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Addressing Climate Change Through Green Technology with Reference to Solar Water Heating System Scheme: A Review of State of Punjab (India)

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Abstract

Planet Earth is facing challenge of Environment degradation which could be checked by usage of Green technology in order to achieve Energy Conservation. Usage of Renewable energy resources would meet energy demand without compromising the need of future generation and would replace conventional fuels. Adoption of decentralized approach such as solar thermal technology based products like Solar Water Heating System (SWHS). MNRE had introduced SWHS scheme under National Solar Mission as the economic benefits of the utilization of SWHS in both domestic and industrial sectors can lead to savings in fuel costs for water heating and by reducing environmental issues.The main objective of paper is to explore the development of SWHS in Punjab state installed under subsidy provided by State Nodal Agency of Punjab i.e. Punjab Energy Development Agency (PEDA). This paper had examined the assessment of role played by PEDA in process and functioning of installation and release of subsidies for SWHS and also analyzed the perspective of beneficiaries towards use of SWHS from three districts of Punjab.

The analytical study showed that the installation of SWHS has saved energy in providing hot water supply in domestic and commercial areas. The results of study highlighted that there is lack of maintenance provision by private companies. There is need to monitor Private companies, initiate feedback mechanism, provide more government rebates and benefits which will help the small scale manufacturers to flourish more by maintaining quality assurance.

Keywords: Energy Conservation, Renewable Energy, Green Technology, Domestic, Hot Water Supply

Introduction

The climatic changes across the globe had led to degradation of Environment. This degradation of air, water and soil could be reduced to larger extent by usage of Green Technology. Green technology refers to development of equipment and systems which will help in conservation of natural environment and reduces the negative impact of human activities.

Green technology plays a significant role in four elementary phases i.e. provision of independent energy while promoting its efficient utilization; conserving environment, improvises national economic development and improves quality of life. Green Technology could only achieved by targeting all sectors to put into action the adoption of measures fall under Green Technology. These sectors are: Energy Sector: Apply Green Technology in electricity generation power plants, in managing energy supply and co-generation (co-generation) in the industrial and commercial sectors; Building Sector: Adopt Green Technology in the construction sites, management, maintenance and destroying of buildings; Water and Waste Management Sector: Adopt Green Technology in the management and use of water resources, waste water treatment, solid waste landfill; Transport Sector: Incorporation of Green Technology in the transportation infrastructure and vehicles and public road transport.

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The components of Green Technology include development of alternative fuels as new means of generating energy to bring features like Energy Efficiency and Sustainable Development. Usage of Renewable energy resources would meet the needs of energy demand without compromising the need of future generation. Renewable energy sources have the capacity to play a significant role in replacing conventional fuels in four distinct zones, such as electric power production, hot water production, transportation of fuels, and countryside (off-grid) power services. The Government of India had implemented various policies to promote green technology through energy efficiency and promoting renewable energy sources. Since 2003 the Government of India has introduced fiscal incentives for companies that generate electricity from renewable energy sources or the Renewable Energy (RE) and to encourage companies to adopt energy-saving activities of the Energy Efficiency (EE) by providing tax exemption Investments wherever applicable.

In India estimated solar energy potential is 200 MW/sq.km which could be utilized in the form of thermal applications (Solar Water Heating Systems for industrial, commercial and domestic use and other products like solar cookers, solar dryers, solar stills) and electrical applications.

Significance and History of Solar Water Heating System

SWHS came into existence in 1767 from hypothesis by Swiss naturalist De Saussure, who built an insulated box painted black at its bottom with two panes of glass covering at the top. He called it "Hot Box", which was able to aid cooking, heating, and producing hot water. However the first commercial SWHS was patented in the US by Clarence M. Kemp in 1891 and named Climax. Until 1930 coal fired boilers were used to produce hot water for domestic purposes and for space heating and SWHS become a commercial product in the early 1960s only.

A Solar Water Heating System (SWHS) is an efficient and reliable technology that converts sunlight into heat to produce hot water. SWHS leads to economic benefit in domestic and industrial but also helps in saving fuel costs. Renewable Energy Policy Network in 2010 reported that about 70 million houses were using solar water heating systems (SWHS) worldwide. SWHS bring savings in fuel costs for water heating and environmental issues.

Overview of Solar Water Heating System

A solar water heater consists of a collector to collect solar energy and an insulated storage tank to store hot water. The panels absorb solar energy and selected coating transfers coated on panels transfer the heat to the riser pipes underneath the absorber panel. The water passing through the risers get heated up and are delivered to the storage tank. During a good sunny day the re-circulation of the same water raises the temperature to 80 C (Maximum) through absorber panel in the collector. The total system with solar collector, storage tank and pipelines is called solar hot water system.

The solar water heating systems are of two categories. They are: closed loop system and open loop system. In former system heat exchangers are installed to protect them from hard water obtained from borewells or from freezing temperatures in the cold regions. The later systems require treated water which is potable in quality and are suitable for domestic and small institutional systems. The water in the system is open to the atmosphere at one point or other. The SWH systems are economical, pollution free and easy for operation in warm countries like ours.

Salient Features of Solar Water Heating System

i) Sun rays enables Solar Hot Water System to turn cold water into hot water .SWHS could attain 60 deg. – 80 deg. C temperature depending on available solar radiation, weather conditions and efficiency of solar collector system and SWHS could be installed on roof-tops, building terrace and open ground.

ii) SWHS requires south orientation of collectors and over-head tank above SWH system.

iii) SWHS use only soft and potable water and Small tanks of SWHS are made of stainless steel whereas large tanks are made of mild steel with anti-corrosion coating .Small SWHS (100-300 litres) are installed for domestic application and Large SWHS are used in restaurants, guest houses, hotels, hospitals, industries etc.

There are three types of Solar Water Heating System**:** Flat Plate Collector (FPC) system; Evacuated Tube Collector (ETC) system; Parabolic Concentrated (Dish Type) system.

Role of Government Institutions in Deployment of SWHS in India

Government had initiated the programmes for promotion of usage of Renewable energy sources with the formation of Department of Non-Conventional Energy Sources (DNES) in 1982. The programs were expanded and attempts were made to disseminate to all the states. Following Table 1 presents the sector wise installation of SWHS installed in India till 2009.

Table 1: Estimated Breakups: Functional SWH Installations Till 2009

Sector	*Million m^2*
Residential (80%)	2.108
Hotels (6%)	0.158
Hospitals (3%)	0.079
Industry (6%)	0.158
Other; Railways + Defence + Hostel + Religious places + others (5%)	0.132
Total	2.635

*It is assumed that 85% of the installed SWH are functional

Source: Green Tech Knowledge Solutions Private Ltd (2010), "Solar Water Heaters in India: Market assessment studies and surveys", retrieved from http://mnre.gov.in/filemanager/UserFiles/greentech_SWH_MarketAssessment_report.pdf as on 19 Dec, 2014

The Jawaharlal Nehru Solar Mission in its first two phases promotes solar heating systems through scheme named as "An Accelerated scheme on development and deployment of solar water heating systems". The mission targeted to implement SWHS at domestic and industrial level, below 80° C is solarised. Ministry of New and Renewable Energy is providing 30% subsidy on this scheme i.e. Rs. 6600/- on FPC system and Rs. 4500/- on ETC system of capacity 100 LPD. The subsidy on Parabolic system is Rs. 5400/- per Sq.m of dish area The mission strategized to make necessary policy changes to meet this objective:

i) Through building byelaws and incorporating National Building Code, SWHS are made mandatory for all buildings and to Introduce effective mechanisms for certification and rating of manufacturers of solar thermal applications.

ii) To facilitate measurements to enable local agencies and power utilities to promote SWHS at individual level.

iii) To achieve higher efficiency and cost reduction in SWHS, support is provided through soft loans to upgrade the technologies and manufacturing capacities.

Table 2: Selected State-wise Status of Projects Sanctioned for Solar Water Heating Programme under Jawaharlal Nehru National Solar Mission (JNNSM) in India (2010-2011 to 2012-2013)

States/UTs	*Target Collector Area (m^2)*	*Cost of System*	*MNRE Share (Funds Allocated) (Target)*
Andhra Pradesh	83473	7084.20	2564.18
Arunachal Pradesh	4596	997.00	43.00
Assam	9521	1147.00	541.00
Chandigarh	32	782.00	217.00
Chhattisgarh	17868	1768.06	564.38
Delhi	4135	524.00	136.00
Goa	6450	695.00	207.65
Gujarat	78580	8326.01	2461.77
Himachal Pradesh	28273	3703.00	1580.00
Haryana	26500	2785.00	522.45
Jammu and Kashmir	27860	3094.00	1660.00
Jharkhand	4000	395.00	122.00
Karnataka	30000	3100.00	958.00
Kerala	16660	2048.00	549.00
Madhya Pradesh	47500	5175.00	1405.00
Maharashtra	83737	7927.00	2450.00
Manipur	6822	778.00	463.00
Meghalaya	1726	215.75	117.33
Mizoram	2894	392.00	195.00
Nagaland	5188	607.00	334.00
Odisha	4632	651.00	148.00
Punjab	27500	3500.00	968.00
Rajasthan	21335	2407.00	677.00
Sikkim	440	57.00	30.00
Tamil Nadu	50000	5670.00	1648.00
Tripura	410	69.40	25.83
Uttar Pradesh	21650	2285.00	819.00
Uttarakhand	25465	2880.00	1395.00
West Bengal	1000	147.97	32.44
India	**6,38,248**	**69,210.00**	**22,834.00**

Source: Ministry of New and Renewable Energy (2016), "National Solar Mission", Chapter- 4, *Annual Report 2015-16*, retrieved from http://mnre.gov.in/file-manager/annual-report/2015-2016/EN/ Chapter %204/ chapter_4.htm as on 20 Nov, 2016

The total installed collector area increased from 119000 m^2 in 1989 to 525000 m^2 in 2001 and 3.1 million m^2 by December 2009. The Table 2 shows the state wise installation of SWHS in first phase of JNNSM (2010 to 2013) and also shows the contribution of MNRE in the form of subsidy. The cumulative targets set for installing Solar Collector area under Jawaharlal Nehru National Solar Mission (JNNSM), are 15 million m^2 up to 2017 and 20 million m^2 up to 2022 respectively. Till 31/12/2015 around 12 million m^2 collector area had been installed, which is not even comparable to the gross potential for solar water heating systems in India which is estimated about 140 million m^2 of collector area.

Other Policies Initiated for Development of SWHs

"Global Solar Water Heating" (GSWH) project was started in December 2008 and it was supported by UNDP- GEF. The GSWH project targets to achieve acceleration in SWH market while emphasizing on awareness on SWH technologies; setting standards and specifications for quality assurance; demonstrating innovative investment methods; initiating needed capacities in the supply chain and helping in establishing a supportive regulatory environment. This project increased the installation of solar water heating systems in India by 20 percent each year which resulted in a saving of 3.57 million units of electricity and reduced greenhouse gas emissions of 1.66 million tCO_2.

"Transformation of users of Conventional Water heaters to Solar Water Heaters" was introduced in 2002 under GEF small grant programme. The project aimed to collect the baseline information about wood fired heaters which included the study of the pattern of the resources used and fuel consumption, cross check solar water heaters market. The projects also targeted to provide financial support to beneficiaries to change over from wood fired heaters and change to solar water heaters by providing incremental cost. The project promoted the solar water heaters in the city which led to adoption of solar water heaters amongst 90% in the community.

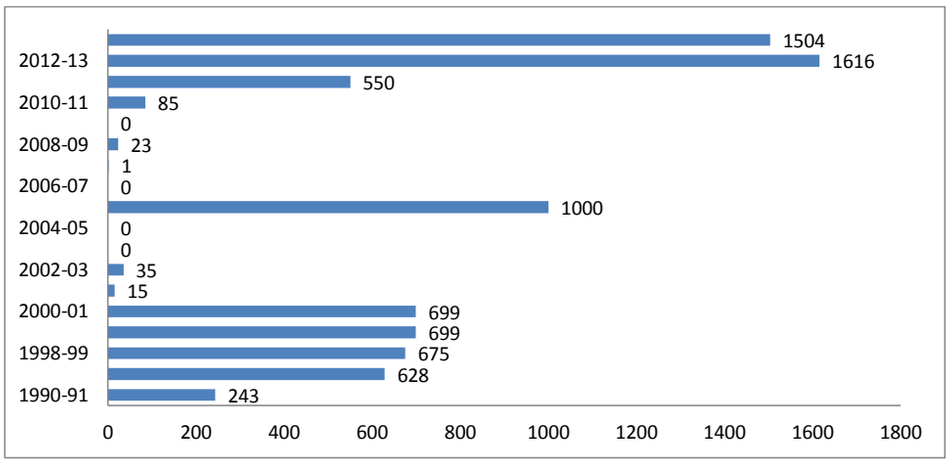
Contribution of Punjab Energy Development Agency in Implementation of SWHS Scheme

PEDA is a state nodal agency for promotion and development of renewable energy programmes/projects and energy conservation programme in the State of Punjab. Punjab Energy Development Agency is registered as a Society under the Societies Act of 1860. Punjab Energy Development Agency also provides assistance to private companies in the form of 30% subsidy in installation of Biogas plants, Solar Water Heating System and Solar Water Pumps.

In Punjab, Punjab Energy Development Agency provides assistance to consumers in the form of state subsidy in installation of Solar Water Heating System. PEDA promotes the use of solar water heating systems through advertisements in newspapers, television and radio and by organizing camps and exhibitions to demonstrate benefits of SWHS in schools, colleges and during important festivals of the State. Solar Water Heating System has been fitted on the exhibition Van of PEDA which covers all rural and urban areas to demonstrate SWHS and make the people aware of the technology. Solar Water Heating System has various benefits which encouraged Punjab Government to issue a notification on 17th March, 2006 which introduced mandatory installation of SWHs in the following type of buildings:-

i. All Government buildings, Residential Schools, Educational Colleges, Hostels, Technical / Vocational Education Institutes, District Institutes of Education and Training, Tourism Complexes and Universities etc.
ii. Industries which requires hot water for processing.
iii. Government Hospitals and private Nursing homes
iv. Hotels, Motels and Banquet halls, Jail Barracks, Canteens.
v. Housing Complexes set up by Group Housing Societies/Punjab Urban Development Authority and all residential buildings built on a plot of size 500 square yards and above falling within the limits of municipal committees/corporations and Punjab Urban Development Authority sectors.

Fig 1 shows the no. of SWHS installed in Punjab from 1990-91 to 2013-14. Till 2001, the installation of SWHS was increasing but later installations were there only in 2005-06 which shows the worst installation period for SWHS and then later after 2010, there was again increase in installation of SWHS till 2014.



Source: Retrieved from http://www.punjabstat.com/table/power/26/solarenergy19932022/ 452704/ 360857/ data.aspx as on 23 Feb, 2017

Fig. 1: Year- wise Progress Report of Solar Water Heating System in Punjab

Table 3: District Wise Progress Report of Solar Water Heating Systems in Punjab (litres capacity)

District	*2010-11*	*2011-12*	*2012-13*	*2013-14*
Amritsar	13,100	17,400	29,600	1350
Barnala	1000	900	3950	250
Bathinda	6600	5300	26,600	100
Faridkot	8600	10,000	15,500	1000
Fatehgarh Sahib	2600	1500	13,400	750
Fazilka	1400	2000	4550	2400
Ferozepur	4100	4000	17,100	1600
Gurdaspur	2000	500	2500	200
Hoshiarpur	11,900	5000	5300	0
Jalandhar	15,000	18,150	11,400	6500
Kapurthala	3000	4100	2600	1300
Ludhiana	37,550	10,8,0,000	33,800	3200
Mansa	3300	3000	2800	0
Moga	4000	3400	9100	700
Mohali	31,800	26500	15,650	2100
Mukatsar	4300	4000	10,000	1900
Nawanshehar	13,500	6900	4850	0
Pathankot	5650	7800	0	6000
Patiala	14,900	8450	36,250	1100
Ropar	13000	1450	2900	500
Sangrur	500	800	5950	0
TaranTaran	2200	2000	1750	500
Grand Total	2,00,000	2,41,150	2,55,550	31,450

Source: PEDA office Document

Table 3 shows the district wise capacity (litre) of Solar Water Heating Systems installed in Punjab from 2010 to 2013 i.e. during Phase-1 of JNNSM. The available data shows that it is increasing. During 2010-11 Ludhiana had maximum capacity of SWHS installed and worst is with Sangrur. During 2011-12, Ludhiana is leading again but Gurdaspur had least no. Patiala had highest capacity of SWHS installed during 2012-13 and Pathankot had no SWHS installed. In 2013-14, there were major SWHS installaions in Pathankot and Jalandhar while there was no installation in Hoshiarpur, Mansa, Nawansheher and Sangrur districts. Since 2013, 25 Lac litres capacity SWHS have been installed in the state. During 2013, 3 Lac litres capacity systems have been set up in the state by PEDA. There were no major installations of SWHS after 2014 as there was no subsidy by MNRE and Punjab Government.

Evaluation of Research Paper

In the research paper, both primary method and secondary method of data collection are used. It is conducted in the state of Punjab and three districts; Ludhiana, Jalandhar and Kapurthala (highest, medium and lowest no. of Solar Water Heating System installed) are selected from whole Punjab. Random sampling is used to select beneficiaries and questionnaire is employed to know their perception towards Solar Water Heating System. The sample for SWHS consists of 50 beneficiaries from Ludhiana

district, 50 beneficiaries from Jalandhar district and 28 beneficiaries from Kapurthala district. The data pertains to the period 2001 to 2015. Secondary data is collected from annual reports of Punjab Energy Development Agency. There is use and reference of statistical abstracts, reports of government ministries, e-journals etc. This is done to adequately substantiate primary data.

Primary data is based on few parameters. The first parameter is an awareness of the beneficiary which indicates knowledge towards SWHS they have installed and the policy implementation and promotion spread by the state government regarding SWHS in rural areas of Punjab. The second parameter component is the subsidy which includes various indicators like funds availability, affordability, installation expenses etc. The third is the grievances of beneficiaries which indicate the repair/ replacement and performance concerns of SWHS and response of companies towards the complaints. The fourth component is the satisfaction among beneficiaries towards working of PEDA officials. All these parameters are integral to analyse the extent of implementation of SWHS scheme in Punjab for sustainable rural electrification while considering the perception of beneficiaries towards SWHS installation to meet their requirement of energy.

Table 4: Subsidy Provided by PEDA to Beneficiaries

Districts	*Yes*	*No*	*Total*
Ludhiana	46	4	50
Jalandhar	48	2	50
Kapurthala	26	2	28
Total (Percentage)	120 (93.75%)	8 (6.25 %)	128 (100%)

The above table reveals that 93.75 percent beneficiaries in Ludhiana, Jalandhar and Kapurthala got their subsidy on time after installation of SWHS and only 6.25 percent beneficiaries did not get subsidy on time. During field work they informed researcher that SWHS is an expensive system and it is not affordable to get it installed without any subsidy provision. They were of opinion that State Government should also release some portion of subsidy every consecutive year on installation of SWHS which would increase the interest of people in SWHS.

Table 5: Satisfaction Level of Beneficiaries Regarding Subsidy Provided by Government

Districts	*Satisfied to large extent*	*Satisfied to some extent*	*Dissatisfied*	*Total*
Ludhiana	10	33	7	50
Jalandhar	13	33	4	50
Kapurthala	5	21	2	28
Total (Percentage)	28 (21.88%)	87 (67.97%)	13 (10.15%)	128 (100%)

The above table reveals that majority of beneficiaries (67.97 percent) in Ludhiana, Jalandhar and Kapurthala district were satisfied to some extent and beneficiaries (21.88 percent) were satisfied to large extent and beneficiaries (10.15 percent) were dissatisfied with the subsidy provided by central and state Government. Any kind of discontinuity of subsidy either by central or state Government make SWHS unaffordable for beneficiary.

Table 6: Information About PEDA's Awareness Programmes Regarding Solar Water Heating System

Districts	*Yes*	*No*	*Total*
Ludhiana	31	19	50
Jalandhar	22	28	50
Kapurthala	19	9	28
Total (Percentage)	72 (56.25%)	56 (43.75%)	128 (100%)

The above table reveals that majority of beneficiaries (56.25 percent) from Ludhiana, Jalandhar and Kapurthala district are informed about various programmes initiated by PEDA for dissemination of information regarding usage of SWHS. 43.75 percent of beneficiaries are not informed about PEDA's awareness initiatives. In total almost 89.84 percent, 64.84 percent and 54.69 percent beneficiaries from Ludhaina, Jalandhar and Kapurthala did not have any information about camps/ exhibitions, advertisements regarding SWHS in newspaper and seen boards/ hoardings and mobile exhibition vans respectively organized and managed by PEDA During field work, they informed the researcher that none of the camp was organized by PEDA in their locality and some of the beneficiaries had attended camps organised by Punjab Agriculture University in Ludhiana.

Table 7: Perception of Beneficiaries Regarding Working of SWHS

Districts	*Yes*	*No*	*Total*
Ludhiana	44	6	50
Jalandhar	47	3	50
Kapurthala	23	5	28
Total (Percentage)	114 (89.06%)	14 (10.93%)	128 (100%)

The above table reveals that 89.06 percent beneficiaires in Ludhiana, Jalandhar and Kapurthala district confirmed the functionality of SWHS in providing hot water in day routine works and only 10.93 percent beneficiaires confirmed the non-functionality of SWHS. During field work they informed researcher that their SWHS stopped working due to failure in getting maintenance/ repair service from companies.

Table 8: Perception of Beneficiaries Regarding Performance and Maintenance of SWHS

Districts	*Satisfied to large extent*	*Satisfied to some extent*	*Dissatisfied*	*Total*
Ludhiana	28	14	8	50
Jalandhar	32	12	6	50
Kapurthala	14	9	5	28
Total (Percentage)	74 (57.81%)	35 (27.35%)	19 (14.84%)	128 (100%)

The above table reveals that majority of the beneficiaries (57.81 percent) in Ludhiana, Jalandhar and Kapurthala district were satisfied with efficient working of SWHS and with after sale service of companies. 27.35 percent of beneficiaries were satisfied to some extent as they were satisfied with performance but not maintenance of SWHS through companies. There were few beneficiaries (14.84 percent) were dissatisfied with functioning of SWHS due to occurrence of fault in them and did not get maintenance or repair service from companies.

Table 9: Functional Fault in the Installed SWHS

Districts	*Yes*	*No*	*Total*
Ludhiana	32	18	50
Jalandhar	25	25	50
Kapurthala	15	13	28
Total (Percentage)	72 (56.25%)	56 (43.75%)	128 (100%)

Above table reveal that nearly more than half of beneficiaries (56.25 percent) in Ludhiana, Jalandhar and Kapurthala district faced functional faults. These functional faults may range from negligence of company people during installation of SWHS, lack of knowledge about SWHS, low quality of product. This question was asked to only 67 beneficiaries who complained to company regarding fault in SWHS. The above table reveals that 59.70 percent beneficiaries in Ludhiana, Jalandharand Kapurthala district got assistance from company's distributors or retailers. During field work they also informed researcher that some of beneficiaries got assistance informally as they know company people.

Table 10: Visit of District Manager During SWHS Installation

Districts	*Yes*	*No*	*Cannot say*	*Total*
Ludhiana	13	34	3	50
Jalandhar	21	28	1	50
Kapurthala	12	14	2	28
Total (Percentage)	46 (35.94%)	76 (59.38%)	6 (4.69%)	128 (100%)

Above table reveals that majority of beneficiaries (59.38 percent) in Ludhiana, Jalandhar and Kapurthala district assured that there was no visit of PEDA official during SWHS installation. It was only company people who installed SWHS and completed other official formalities of form filling, photograph clicking etc. There were some beneficiaries (35.94 percent) who mentioned the visit of District Manager after installation of SWHS.

Findings: Challenges Faced by Beneficiaries Regarding the Installation and Functioning of SWHS

i) *Lack of Knowledge regarding Subsidies provision and installation process:* Beneficiaries are not aware about whole installation process. They have no idea about central subsidy/ state subsidy for SWHS and are not aware about companies name which have installed them. Some of beneficiaries are not even aware about PEDA.

ii) *Subsidy provision for SPV is not adequate:* The MNRE provides only 30% of these costs as subsidy and remaining cost is bear by the beneficiary. 50% of the cost of SWHS 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 makes SWHS unaffordable to low income group.

iii) *Lack of awareness:* There is a lack of knowledge and training regarding benefits and usage of SWHS among various players, institutions, rural communities, consumers, financing institutions, entrepreneurs, and all other stakeholders in the supply chain. PEDA is not even technically advanced to periodically monitor and collect data on the promotion and usage of SWHS among society.

iv) *Lack of access to companies/ PEDA officials:* Many of beneficiaries are not aware about the companies name and they don't have any pamphlet/ visiting card of company. Personally many of SWHS beneficiaries did not meet District Manager or any PEDA official anytime and they don't know about District Manager office.

v) *Delay in maintenance service through Private Companies:* Many times the company which installed SWHS gets closed and fails to provide service to beneficiaries. Sometimes the company delays to provide service which forces beneficiary to get repair service from some local electrician or plumber.

vi) *Low quality of SWHS solar panels:* The available RES from SNAs/ by dealers or channel partners of MNRE are expensive in comparison to market rates and are of low quality as in lieu to provide subsidy under high pricing.

vii) *Absence of office for Grievance Redressal of Beneficiaries:* PEDA is a single window clearance organization regarding all RES which needs to address the grievances of beneficiaries regarding RES. However there is no proper grievance cell set up in PEDA to address these issues.

viii) *Lack of Inspection of Installed SWHS:* There was no 100% inspection by District Manager and did not visit beneficiaries place after installed SWHS. However, District Manager look over all installed RES in their respective districts but without meeting beneficiaries. District office of PEDA contains only District Manager and no other staff to support and assist District Manager's work load.

Conclusion and Recommendations

The use of hot water for bathing and other purposes plays an integral part of modern lifestyles and the abundance of sunlight makes Solar Water Heating System, a natural solution. The investment on solar water heaters pays itself back through saving electricity costs in 4 to 5 years and thereafter the hot water is available at free of cost for over more than 15 years. However the penetration of SWHS in Indian market is still not adequate due to few loopholes present at administrative and execution level. The cost and quality of SWHS are still not in the satisfactory level as SWHS available from SNAs/ by dealers or channel partners of MNRE are expensive in comparison to market rates and are of low quality as in lieu to provide subsidy under high pricing. There is need for more government rebates and benefits for small scale manufacturers to flourish more by maintaining quality assurance on SWHS and control their pricing, so that it can compete with the conventional water heating systems. The beneficiaries are not satisfied with maintenance provision of SWHS as many times either the company gets closed or the delays to provide service enforces beneficiary to get repair service from local electrician and pay during warranty period. PEDA should initiate focused group discussions during awareness campaigns, set up a drop box at PEDA Headquarter and District Manager offices and should publicize the grievance cell contact no. to address their grievances regarding companies. There is still lack of knowledge and training regarding benefits and usage of SWHS which can be checked by involving local media, civil societies, and demonstrations during awareness campaigns, distribution of more literature etc. Environmental preferences and reliability are two competitive benefits of SWH systems in the international market. These two preferences can get credential only if the subsidy on conventional energy resources will be reduced by Indian Government to motivate people to get RES installed. This requires all the sectors like private sector, public sector, professionals and researchers to work together to create and commercialize green technologies.

References

Bhardwaj, M., & Neelam (2015). The advantages and disadvantages of green technology. *Journal of Basic and Applied Engineering Research*, 2(22), 1957-1960, Krishi Sanskriti Publications.

Retrieved from http://www.krishisanskriti.org/vol_image/21Jan201607013904 Monu Bhardwaj _Applied 1957-.pdf as on 4 Sept, 2017.

Islam, M. R., Sumathy, K., & Khan, S. U. (2013). Solar water heating systems and their market trends. *Renewable and Sustainable Energy Reviews*, pp.1-25. Retrieved from http://ac.els-cdn.com/S1364032112005084/1-s2.0-S1364032112005084-main.pdf?_tid=e35feeee-8b40-11e4-b794-00000aacb35e&acdnat=1419407333_e13dc41bee-821432bb43050bd55cc775 as on 21 Dec, 2014.

Bhardwaj, M., & Neelam (2015). The advantages and disadvantages of green technology. *Journal of Basic and Applied Engineering Research*, *2*(22), 1957-1960, Krishi Sanskriti Publications. Retrieved from http://www.krishisanskriti.org/vol_image/21Jan201607013904 Monu Bhardwaj _Applied 1957-.pdf as on 4 Sept, 2017.

Billur, S. S., Yerigeri, V. V., & Yerigeri, R. V. (2015). An Overview of evacuated solar water heating system. *International Journal of Innovative Research in Science, Engineering and Technology, 4*(4), 2096-2102. Retrieved from https://www.rroij.com/open-access/an-overview-of-evacuated-solar-waterheating-system.pdf as on 19 Sept, 2017.

Islam, M. R., Sumathy, K., & Khan, S. U. (2013). Solar water heating systems and their market trends. *Renewable and Sustainable Energy Reviews*, pp.1-25. Retrieved from http://ac.els-cdn.com/S1364032112005084/1-s2.0-S1364032112005084-main.pdf?_tid=e35feeee-8b40-11e4-b794-00000aacb35e&acdnat=1419407333_e13dc41bee-821432bb43050bd55cc775 as on 21 Dec, 2014.

Ministry of new and renewable energy, Solar Water Heating System. Retrieved from http://mnre.gov.in/file-manager/UserFiles/brief_swhs.pdf as on 7 Dec, 2014.

Ministry of new and renewable energy, Solar Water Heating System. Retrieved from http://mnre.gov.in/file-manager/UserFiles/brief_swhs.pdf as on 7 Dec, 2014.

Punjab Energy Development Agency. Retrieved from http://peda.gov.in/eng/prom_solar.html as on 19 Dec, 2014.

Punjab Energy Development Agency. Retrieved from http://peda.gov.in/eng/prom_solar.html as on 19 Dec, 2014.

Ministry of New and Renewable Energy. Jawaharlal Nehru National Solar Mission towards Building Solar India. p.4. Retrieved from http://www.mnre.gov.in/file-manager/UserFiles/ mission_ document _JNNSM.pdf as on 24 Dec, 2016.

Ministry of New and Renewable Energy. (2016). National Solar Mission. Chapter 4, Annual Report 2016-17. Retrieved from http://mnre.gov.in/file-manager/annual-report/2016-2017/EN/pdf/4.pdf as on 4 Sept, 2017.

United Nation Development Program. Retrieved from http://www.in.undp.org/content/india/en/home/operations/projects/environment_and_energy/global_solar_waterheatingmarkettransformationandstrengtheningini.html as on 1 Jan, 2015.

United Nation Development Program. Retrieved from https://sgp.undp.org/index.php?option=com_sgpprojects&view=projectdetail&id=5198&Itemid=205 as on 1 Jan, 2015.

Punjab Energy Development Agency. Retrieved from http://peda.gov.in/eng/prom_solar.html as on 2 Jan, 2015.