
Renewable Energy Technologies Diffusion in Sindh: An Overview

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ABSTRACT

The abundant resources of Sindh province for RE (Renewable Energy) such as wind, solar, etc. can be tapped through RETs (Renewable Energy Technologies) to fulfil energy needs. But RETs are still not able to make major breakthrough in individual's life to enhance it. Even though individuals began to use solar panels to conquer power deficiencies, more endeavours are required to diffuse RETs in Sindh. This research paper explores the present situation for the dissemination of RETs in masses. A survey is conducted to achieve the said task. It measures the opinion difference of respondents regarding awareness creation towards RETs, needs for funding, provision of incentives and role of community engagement required for promotion of RETs in Sindh. The opinion difference was measured regarding stakeholders' individual perception and chances of occurring the same (societal perception). The outcome of the survey identifies an entirely opposite opinion of stakeholders regarding their individual and social perceptions. Thus, predicting the real situation for RETs diffusion in Sindh. It indicates that despite much enthusiasm for RETs, lesser possibilities are accessible for their fruitful dispersion in Sindh in current conditions. Lack of awareness regarding RETs, few funding opportunities and absence of incentives from government resulted in the low engagement of communities to utilise RETs. Hence, due to hurdles identified, RETs face hindrances in their popularisation, which can be addressed through appropriate policy decisions.

Key Words: Renewable Energy Technologies, Awareness, Funding, Community, Sindh.

1. INTRODUCTION

The Need for fast development of RE sources increased because of higher energy consumption combined with the decrease in the usage of fossil fuels [1]. The RE frameworks are steadily being diffusing in the local society. RE frameworks are getting well known due to their unending nature and environment-friendly image [2]. While, effective dispersion of RETs shifts with the capacities of individuals inside the groups of social communities, that is how they react to the evolving patterns. From

one perspective, there are a few societies which are sufficiently engaged to face challenges, however, then again, some were remained deserted. Since the energy crises in 1970', RE sources management is prioritised in various countries around the world. [3]. The success of sustainable development as multi-dimension task relies on the efficiency of policies aimed at utilisation of RETs at the ground level in the society [4]. Therefore, customized policies for RE are required to effectively align communities with effective utilisation of RETs in

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achieving sustainable development. Lack of Governance and unsystematic framework for the promotion of RE development are blind spots on the part of the supply-side stakeholders [5]. This will leads towards unsystematic progress for the diffusion of RETs.

In Pakistan, policies are made without analysing the capabilities of society or society can't catch up with the new reforms [6]. While other nations devise policies that best suits their needs. China while shifting towards a knowledge-based economy, significantly increased R&D (Research & Development) funding. India accelerated the pace of its economic growth through extraordinary accomplishments in S&T (Science & Technology) on individual categories of the technological growth [8]. Inclusive growth approach was one of the main approach adopted. Inclusive growth approach stresses the use of S&T for the betterment of poor and middle class, by providing drugs and consumable at low prices.

Pedro et. al. [9] recommended that at the national level, it is obvious that innovation is not an immediate outcome of R&D, it can establish because of the set of organisations working for accomplishing the sustainable growth. Along these lines, to accomplish sustainable growth in Pakistan, particularly in Sindh, a greater amount of the population needs to adapt RE based technologies, which as of now has all the symptoms of being unachievable. SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis performed by Shakeel et. al. [10] for energy sector of Pakistan highlights the ineffective use of natural resources available at the domestic level despite the colossal capability of RE (Wind, Sun, Biomass and Hydro etc). It then, resulted in the expensive cost of electricity generation (Fig. 1). To promote RETs in larger part of society, smart grid systems which have distributed generation can emerged as opportunity to fulfill energy shortages.

The additional obstacle that influences the dissemination rate of RETs among the bigger population in society are

the misguided judgments about their efficiencies. RETs mostly supposed as less market competitive than traditional energy systems [11]. Whereas, a sharp contrast was identified in another research [12], which considered solar energy as a feasible source of electrical power generation for small, medium and large scale. To make business opportunities for RETs, producers need to improve operational features of these devices by diminishing their cost [13]. Whereas another research [14] identified that in Sindh lesser knowledge makes a negative discernment about the efficiencies of these technologies in masses, which can be minimised by increasing awareness towards these technologies. Therefore, keeping in mind the present status of RETs dissemination in Sindh, this research targets to identify the current status of RETs diffusion in Sindh on the basis of stakeholders viewpoint. Furthermore, the current research investigated the individual liking of RETs for successful diffusion in the society w.r.t the possibilities of achieving the same. It will then anticipate the present situation for the dissemination of RETs by presenting real flaws in different strategies and policies to achieve the task of RETs fruitful dispersion in Sindh.

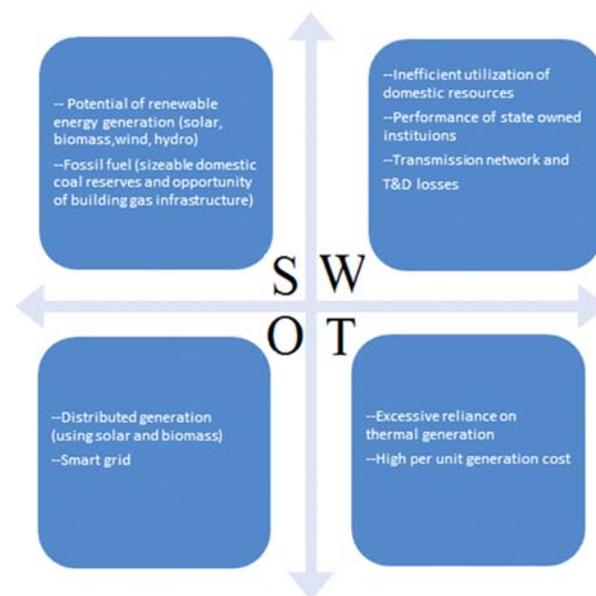


FIG. 1. SWOT ANALYSIS OF PAKISTAN ENERGY SECTOR [10]

2. MATERIALS AND METHOD

For this research, a questionnaire was designed, various tests were performed to check the reliability of questionnaire, then that questionnaire was used to obtain perspectives of various stakeholders for RETs diffusion in Sindh. The convenient sampling technique is adopted, and details of stakeholders were obtained from PCSIR (Pakistan Council of Scientific & Industrial Research) Laboratories, Hyderabad, and TTI (Technology Transfer Institute), Tandojam, Pakistan. A total of 63 stakeholders were identified, who are in touch with PCSIR and TTI to adopt RETs. These stakeholders belonging to six main sectors i.e. industry, Financial Institutions, government, academia, NGOs and landowners have shown interest in the diffusion of RETs. Survey questionnaire was sent to all. However, 46 returned the filled questionnaire. The survey questionnaire was designed by adopting the parameters of Bergek et. al. [15] required for the successful diffusion of RETs. These parameters were further modified in Sindh perspectives keeping in view its stage of development. Such as awareness creation through education, funding & viability and community involvement. The survey questionnaire was based upon the quantitative nature of research, and closed-ended questions were included in the survey questionnaire. The structure of survey questionnaire is given in **Table 1**. The survey questionnaire is structured in such a way that it can accommodate stakeholders' opinion on two dimensions i.e. Individual and Societal perceptions. The individual liking is termed as individual perception (I) and the stakeholder visualization for chances of acceptance/happening/occurring the same in Sindh is termed as societal perception (S). The collection of data in 2D (Two Dimensions) (Individual and Societal) provided the real situation for the diffusion of RETs in Sindh for near future by identifying the opinion difference of respondents such as: Real Situation=Individual liking - Societal Perception.

The data collected was analyzed through SPSS and WSRT (Wilcoxon Signed Rank Test) then applied for 2-related

samples approach. It investigated the combined response for individual and societal perceptions at the significant level of (0.05). From collected data for individual and societal perceptions, the hypothesis tested is shown below:

Hypothesis: The current scenario for RETs diffusion in Sindh is constructive.

3. RESULTS

The WSRT when performed on the data collected for individual and societal perception a highly strong opinion difference emerged. The widened opinion difference between the stakeholder's individual and societal perceptions provided the real situation for RETs diffusion in Sindh, which appears to be unencouraging. The same is also witnessed through the comparison between Matched Samples, which is performed in **Table 2**. It shows population mean N, Mean Rank and their level of difference for each parameter/question. Primarily this Rank Table indicates differences in stakeholders' responses related to their individual liking and societal perception.

The WSRT (Table 3), thus indicate that in all three aspects i.e. Awareness Creation through Education, Funding & Viability and Community involvement, the Significance Value (p-value i.e. Asymp. Significant (2-Tailed) for all Variable is $p < 0.05$, therefore it is concluded that individual and societal perception of stakeholders are significantly different. Hence, we reject the null hypothesis. The level of assertion changes massively for all the three chosen parameters assigned to study current situation of RETs dispersion in Sindh. It predicts the unconstructive circumstance for the dispersion of RETs in Sindh.

An example for the outcome of awareness creation through education is being explained for further understanding. The analysis for awareness creation through education parameters points towards the fact

that despite the respondent's strong agreement as per their individual perception that education plays an important role in the dissemination of RETs, but as per their societal perception they are extremely dissatisfied with the alignment of the local education system in society in achieving the said task. Thus, not playing any significant part in the diffusion of RETs in Sindh. Hence,

the huge gap between individual liking and societal acceptability makes the Sindh's RETs diffusion dysfunctional, which can be achieved by devising awareness program for RETs through education (Fig. 2). This dynamic as explained earlier is valid for all the three parameters, showing the current unconstructive scenario for RETs diffusion in Sindh.

TABLE 1. SURVEY QUESTIONNAIRE

No.	Statements	Level of Agreement ↔					Chances of Acceptability etc ↔				
		5	4	3	2	1	5	4	3	2	1
Awareness Creation Through Education											
1.	Success of RETs diffusion depends upon knowledge transfer (KT).										
2.	Is it time to include more courses on RE in general education.										
4.	The role of matriculation level education is crucial for the promotion of RE.										
5.	The role of intermediate level education is crucial for the promotion of RE.										
6.	The role of university education in promotion of RE is most significant.										
7.	More trainings/seminars/conferences increases the awareness of RETs/STTs.										
8.	Institutes of technical education should incorporate more courses on RETs.										
Funding and Viability											
1.	Increase of capital volume may increase resource mobilization for RETs.										
2.	Increase in Seed and Venture Capital [Funds for startup Firms and Business], also increases potential for resource mobilization for RETs.										
3.	Resource mobilization for RETs can be done through change and increase in quality of human resources.										
4.	Change in complementary Assets (Products, Services, Work Infrastructure etc.) increases resource mobilization for RETs.										
5.	Lack of efficiency in technologies of RETs is the main hurdle in their commercialization. If they are made more efficient society will adopt them easily.										
6.	Creation of Business Incubators [places providing business management help] is the main source to encourage new firms in the field of RETs.										
Community Involvement											
1.	NGOs and private sector can perform efficient role in poverty alleviation in Sindh										
2.	Do NGOs and private sector ever focused on alleviating poverty through RETs utilization.										
3.	Poverty can be reduced in Sindh if RETs policies are giving more focus to communities.										

TABLE 2. RANKS

	N	Mean Rank	Sum of Ranks	
S: RET can be successfully diffused in our society? I: RET can be successfully diffused in our society?	Negative Ranks	36 ^a	19.19	691
	Positive Ranks	1 ^b	12	12
	Ties	9 ^c		
	Total	46		
S: RET can improve economic conditions, remove poverty in Sindh	Negative Ranks	31 ^d	16.74	519
	Positive Ranks	1 ^e	9	9
	Ties	14 ^f		
I: RET can improve economic conditions, remove poverty in Sindh.	Total	46		
	Negative Ranks	25 ^g	13	325
	Positive Ranks	0 ^h	0	0
S: The problem of water purification/cleaning can be solved through Solar Desalination - I: The problem of water purification/cleaning can be solved through Solar Desalination	Ties	21 ⁱ		
	Total	46		
	Negative Ranks	29 ^j	15	435
S: Solar Geysers can provide suitable options for water heating	Positive Ranks	0 ^k	0	0
	Ties	17 ^l		
	Total	46		
S: Solar stoves (Cookers) can be an ideal way for Cooking of food in off grid areas - I: Solar stoves (Cookers) can be an ideal way for Cooking of food in off grid areas	Negative Ranks	33 ^m	17.59	580.5
	Positive Ranks	1 ⁿ	14.5	14.5
	Ties	12 ^o		
	Total	46		
S: Food/vegetables drying provide much economic up-gradation opportunities through solar dehydrators. I: Food/vegetables drying provide much economic up-gradation opportunities through solar dehydrators.	Negative Ranks	27 ^p	14	378
	Positive Ranks	0 ^q	0	0
	Ties	19 ^r		
	Total	46		
S: Solar dehydrators can be efficiently used for dates drying	Negative Ranks	25 ^s	13	325
	Positive Ranks	0 ^t	0	0
	Ties	21 ^u		
I: Solar dehydrators can be efficiently used for dates drying	Total	46		
	Negative Ranks	25 ^v	13	325
	Positive Ranks	0 ^w	0	0
S: Solar dehydrators can be efficiently used for chillies drying	Ties	21 ^x		
	Total	46		
	Negative Ranks	25 ^y	13.66	341.5
S: Solar dehydrators can be efficiently used for Rose petals/Spinach/ Onions/tomato etc drying	Positive Ranks	1 ^z	9.5	9.5
	Ties	20 ^{aa}		
	Total	46		
S: After sales service for STT is essential for their commercialization. If it is provided society may greatly adopt STTs. I: After sales service for STT is essential for their commercialization. If it is provided society may greatly adopt STTs.	Negative Ranks	40 ^{ab}	20.5	820
	Positive Ranks	0 ^{ac}	0	0
	Ties	6 ^{ad}		
	Total	46		
S: STTs can easily be diffused in society, if it contains more applications other than water purification, heating, cooking and drying. I: STTs can easily be diffused in society, if it contains more applications other than water purification, heating, cooking and drying.	Negative Ranks	37 ^{ae}	19.8	732.5
	Positive Ranks	1 ^{af}	8.5	8.5
	Ties	8 ^{ag}		
	Total	46		
S: STT can improve economic conditions, remove poverty in Sindh. I: STT can improve economic conditions, remove poverty in Sindh.	Negative Ranks	38 ^{ah}	20.84	792
	Positive Ranks	2 ^{ai}	14	28
	Ties	6 ^{aj}		
	Total	46		
S: The shortfall of electricity can be removed through RE. I: The shortfall of electricity can be removed through RE.	Negative Ranks	25 ^{ak}	13.6	340
	Positive Ranks	1 ^{al}	11	11
	Ties	20 ^{am}		
	Total	46		
S: The cooling systems of buildings can be done through RE. I: The cooling systems of buildings can be done through RE.	Negative Ranks	23 ^{an}	12.57	289
	Positive Ranks	1 ^{ao}	11	11
	Ties	22 ^{ap}		
	Total	46		
S: High cost of RET (STT) brings hurdle in their diffusion. Is society ready to pay more for these technologies? I: High cost of RET (STT) brings hurdle in their diffusion. Is society ready to pay more for these technologies?	Negative Ranks	37 ^{aq}	19.7	729
	Positive Ranks	1 ^{ar}	12	12
	Ties	8 ^{as}		
	Total	46		

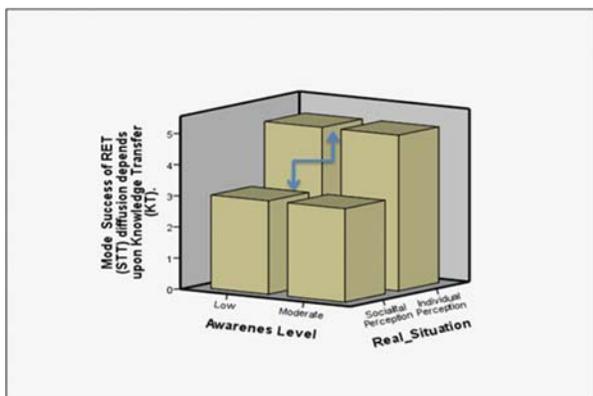


FIG. 2. COMPARISON: 2-RELATED SAMPLES APPROACH (INDIVIDUAL VS SOCIETAL PERCEPTIONS)

Presently the question emerges, “what is the alternative strategy to rapidly diffuse RETs in Sindh”. The simplest approach to effectively diffuse RETs in Sindh is to take care of most usual issues of individuals concerning with power deficiencies both required for heating and cooling. Right now, according to correlation **Table 4**, which represents the data for successful diffusion of RETs in societal perspective w.r.t stakeholders self /individual opinion, there exists a negative relationship between the effective dissemination of RETs with the tremendous request of satisfying power and cooling requirements.

TABLE 3. WILCOXON SIGNED RANK TEST (I=INDIVIDUAL LIKING AND S= SOCIETAL PERCEPTION)

Awareness Creation through Education							
	S: Success of RETs diffusion depends upon Knowledge Transfer (KT). - I: Success of RETs diffusion depends upon Knowledge Transfer (KT).	S: It is time to include more courses on RE in general education. - I: It is time to include more courses on RE in general education.	S: The role of matriculation level education is crucial for the promotion of RE. - I: The role of matriculation level is crucial for the promotion of RE.	S: The role of intermediate level education is crucial for the promotion of RE. - I: The role of intermediate level education is crucial for the promotion of RE.	S: The role of university education in the promotion of RE is most significant. - I: The role of university education in the promotion of RE is most significant.	S: More trainings/seminars/conferences increase the awareness of RETs. - I: More trainings/seminars/conferences increase the awareness of RETs.	S: Institutes of technical education should incorporate more courses based upon RETs. - I: Institutes of technical education should incorporate more courses based upon RETs.
Z	-5.528	-5.789	-4.616	-5.010	-5.457	-5.831	-5.951
Asymp. Significant (2-Tailed)	.000	.000	.000	.000	.000	.000	.000
Funding and Viability							
	S: Increase of capital volume will increase resource mobilization for RETs. - I: Increase of capital volume will increase resource mobilization for RETs.	S: Increase in Seed and Venture Capital increases diffusion of RETs. - I: Increase in Seed and Venture Capital increases diffusion of RETs.	S: Resource mobilization for RETs can be done through change and increase in quality of human resources. - I: Resource mobilization for RETs can be done through change and increase in quality of human resources.	S: Change in complementary Assets (Products, Services, Work Infrastructure etc.) Increases the diffusion of RETs. - I: Change in complementary Assets (Products, Services, Work Infrastructure etc.) increases resource mobilization for RET (STT).	S: Lack of efficiency in technologies of RETs is the main hurdle in their commercialization. - I: Lack of efficiency in technologies of RETs is the main hurdle in their commercialization.	S: Lack of efficiency in technologies of RETs is the main hurdle in their commercialization. - I: Creation of Business Incubators [places providing business management help] is the main source to encourage new firms in the field of RETs.	
Z	-6.014a	-5.938a	-5.889a	-5.645a	-3.164a	-5.644a	
Asymp. Significant (2-Tailed)	.000	.000	.000	.000	.002	.000	
Community Involvement							
	S: NGOs and private sector can perform an efficient role in diffusion of RETs in Sindh. - I: NGOs and private sector can perform an efficient role in poverty alleviation in Sindh through RETs.	S: Do NGOs and private sector ever focused on alleviating poverty through RETs utilization. - I: Do NGOs and private sector ever focused on alleviating poverty through technology utilization.	S: Poverty can be reduced in Sindh, if RETs policies giving more focus to communities. - I: Poverty can be reduced in Sindh, if RETs policies giving more focus to communities.				
Z	-2.036a	-2.828a	-5.819a				
Asymp. Significant (2-Tailed)	.042	.005	.000				
a. Based on positive ranks. b. Wilcoxon Signed Ranks Test							

TABLE 4. CORRELATION

S: Renewable Energy Technologies can be Successfully Diffused in our Society?		I: The Shortfall of Electricity can be Removed through RE	S: The Shortfall of Electricity can be Removed through RE	I: The Cooling Systems of Buildings can be done through RE	I: Diffusion of RET (STT) Depends upon Incentives/Disincentives from Govt.
	Pearson Correlation	-0.141	-0.026	-0.003	-0.348
	Significant (2-Tailed)	0.351	0.863	0.984	0.018

Hence, fewer chances are accessible to accomplish these two goals through RETs in current conditions. In this way, to make RETs more viable in Sindh, household energy needs of cooling and heating ought to be satisfied through these technologies. In this specific situation, more R&D efforts and government interest, for example, such as incentives are needed to be diverted in this direction.

4. CONCLUSION

The above discussion indicates that despite much interest of stakeholders in the utilization of RETs, an entirely opposite scenario is being visualized by them regarding their diffusion. Less focus on awareness creation through education, low priority to increase funding to establish systems to diffuse RETs and un-involvement of communities are the major issues in creating an unconstructive environment for diffusion of RET in Sindh. Hence, it is concluded that to diffuse RETs in Sindh rapidly; focus must be laid down on the introduction of financial incentives on RETs by concentrating on solving the common problem of people i.e. cooling of buildings and availability of electricity itself. The same approach in current practices needed to be adopted by the organisation responsible for the diffusion of RETs, once these strategies are adopted, the diffusion rate of RETs can be improved drastically.

5. RECOMMENDATIONS

The policy recommendations emerged from the conclusion are given below. These recommendations not only have valid implications for Sindh but can be generalised for other developing regions as well.

- (i) Sindh and other developing regions should focus more on awareness creation of RE through education.
- (ii) The emergency must be declared to introduce incentives from the government to lower the cost of RE technologies in lesser developing regions such as Sindh.
- (iii) All NGOs must be bound to undertake at least one RE projects involving communities.
- (iv) The drive for sustainable development is still missing in development projects; the same approach must be included in future projects to be initiated by governments.

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