

## 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

# Solar Alternative An Economic Perspective

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## **Solar Alternative An Economic Perspective:**

The Solar Alternative Amy L. Walton, Eugene H. Warren, 1982      **Energy Abstracts for Policy Analysis** , 1986

Climate Change And The Energy Problem: Physical Science And Economics Perspective (Second Edition) David L. Goodstein, Michael D. Intriligator, 2017-03-14 This important compendium deals with the primary world problems of global warming and the coming energy crisis. In alternating chapters it lays out the nature of the two interrelated problems and specifies the various economic considerations. Thus it describes the coming shortfall of fossil fuel energy in detail and then presents the economic factors governing possible solutions. Written by two world renowned academics: a physicist who writes about the nature of the problem and an economist who discusses various scenarios and solutions, this unique must-have book highlights the problem from the point of view of a scientist and an economist.

Regeneration of the Built Environment from a Circular Economy Perspective Stefano Della Torre, Sara Cattaneo, Camilla Lenzi, Alessandra Zanelli, 2019-12-30 This open access book explores the strategic importance and advantages of adopting multidisciplinary and multiscale approaches of inquiry and intervention with respect to the built environment based on principles of sustainability and circular economy strategies. A series of key challenges are considered in depth from a multidisciplinary perspective spanning engineering, architecture, and regional and urban economics. These challenges include strategies to relaunch socioeconomic development through regenerative processes, the regeneration of urban spaces from the perspective of resilience, the development and deployment of innovative products and processes in the construction sector in order to comply more fully with the principles of sustainability and circularity, and the development of multiscale approaches to enhance the performance of both the existing building stock and new buildings. The book offers a rich selection of conceptual, empirical, methodological, technical, and case study project-based research. It will be of value for all who have an interest in regeneration of the built environment from a circular economy perspective.

Green Collar Jobs Scott M. Deitche, 2010-01-22 This is a comprehensive yet practical guide for job seekers looking for green career opportunities. *Green Collar Jobs: Environmental Careers for the 21st Century* is a simple, easy-to-reference guide that will help students, recent graduates, job seekers, and career changers at all levels find the latest information and job resources in this burgeoning new field. This exceptionally timely book examines all aspects of green careers, beginning with an overview discussing green jobs from environmental, economic, and political perspectives. The core of the book is comprised of chapters that describe specific types of green jobs and career paths. These include jobs related to alternative energy, water resources, green marketing, green business, green building, and environmental law. For those willing to leave home, there is a chapter on global environmental jobs, and there is information on niche green careers such as ecotourism and green interior design. Each chapter includes job sources, education and training resources, and a listing of companies involved in the particular business.

*Sustainable Engineering* Yasar Demirel, Marc A. Rosen, 2023-08-04 Sustainable engineering is of great importance for resilient and agile technology and society. This book

balances economics environment and societal elements of sustainable engineering by integrating process intensification energy analysis and artificial intelligence to reduce production costs improve the use of material and energy product quality safety societal well being and water usage The book provides comprehensive discussion of topics on process intensification energy analysis and artificial intelligence that include optimization energy integration green engineering pinch analysis exergy analysis feasibility analysis life cycle assessment circular economy bioeconomy data processing machine learning expert systems digital twins and self optimized plants for sustainable engineering **Energy: a Continuing Bibliography with Indexes** ,1978 **Power Economics** Elena Cahill,2021-02-04 Energy efficiency is more of a journey than a battle It starts with small steps taken at the local and state levels It is a matter of identifying and then practicing good habits in our daily lives at home and at work Every idea and process described in this book if performed reasonably well will put money in your pocket You will not only save money you will probably make money and you will take important steps toward saving the planet Power Economics is a book for thoughtful people who want to cut their energy costs and diminish the harmful effects of greenhouse gas emissions Climate change and global warming are not speculative fantasies They are real They threaten communities towns cities regions nations and continents Even if you don t care about polar bears and penguins the effects of melting icecaps and shifting ocean currents will transform your life and the lives of the people around you Power Economics offers practical steps and achievable strategies for reducing the destructive impact of climate change and global warming Yes we need energy to live and to sustain our economies But we don t need to burn fossil fuels and release CO2 gas at levels that will result in a global catastrophe There are reasonable alternatives to our current practices None of the ideas that described in this book are entirely new or totally unfamiliar They aren t extreme or bizarre They won t require harsh or draconian measures to work All of them follow basic rules of common sense and can be achieved at reasonable cost I have done my best to convey the complexity and urgency of the matter I hope that you find this book informative and useful Working together we can shed many of our wasteful energy habits and begin the task of building a world that is safe sustainable and healthy writes author and energy expert Elena Cahill **Latin American Economic Outlook 2022 Towards a Green and Just Transition** OECD,European Commission,CAF Development Bank of Latin America,Economic Commission for Latin America and the Caribbean,2022-11-07 What challenges and opportunities does the green transition entail for Latin America and the Caribbean This 15th edition of the Latin American Economic Outlook explores options for the region to recast its production models transform its energy matrix and create better jobs in the process **Energy Storage, Grid Integration, Energy Economics, and the Environment** Radian Belu,2019-09-10 The book covers energy storage systems bioenergy and hydrogen economy grid integration of renewable energy systems distributed generation economic analysis and environmental impacts of renewable energy systems The overall approaches are interdisciplinary and comprehensive covering economic environmental and grid integration issues as well as the physical and engineering aspects

Core issues discussed include mechanical electrical and thermal energy storage systems batteries fuel cells biomass and biofuels hydrogen economy distributed generation a brief presentation of microgrids and in depth discussions of economic analysis and methods of renewable energy systems environmental impacts life cycle analysis and energy conservation issues With several solved examples holistic material presentation in depth subject matter discussions and self content material presentation this textbook will appeal strongly to students and professional and nonprofessional readers who wish to understand this fascinating subject Readers are encouraged to solve the problems and questions which are useful ways to understand and apply the concepts and the topics included

Hydrogen Production and Energy Transition Marcel Van de Voorde, 2021-09-07 Carbon neutral hydrogen technologies play a key role in preventing climate change Maximizing production of hydrogen in a clean and efficient manner is critical to the hydrogen economy This book describes most of the potential hydrogen processing technologies and presents the state of the art and future developments of modern hydrogen technologies Attention has been given to the theoretical aspects thermodynamics process calculations and modeling approaches new technologies and reports of multiple successful new pilot systems The book should appeal to a broad readership and ideal for students of materials science chemistry physics for researchers chemical and mechanical engineering for industrialists policymakers economics safety agencies and governments

**Social and Economic Perspectives on Sustainability** Raya Tsvetkova, Savina Ezekieva, Caroline Duvier, Crina Oltean-Dumbrava, Dilek Akbaş Akdoğan, Coşkun Karaca, Övünç Gürsoy, Semra F. Aşçıgil, Uğur Soytas, Meltem Ö. Özcanlı, Sadullah Çelik, Ashi Yüksel Mermod, Ayşe Demirhan, Serdar Bozkurt, Burcu Yiğit, Mehmet Çağlar, Solomon Chukwuemeka Ugbajaa, Refika Bakoğlu, Neşe Soysal, Ahmet Ok, Merve Er Kara, Özlem Yurtsever, Seniye Ümit Oktay Fırat, Ayşe Ümit Gökdeniz, Ayşe Uygur, Recep Kurt, Artür Yetvart Mumcu, Ozan Emre Ufacık, 2016-12-20

Environment Sustainability possesses numerous meanings for different people and various circumstances and it is a common mistake to define sustainability strictly in terms of environmental sustainability is misconception believes the major flaw of the contemporary pattern of development is simply its destruction of the environment Handling sustainability only from an environmental standpoint is a superficial view that needs to be assessed carefully and underlined correctly As A D Basiago suggests the protection of natural systems represents not an overarching panacea for achieving economic vitality and social justice but a necessary component of an entire system for achieving economic social and environmental sustainability in which economic reforms and social reforms are as important

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sustainability not only from an environmental point of view but also in terms of socio economic process Its mission is to produce information as well as enhance research and practice at Micro and Macro levels in Sustainable Development with a holistic and a cross disciplinary approach

**World Economic Outlook, April 2025** International Monetary,International Monetary Fund. Research Dept,2025-04-22 The latest World Economic Outlook reports a slowdown in global growth as downside risks intensify While policy shifts unfold and uncertainties reach new highs policies need to be calibrated to rebalance growth inflation trade offs rebuild buffers and reinvigorate medium term growth thereby reducing both internal and external imbalances Policies that promote healthy aging bridge gender disparities and enhance the alignment of migrants skills with local labor market demands can play a crucial role in countering slow economic growth and fiscal pressures especially when coupled with infrastructure investment The movement of migrants and refugees has become a fixture of public debate Chapter 3 examines how changes in the stringency of migrant and refugee policies can alter the journeys and legal pathways people choose to take within and between economies For example stricter policies can deflect flows of people to new destinations Those economies can experience short term challenges from strains on local services but ultimately benefit in the longer term Costs are likely to be more severe where challenges to integrate newcomers are larger notably in emerging market and developing economies and their skills are not well matched with local labor market needs Benefits can materialize sooner by boosting infrastructure investment and promoting private sector development International cooperation can also help by more evenly distributing short term costs across economies

**Commonwealth Heads of Government Meeting 2007** Commonwealth Secretariat,2007 Presents current thought and pertinent analysis on Commonwealth issues and challenges In depth articles and case studies focus on topical issues including the theme of the 2007 Commonwealth Heads of Government Meeting Transforming Commonwealth Societies to achieve political economic and human development

*Handbook on the Economics of Renewable Energy* Pablo del Río,Mario Ragwitz,2023-07-01 Renewable energy technologies produce many measurable benefits such as a clear reduction in greenhouse gas emissions However it is also apparent that these methods of energy production come with costs Discussing renewable energy developments within an economic context this pertinent Handbook provides a comprehensive view of the present and future dimensions of renewable energy use

**Energy Alternatives** Margaret Haerens,2013-03-12 This must have volume explores global developments in energy alternatives focusing on nuclear energy particularly the impact of the Fukushima nuclear crisis as well as the politics and economics of energy alternatives Primary sources and essays from international sources offer a truly panoramic view Stellar essay sources include Yazeed Kamaldien Integrated Regional Information Networks Barack Obama Young Il Choung James Holloway Yazeed Kamaldien The Economist and Siobhan Dowling

**The Energy Journal** ,1996 **Energy** ,1977 **Latin American Economic Outlook 2017 Youth, Skills and Entrepreneurship** OECD,CAF Development Bank of Latin America,Economic Commission for Latin America and the

Caribbean,2016-10-29 The 2017 edition of the Latin American Economic Outlook explores youth skills and entrepreneurship Young Latin Americans embody the region s promise and perils They stand at the crossroads of a region whose once promising economy and social progress is now undergoing a slowdown      *Multi-Criteria Decision-Making for Renewable Energy* Mohamed Abdel-Basset,Mohamed Elhoseny,Abduallah Gamal,Md Alamgir Hossain,2023-10-26 Multi Criteria Decision Making for Renewable Energy Methods Applications and Challenges brings together the latest fuzzy and soft computing methods models and algorithms as applied to the field of renewable energy and supported by specific application examples and case studies The book begins by approaching renewable energy sources challenges and factors that affect their development as well as green renewable energy sites and the utilization of fuzzy multi criteria decision making MCDM techniques in these broad contexts as well as utilization in addressing the various environmental economic and social barriers to ensuring the sustainability of energy resources Detailed chapters focus on the application of multi criteria decision making methods for planning modeling and prioritization in specific areas of renewable energy including solar energy wind farms solar powered hydrogen production plants biofuel production energy storage hydropower and marine energy Finally future opportunities and research directions are explored Provides a set of multi criteria techniques to address challenges across renewable energy Reviews and analyzes the current state of the art and identifies future opportunities and directions Offers clear examples case studies and practical applications of the described concepts

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