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### RENEWABLE ENERGY SUPPLY AND ENERGY EFFICIENCY TECHNOLOGIES: A REVIEW

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**Abstract:** Electricity consumption will comprise an increasing share of global energy demand during the next decades. In recent years, the increasing prices of fossil fuels and concerns about the environmental consequences of greenhouse gas emissions have renewed the interest in the development of renewable energy resources. Renewable energy is now considered a more useful source of fuel than nuclear power or conventional energy resources due to the absence of risk and disasters. Carbon dioxide emissions is a global concern issue which is very harmful for environment also. In this regards, we have two options to reduce CO<sub>2</sub> emissions are i) replacing fossil fuels with renewable energy sources as much as possible ii) Enhancing energy efficiency. In this paper, we will discuss alternative technologies for enhancing renewable energy deployment and energy use efficiency.

**Keywords:** Renewable Energy Resources (RER); combined heat and power (CHP); virtual power plants (VPP)



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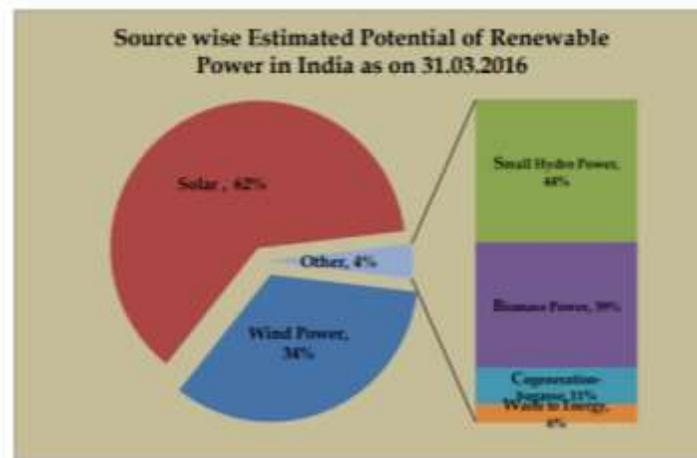
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## INTRODUCTION

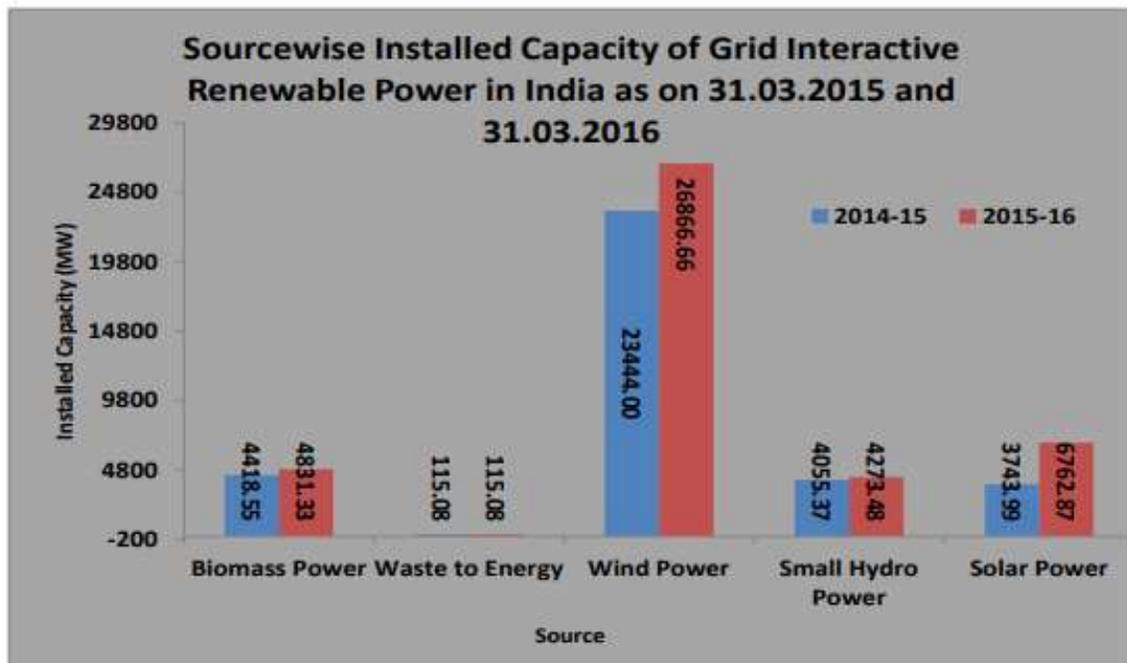
The importance of Renewable energy sources comes together with climate change challenges associated with the excessive use of fossil fuels. There are three primary motivators that stimulate the growth of renewable energy technologies: energy security, economic impacts and carbon dioxide emission reduction. The term “Renewable Energy” refers to any form of energy other than the conventional sources of energy, including hydropower.

When talking about clean technologies, there are two primary concepts of energy technologies: energy supply technologies, which refers to alternative sources of renewable energy (e.g., wind and solar power), and energy efficiency technologies, or those technologies which are hired to enhance energy use efficiency, (e.g., combined heat and power (CHP), virtual power plants (VPP) and smart meters).



## RENEWABLE ENERGY SUPPLY TECHNOLOGIES

The renewable energy supply is continuously increasing. A large amount of investment has been made during recent years and the advancement of technology has enabled countries to produce renewable energy more cost effectively. The Renewable technologies may not be comparable with conventional fuels in terms of production cost, but they are comparable with their associated externalities, such as their environmental and social effects.



### Hydro power

Hydro power is currently the largest renewable energy source for power generation around the world. Currently, hydro power development is difficult due to a large initial investment cost & environmental concerns. The environment is also influenced by hydro power construction because of large engineering works. On the other hand, hydro power is attractive due to a pre-existing supply of water for agriculture, household and industrial use and enables the storage of both water and energy.

There are three kinds of hydropower generation plants:

- (i) Run-of-River, where the power is generated by the flow of a river.
- (ii) Reservoir, where the power is generated by the release of stored water.
- (iii) Pumped storage, where stored water is backed up into the reservoir in order to be pumped again.

### Wind power

The installed capacity of wind power has increased from 4.8 MW in 1995 to more than 239 GW in 2011. Today, each wind turbine could generate as much electricity as a conventional power plant. Wind energy has made its most significant contributions in China, the US and Germany, where the cumulative installed capacities are 62, 47 and 29 GW, respectively.

### Solar power

During the two last decades, the economic feasibility of solar power for residential, commercial and industrial consumption has been investigated by researchers.

### **Geothermal**

Geothermal is a type of thermal energy generated and stored within the Earth. It has been used throughout history for bathing, heating & cooking. Geothermal energy is created by radioactive decay, with temperatures reaching 4,000°C at the core of the Earth. While geothermal energy is available worldwide, there is an important factor called the geothermal gradient that indicates whether a region is a favored place for enactment. It measures the rate at which the temperature increases as the depth of the Earth increases. For example, the average geothermal gradient in France is 4°C/100m with a range of 10°C/100m in the Alsace region to 2°C/100m in the Pyrenees. The another important measure is permeability of rocks, which determines the rate of flowing heat to the surface. Geothermal energy has a major advantage compared to wind and solar energy in that it is available 24 hours a day through the year. The estimated CO<sub>2</sub> emissions produced by geothermal resources is 55 g/kWh when utilizing data from a survey of 73% of the geothermal power plants.

### **Other Renewable sources**

There are other types of renewable energy sources including biomass, ocean waves and tides. Biomass is defined as living plants and organic waste which are made by plants, human, marine life and animals. Various types of energy can be produced from biomass: electricity, cooking heat, chemical feedstock etc. As a feedstock, biomass has a lower sulfur content than coal and a lower emission is produced by combustion.

Extracting energy from the ocean is considered to be an interesting option due to wide availability of ocean sources. There are six different resources which are available from oceans: offshore wind energy, wave power, marine current energy, ocean thermal energy conversion, tidal power and osmotic power.

### **ENERGY EFFICIENCY TECHNOLOGIES**

There are two main solutions to reducing CO<sub>2</sub> emissions & to overcoming the climate change problem:

- i) Replacing fossil fuels with renewable energy sources as much as possible.
- ii) Enhancing energy efficiency.

Energy efficiency for an electricity network could be considered in different stages, such as the power generation, transmission, distribution and consumption.

### **Electric Vehicles**

Electric Vehicles (EV) (battery, fuel cell and hybrid types) have the potential to be considered viable options for both electricity storage and power generation. Considering that the transportation sector is one of the main sources of emissions, improving fuel efficiency enables us to achieve the largest fuel savings and CO<sub>2</sub> reduction in the short term. Thus, the increased usage of EVs and increasing their share of the vehicle fleet can play a key role in the long term. "In long-term, smart grid technology may enable EVs to be used as distributed storage devices,

feeding electricity stored in their batteries back to the system when needed (vehicle to grid), to help provide peak-shaving capability.”

### **Combined Heat and Power (CHP)**

Cogeneration or combined heat and power, is the use of heat and electric power together. It is expected to have a substantial gain in efficiency over each source separately. Most power distribution companies supply only electricity not hot water or steam. Considering that almost 30-40% of a country's total energy load is used for heating, CHP is an efficient use of fuel when a portion of the energy is discarded as waste heat. It captures some or all of the waste energy as a by-product for heating. CHP could transform a significant part of the waste heat into a positive economic value for industrial processes or heating in residual and commercial buildings.

### **Virtual Power Plant (VPP)**

A Virtual Power Plant is a cluster of Distributed Energy Resources (DER), such as micro-CHP, wind turbines, and solar photovoltaic panels, which are controlled and managed by a central control unit. A DER system has been defined in order to overcome energy waste problems due to long distances and transmission losses. Therefore, DERs are generally located close to the distribution networks. The share of distributed generation (DG) in an electricity network is increasing in importance and VPP is considered to be an emerging technology that enhances energy efficiency.

### **Smart meter**

A smart meter is a device to record the consumption of electricity in hourly intervals and the information is monitored by both the utility and customer. A smart meter is able to have two way communication and intelligence management for home appliances. Applying smart meters could facilitate a significant change in the energy efficiency of electricity networks.

## **MAIN DRIVERS FOR USING RENEWABLE ENERGY TECHNOLOGIES**

### **Energy security**

The energy security risk can be classified as strategic and domestic system risks. It also includes damage costs and control cost as potential costs imposed by energy insecurity. The damage cost can be evaluated by potential decreases, but that it is difficult to estimate how much money is spent as control costs.

### **Economic impacts**

The emphases for economic impacts are job creation, industrial innovation and Lower Consumer Expense. A main economic driver to the enhancement of renewable energy technologies is their job creation potential. It's estimated that 5 million people work in

renewable energy industries. Production of renewable energy is usually more efficient compared to traditional energy. The American Wind Energy Association claims that a sufficient number of wind plants – that could be built in four years. All other forms of renewable energy sources also turn out to be way cheaper than traditional non-renewable sources.

### **CO<sub>2</sub> emission reduction**

Renewable energy technologies could reduce carbon dioxide emissions by replacing fossil fuels in the power generation industry and transportation sector. Life-cycle CO<sub>2</sub> emissions for renewable energy technologies are much lower than fossil fuels.

### **SUMMARY AND CONCLUSION**

Renewable energy sources an important component of the world energy consumption portfolio. Renewable energy technologies could reduce carbon dioxide emissions by replacing fossil fuels in the power generation industry. Power generation using renewable energy sources should be increased in order to decrease the unit cost of energy and to make them compatible with a competitive alternative to the conventional energy sources. Two main solutions may be implemented to reduce CO<sub>2</sub> emissions and to overcome the problem of climate change: replacing fossil fuels with renewable energy sources as much as possible and enhancing energy efficiency regardless of type. In this review, we considered hydro, wind, solar and geothermal sources.

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