the implementation of various programmes to promote renewable energy resources like providing renewable energy to rural areas for lighting, cooking and motive power, disburse renewable energy in urban, industrial and commercial applications and development of alternate fuels and applications. In addition, it also supports research, design and development of new and renewable energy technologies, products and services. (Government of India 2015)

The ministry had formulated various plans to utilize the solar energy for power generation. The Ministry supported demonstration and utilization of selected photovoltaic system in India. However the program excluded the areas and products which are supported by the schemes on remote village electrification and urban applications of SPV. The demonstration programme is being implemented through the state nodal agencies, the Akshaya Urja Shops and Indian Renewable Energy Development Agency Ltd. (IREDA). The ministry provided Central Financial Assistance (CFA) on SPV systems under the programme in a following manner

(i) Rs 2500 for Model-I and Rs. 4800/- for the other models of solar home lighting system,

(ii) Rs. 9600/- for street lighting system

(iii) Rs. 2,400/- per solar lantern

(iv) Rs.30/- per watt of the PV array used subject to a maximum of Rs. 50,000/- per Solar Water Pumping system.

The Special Category States and the NE Region States were provided higher level of CFA. Under this scheme, in addition, a provision is given to provide soft loan to users at 5% per annum from IREDA and at 2.5% through the financial intermediaries. (MNRE Document 2007)

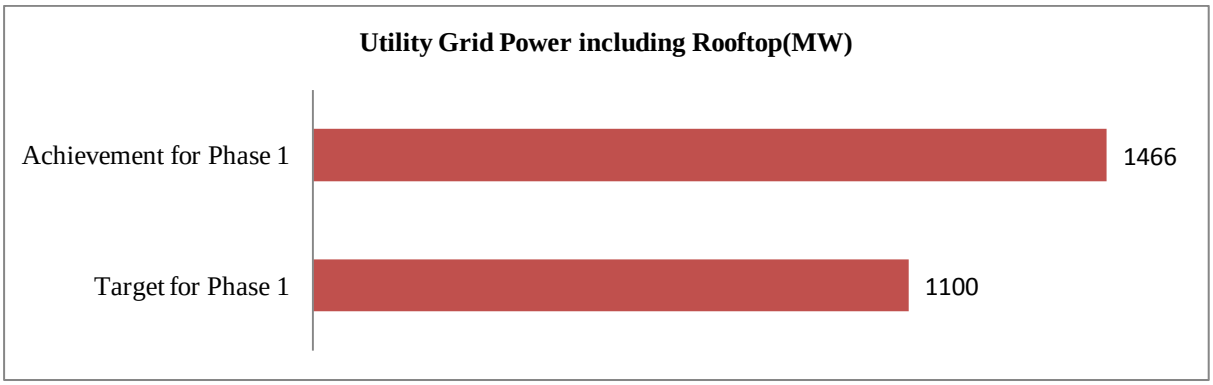
Till 2010, 40% of India's population lacked electricity generated from Grid power. In India there are many remote and far-flung areas where grid penetration has not reached yet and is very costly. There solar energy with feature of cost effectiveness can contribute a lot. It can ensure people with no access to power to move directly to solar by replacing fossil fuels which is an important element for energy security of nation.(MNRE Annual Report) Government of India had introduced Jawaharlal Nehru National Solar Mission to commence solar energy services industry into newer regions and markets. The JNNSM is implemented in India in 2010 with objective to improve the policy conditions for its large scale diffusion both at centralized and decentralized level across the country. The Mission adopted a 3-phase approach, spanning the period in a following way:

(a) Phase 1 includes 11th Plan and first year of the 12th Plan (up to 2012-13)

(b) Phase 2 includes the remaining 4 years of the 12th Plan (2013-17)

(c) Phase 3 includes the 13th Plan (2017-22) (MNRE Annual Report)

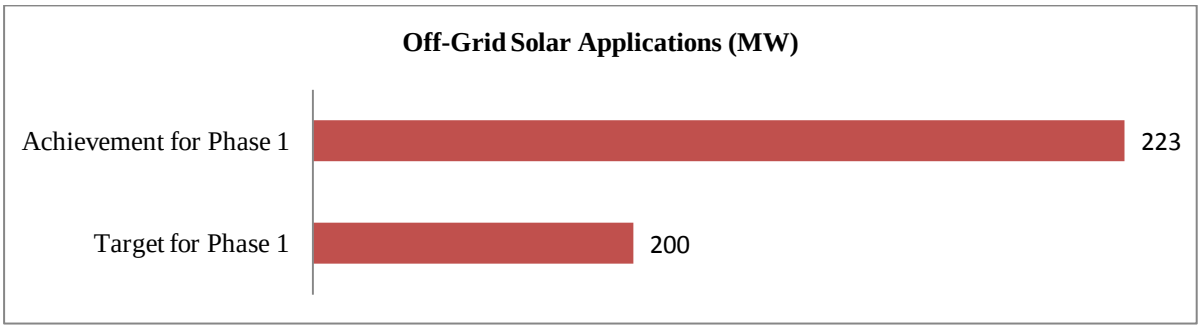
Fig 1.1 Targets and Achievements of Utility Grid Power during Phase 1 (2010-13)



Source: www.indiastat.gov.in

Fig 1.1 shows the target and achievements of Phase 1of JNNSM for Grid power which highlights the target of 1100 MW have been accomplished in a progressive way.

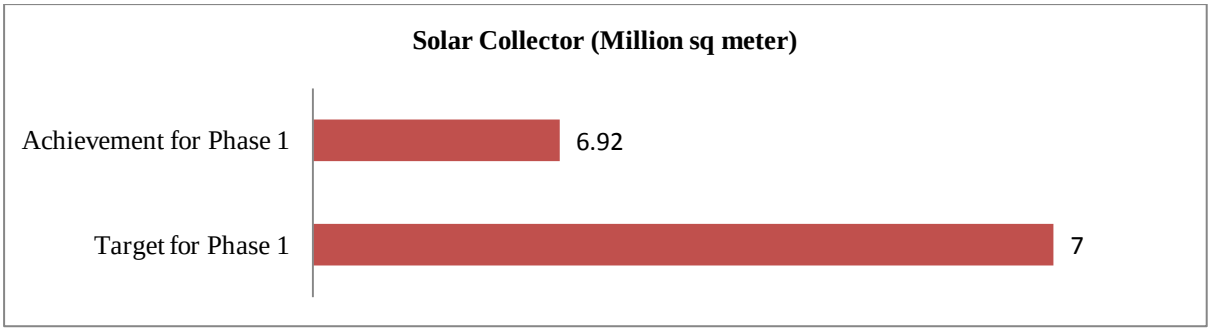
Fig1.2 Targets and Achievements of Off-Grid Solar Applications during Phase 1(2010-13)



Source: www.indiastat.gov.in

Fig 1.2 shows the target and achievements of Phase 1of JNNSM for Off-Grid power which highlights the target of 200 MW have been accomplished in a progressive way.

Fig1.3 Targets and Achievements of Solar Collector during Phase 1 (2010-13)



Source: www.indiastat.gov.in

Fig 1.3 shows the target and achievements of Phase 1of JNNSM for Solar Collector which highlights that the target of 7 million sq m has been almost achieved.

Table 1.1 Target of JNNSM (2013-17 and 2017-22)

Application Segment	Cumulative Target for Phase-II 2013-17	Cumulative Target for Phase-III 2017-22
Utility Grid power *	4000 MW	20000 MW
Off-Grid Solar	1000 MW	2000 MW
Solar Collectors	15 Million Sq. Meters	20 Million Sq. Meters

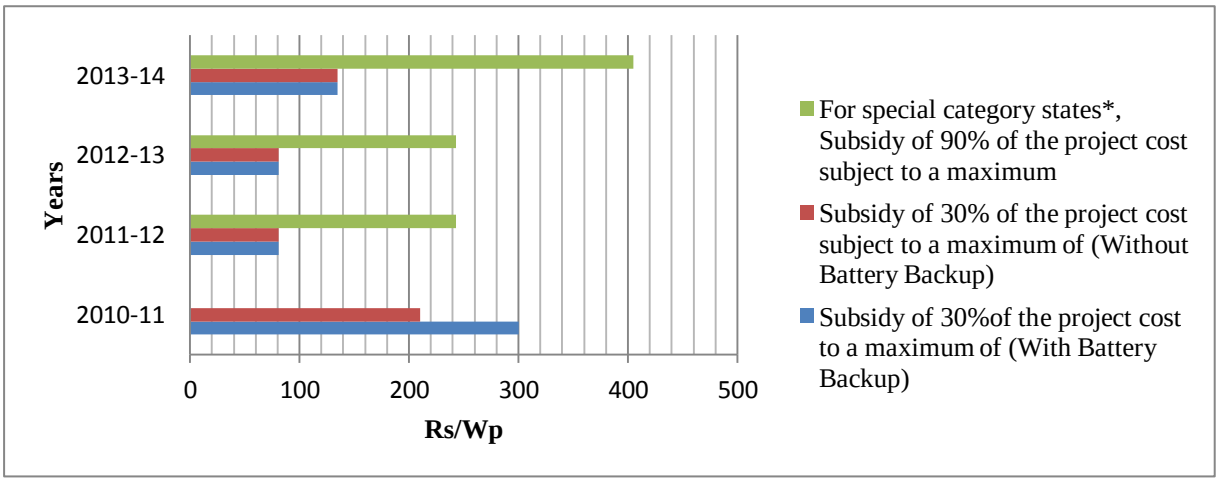
Source: www.indiastat.gov.in *including rooftop

Table 1.1 highlights the cumulative targets of Phase 2 and Phase 3 allocated under JNNSM. Under JNNSM, a scheme named "Off-grid and Decentralised Solar Application" is introduced with the following objectives: to promote off-grid applications by creating awareness and demonstrating innovative benefits of solar systems; by encouraging innovative and sustainable business models related to Off- grid systems; by providing support to channel partners and beneficiaries who have vested interest in the SPV devices; by creating commoditization of off-grid solar applications; and sustaining various support services.(Shrimali and Rohra 2012) Off-grid solar photo voltaic systems / applications like Solar Water Pumps, Solar home lightning systems, lanterns, solar street lights, solar power plants up to a maximum capacity of 100 kWp per site would be eligible for being covered under the "Off-grid and Decentralised Solar Application" scheme. (Garg 2012).

SPV technology has potential to directly convert sunlight into electricity without any moving parts and without causing pollution. The additional features like depleting fossil fuels and large import bill are also the reasons that increase the need to promote the renewable energy programmes like SPV programme. (Velayudhan 2003) The implementation of the programmes at the state level is through the state renewable energy agencies which have established offices and infrastructure at the district level. For most of the programme activities MNES meets up to 50% of the ex-works costs of the SPV systems and the state agency and the actual users meet the remaining cost of the systems and the installation costs. (Velayudhan 2003)

The first phase of the Mission was mainly focussed on grid electricity but also contributed in dissemination of various off-grid applications of solar energy. The financial assistance was given in the form of subsidy i.e. 30% capital subsidy and / or 5% annual interest bearing loans. IREDA was designated to provide refinance to the interested banks to enable them to offer loans to consumers at 5% annual interest rate. MNRE also signed agreements for with National Bank for Agriculture and Rural Bank of India (NABARD), National Housing Bank and Central Bank of India. NABARD enabled the Regional Rural Banks to sanction loans at 5% annual interest rate and also directly disburse subsidy to consumers for small solar systems, including solar lighting systems. Reserve Bank of India initiated subsidized loans to entrepreneurs at interest rates not exceeding 5% where refinance at 2% from Government of India is available for solar lighting systems. (MNRE Document 2010) Figure 1.4 shows the assigned benchmark costs for SPV devices by MNRE under JNNSM.

Fig 1.4 Benchmark cost for Solar Photovoltaic Projects



*Special Category States: North Eastern Region, Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Union Territories, Island and Districts with International borders

Under the Off-grid and Decentralized Solar Applications for the year 2014-15, the Ministry provides:

(a) 30% CFA on the cost of the system ranging from Rs.21/- per watt peak to 120/- depending upon the capacity of the modules and configuration of the SPV systems in General Category States in the country.

(b) For Special Category States, the Ministry provides subsidy ranging from Rs.72/- to Rs.396/- for off-grid solar PV applications.

(c) For Solar Water Pumping system, the CFA ranges from Rs.27,630 per Hp to Rs.57,600 per Hp depending upon category and capacity.(MNRE Document 2014)

The financial allocation under various sub heads for the implementation of the JNNSM is done state wise and subsidies are given under different capping. (MNRE Document 2010) The funds released for SPV by MNRE 2008-09 is 5849.98 lacks which increased to 25449.60 lacks in 2010-11 and further increased to 44052.60 in 2014-15 as shown in Table1.2.

Table1.2 State-wise Funds Released under SPV Programme in India (2010-2015)

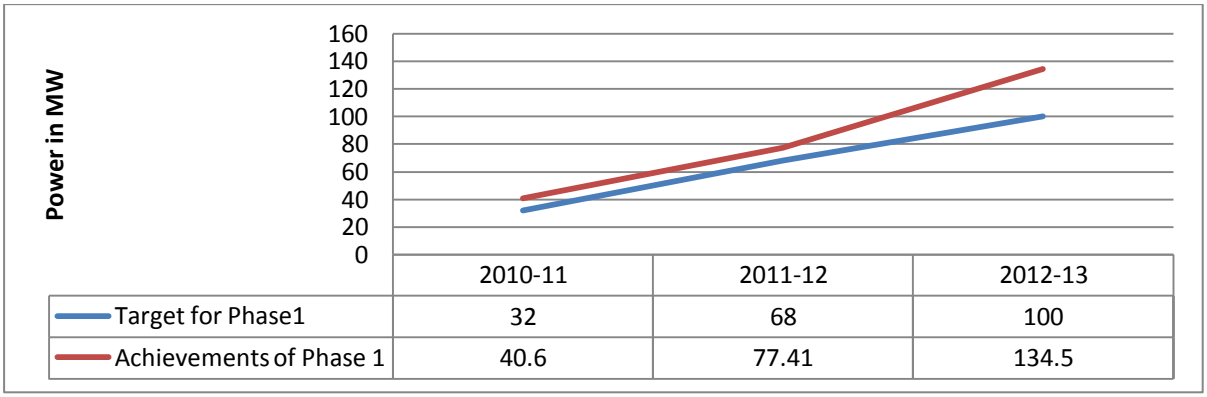
States/UTs	2010-11	2011-12	2012-13	2013-14	2014-15
Andhra Pradesh	631.00	287.99	134.41	90.57	1078.73
Arunachal Pradesh	372.67	250.00	582.26	428.14	20332.21
Assam	651.22	532.16	223.00	1572.27	257.04
Bihar	2.25	576.88	20.00	350.00	34.20
Chandigarh	-	-	-	-	-
Chhattisgarh	2891.53	4841.45	5282.13	1219.41	1629.78
Delhi	0.00	0.00	0.00	376.76	102.14
Goa	2.95	0.00	0.00	0.00	276.04
Gujarat	13.75	100.42	0.00	261.55	396.12
Haryana	603.07	691.33	225.69	26.43	249.37
Himachal Pradesh	440.00	515.00	191.39	2098.31	1228.02
Jammu and Kashmir	2145.58	7893.11	3361.10	4179.01	1914.75
Jharkhand	206.70	353.00	270.49	0.00	0.00
Karnataka	95.75	58.45	113.59	1658.30	689.28
Kerala	4.50	551.11	854.68	0.00	1902.17
Lakshadweep	1387.00	871.20	0.00	644.96	0.00
Madhya Pradesh	1071.91	1793.11	448.97	0.00	74.34
Maharashtra	115.35	126.08	27.57	966.70	509.61
Manipur	265.98	499.35	1483.30	368.97	147.47
Meghalaya	618.98	178.86	0.00	501.83	558.91
Mizoram	246.40	60.00	178.80	3132.15	649.61
Nagaland	14.86	866.10	1036.40	425.00	349.60
Odisha	12.50	113.44	0.00	0.00	69.78
Puducherry	0.00	154.80	0.00	0.00	26.40
Punjab	489.57	160.00	96.51	203.39	138.97
Rajasthan	3097.37	4773.50	3890.32	1248.31	5843.84
Sikkim	223.20	1030.00	261.63	819.75	141.33
Tamil Nadu	45.08	2798.78	127.95	2150.06	2168.19
Telangana	-	-	0.00	126.24	528.42
Tripura	91.23	400.00	401.90	0.00	0.00
Uttar Pradesh	1753.53	2562.58	2675.35	947.31	2505.62
Uttarakhand	2064.67	654.53	123.00	5252.57	115.42
West Bengal	1247.02	811.95	382.02	40.82	135.24
Others	5986.75	14691.40	-	-	-
India	**25449.60**	**48476.01**	**22392.46**	**29088.81**	**44052.60**

Note: CEL, REIL, NABARD, Regional Rural Banks, NGOs and other channel partners

Source: www.indiastat.gov.in

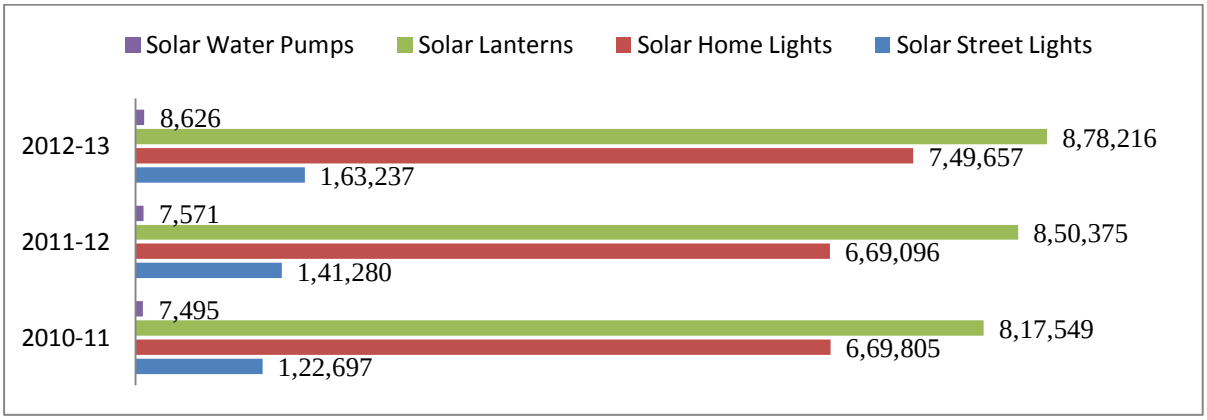
The success of the Jawaharlal Nehru National Solar Mission depends on various aspects– the subsidy structure, the role of standardised systems and institutional models of delivery. Following Fig 1.4 shows the cumulative achievements of Phase 1 of JNNSM in the form of generated power in all consecutive years from 2010 to 2013. Targets of Phase 1 in every consecutive year have been achieved in an escalating way.

Figure 1.4 Targets and achievements during Phase-I of JNNSM (2010-13)



Source: www.indiastat.gov.in

Fig 1.5 Cumulative Installation of SPV devices during Phase 1



Source: MNRE documents

Fig 1.5 highlights the cumulative installation of SPV devices namely Solar Street Lights (STL), Solar lantern Systems (SLS), Solar Water Pumps (SWPs) and Solar Home Lightning Systems (SHS) during Phase 1 of JNNSM i.e. 2010 to 2013. All installations have increased in every consecutive year.

Table1.3 District-wise installation of Solar Street Lights (STL), Solar Lanterns Systems (SLS), Solar Water Pumps (SWPs) and Solar Home Lighting Systems (SHS)

States/UTs	2010-11				2011-12				2012-13			
	SLS	STL	SWP	SHL	SLS	STL	SWP	SHL	SLS	STL	SWP	SHL
Andhra Pradesh	0			1	329			40	2816	2268		6295
Andaman & Nicobar										32		63

Arunachal Pradesh				2000	496		3	171				4223
Assam												
Bihar								3121				42
Chandigarh						669						
Chhattisgarh						34	60	22			10	
Delhi	54											
Goa						88			28			31
Gujarat				0								
Haryana	1470	980		8749				4113				2602
Himachal Pradesh										628		
Jammu and Kashmir					15150	210						
Jharkhand								436	7000			1091
Karnataka								1214				2084
Kerala					13186	645						608
Lakshadweep					3600	1725						
Madhya Pradesh						84		266		2040		156
Maharashtra						2949	11	1362				2
Manipur												
Meghalaya												
Mizoram	2519			2350					1258			1406
Nagaland								148	449			177
Odisha												
Puducherry												
Punjab		400										
Rajasthan		90		24449							1045	6740
Sikkim	2730			335		30			16180	15		513
Tamil Nadu												302
Telangana												
Tripura												
Uttar Pradesh					65	12149	2	65	110	16974		21630
Uttarakhand												
West Bengal												5623
Others												
India	**6719**	**1470**	**0**	**37614**	**32826**	**18583**	**76**	**32826**	**27841**	**21957**	**1055**	**53588**

Source: MNRE Documents

Table 1.3 shows that in 2010-11 there is few installations of SPV devices and in 2011-12, the installations have increased and further the installations increased more in 2012-13. There is progressive increase in installation of SPV devices every year. In 2010-11, Solar Lanterns installation is 6,719 which increase to 32,826 in 2011-12 and decrease to 27,841 in 2012-13. Solar Street Lights installation in 2010-11 is 1470 which increased to 18583 in 2011-12 and increased more to 21957 in 2012-13. In case of Solar Water Pumps, in 2010-11 there was no installation and in 2011-12, 76 SWPs got installed which increase to 1055 in 2012-13. Solar Home Lightning Systems installation in 2010-11 is 37,826 which decreased in 2011-12 and came to 32,826 and rose again in 2012-13 and reached to 53,588. It also shows that there is no continuous and regular installation of SPV devices in every state of India. Few states like Haryana, Uttar Pradesh, Rajasthan, Sikkim, Maharashtra, Madhya Pradesh have maximum installations. Other areas like Delhi, Goa, J& K, Gujarat, Punjab, Tamil Nadu, West Bengal, HP have less SPV installations. States like Assam, Manipur, Meghalaya, Orissa, Puducherry, Telangana, Uttarakhand, there is no installation of any SPV devices at all.

Solar PV projects completed during 2013-14 are as follows:

- 8204 Solar Street Lights installed in various villages of Himachal Pradesh
- Distributed 20,000 Solar Lanterns in flood affected areas of Uttarakhand

Solar PV projects completed during 2014-15 are as follows

- 24552 solar street lights have been installed at various villages of Himachal Pradesh
- 18844 solar street lights have been installed at Lohiya villages of Uttar Pradesh.
- Distribution of 10,000 solar lanterns in cyclone affected areas of Andhra Pradesh (MNRE Document 2014)

The stats of installed SPV devices in 2013-14 and 2014-15 show that only two states HP and Uttarakhand with few SPV installations have been covered in these two years. The data highlights that there is no equal dissemination of all SPV devices in whole India. This leads to unequal growth and development of states in lieu of solar energy. JNNSM is an excellent model for India to combat energy deficiency, climate change, and shortage of fossil fuels. JNNSM model is not working in fruitful manner in which it is expected to perform. It has been found that various issues exist in the process for installation of SPV systems under JNNSM. Following are:

1. Subsidy provision under JNNSM: The MNRE provides only 30% of these costs as subsidy and remaining cost is bear by the beneficiary. 50% of the cost of device is eligible for a loan at 5% per annum and the user needs to deposit down payment to the tune of 20% of these costs. This approach to pay the cost is not feasible for the user who is interested in individual small system as these results in high price to them and reasonable price for big system or bulk of products. (Shrimali and Rohra 2012) It also makes solar energy devices unaffordable to low income group. As per guidelines written in JNNSM, beneficiary does not have choice to select the subsidy type among capital subsidy or interest subsidy. This initiates a crucial concern that whether banks will also be selective in choosing the customers interested in interest subsidies to avoid the risk of financing which in result is not much terrible to market. (Harish and Raghavan 2011)

It can be resolved by introducing local intermediary Non-Governmental Organisation (NGO) or a government body who can absorb the financing risks. Such an intermediary will voluntarily pay the upfront costs of the device and the loan advanced by the regional rural banks, in return for a monthly payment over a fixed period of time. Till the user becomes the owner of the device, this system will work on credit or lease model between beneficiary and intermediary body. This system is advantageous by making the system much more affordable for the rural poor as margin money can be avoided under this. Furthermore, if the intermediary is a Self- Help Group or a NGO, such a system will help in the overall sustainability of the project in terms of maintenance, and training of users. (Harish and Raghavan 2011)

2. Lack of awareness among beneficiaries: JNNSM does not include awareness program for citizens. Lack of promotion and provision of knowledge regarding cost efficient, their usage, their availability etc. among people is major hindrance to the growth of SPV devices. There is an urgent need to increase the level of information and knowledge about mission's progress available to mass. The government should enforce and distribute periodic updates on each project's progress, to make project selection process in interest of mass and to attract people to invest in the SPV program under JNNSM. (CEEW 2012) To create awareness and knowledge about adoption of JNNSM, there is a need to improve the flow of information through the local self government institutes. In addition to demonstrations, having group meetings and discussions in a community place or even the house of the village head can improve the demand and spread of SPV systems at grass root level.

3. Problem with design of JNNSM: JNNSM design is not appropriate as the process of formulation and implementation was non transparent and non-participatory. No public consultation was held on the NSM. There is lack of prioritisation in achieving the objectives of the NSM and failed to provide a concrete plan to achieve its stated targets. JNNSM targets to distribute 20 million solar lighting systems by 2022. The target is much lower than the 72 million households that use kerosene today. The basic solution to this problem is distribution of solar PV lanterns which is a quick and good alternative to the ubiquitous kerosene lamps. It is only the stopgap solution for those without access to electricity, till other solutions such as grid electricity, off-grid distributed power or larger home lighting systems are provided. (Deshmukh et al. 2010)
But, the main requirement of JNNSM is to install central charging station in every village with a trained staff to maintain batteries and system. The households can drop off lanterns or batteries to be charged or can rent the lantern on a daily basis for a small fee. (Harish and Raghavan 2011)

Another issue in designing of JNNSM is unequal dissemination of SPV devices in different districts of same state as no criteria have been developed by states to allocate funds. This anomaly leads to unequal distribution and development of solar energy devices in states. This requires check of MNRE over SNAs regarding their criteria of using funds to allocate SPV devices equally in every area of state and no voluntary basis distribution of SPV devices is followed.

4. Insufficient maintenance services for device: Under JNNSM company provides a warranty of five years against manufacturing or installation defects for all components and at least five years for overall structure. But, the absence of repair services by companies, non availability of spare material in local market and no access of

any helpline no. are main features of repeated stress among beneficiaries regarding maintenance of SPV devices which is a critical requirement for the success of SPV dissemination. Maintenance contracts are conspicuously absent in the off-grid guidelines. (Harish and Raghavan 2011) So there is need of Annual Maintenance Contracts between SNAs and companies. The obstacle of maintenance is removed by boosting monitoring and evaluation of SNAs regarding performance of companies in providing efficient maintenance and repair services, other forms of technical support to beneficiaries.

5. Miscellaneous issues: SPV systems can lead to national saving, social and environmental benefits. So it will be of no use to wait for uncertain international funds to support off- grid while domestic resources are used mainly for grid-connected systems. Hence, NSM should use domestic subsidy for this urgent social need. (Deshmukh et al. 2010) Government support is insufficient to provide access to poorer households for whom affordability is a major obstacle, low quality of devices are provided by dealers or channel partners of MNRE, systems are also expensive in comparison to market price as in lieu to provide subsidy under high pricing. (Harish and Raghavan 2011) It is important for all actors involved in governance of JNNSM to use existing systems of production, marketing and information efficiently to promote the usage of SPV devices among society.

Conclusion

The phase wise target allocation and target achievement across the states in India reflects that solar energy generation through JNNSM is successful to somewhat extent. SPV technology which converts sunlight into electricity is workable option keeping in view the climate conditions (long summer spells in major part of India). However the expensive solar power of JNSSM will continue to reach only those households that are already connected to grid energy supply as JNNSM is more focussed on grid connected power generation. Government subsidies and investments need to be directed towards off-grid generation of solar and other renewable energy to meet the needs of the millions of energy starved population and that too without compromising the energy security of the country. It is significant to follow a systemic approach to understand while designing and conducting research to diffuse SPV devices to mass in a better manner. The efficient feedback mechanism and regular interaction between technology developers and users needs to be included in JNNSM model to flexibly design the product features and benefits according to users need. JNNSM has ability to establish and enforce standards in delivering solar energy power to whole India by introducing and altering few features like providing after sales service, provisioning of access to low cost finance, altering interest rates to meet the needs of the range of financial institutions, attaching greater emphasis to the role of Self-Help Groups, and increasing the participation of women.(Shrimali and Rohra 2012) It is important for Indian government to push policymakers to improve and expand SPV markets by analyzing the market barriers, political constraints, and cultivating locally appropriate service models. (Bhattacharyya 2013)"An analysis done by Greenpeace shows that the Jawaharlal Nehru National Solar Mission plan could ensure an annual reduction of 434 million tons of CO2 emissions every year by 2050 based on the assumption that solar will replace fossil fuels". (Sharma 2011)

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