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For Sustainable Development: Future Trends in Renewable Energy and Enabling Technologies

Mustafa Seckin Salvarli and Huseyin Salvarli

Abstract

Energy demand in the world is nowadays growing further out of limits of installable generation capacity. Therefore, future energy demands should be met and improved efficiently and securely. Energy solutions should be supported by utilizing renewable energy sources. At present, the contribution of renewable energy to the world primary energy is not high to meet the primary energy and electricity supplies. Both developed and developing nations will necessarily continue to rely on fossil fuels in the coming decades. In developing countries, the situation is more inconvenient than that for developed countries. Many developing countries have been apparently trying to restructure their energy sectors. It seems that it is difficult to realize innovations. Cost, market share and policy are the main barriers for the development of renewable energy. In the strategy plans of many countries, the sustainable development in relation to the parameters such as economic, social and industrial is supported by their energy policies. New enabling technologies related to renewable energies will also help to reduce environmental costs, and thus the energy systems will be operated as both securely and economically without environmental problems. New renewable energy markets are surely required in both the wholesale and retail markets.

Keywords: renewable energy, sustainable development, environment, energy mix, trends, strategies, enabling technologies

1. Introduction

The demand for energy increases enormously. As indicated in [1], the industrial countries have 28% of the world's population, and they consume 77% of the world energy production. It is expected that today's world population will increase 1.26 times to reach 9.7 billion in 2050. Most of the world's population which include 90% of the population growth belong to the developing countries. By 2050, although the developed countries will be adopting more effective energy conservation policies, their energy consumption will not increase. However, in the developing countries, people generally have an aim to construct their own electricity-generating facilities.

According to the data given in Ref. [2], about 75% of the final energy demand and 67% of the electricity supply in 2016 will be met by the fossil fuels. As a basic energy resource in the world, coal is very important, and it is expected that its usage will be increased by 27% over 20 years.

It is expected that the reserves of fossil fuels will naturally come to an end. Thus, the alternative and renewable energies will be the most significant energy resources in the near future. This situation will be a reason to generate new jobs and to develop future industries.

The environment is being increasingly polluted because of rapid industrialization and human work. Sustainable development mainly covers the use of renewable energy, energy security, energy pricing, energy policy, renewable energy applications and smart grid technologies.

Two trends are currently related to the consumption of fossil resources and the global climate change. Renewable energy is fast emerging to both these problems. For the level development and life quality in a country, energy consumption is one of the most reliable indicators.

The data of parameters—such as economical, political, and partly environment and human life—are related to the present energy systems. According to the most of energy policies, the fundamental parameters are to save energy and use domestic energy sources. However, there will be a close relationship between the energy use and environment in the future.

While planning and building all industrial plants, their effects on the environment should be taken into consideration for improving the economy, supporting ecology and saving energy. Energy investments related to the environmental protection are to necessitate large financial resources. The success of any new technology will be measured by the parameter of cost-effectiveness that improves the environment. Thus, the growing energy demand in the world will be met by means of the clean power generation. It is a fact that clean and affordable energy will power progress toward achieving the sustainable development goals.

The emerging trends and new insights open up significant new business opportunities for the energy leaders and organizations to inform better decisions and enabling new technologies [3]. According to the review carried out on technology trends, the results may be identified and grouped as renewable energy, advanced materials and nanotechnology, advanced manufacturing technologies, information society technologies, life sciences, aerospace technologies and biotechnology, global change, green energy and ecosystem. In order to have high market growth and solve social problems, these technologies support strategic sectors, too [4].

2. Overall distribution of energy resources

At present, the contribution of renewable energy is not high to meet the primary energy and electricity supplies. Appropriate cost reductions, increase of the renewable energy industry and technology improvements are firstly related to government policy precision, private sector inventiveness and investment. In **Table 1**, the share of oil in total primary energy supply is the first level, and the fossil fuels include around 81% of total. It is aimed that the renewable energy will be used to displace fossil fuels as both environmentally safe and economically sustainable.

In the developing countries, the largest renewable energy source of global renewable supply, which includes solid, biofuels and charcoal, is 60.7% due to its use for residential heating and cooking. In **Table 2**, it is seen that the second largest source is hydropower, which provides 18.5% of renewable. The rest of renewable makes up a smaller share.

On the other hand, as will be seen in **Table 3**, the majority of renewables are consumed in the residential, commercial and public services sectors.

Renewables, which account for 24.5% of world electricity production, are the second largest contributor to global electricity production (**Table 4**).

Resources	Share (%)
Oil	31.8
Coal	27.1
Natural gas	22.2
Biofuels and waste	9.2
Nuclear	4.9
Hydro	2.5
Solar, wind, geothermal and tidal	1.8
Other	0.3

Table 1.
 Fuel shares in world total primary energy supply (2017) [5].

Resources	Share (%)
Solid biofuels and charcoal	60.7
Hydro	18.5
Wind	5.1
Liquid biofuels	4.6
Geothermal	4.5
Solar, tidal	3.9
Biogases	1.7
Renewable municipal waste	0.9

Table 2.
 Product shares in world renewable energy supply (2017) [5].

Sector	Share (%)
Residential, commercial and public	41.7
Electricity plants	35.1
Industry	10.5
Transport	4.4
Combined heat and power plants	3.0
Heat plants	0.5
Other	4.8

Table 3.
 World sectoral consumption of renewables (2017) [5].

The average values for the world's total final consumption by sectors in 2017 are given in **Table 5**. The sectors of industrial, transport and residential energy use account for 37, 29 and 22%, respectively.

According to the data given in **Table 6**, renewable will have the fastest growth in the electricity sector, providing 29.4% of power demand in 2023, up from 23.9% in 2017.

Bio-energy (as solid, liquid or gaseous fuels) is, however, the largest source of growth in renewable consumption over the period 2018–2023 and will account for 30% of the growth in renewable consumption in this period due to the use of

Resources	Share (%)
Coal	38.5
Natural gas	23.0
Hydro	16.0
Nuclear	10.3
Solar, wind, geothermal and tidal	6.5
Oil	3.3
Biofuels and waste	2.0
Other	0.4

Table 4.
Fuel shares in world electricity production in 2017 [5].

Sector	Share (%)
Industry	37
Transport	29
Residential	22
Commerce and public services	8
Agriculture	2
Forestry	2
Other	2

Table 5.
World total final consumption by sector (2017) [6].

	Year	
	2017	2023
	Share (%)	
Renewable electricity	23.9	29.4
Renewable heat	10.3	11.8
Biofuels in road transport	3.4	3.8

Table 6.
Shares of renewables in 2017 and 2023 [7].

bio-energy in heat and transport. On the other hand, the rest of renewable, which include the 80% of the total final energy consumption, have less influence in the sectors of heat and transport. As predicted, although solar PV and wind energies continue to grow in the electricity sector, bio-energy will keep its place in the first level. During the period (2018–2023), renewables such as solar PV, wind, hydropower and bio-energy are expected to meet about 70% of global electricity generation growth. By 2023, the global electricity demand will be met by hydropower (16%), wind (6%), solar PV (4%) and bio-energy (3%). Biofuels in road transport have the lowest share of renewable, which is 3.4% in 2017 and 3.8% in 2023. Renewable heat consumption is also expected to reach a share of 11.8% by 2023. Due to the weaker policy support and additional barriers to deployment, the growth of renewable use in the transport and heat sectors is slower [7].

3. Energy and sustainable development

The energy systems can be an important reason of environmental impact for both developing and developed countries. Thus, a sustainable global energy system should provide to optimize efficiency and limit emissions. The technology and the global economy must also develop in harmony with a sustainable and steady development.

As the consumption of energy, especially from fossil fuels, increases, the global environmental problems are inevitable. Both developed and developing countries plan to enable the most appropriate energy systems and improve human, economic, social and environmental conditions for sustainable development. At present, there can be several challenges such as demographic, social, economic and technological trends for the long-term sustainability of the global energy systems.

As concluded in Ref. [2], to obtain sustainable energy systems, vigorous action should be mostly taken in the areas of energy diversity and efficiency, supply reliability, public trust, market-sensitive interventions, market-based climate change responses, cost reflective prices, technological innovation and development and regional integration of energy systems.

Government policies should be carefully planned for the production, replacement, transportation, distribution and usage of energy. Due to the energy-related environmental problems and challenges, countries should aim to protect the climate system, improve their policies and implement related preventions. Thus, the standards on reducing local air pollution should be also strengthened and implemented effectively and efficiently.

Dependence on conventional fossil resources, which is mostly produced in politically unstable countries, the current energy supply and use are highly unsustainable. To meet the present and future demands for improving conditions—such as human, economic, social and environmental—fundamental changes in technologies will be required everywhere. Some topics such as innovation, investment, work, organization and leadership should be taken into consideration.

There are three groups of critical factors shaping the energy future which are the global politics and economic situation, technology and energy policy and market development [8]. To ensure the energy need of a country, the environment, cultural heritage and rich natural sources should be applied. On the other hand, energy generation, transmission, distribution and trade should be also supported by using standardized equipment and materials.

Although the use of coal creates risks in local environmental pollution and greenhouse gas emissions, it somehow increases energy security. Carbon dioxide emissions per unit power at the point of use are high for coal. However, resources, such as coal and gas, will remain important [6, 8].

Diversification and utilization of the country's resources are always the key components that ensure sustainability and low-cost energy supply. The next investments on industry should be made for the clean technologies. Depending upon the technological developments, the quality of the cleaner environment will be also affected by the economic and political factors. To provide the resource diversity, the use of domestic renewable energy resources such as hydro, wind, solar, geothermal and biomass should generate more electricity.

By 2040, the world's energy supply mix will, however, consist of oil, gas, coal and low-carbon sources. As expected, to tackle pollution and reduce CO₂ emissions, the use of coal should be constrained. Renewable energies are both environmentally safe and economically sustainable when compared to fossil sources of energy.

The use of hydropower can ensure many profits for water supply and for irrigation in agriculture, but it has consequences for the aquatic ecosystems.

Geothermal power plant is sustainable and emits low emissions when compared to the conventional fossil fuel plants. If the pollutants are released from the power plant, an environmental damage could occur. Therefore cooled geothermal fluids are injected back into the earth, and the environmental risk is reduced.

The environmental impact of wind power when compared to the environmental impacts of fossil fuels is relatively minor. Depending on specific circumstances, the siting and operation of wind turbines may cause negative health effects on people who live in the vicinity of wind turbines.

The use of solar energy is rapidly increasing all over the world. There are, however, many arrangements on solar thermal and PV installed power, and it is also expected to be the same for the concentrating solar power systems.

Bio-energy is produced from biomass, which is a clean energy resource in relation to the type of biomass and conversion technology used.

4. Energy security, sustainability challenges and expectations

Energy, briefly, is principal to the challenge of sustainability with regard to the social, economic and environmental parameters. Thus, various environmental, economic, and development needs are associated with the transition to sustainable energy resources and systems. The local renewable resources, installation costs and policy structure will be principal factors.

Although the environmental impacts from energy production and use are local, the significant impacts related to the transport of pollutants in the atmosphere can occur on regional, continental and even transcontinental scales.

While electricity demand and sustainable development are rapidly growing worldwide, the goals of energy policy considering energy mix, efficiency, market and environmental standards should also be created to provide several rehabilitations on unlicensed electricity generation and renewable energy resources. Several main elements of the policies can be as follows:

- To ensure better free market prices than feed-in tariff
- To give extra encouraging sales tariff or domestically produced parts of renewable energy power plants
- To give priority to renewable energy when connecting to grid

Developing countries face energy challenges that are significant and increasing. However, many developing countries have some advantages in attempting to restructure their energy sectors and can have an opportunity to build cleaner and more efficient technologies. It is obvious that the situation in many ways for developing countries is more difficult than that for developed countries. A significant part of the population can have some difficulties in reaching to basic energy services due to the resource constraints. Many conventional technologies are likely to remain cheaper than sustainable energy technologies.

For the sustainable development of any country, renewable energy sources should be provided due to depleting fossil fuel level, climbing fossil fuel prices across the world and reducing environmental impacts. In order to meet future energy challenges, major types of renewable energy sources which have huge potential are solar, wind, hydro and biomass [9]. To have sustainable energy supply, as detailed in Ref. [10], there are several requirements such as climate compatibility, sparing use of resources, low risks, social equity and public acceptance that should be satisfied.

5. Barriers to renewable energy

While developing renewable energy, a lot of problems and barriers are faced. Some technologies have commercialized and industrialized to some extent, and with regard to the technologies, industries' scale and developing speed compared to those in developed countries are inevitable and have large gaps. The following barriers for the development of renewable energy may be classified in three groups:

1. Cost barriers. Traditional energy sources have a lower cost and price than renewable energies. As the production cost of renewable energy is higher than that of fossil fuels with the same technology, there are serious barriers for the commercialization and distribution in relation to renewable energy. The main reasons in high production cost of renewable energy are small scale and low production technology.
2. Market share barriers. The current development of renewable energy includes the cost barriers. However, a system operation reliability and decreasing production cost can be obtained by means of a developed market.
3. Policy barriers. Policy enactment and implementation are distinctive elements of the policy process. In the future, renewable energy should be developed to an industrial scale. Thus, depending on the support of policies, market share of renewable energy has to be increased.

In order to have more sustainable lifestyles, barriers related to the societal and cultural patterns must be prevented, and thus desirable and more sustainable alternatives and various incentives will be required. The current economic system still remains a barrier to change due to the existing belief in unlimited natural resources and in continuous economic growth.

On the other hand, the existing construction sector is a rather conservative industry. It is well known that new and more sustainable designs, building materials and construction methods are only emerging and being implemented slowly. The other challenge for the energy efficiency of buildings is related to high costs and long payback period for renovations.

6. Strategies, policies and measures of renewable energy developments

In implementing sustainable strategies, renewable energy has become a critical choice for countries. It is an inevitable situation that energy is the key element to drive social and economic development. However, as the fossil energy is commonly used, sustainability of the economy and environment suffers.

Renewable energies are clean and nonpolluting. They support and impel the goal of sustainable development. Therefore, the development of renewable energies is accelerated by forming policies and legislation with the fundamental incentives. The strategic goals realized for the renewable energies are basically increasing energy competitiveness, securing supply and protecting the environment.

Renewable energy resources are also chosen to substitute fossil fuels for organizing the energy structure and improving the energy supply safety. As renewable resources are local resources, they can be transformed directly or indirectly into electricity or liquid fuels.

In rural areas, the development of renewable energy resources can solve the problem of energy consumption and combine with the agriculture production

procedure that increases the income of farmers. It is estimated that in 2050 renewable energy will approximately account for 30% of energy structure in the world.

The development of renewable energy relies on technology innovation and improvement of new high technology level that belong to industrialization and commercialization. It is a fact that the cost of renewable energy development is in some degree high. If the government's support and policy presentation cannot ensure a large-scale development, countries will not help to reduce cost, increase profit, maintain reliability and improve value of renewable energy.

Renewable energy is a basis for energy system in the future and supplies urgent needs for its environmental impacts, sustainable development and usage. Due to the current problems of energy and environment problems, it is necessary to impel the development and trends of renewable energies [11].

7. Global future trends in renewable energy

In Ref. [12], it is detailed that the global energy trends and their possible impacts are related to the issues such as supply and demand, energy access and environment and air pollution. Current policies have been planned to meet long-term climate goals under the Paris Agreement, and they will serve to reduce air pollution and ensure universal energy access. Due to the falling costs and supportive government policies, renewable technologies are being the first choice in power markets. It is possible that an enterprising utility will prefer to provide renewable energy at a low and fixed price to attract investment.

By 2040, it is expected that the global power mix will be sharing renewables in generation rising to over 40%. However, coal and gas will maintain to be the largest resources of energy.

Future electricity markets depending on the variability in supplies and power systems will have flexibility and adaptability. Market reforms, grid investments and new enabling technologies are required to be active in sharing of renewable [12].

As mentioned in Ref. [13], energy technologies have focused on the spreading of clean energy technologies with regard to the opportunities and challenges. The competitiveness and future development of industries are under the impression of global technology trends. Industrial dependency on foreign technology should be reduced by identifying problems for innovation and technology. At the present, to improve development of technologies, basic international trends can be as follows:

- Technology union
- Information and communications technology
- Digitisation
- Emphasis on high technology industries
- Recognition of importance of transnational corporations

While preferring an appropriate energy source in the energy mix, factors such as technological innovation, cost efficiencies, energy storage technology and increasing consumer demand are important for the handling of renewables and alternative resources. On the other hand, the growing influence of offshore wind will also attract new investors and could see more onshore wind suppliers and developers pivot into the sector.

8. Enabling technologies and applications

While the global energy demand is growing and the installation of new power plants is required, energy security and reliability should be improved, and alternative energy sources should be also investigated.

As concluded in [14], the elements such as high research and development intensity, rapid innovation cycles, high capital expenditure and highly skilled employment are provided to develop enabling technologies. The processes for goods and service innovation are met by the enabling technologies that are also multi-disciplinary and supporter of technology leaders on research attempts. Enabling technologies are essentially selected as follows:

- To address global challenges such as low-carbon energy or resource efficiency
- To support the development of new products
- To stimulate economic growth and provide jobs

In order to realize global renewable energy trends, a requirement for the combination of enabling trends and demand trends is provided to decrease costs and improve integration. Current enabling technologies are as follows:

- Advanced materials
- Advanced manufacturing systems
- Micro and nano-electronics
- Nanotechnology
- Industrial biotechnology
- Photonics

As also outlined in [14], to address societal challenges and accelerate the development of economy and the energy transition, advanced materials, advanced manufacturing systems and industrial biotechnology are essential. Due to the current digital evolution and the enormous benefits, the digital technologies are integrated into the process technologies, materials development and business model creation. Enabling technologies will also accelerate the creation of new markets, growth and jobs. There are primary technology developments and initiatives that are needed as follows:

- Creating advance materials for the use of energy efficiency (e.g. light weight), renewable energy generation and energy storage (e.g. battery components) or smart functionalities responding to stimulants (e.g. self-repair). The advance materials also create materials for construction, energy, mobility, food, health and electronics. 3D-printing polymer materials are used in automotive sector, lightweight design, medical sector and 3D printing.
- Developing advance process technologies and industrial biotechnology for more sustainable generation and alternative energy resources.

- Leveraging digital technologies for the use of advanced process control, enabling business models and creating new customer experiences. Digital technologies enable the transition from batch to flexible continuous intensified processes.

On the other hand, the development of technologies to turn CO₂ into a valuable resource and for its implementation in making polymers can help to reduce the use of petroleum. Process technologies enable the transformation of raw materials into materials which have a different chemical composition structure and properties than the input raw materials. Advanced process technologies are a specific type of enabling technologies that enable the chemical industry to provide all industrial value chains (e.g. construction, automotive, medical, electronics, energy) with the materials (solid, gas and liquid) and novel properties required to produce a vast range of user products.

As explained in [15, 16], solar energy can be converted to both electricity and thermal energy simultaneously by a hybrid photovoltaic/thermal (PV/T) system which can also maintain the energy demand of buildings. While designing PV/T systems to match with the operating conditions, performance analysis of such systems is important. The energy flow analysis should be used to consider economic limitations and applications. As expected, solar power has several advantages and has more competitive levels than other energy sources. For installation of onshore wind turbine, there may be a problem in land adequacy. Therefore, if the location is appropriate, offshore wind turbine that has higher economic costs is, however, an alternative development in these days.

Main challenges for wind energy are technical, social and environmental. However, for both developed and developing countries, wind energy also becomes an effective choice in maintaining green environment [17].

Basic emerging visions for future sustainable lifestyles may be summarized as follows:

- To shift the focus of design, planning and action from the individual to the community that enables communities to take responsibility. For instance, if a community is based on equity, mutual support and stakeholder involvement, a more connected communities and sustainable neighborhoods can be formed.
- To share goods and services supports collaborative infrastructure. Thus, the high impacts of individual consumption have been reduced by the community-based consumption. For instance, the applications in relation to the smart renewable energy support for distributed renewable energy generation and consumption.
- Without restricting the people's freedom of choice, sustainable options are required to be normalized. Several options can make sustainable choices easy and desirable and change the need for individual behaviour. For instance, according to the consumption levels and resource use, people will coordinate their behaviour.

There is a major emphasis on innovation in enabling technologies that can help integrate variable renewable resources into electricity systems.

9. Some aspects on marketing renewable energy

As the share of renewable energy sources is steadily increasing, it seems that much more flexibility for energy markets are required [18]. Large end users of

electricity—such as retailers, manufacturers and technology companies—are important customers to purchase renewable power directly. There is an interaction between independent power producers, utilities and commercial and industrial users which is varying. By developing new models, the role of utilities changes in each transaction [19].

It is concluded that sustainable business models, which are more and more popular among different sectors, dedicate solutions such as designing a market model to ensure earnings for the stakeholders [20]. The application of these models can be classified in many different groups such as energy, innovation, marketing, entrepreneurship, developing countries, engineering, construction, mobility and transportation [21].

To encourage renewable energy market, the most frequently used policy tool is the feed-in tariff. Thus, a fixed price per unit of electricity sold is guaranteed during a period of agreement. While the feed-in tariffs provide rapid cost reductions of renewable, there is a risk that the renewable have to be subsidized by the governments for a long time. On the other hand, a transition from government-administered feed-in tariffs to auction systems has taken place during the past few years. By identifying the price for renewable energy contracts, it is aimed to obtain substantial cost reductions in renewable energy. Financing is an important factor in the deployment of renewable energy technologies. The main financing sources are public finance institutions, private investors and institutional investors [22].

Business-to-business marketing is known as industrial marketing, and its products are based on the functional consumption values such as price and quality. Business-to-business companies sell, rent and supply goods to other companies. Under the conditions of the globalized market, local customers do not simply purchase products from local suppliers. Business-to-business companies need to find new ways to stay relevant on the market as they are facing increased global competition. Companies must also approach their customers as humans with values to fulfil their personal needs. In contrast, the purpose of business-to-consumer marketing is to sell products or services directly to the consumers.

For sustainable solutions, business-to-business renewable energy companies can have a marketing advantage. However, marketing renewable energy is complex. Buying a renewable energy product is an investment. To help finance the investment, customers are frequently depended upon the support schemes which are not fixed and can vary in different countries.

It is expected that companies investing in renewable energy can use their environmental credentials for marketing purposes by supporting their use of renewable energy. Governments, having an interest in renewable energy and its benefits, secure different support schemes such as tax credits and subsidies. On the other hand, to make renewable energy more attractive, subsidies for fossil fuels are reduced [23].

In some energy markets, the needs of power systems with higher shares of variable renewable energy are reflected and responded to the trends of digitalization, decentralization and electrification. Gradual improvement of energy market pricing is imported. Package can generally include the real value of electricity in time, new dispatch rules, flexibility, economic energy resources, self-consumption and market link. Appropriate electricity market designs for changing models in power systems are necessary to speed up the energy transition. At the present, end users of electricity have more suppliers and innovative deals to choose and can easily switch tariffs and suppliers. The desired consequences for all end users cannot be, however, delivered by the retail market [24].

10. Conclusions

Fossil fuels are still maintaining the largest portion of energy consumption and keep on their increasing trend all over the world. In this situation, environmental pollution is somehow inevitable, whereas the renewable energy plants do not directly contribute any.

In the future, it is aimed that the main energy sources will become new and renewable energies. While the fossil fuels are inevitably running out, renewables are to be more important. They are effective in many areas such as continuous cost reductions, generating jobs, developing future industries and meeting energy and environmental targets.

The development and use of renewable energy will improve the energy security, environment, economy, mechanical manufacturing, construction, transportation and industry and also help to create new jobs. Energies of solar, wind and biomass can meet local energy demands and assist to improve the environmental protection. Current situation related to the energy demand encourages an enormous market for renewable energy. As predicted, the share of renewable in meeting global energy demand will grow to reach 12.4% in 2023.

In the longer term, if the investments in the renewable technologies continue, renewable will have the potential to make significant contributions to energy needs. Further, there are several technologies that include biofuels, and fuel cells also can contribute to heat, transport and electricity markets.

The share of fossil fuels in total primary energy supply is expected to include around 81% of total in 2023. By 2050, renewable energy will approximately account for 30% of energy structure in the world.

By providing a balanced resource diversification of countries for the primary energy resources, the share of domestic and renewable energy resources in the generation system can be increased to the maximum extent. As also aimed in the current strategy plans of many countries, targets should be obtained in time for supporting, developing and encouraging new environment-friendly practices in generation and services. The largest market share and the most of advanced renewable energy technologies belong to the leading developed countries such as the USA, Japan and the Europe.

In order to use less and cleaner energy in power plants, buildings, industrial facilities and transport systems, many energy-efficient enabling technologies are applied. These technologies could slash costs by up to 80 per cent, ensure energy savings by up to 30 per cent and help to slow global warming in the future. Thus, the countries could stay cost-effective and make sustainable progress. Marketing renewable energy can be also defined as the art of understanding consumers and their needs.

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