

Article

# Evolutionary Analysis of the Solar Photovoltaic Products Trade Network in Belt and Road Initiative Countries from an Economic Perspective

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**Abstract:** Against the backdrop of global energy transition and the imperative for sustainable development, the trade dynamics of solar photovoltaic (PV) products among “Belt and Road Initiative (BRI)” countries gained momentum. This study investigates the evolving trade patterns of PV products within BRI nations, alongside the underlying determinants. The paper constructs and analyzes a solar PV product trade network, elucidating evolutionary trends, structural complexities, and clusters. A novel centrality influence model explores influencing factors across five dimensions. Methodologically, trade data, the “Five Connectivity” framework, and socio-economic indicators from 2001 to 2022 across 65 BRI countries underpin the study. Empirical insights reveal a robust PV product trade network with density exceeding 0.4 and reciprocity surpassing 0.38. China’s rising centrality, reflected in a weighted degree surge from 14.38 to 79.37 since 2011, signifies its consolidation within the network. Results show sustained high density and reciprocity in the PV trade network, signaling robust communication among BRI countries. China’s centrality in the network has consistently grown since 2011. Trade cluster analysis reveals isolated segments predominant, depicting emerging economies with limited photovoltaic exchanges, mainly export-focused. The study highlights the pivotal role of “Five Connectivity” dimensions in promoting PV trade, while financial connectivity’s impact remains modest. The emergence of PV product centers challenges traditional energy hubs, prompting the need for new energy trading paradigms and robust financial hubs.

**Keywords:** solar photovoltaic (PV) products trade; Belt and Road Initiative (BRI); green and sustainable development; comprehensive network model; factors influencing PV products network



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## 1. Introduction

The Belt and Road Initiative (BRI), introduced by China in 2013, aims to enhance trade, foster infrastructure development, and facilitate international collaboration across Asia, Africa, and Europe. As part of this expansive initiative, there was considerable attention directed towards the trade of solar photovoltaic (PV) products due to their potential to drive green and sustainable development [1]. These nations, positioned along the Belt and Road, possess strategic resources such as oil, coal, natural gas, and uranium, endowing them with pivotal roles in global supply chains and offering prospects for mutually beneficial partnerships. Approaching its 10th anniversary, the BRI places a heightened emphasis on achieving green and sustainable growth, given the escalating global greenhouse gas emissions [2]. Solar PV products encompass a broad array of technologies and equipment designed to convert sunlight into electricity through the photovoltaic effect. These include solar cells, which are the basic units for electricity generation, and solar panels, which are assemblies of these cells. Inverters play a crucial role in converting the direct current generated into usable alternating current. Mounting

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