Coupling Transition Theories with Simulation Modelling: A Case Study of Indian Renewable Power

Author: Enayat A. Moallemi
Email: emoallemi@student.unimelb.edu.au
Supervisors: Dr. Biju George, Assoc. Prof. Lu Aye, Prof. John Webb
Department: Infrastructure Engineering

THE UNIVERSITY OF MELBOURNE

Abstract: Transition theories and system engineering have widely analysed the development of socio-technical systems with narrative description and simulation modelling respectively while have not enough attended to each other's capabilities. This research is going to couple them together to better capture the mechanisms of change with transition theories as well as to enable explorative analysis by their modelling. It will be done through a case study in transition to renewable energy power in India, with concentration on on-grid solar power. The outcome provides a useful tool for practitioners for informed policy making while makes academic contributions in formalising transition theories.

Introduction

The reorientation of energy sector to a sustainable form has recently found resonance in both developed and developing countries. However, established fossil energies are tightly linked with complex and inter-correlated societal systems and have been trapped in carbon lock-in. The process of destabilizing the established energy regime and forming a new system is usually referred to as sustainability transitions. As an original contribution, this research aims to analyse the effect of different policies in this transition. With this regard, the main questions that direct the research are:

1. How can an integrated conceptual framework, based on transitions studies, be developed to capture dynamics of energy transitions?
2. How to model quantitatively the dynamics of transition?
3. What lessons can be learnt by applying the model in the case of Indian solar power generation?

Methodology

The research will be performed in four main steps:

1. Building a conceptual framework that explains the development of renewable energies;
2. Identifying the levers of change in the complex processes of Indian solar power development using the conceptual framework;
3. Developing the stock and flow diagrams (cause and effect diagrams) of the transitions based on the identified factors;
4. Assessing the impacts of some policy options in the long term run of the model.

Conclusion

The main insight put forward in this research is to provide a quantitative multi-dimensional basis for understanding the dynamics of renewable energy development. The research results in a theoretical integration, enabling simulation modelling, and empirical lessons from a real case study as its contributions to knowledge.

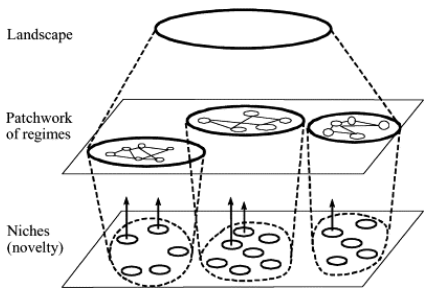

Fig 1. Conceptualization of energy system in socio-technical perspective (Geels, 2002*)

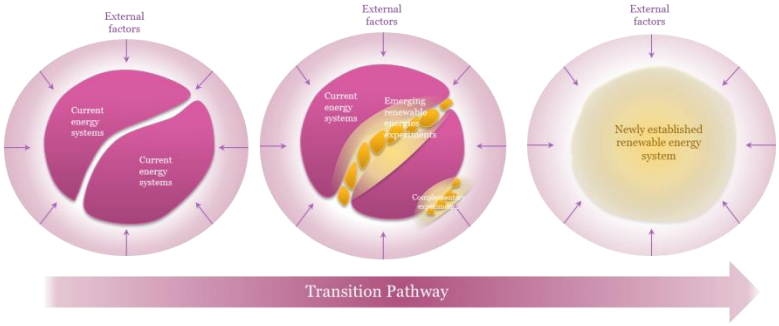

Fig 2. Conceptualization of transition pathway

Reference: Geels, F. W. (2002). "Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study." Research Policy 31(8-9): 1257-1274.