

**EXPLORING SUSTAINABILITY TRANSITIONS THROUGH THE MULTI-LEVEL PERSPECTIVE:
A REVIEW****Nikhil Jayaraj^{1*}**¹Curtin University, Bentley, Western Australia, Australia*Corresponding Author Email ID: nikhil.jayaraj@curtin.edu.au**ABSTRACT**

Socio-technical transitions are essential to achieving sustainable development, requiring systemic change across technology, institutions, behaviour, and culture. This study explores the theoretical foundations and practical applications of the Multi-Level Perspective (MLP) as a framework for analysing such transitions. The study highlights the shift towards Solar Energy Storage (SES) systems in Australia as a case of decentralised energy innovation that challenges centralised grid dependency. It reviews complementary frameworks—Technological Innovation Systems (TIS), Niche Strategy Management (NSM), Transition Management (TM), and the Techno-Economic Paradigm (TEP)—while focusing on the MLP’s capacity to integrate technological, institutional, and societal dimensions. Through a synthesis of empirical studies, the study demonstrates the MLP’s versatility in examining transitions in urban mobility, energy systems, water management, and waste. Key insights include the co-evolutionary dynamics between technology and society, the influence of governance and policy, and the role of niche innovations in reshaping socio-technical regimes. The study concludes by reflecting on the MLP’s strengths as a heuristic tool, while identifying challenges such as accounting for power asymmetries and context-specific complexities. The findings contribute to understanding how multi-level interactions shape pathways toward resilient and sustainable socio-technical systems.

Keywords: *socio-technical transitions, multi-level perspective framework, solar energy storage, co-evolution, niche, regime.*

1. INTRODUCTION

Transition refers to a sequence of interconnected and gradual changes that move a system from one state of dynamic equilibrium to another (Rotmans et al. [1]). It represents not a single event, but a process involving transformations across multiple domains such as technology, economy, institutions, behaviour, culture, ecology, and beliefs (Maaik & Ingrid [2]). When applied to the electrical supply chain, the transition towards Solar Energy Storage (SES) systems signifies a paradigm shift from centralised, grid-dependent energy models to decentralised, grid-independent solutions. The adoption of decentralised solar power systems disrupts traditional reliance on the electricity grid, enabling households to achieve a new dynamic equilibrium of energy independencies not only addresses technical grid issues but also contributes to a more resilient and decentralised energy network. It enables greater consumer autonomy, allowing households to control energy use and reduce vulnerability to fluctuating prices (Dargusch & Agnew [3]). International studies highlight how SES adoption facilitates better energy management, as seen in Germany, Austria, and Italy. The transition underway is thus not just technological but socio-technical. It involves changes across systems, including infrastructure, markets, behaviours, rules, and industrial relationships. To analyse this complex process, this study applies the Multi-Level Perspective (MLP), a well-established framework for understanding socio-technical transitions towards sustainability (Geels [4]). Implementation of MLP refers to the conversion of landscape, regime, and niche levels into simple, measurable factors that show how pressure of existing systems, and new innovations interact. This helps researchers and governments to follow real-world transitions and design practical tools like roadmaps, risk assessments, and targeted support policies. MLP shows that transitions are shaped by power and politics, as established actors like utilities and regulators often resist new technologies