

Summary of Thesis

Technological Innovation Systems Building for Diffusion of

Solar Energy Technology in Developing Countries:

A Multilevel Analysis in Ethiopia

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Summary

The global diffusion of renewable energy technologies (RETs) has been sluggish, and as a result, governmental supports and policy interventions have been often recommended. A lot has been discussed in literature on the challenges and barriers to the diffusion of RETs but the diffusion is still far from success. For instance, Ethiopia, one of the highest solar radiation-endowed countries in sub-Saharan Africa, has a huge renewable potential that has yet to be exploited through the application of appropriate RETs. Wider and faster diffusion of RETs, including off-grid energy solutions, to the un-electrified mass of population has been a shared agendum among many actors in developing countries. Often, it is claimed that there are disintegrated approaches of the actors involved in the development and diffusion of RETs in developing countries. Due to such disparate efforts and myriad challenges, a little success of adoption has been registered, and such failures heighten the need for strategic and systemic approach. Also one of the policy puzzles in addressing the sluggish diffusion of RETs is lack of replicable policy format or strategy to address the multitude of challenges.

There has been a relatively recent understanding and trend in literature that the development, diffusion and use of new (energy) technology is influenced by the establishment of technological innovation systems (TIS) surrounding the technology in focus. Past studies on TIS were conducted to address the challenges of development and diffusion of RETs, mainly in the context of developed countries. In this thesis work, we empirically investigated how the concepts of TIS can be applied in a developing country setting for enhanced diffusion and further development of solar photovoltaics (PV) systems. Using solar energy technology as an empirical field, we studied how TIS can be built for successful diffusion of PV systems in the context of developing countries. In the study, diffusion of solar PV systems in Ethiopia was used as a main case along with other similar practices in the developing world. The main goal of the study has been showing the process of TIS building for enhanced diffusion of solar PV systems in developing countries and thereby identifying potential system builders at the formative phase of TIS building in such countries. In the study, departing from the traditional technology transfer thinking and practice, we pursued the argument that there is a need to build innovation systems and look for system builders so as to facilitate the diffusion

and further development of RETs in developing countries. The context of the developed world is where we find *systems in action (well-functioning systems)* in many ways but the developing world is often *void of systems*, becoming worse when considering (political) governance systems and technical systems. Hence, we argue that the demand for system building and system builders is more in a context where there is no system or lack of well-functioning system. Previous TIS studies in the context of technologically advanced countries emphasized on *generating, diffusing* and *using* a new technology (which we call it *R&D-based TIS*) while in this study context, the emphasis is on first *introducing, diffusing* and *using* a technology developed elsewhere and thereby aiming to build innovative capacity in the process (which we call it *diffusion-driven TIS*). Hence, the TIS building process and /or its aim kicks off at a different stage which would shed more light on the applicability of TIS framework in a domain out of which it was born.

The early phase of our research focused on exploring the diffusion barriers and systemic problems. As part of this phase of the research, we mapped out and analysed the status-quo and the historical trends of PV systems in Ethiopia. It was learnt that solar PV systems were introduced to Ethiopia in the early 1980s, and among the early solar projects was the first stand-alone PV system of 10.5 kW size (later upgraded to a double size) introduced in a village called Mito. However, such pioneer projects did not last beyond their initial few years. Inconsistent and paradoxical policies, lack of integration among solar actors, poor networks and networking mechanisms, and financial problems facing both the demand and the supply sides were among the major barriers to the diffusion of solar energy technology in Ethiopia. Following the empirical investigation in Ethiopia and further literature work, comparative practice in Bangladesh was studied. Particularly, the practices of two key actors in these two countries (Solar Energy Foundation (SEF) in Ethiopia and Grameen Shakti in Bangladesh) were investigated using a proposed theoretical framework of TIS building. In retrospective manner, we analysed the engagement of SEF in Ethiopia starting from day one when there were very few actors in the solar energy technology market. Going further level in analysing and learning from a global practice of an 'exemplary' case organization, we studied the practice of Grameen Shakti in Bangladesh. Hence, the overall study has been designed

in a multilevel phase where country level, organizational level, and individual level of cases are intertwined. Our proposed theoretical framework of TIS building which was refined using empirical cases shows the structural build-up process of innovation systems building through: *experimentation (pilot projects), attracting or creating actors, building networks, and influencing institutions.*

In the study, overall, pursuing a clear argument that there is a need to build TIS for enhanced diffusion of RETs, we showed how TIS can be built in the context of developing countries where the assumption that system components are out there may not hold true as opposed to the context of developed countries. Finally, based on exemplary and embedded empirical cases, the study forwarded theoretical propositions on the process of TIS building, the role of NGOs and NPOs as system builders at the early phase of TIS building, and the opinion leadership role of religious organizations in the diffusion of rural RETs. Furthermore, the study recommended policy intervention areas in developing countries including exploring potential innovation system builders and scaling up TIS building practices. It is our strong argument that through building diffusion-driven TIS, the prevalent energy poverty can be addressed and thereby a local energy industry can be built.

Let there be system \leftrightarrow Let there be light

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