



A The Adoption of Renewable Energy Technologies, Benefits, and Challenges: Mini-Review

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اعتماد تقنيات الطاقة المتجددة وفوائدها وتحدياتها: مراجعة مصغرة

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Abstract

Due to a growing understanding of the environmental and financial advantages of these technologies, the adoption of Renewable Energy Technologies (RETs) is accelerating globally. By reducing dependency on Fossil Fuels (FFs) and reducing their detrimental effects on the environment, RETs like solar, wind, and hydropower can provide clean and sustainable sources of energy. These technologies are being adopted thanks to regulatory incentives, technological development, rising public demand, and more public knowledge. Wider acceptance is still hindered by concerns including some technologies' intermittent nature and expensive upfront prices. In general, RET adoption is crucial for building a more robust and sustainable energy system and tackling the world's climate catastrophe. This article summarizes the main benefits and challenges of RET and is considered to be beneficial to scholars in the field of renewable energy systems.

Keywords: RETs; FFs; Benefits; Challenges.

الملخص

نظرًا للفهم المتزايد للمزايا البيئية والمالية لهذه التقنيات، فإن اعتماد تقنيات الطاقة المتجددة (RETs) يتسارع على مستوى العالم. من خلال تقليل الاعتماد على الوقود الأحفوري (FFs) وتقليل أثارها الضارة على البيئة، يمكن أن توفر تقنيات الطاقة المتجددة مثل الطاقة الشمسية وطاقة الرياح والطاقة الكهرومائية مصادر طاقة نظيفة ومستدامة. يتم اعتماد هذه التقنيات بفضل الحوافز التنظيمية والتطور التكنولوجي وزيادة الطلب العام والمزيد من المعرفة العامة. لا يزال القبول الواسع يعوقه مخاوف بما في ذلك الطبيعة المتقطعة لبعض التقنيات وأسعارها الأولية الباهظة. بشكل عام، يعد اعتماد تكنولوجيا الطاقة المتجددة أمرًا بالغ الأهمية لبناء نظام طاقة أكثر قوة واستدامة ومعالجة كارثة المناخ في العالم. تلخص هذه المقالة الفوائد والتحديات الرئيسية لـ RET وتعتبر مفيدة للمهتمين في مجال أنظمة الطاقة المتجددة.

الكلمات المفتاحية: تقنيات الطاقة المتجددة؛ الوقود الحفري؛ فوائد؛ التحديات.

1. Introduction

Challenges related to public opinion and perception play a significant role in limiting or accelerating the adoption of Renewable Energy Technologies (RETs) [1]. Public support is an essential for the adoption of the RETs, as well as that of decision-makers [2]. If the public perception of renewable energy is positive, it can accelerate the adoption and implementation of RETs [3]. Therefore, positive public perception can also lead to policies and incentives that promote the development of RETs [4]. On the other hand, if the public perception of renewable energy is negative, it can limit the adoption and implementation of these technologies [5]. Negative public perception can lead to difficulties in obtaining financing and permitting, which can slow down the development of renewable energy projects [6]. Therefore, it is essential to address the public's concerns and provide education

and awareness about the benefits of renewable energy technologies, such as reduced emissions, energy security, and cost savings [7]. Development plays a crucial role in promoting renewable energy by providing incentives, investing in research and development, and implementing policies that support the adoption of these technologies [8], [9]. By addressing public opinion and perception challenges, renewable energy technologies' adoption can be accelerated, leading to a cleaner and more sustainable future [10], [11].

Based on the preceding consideration, this mini-review article comprehensively states the main advantages and disadvantages along with the future trends of the utilization of the adoption of renewable energy technology. The rest of the article is organized as follows: the benefits of renewable energy technologies with the explanation is presenting in Section 2, Section 3 listed the main challenges of renewable energy technologies. Some of future trends of the renewable energy technologies adoption is placed in Section 4. Finally, the summery conclusion of the article followed by the recent references are closing the article.

2. Renewable Energy Technology Benefits

Generally, integrating RESs into the grid-tied system has several benefits, including environmental, social, and economic benefits. Renewable energy technologies have gained significant attention and adoption in recent years due to concerns about the environment and climate change [12]. The adoption of renewable energy technologies has several benefits, including reducing carbon emissions, creating jobs, and reducing dependence on fossil fuels [13]. However, the adoption of renewable energy technologies also faces several challenges, including high upfront costs, intermittent renewable energy production, and a lack of infrastructure in some regions [14]. Nevertheless, with advances in technology and government incentives, renewable energy technologies are becoming more accessible to individuals and companies [15]. As such, renewable energy technologies are expected to continue to gain widespread adoption and become a significant contributor to the world's energy mix in the years to come [16]. Integrating Renewable Energy Sources (IRES) into the grid system has several benefits as tabulated in Table 1.

Table 1 Benefits of Utilization of Renewable Energy Sources [5], [17], [18].

Benefits of RESs	Features
Environmental Benefits	RES is sustainable, produces fewer greenhouse gas emissions, and reduces air pollution compared to fossil fuel energy sources
Cost-effective	Many RES technologies like solar and wind energy have become more cost-effective, making them more affordable than fossil fuels in many cases.
Diversification	Integrating RES into the grid can diversify the energy mix, providing a more stable and secure source of energy.
Local benefits	RES can provide power to remote and rural areas where a centralized grid may not be available or economical.
Job creation	The development and installation of RES require a skilled workforce, thus creating jobs and boosting the economy
Improved grid stability	Integrating RES into the grid can improve grid stability by reducing the reliance on a small number of large power stations

3. Renewable Energy Technology Challenges

Some of the important challenges faced by renewable energy technologies include cost and intermittency as formulated in Table 2.

Table 2 Challenges of the Utilization of Renewable Energy Sources [4], [6], [19].

Challenges of RESs	Remarks
Cost	<ul style="list-style-type: none"> • RETs can be expensive to install and maintain, especially when compared with conventional FF technologies. • This can make them unaffordable for some businesses and households.
Intermittency	<ul style="list-style-type: none"> • Many RESs (solar and wind) are intermittent in nature and dependent on weather conditions. • Intermittency make RESs difficult to predict and manage energy production, which can cause stability issues for power grids.
Grid Integration	<ul style="list-style-type: none"> • The integration of RESs into existing power grids can be challenging. • The power grids were primarily built to accommodate power generation from centralized large power plants, and so the integration of diverse small-scale RESs can require grid upgrades.

Storage Technology	<ul style="list-style-type: none"> • The development of efficient energy storage technologies is essential for the effective deployment of RESs. • The storage of renewable energy must be done in a way that is cost-effective and scalable
Environmental Impact	<ul style="list-style-type: none"> • RETs produce fewer GHG emissions than FF technologies, they still have some environmental impacts. For example, the construction and maintenance of solar and wind farms can impact wildlife habitats and ecosystems.

4. Future trends of RETs adoption.

Some potential future trends in the widespread adoption of renewable energy technologies include energy storage and policies as listed below [20]–[22]:

- Technological advancements: the development of improved renewable energy technologies will likely lead to increased adoption rates as they become more cost-effective and efficient.
- Policy and regulation: supportive policies and regulations that promote the use of renewable energy, such as tax credits, subsidies, and renewable portfolio standards, can create a favourable environment for increased adoption.
- Consumer attitudes: as more people recognize the benefits of renewable energy, such as reduced greenhouse gas emissions and lower electricity bills, demand for renewable energy technologies will likely increase.
- Energy storage: efficient energy storage technologies will help to overcome the intermittent nature of solar and wind power, increasing their reliability and making them more competitive with conventional energy sources.

Some potential challenges for the widespread adoption of renewable energy technologies include:

- Cost: While the cost of RETs has decreased in recent years, they are still often more expensive than conventional energy sources such as coal and natural gas.
- Infrastructure limitations: The existing energy infrastructure may not be designed to accommodate renewable energy sources such as solar and wind, which could require significant investment in new infrastructure and grid upgrades.
- Geographic limitations: RESs are not equally distributed throughout the world, and some areas may have limited potential for their use.
- Political and social pressures: Some political and social groups may be resistant to renewable energy due to concerns about the impact on jobs in the FF industry or visual impacts on the landscape.

Conclusion

Reducing dependency on FFs and attaining sustainable energy production have both benefited greatly from the adoption of RETs. The use of RESs including wind, solar, biomass, geothermal, and others has grown significantly over time. Numerous advantages have resulted from this transformation, including less GHG emissions, better air quality, less reliance on foreign energy supplies, and more employment opportunities in the renewable energy industry. However, concerns with intermittency and storage make the implementation of renewable energy solutions difficult. But if we keep funding research, development, and use of renewable energy, we'll find even better answers and move toward a more sustainable future.

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