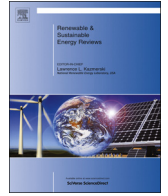




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Renewable energy resources: Current status, future prospects and their enabling technology

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ABSTRACT

Electric energy security is essential, yet the high cost and limited sources of fossil fuels, in addition to the need to reduce greenhouse gasses emission, have made renewable resources attractive in world energy-based economies. The potential for renewable energy resources is enormous because they can, in principle, exponentially exceed the world's energy demand; therefore, these types of resources will have a significant share in the future global energy portfolio, much of which is now concentrating on advancing their pool of renewable energy resources. Accordingly, this paper presents how renewable energy resources are currently being used, scientific developments to improve their use, their future prospects, and their deployment. Additionally, the paper represents the impact of power electronics and smart grid technologies that can enable the proportionate share of renewable energy resources.

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1. Introduction

Conventional energy sources based on oil, coal, and natural gas have proven to be highly effective drivers of economic progress. However, with the rapid depletion of conventional energy sources and increasing energy demand, worldwide primary energy consumption has grown by 1.8% in 2012 [1]. Due to certain environmental issues, many related organizations have encouraged intensive research for more efficient and green power plants utilizing advanced technology. Since environmental protection concerns are increasing, both clean fuel technologies and new energies are being intensively pursued and investigated. In fact, fossil fuel and renewable energy prices, social and environmental costs are moving in opposite directions and the economic and policy mechanisms needed to support the widespread dissemination of sustainable markets for renewable energy systems are rapidly evolving. It is clear that future growth in the energy sector is primarily in the new regime of renewable. Therefore, shifting to renewable energy can help us meet the dual goals of reducing greenhouse gas emissions, thereby limiting future extreme weather and climate impacts, and ensuring reliable, timely, and cost-efficient delivery of energy. Investing in renewable energy can have significant dividends for our energy security.

Renewable energies are energy sources that are continually replenished by nature and derived directly from the sun (such as thermal, photo-chemical, and photo-electric), indirectly from the sun (such as wind, hydropower, and photosynthetic energy stored in biomass), or from other natural movements and mechanisms of the environment (such as geothermal and tidal energy). Renewable energy does not include energy resources derived from fossil fuels, waste products from fossil sources, or waste products from inorganic sources [2]. Fig. 1 shows an overview of renewable energy sources [3,4]. Renewable energy technologies turn these natural energy sources into usable forms of energy—electricity, heat and fuels. Fig. 2 illustrates the ability of renewable energy sources to provide over 3000 times the current global energy needs [5].

Renewable energy markets – electricity, heating and transportation – have been growing sharply over the last five years. The deployment of established technologies, such as hydro, as well as newer technologies such as wind and solar photovoltaic, has risen quickly, which has increased confidence in the technologies, reduced costs and opened up new opportunities [6].

Global electricity generation from renewable energy sources is expected to grow 2.7 times between 2010 and 2035, as indicated by Table 1. Consumption of biofuels is projected to more than triple over the same period to reach 4.5 million barrels of oil equivalent per day (mboe/d), up from 1.3 mboe/d in 2010. Almost all biofuels are used in road transport, but the consumption of aviation biofuels will make an inroad towards 2035. The use of modern renewables to produce heat will almost double, from 337 Mtoe in 2010 to 604 Mtoe in 2035. The share of renewables in electricity generation is higher than in heat production or Transportation road, as shown in Fig. 3 [7].

The goal of the paper is to present an overview of the different types of renewable energy resources, their current and future

states, their share in different end use applications, and their benefits, growth, investment and deployment. Furthermore, power electronics and smart grid will be discussed as enabling technologies for different renewable energy resources.

2. Description of renewable energy sources

2.1. Biomass energy

Biomass is the term used for all organic material originating from plants, trees and crops, and is essentially the collection and

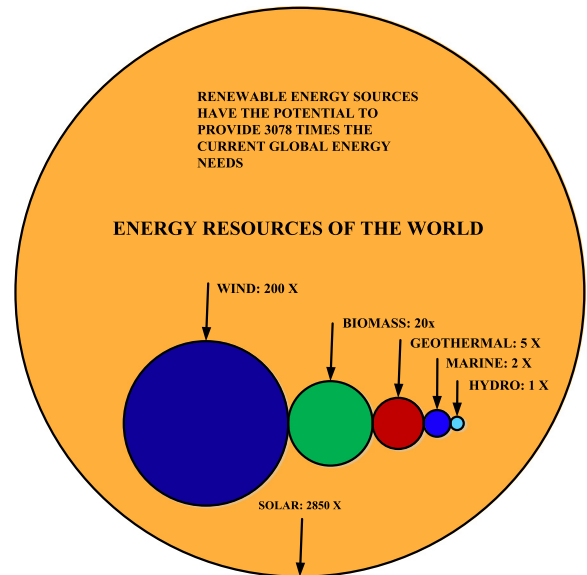


Fig. 2. Energy resources of the world [5].

Table 1
World renewable energy use by type [7].

| | 2010 | 2020 | 2035 |
|--------------------------------------|-------------|-------------|---------------|
| Electricity generation (TW h) | 4206 | 6999 | 11,342 |
| Bioenergy | 331 | 696 | 1,487 |
| Hydro | 3431 | 4513 | 5,677 |
| Wind | 342 | 1272 | 2,681 |
| Geothermal | 68 | 131 | 315 |
| Solar PV | 32 | 332 | 846 |
| Concentrating solar power | 2 | 50 | 278 |
| Marine | 1 | 5 | 57 |
| Share of total generation | 20% | 25% | 31% |
| Heat demand (Mtoe) | 337 | 447 | 604 |
| Industry | 207 | 263 | 324 |
| Buildings and agriculture | 131 | 184 | 280 |
| Share of total production | 10% | 12% | 14% |
| Biofuels (mboe/d) | 1.3 | 2.4 | 4.5 |
| Road transport | 1.3 | 2.4 | 4.4 |
| Aviation | – | – | 0.1 |
| Share of total transport | 2% | 4% | 6% |

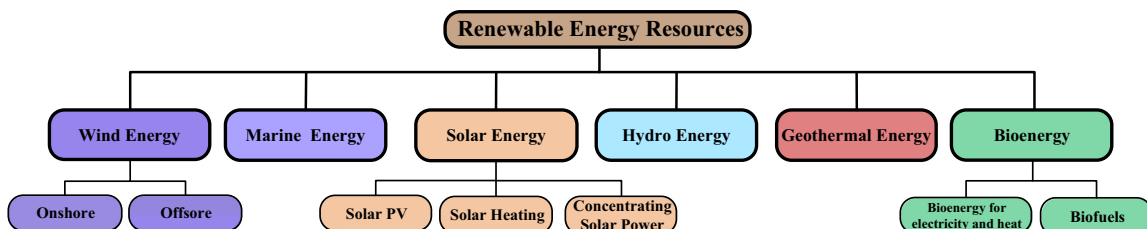


Fig. 1. Overview of renewable energy sources.

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