



Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

Factors impacting diverging paths of renewable energy: A review

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ARTICLE INFO

Keywords:

Renewable energy deployment
Renewable energy drivers and barriers
Systematic review

ABSTRACT

Considered an essential factor for countries' development, energy demand is growing worldwide. Unlike conventional sources, the use of renewable energy sources has multiple benefits, including increased energy security, sustainable economic growth, and pollution reduction, in particular greenhouse gas emissions. Nevertheless, there is a considerable difference in the share of renewable energy sources in national energy portfolios. This study conducts a systematic literature review to identify drivers and barriers which could help understanding the diverging paths of renewable energy deployment for countries. Among a total of 1431 academic studies, 60 qualitative and quantitative studies were identified using a multistage selection process. Designated manuscripts were explored in detail including publication years, length of the studies, countries represented, and renewable energy sources referenced. Factors explaining countries' renewable energy deployments were defined and organized into seven main categories: economic, environmental, political, regulatory, social, technical potential, and technological. Within these categories, economic considerations appeared most frequently across manuscripts, while environmental factors were least represented. These categories were then classified as drivers, barriers or undetermined towards renewable energy deployment based on a one-sample proportion statistical test. Economic, environmental, and social factors were found to be drivers, whereas political, regulatory, technical potential and technological factors were not classified as either a driver or a barrier (i.e., undetermined). Each main category contains several subcategories, among which only *national income* was found to have a positive impact, whereas all other subcategories were considered undetermined. No significant barriers to the deployment of renewable energy sources were found over the analyzed period.

1. Introduction

Energy is recognized as a crosscutting contributor to the achievement of countries' economic and social development goals [1]. As a result, there is worldwide growth in energy demand (Fig. 1). The latest global financial crisis in 2008 highlighted the close link between energy security and continuous economic growth. Unlike fossil fuels, which are non-renewable and considered the largest contributor to the increase in anthropogenic greenhouse gas concentrations [2], renewable energy sources cannot be depleted, and their use releases little or no additional CO₂ back into the atmosphere [3]. Increasing the use of renewable resources contributes to the economic growth and greenhouse gas mitigation of countries.

The growing threat posed by climate change to the economic, social, and environmental welfare of countries was first recognized in 1979 by the World Climate Conference, which called on governments "to foresee and prevent potential man-made changes in climate" [4]. The Kyoto Protocol was the first international treaty that set binding targets to reduce greenhouse gas emissions for participating countries.¹ It was adopted in 1997, became effective in 2005, and was signed by 89 countries (including the United States) by 2009 [5]. Ratified by 191 states (excluding the United States) and one regional economic integration organization (European Union) between 1998 and 2013 [5], the Kyoto Protocol is considered a "historic milestone" in the fight against the increase in greenhouse gas emissions [6]. Since 2005, when the Kyoto Protocol came into effect, there has been a

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¹ The Protocol has two commitment periods. First commitment period started in 2008 and ended in 2012. During this period, 37 industrialized countries and the European Community committed to reduce GHG emissions by an average of five percent from their 1990 levels. The second period started in 2013 and ends in 2020. During the second commitment period, Parties committed to reduce greenhouse gas emissions by at least 18% below 1990 levels. The composition of Parties in the second commitment period is more comprehensive than the Parties of first commitment period [6].

<http://dx.doi.org/10.1016/j.rser.2017.06.042>Received 24 October 2016; Received in revised form 14 March 2017; Accepted 16 June 2017
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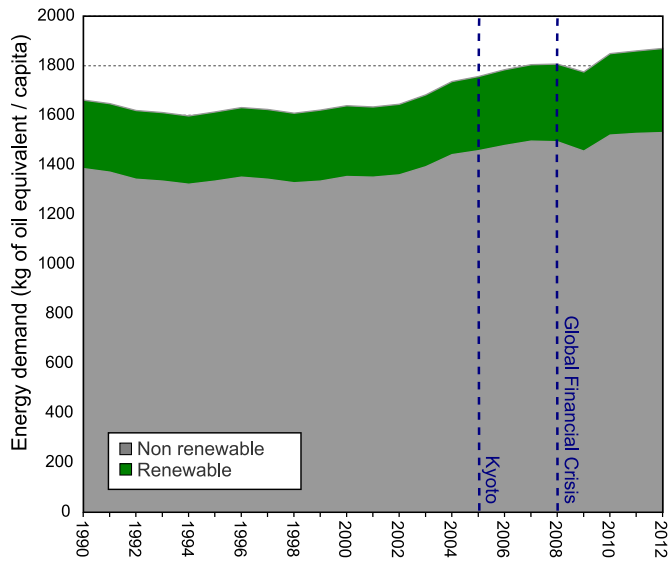


Fig. 1. Global energy demands (data from [7]).

growing interest in greenhouse gas mitigation strategies, including the increased use of renewable energy sources.

Despite its benefits, renewable energy consumption accounts for less than 17% of the total energy demand per person worldwide and this proportion has only increased by 1.5% in 20 years (Fig. 1). Of particular interest for this work is the difference in the share of renewable energy sources of individual countries. At this point, there here is no clear understanding why certain countries may favor renewable energy over traditional energy sources.

The literature available on the drivers and barriers explaining the diversity of countries' renewable energy deployments presents inconsistent findings. The inconsistencies may be due to varying study research designs (e.g., quantitative or qualitative), sampling variation, or other factors (e.g., data availability).

To compare results among studies, a systematic review of the literature is required. One study was published on the subject in 2014 but focused on only the drivers and four types of renewable energy sources (wind, solar, biomass, and wave energy) in eight European countries (UK, Sweden, Italy, France, Germany, Netherlands, Spain, and Ireland) [8].

This research, by comparison, does not limit the scope to any specific renewables or country. The objective is to identify and categorize factors as drivers and barriers of renewable energy source deployment using a formal systematic literature review process [9] and a one-sample proportion statistical analysis. The overarching goal is to aid in the understanding of countries' renewable energy deployment decisions. The designated manuscripts from the literature review were explored in detail with a focus on the renewable energy sources referenced, the publication years, the countries represented, and the length of the studies to identify additional trends. The current systematic study will allow future researchers to identify additional research gaps and priorities in investigating renewable energy source deployment, and to avoid unnecessary duplication of research. Researchers will also be able to update this review and integrate new findings considering the reproducible structure of the methodology.

2. Methodology

This literature review aims to systematically identify, select, and evaluate the current state of knowledge on the drivers and barriers (from here on, referenced as "factors") of countries' decision-making processes for renewable energy deployment. Using a multistage selection process, 60 quantitative and qualitative studies (from here on,

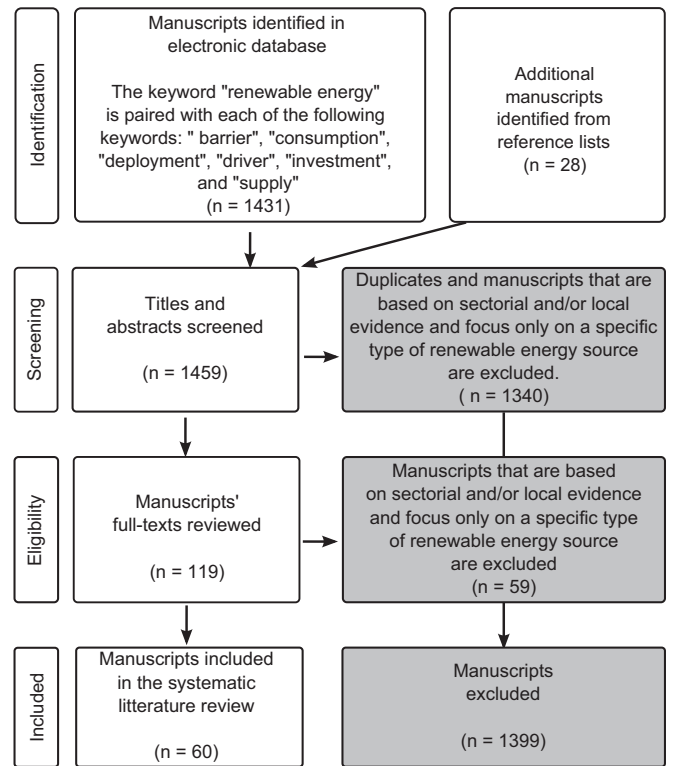


Fig. 2. Flow diagram of the selection process of manuscripts identified through the PRISMA statement [10].

referenced as "focal manuscripts") were identified out of 1431 screened academic manuscripts extracted from three comprehensive databases (Science Direct, JSTOR, and Google Scholar).

Systematic literature reviews are essential to answer clearly-formulated research questions by gathering together all available published academic work. Poor reporting of the literature diminishes the value of the answer to the research question for policy makers, future scholars, and other users. In this review, manuscripts were selected according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement, which ensures a transparent and complete reporting in the selection process of manuscripts for systematic literature reviews [9]. The PRISMA statement offers a practical process to review literature that is implemented in three phases: (i) identification, (ii) screening, and (iii) eligibility as summarized in Fig. 2 [10].

The identification phase of the PRISMA statement process involves searching databases using all key search terms and applying appropriate limits of the search (e.g., years of search, language of search, etc.) [11]. The articles identified through sources other than databases (i.e., manual searches through reference lists) are also included in the review process in the identification phase [11]. In this study, the identification phase included a search of Science Direct, JSTOR, and Google Scholar databases for relevant manuscripts using the keyword "renewable energy" combined with each of the following keywords: "barrier," "consumption," "deployment," "driver," "investment," and "supply" (e.g., "renewable energy" and "barrier," "renewable energy" and "consumption," etc.). The paired key search terms were entered individually into each database; the search was limited to studies published in the English language and after the year 2005. The focus on studies published after 2005 was due to CO₂ emissions reporting and reduction requirements in order to comply with the Kyoto Protocol. The year 2005 was a turning point since the emission targets became binding commitments and the market-based greenhouse gas emission trading mechanisms of the Protocol became fully operational at that time. A total of 1431 manuscripts related to the factors and decisions for

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