



Tracing the Functional Dynamics of Technological Innovation System (TIS) for
Solar Thermal Technologies (STTs) in Sindh

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Abstract: The technological innovation system (TIS) basically discusses the development, diffusion and use of a particular technology (in terms of knowledge, product or both) in a society. Whereas, functioning of the innovation system in any region depends upon the stage of its development. Therefore, this research aims to trace the Sindh's TIS for Solar Thermal Technologies (STTs) by identifying key functional parameters to define it. These functional parameters are derived from a survey questionnaire conduct from the stakeholders having potential to shape Sindh's TIS for diffusion for appropriate renewable energy technologies in Sindh.

Keywords: Technological Innovation System (TIS), Solar Thermal Technologies (STTs), S&T, Sindh, Pakistan.

1. **INTRODUCTION**

In global competitiveness report (GCR, 2016) Pakistan ranked higher only from few worst performing African countries in many basic parameters, but it is surprising that after acquiring lower rank i-e 122 it has shown many encouraging signs in some of the parameters such as innovation and sophistications (rank: 85). It indicates that Pakistan can have bright scope for innovation if better opportunities exists to its people. This can be achieved through policy approaches best suiting to people needs, which satisfy their basic requirements at grass root level of the society.

In developing countries, the concept for introduction of Innovation Systems national or technical is still in the early stage. In order To explore these systems, it is crucial to understand the interaction of technologies within a society. Sindh has no proper system of organizations, institutions providing aligned set of activities to efficiently interlink technologies within its society. The absence of networks, low literacy, incompetent and unstable governments is the reason behind this situation (Qureshi, 2006). Therefore, tracing the interaction of various stakeholders, which tends to establish Technological Innovation System (TIS) is a huge challenge in Sindh. Pakistan Council for Science and Technology way back in 1999 pointed out that non-existence or weak alliance exists between government, R&D organizations, Universities and industry (PCST, 1999). Hence, to investigate the Sindh's TIS, the focus on Techno dynamics for simple Solar Thermal Technologies (STTs) are investigated at grassroots level of the society. It could helps in identifying the hurdles,

which interlinks technology with its successful diffusion in society.

The system efficiency depends upon policy makers as it their major responsibility to design an innovation system, which can work as a single entity, offering all stakeholders the equal benefits. (Qureshi 2013) suggested that it is essential for developing countries to carry out dialogue at provincial and national levels on policy approaches to come up with ideas for national development through efficient technology utilization, when facing inadequacy of institutional structure. This leads to absence of generating knowledge based informed judgment and decision. Since the ultimate aim of this research is to trace Sindh's TIS, the policy recommendations emerged will help in establishing a systematic procedure for proper diffusion of appropriate technologies such as STTs.

2. **DATA COLLECTION AND ANALYSIS**

Research Methodology

Like many developing regions, Sindh has literature shortage for established research models/frameworks, to investigate its TIS for STTs (Shah, 2012). This research fills this gap by adopting the (Bergek *et al* 2008) framework as shown in (Fig-1). This framework discusses the TIS in emerging stage. Hence, it is ideal to trace Sindh's TIS for STTs to investigate its status. Bergek and his colleagues examined the functionality of emerging TIS on the basis of seven parameters such as Market Formation, Knowledge Development, Legitimation, Entrepreneurial experimentation, Resource Mobilization, Influence on the direction of search and Development of external economics.

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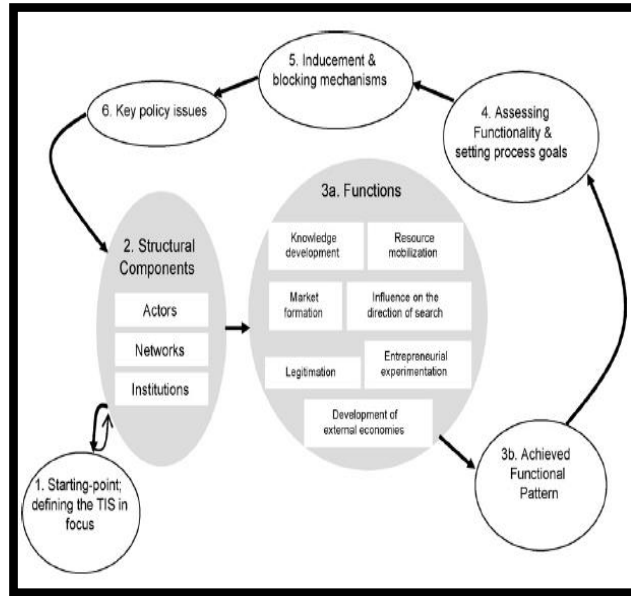


Fig. 1: framework

The seven functional parameters of (Bergek *et al* 2008) framework needed modification in Sindh's context. The compelling factors for modification in Sindh's perspective are: low literacy & awareness towards STTs, lower rates of developments, weak institutional linkages and absence of community based policies encouraging the techno-economics nexus through STTs.

In this context new parameters are required to investigate the Sindh's TIS. Thus, through the literature available, practical Knowledge gathered through the Surveys, the Bergek *et al*'s seven parameters are modified in Sindh's context. The modification process discussed below, indicate that the (Bergek *et al* 2008) functional parameters appears to be of advanced nature for emerging Sindh's TIS, where even the basic steps required for establishment of TIS are missing. Hence, each parameter needed to be kept at lower or initial levels. In order to identify the appropriate functional parameters in Sindh's context a survey questionnaire was conducted from the stakeholders having the potential to establish the Sindh's TIS for solar thermal technologies. Consisting of Institutes, stakeholders of relevant sectors working/engaged in the area of STTs, whose interaction shapes the TIS dynamics in Sindh. For each Bergek *et al* 2008). parameters, the stakeholders asked to suggest a alternative parameters, keeping in view development stage of Sindh.

3. RESULTS

3.1. Knowledge Development:

New borough *et al* (1991) emphasized that future prosperity merely depends solely upon scientists and

engineers progress: it mainly depends upon energy-use and energy thrift becoming essential components of average person's knowledge-base. In previous research (Shah, 2012) it is identified that majority of respondents when asked about the percentage of population being aware with the STTs were of the opinion that almost 70% of population are unaware regarding the wider application of simple renewable energy technologies (RETs) such as solar thermal technologies (STTs). The "Knowledge Development" parameter as proposed by framework seems to be more advance in Sindh's context, where even the basic awareness of STTs application is not being available to majority of population. Therefore this parameter is suitable to be investigated through "awareness creation of STTs in masses" rather than new knowledge generated by TIS for emerging technologies. This could be achieved by inclusion of courses/topics of STTs in general education system.

3.2. Resource Mobilization:

Fuss *et al* (2009) concluded that the investors are confused because they have to deal with dual uncertainties, some relates with those faced by the policy makers, whereas, some uncertainties are concerned with the actual policies. Through the survey it was identified that the stakeholders working/engage in the area of STTs are highly motivated to diffuse and adopt these technologies if provided appropriate funding. Hence, it is necessary to look "resource mobilization" parameters in terms of "viability and funding of STTs" opportunities available for these technologies in Sindh's context.

3.3. Market formation:

In "nursing phase" market began to open up to learn and adopt new technologies (Kemp, 2009). Higher interest in STTs can be generated in local people if STTs can solve day to day needs of common people. Such as Drying, cooling, heating etc. It was identified that in current circumstances, the chances for market creation of STTs are very small in Sindh. The low awareness towards these technologies and lack of government incentives to popularize these technologies in masses are the root cause for creation of such scenario. Therefore, the respondents were of the opinion that "market creation" parameter needed to be investigated through "Introduction of household services to masses through STTs" so that more people started to attract towards adoption of these technologies.

3.4. Legitimation:

Thomas (2010) argued that implementation of technology subsidy increases the national contribution to early deployment, which is independent of spillover level. At national and provincial level, there is absence of RE based policies focusing on community

development. This cause absence of appropriate subsidies to diffuses STTs in a society. (Fuss *et al.*, 2009) related the uncertainties of future economic growth chances with technology adoption (technological progress) and found out that these uncertainties are mainly concerned with the cost etc. Due to absence of policies as discussed above, at large no legitimation process started in Sindh to diffuse STTs in masses for community development and poverty alleviation. Therefore “legitimation” parameter was stressed to be investigated on the basis of “*Availability of RE policies*” in Sindh.

3.5. Influence on the direction of search:

To develop TIS, whole range of firms and organizations need to enter into it. There must then be sufficient incentives and/or pressures for the organizations to be induced to do so. (Bergek *et al* 2008). But Sindh has no such strong push for organizations/firms to promote STTs. Sindh lacks in policy institutes, which are responsible to introduce innovative approaches by linking STTs with community development etc to establish TIS. In current circumstances when less emphasis is laid upon the diffusion of STTs in masses, hence, it is impossible to open new horizons for advancement in STTs by influencing the direction of search. Now it is time for Sindh to work upon these lines by first creating/aligning policy and educational approaches towards the task of STTs diffusion. Therefore the “Influence on the direction of search” parameters is investigated through “*Creation/ Alignment of Policy RE based Institution*” by focusing on introducing innovative approaches, which links STTs with community development etc to establish TIS.

3.6. Entrepreneurial experimentation:

Through the survey it was identified that there is weak NGO's and private sector engagement to evolve TIS by involving larger set of communities. Very few initiatives involving communities in renewable energy based projects are being witnessed in Sindh. A recent trend in communities is to create unique strategies, which directly manage their energy systems (Denis; 2009). Therefore, linking STTs with communities is an innovative concept in Sindh's to establish TIS. Hence, “Entrepreneurial experimentation” is being visualized by stakeholders to be replaced through “*Community Involvement*” for introduction of STTs”. This task can be easily achieved when the well placed network of NGOs and private sector organizations being utilized efficiently.

3.7. Development of external economics:

Through the literature it was identified that in Sindh, there is no interlinking of educational, economic and

poverty alleviation policies with RE policies. (Bergek *et al* 2008) pointed out that the rate at which new firms enter into market plays a central role in TIS development. Bergek *et al's* parameter of “development of external economics” discusses the entry of new firms in emerging TIS but since the Sindh's TIS is not even much establish to termed as emerging one, when the basic policies and incentives are not available for diffusion of simple RETs like STTs. Hence, in Sindh's context the “development of external economics” is stressed to be investigated with an alternate parameter of “*Interlinking Educational, Economic Policies with RE based policies*”. The selection of this parameter lies in the fact that to rapidly diffuse the STTs in masses, main policies at provincial and national level should contain an element of RE. Currently these policies are made in isolation not having elements of one another. Thus the impact of each policy is lower, keeping in view the deteriorating conditions of Sindh. Hence, the learning output is represented in (Fig-2).

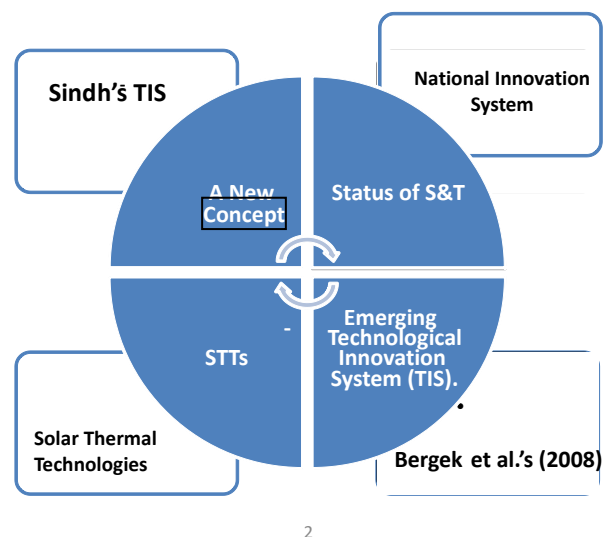


Fig. 2: Learning Output

4.

CONCLUSION

It is identified that keeping in view the Sindh's stage of development, the TIS functional parameters must be of a very basic nature. Sindh's TIS still not qualified to be termed as “Emerging TIS”. An array of different indicators are appeared to be shaping the Sindh's TIS. These parameters based upon the conditions of Sindh, which is less developed. Therefore, due to unavailability of proper parameters to define Sindh's TIS, still STTs are not being popularized in masses.

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