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A Review of Renewable Energy Resources, Technologies And Energy Efficiency Methods

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Abstract : Electricity consumption will comprise an increasing share of global energy demand during the next two decades. In recent years, the increasing prices of fossil fuels and concern about the environmental consequences of greenhouse gas emissions have renewed the interest in the development of alternative energy resources. In particular, the Fukushima Daiichi accident was a turning point in the call for alternative energy sources. Renewable energy is now considered a more desirable source of fuel than nuclear power due to the absence of risk and disasters. Consider the major component of greenhouse gases is carbon dioxide; there is a global concern about reducing carbon emissions. In this regard, different policies could be applied to reducing carbon emissions, such as enhancing renewable energy and encouraging new technological innovations, As such solutions may be implemented to reduce CO2 emissions and overcome the problem of climate change. Replacing the fossil fuels with renewable energy sources as much as possible and it enhances energy efficiency. In this paper, we discuss alternative technologies for enhancing renewable energy development and energy its efficiency.

1. INTRODUCTION

The major component of greenhouse gases (GHGs) is carbon dioxide. So, there is a global concern about reducing carbon emissions. In this regard, different policies could be applied to reduce carbon emissions, such as utilization of renewable energy sources and encouraging technological innovations. In addition, supporting mechanisms, such as feed-in tariffs, renewable portfolio standards and tax policies, are employed by governments to develop renewable energy generation along with implementing energy use efficiency for saving energy.

Many countries have started to install facilities that use renewable energy sources for power generation. The importance of alternative 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 "alternative energy" refers to any form of energy other than the conventional sources of energy, including hydropower. In recent years the focus has been on renewable energy sources

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). It should be noted that transforming the energy sector and replacing conventional energy with renewable energy is evolutionary associated with technological change and forming markets. Jacobson and Bergek (2004) indicate that the transforming process for certain forms of renewable energy, such as wind and solar, will happen after 2020, even if the growth rate of consumption is strongly increasing over the next decade. Also, renewable energy markets are not easily formed due to cost disadvantages and the subsidizing of fossil fuels

1.1 RENEWABLE ENERGY SUPPLY TECHNOLOGIES

The renewable energy supply is continuously increasing. A large amount of investment has **b**een made during recent years and the advancement of technology has enabled countries to produce renewable energy more cost effectively. It is forecasted that the number of countries producing above 100 megawatts (MW) of renewable energy will increase significantly by2017 (IEA, 2012d). Due to some negative and irreversible externalities coming with conventional energy production, it is necessary to promote and develop renewable energy supply technologies. These technologies may not be comparable with conventional fuels in terms of production cost, but they could be comparable if we consider their associated externalities, such as their environmental and social effects. Also, it should be noted that economies of scale could play a key role in reducing the unit production cost. Transmission and distribution costs, as well as technologies, do not differ much among the conventional and renewable energies. Below we present facts about the development of the main renewable energy supply technologies.

1.2. Hydropower

Hydro power is currently the largest renewable energy source for power generation around the world. Hydro electricity generation has had a strong increase over the past 50 years. It was 340 tera watt -hour (TWh) in 1950 and covered about one-third of the global electricity demand. It increased to 1,500 TWh in 1975 and further to 2,994 in 2005. We can compare this to the global consumption of 15,000 TWh of electricity with a global production of 18,306 TWh in 2005 (Ngô and Natowitz, 2009). Currently, hydro power development is difficult due to a large initial fixed investment cost and environmental concerns.

Additionally, hydro power has caused problems for local residents associated with the need to relocate large populations, as well as the construction of dams is permanent with a sunk cost of utilities which cannot be removed. 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 preexisting supply of water for agriculture, household and industrial use, and hydro power is clean and enables the storage of both water and energy. Also, the stored energy can be used for the application of both base-load and peak time power generation.

1.3. 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.

1.4. Solarpower

During the two last decades, the economic feasibility of solar power for residential, commercial and industrial consumption has been investigated by researchers. Industrial countries like Japan and Germany are looking for alternative sources of energy such as solar power due to the limited availability of natural primary energy sources. In early 1990s, Japan started to take advantage of large-scale electricity generation by solar photovoltaic (PV), and was soon followed by Germany. Currently, both countries have taken the lead in the manufacture and production of solar power technologies. More recently, China has developed an extensive solar power capacity due to cheap labor and government subsidies, in turn, decreasing the cost of solar power generation.

1.5. GEOTHERMAL

Geothermal is a type of thermal energy generated and stored within the Earth. It has been used throughout history for bathing, heating and 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 Mountains. In Iceland and the volcanic regions, the gradient can reach as high as 30˚C/100m (Ngô and Natowitz, 2009).

2. 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. Based on Tester (2005), the main advantage of biomass is availability, as it can be readily found in all places. Many kinds of energy can be produced from biomass: electricity, cooking heat, chemical feedstock, etc. As a feedstock, biomass has lower sulfur content than coal and a lower emission is produced by combustion. In early 2000, the United States had an installed capacity of 11 GW from biomass including the forest product and agricultural industry, municipal and solid waste industry, and other sources (Ngô and Nato witz, 2009).

Extracting energy from the ocean is considered to be an interesting option, due in part to the 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. The Bay of Fundy has the largest tidal range in the world that enables it to support a power station with a capacity of 2 GW or more (Tester, 2005). In this paper we considered hydro, wind, solar and geothermal energy, because of their main contribution to renewable power generation.

3. ENERGY EFFICIENCY TECHNOLOGIES

As previously mentioned, there are two main solutions to reducing CO_2 emissions and to overcoming the climate change problem replacing fossil fuels with renewable energy sources as much as possible and through enhancing energy efficiency. We discussed the state of the art methods for technical and economic feasibility of expanding the use renewable energy sources and the possibility of substitution in the first part of this review. In this part that follows, we discuss energy efficiency technologies. Energy efficiency for an electricity network could be considered in different stages, such as the power generation, transmission, distribution and consumption. The different technologies that are currently available include electric vehicles (EV), combined heat and power (CHP), virtual power plants (VPP) and smart grids, which are discussed below.

4. ELECTRIC VEHICLES

Electric Vehicles (Ev, Including The 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_2 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. Iea (2012c) Forecasted An Increased Share Of Plug-In Hybrid Electric Vehicles (Phev) Over The Next Two Decades, With A Total Increase Of Upto50% By 2050.“In Long Term, Smart Grid Technology May Enable Evs To Be Used As Distributed Storage Devices, Ford (1995) Examined The Impact Of The Large Scale Use Of Electric Vehicles In Southern California And Concluded That Southern California Edison (A Power Company In The Area) Was Able To Accommodate A Large Number Of Evs With Their Existing Capacity, Particularly If The Charging System Was Managed By Smart Control. Ford Argued That Evs Can Improve Load

Management, Enhance Efficiency And Save Energy. He Also Calculated That Evs Are Able To Reduce Emissions At A Value Of Around 9,000 Usd Per Vehicle. Kempton (1997) Calculated The Present Value Costs For An Ev Owner And The Benefits To Utilities. Based On The Results, All Three Vehicle/Battery Combinations Are Cost-Effective Power Sources During The Peak Time For The Short-Term. He Argued That If A Part Of The Transportation Section Is Utilized By Electric Vehicles With Connections To The Electricity Network, There Will Be Less Demand For Base-Load Generation.

5. COMBINED HEAT AND POWER

Co generation, or combined heat and power (CHP), 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. In Reykjavik and New York, end users are able to purchase both electricity and thermal energy from a utility company (Tester, 2005). An example of cogeneration is the CHP unit in Avedore, Denmark which is a multifuel plant (Ngô and Natowitz, 2009). Shipley et al. (2008) calculated that increasing the CHP capacity of the United States to 20% by 2030 would lead to a reduction of 5.3 Quads (Quadrillion British Thermal Units) of energy consumption and 848 MMT of carbon dioxide emissions. Based on their findings, the United States would save more than 1.9 Quads of fuel consumption and 248 million metric tons of carbon dioxide emissions by employing CHP. According to the WEO (2012) report, the average efficiency of power plants is 41% worldwide, with almost 60% of the primary energy being converted to waste heat (IEA, 2012e). 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.

Table: 1.Analtycal review of Renewable Energy Technologies over a decade

Title	Objective of work	Methodology	Analysis
Design and analysis of highway windmill electric generation	The work deals with designing a portable highway wind turbine, which is to be contribute towards the global trend in wind energy production in a feasible way	creation of pressure column on both the sides of the road	This design concept is meant to be sustainable and environmentally friendly. Additionally, a wind turbine powered by artificial wind has a myriad of applications theoretically any moving vehicle can power the turbine such as an amusement park ride
Highway mounted horizontal axial flow turbines for wind energy harvesting From cruising vehicles	The objective of this work is to design and analyze a horizontal axis wind turbine to capture wind energy from moving vehicles on the highway	The idea is to have a separate mounting for cars and heavy vehicles which can be realized by having separate lanes on highways	This work is to complement the conventional electrical energy used for powering amenities along highways by a renewable source of energy (wind power) thereby leading to the concept of eco-friendly highways.
Working Design Of vertical Axis Wind Turbine With Road Power Generation (N.VENKATA SUBBAIAH, Issue 4,December 2017)	it is to produce electricity in low cost with no effect on environment	Use arrangement vertical axis blade for power generation called as turbine for owe generation.	This design concept is meant to be sustainable and environmentally friendly. If these types of turbines can be installed on long high speed express highways like golden quadrilateral, a considerable amount of electrical energy can be generated, which can solve the issue of energy crisis to a large extend.
Wind Power Generation on High way (Arvin Kumar at all ,May 2015)	The objective of this report is to describe the data required to perform steady state and dynamic analysis of a WPP	Doubly fed induction generator technology is used	This paper has provided an overview of different wind turbine generators including DC, synchronous and asynchronous wind turbine generators with a comparison of their relative merits and disadvantages.
Wind Turbine Blade Design	To present a detailed review of the current state-	The aerodynamic design principles for	It is said likely that the general shape will remain fixed and will increase in

(Peter J. Schubel * and Richard J. Crossley,Energies 2012)	of-art for wind turbine blade design and including theoretical maximum efficiency, propulsion, practical efficiency, HAWT blade design, and blade loads	a modern wind turbine blade are detailed, including blade plan shape/quantity, aerofoil selection and optimal attack angles.	size until a plateau is reached. Minor changes to blade shape may then occur as manufacturers incorporate new aerofoil's, tip designs and structural materials
Analysis of Vertical Axis Windmill Turbine for Electricity Generation on Highways (Kiran Nakil‡, Akshay Tekale ,Pratush Sambhusand R.S. Patil† Special Issue-6 (Oct 2016))	The main objective is to produce electricity by using the force of air created by the moving vehicle in highways, Electricity can be generated by using the VERTICLE AXIS HIGHWAY WINDMILL.	This force will rotate the vertical turbine blade and this blade is coupled with the generator which produces electricity. In this method one additional generator is coupled to increase the efficiency	Coefficient of performance (Cp) increases with velocity, Rotations per minute (RPM) increases with increase in velocity, Wind potential power is higher at Pune-Nashik highway , The wind velocity increases consistently with increase in altitude and Maximum power rating was found out to be 18.8580W. Wind thus is an reliable source of non-conventional for energy production then Utilization of highways for energy production fields can give out high yield potentials.
Design And Development of Alternate Sources of Energy Using Wind Turbulence Created by Moving Vehicles on Highway by Using VAWT'S (Pranav Sarda at all, Feb-2018)	The foremost aim will be to extract usable power which can run various devices having low power requirement such as mobile devices and wireless sensor networks	the method of harnessing the turbulence of winds generated by the frequently passing vehicles on highway by use of Vertical Axis Wind Turbine [VAWT	It can be used for low power application such as street lighting on highway and charging station at remote areas. Other application could be electronic diversions signal on highway and traffic lights. This can be of hybrid type where presence of sunlight by using Solar Panels
Highway Wind Turbine (Quite Revolution Turbine) (Sushant N. Malave at all,Volume 6, Number 6 (2013))	The objective of the project is to design a wind turbine to recapture wind energy from vehicles on the highway	The design of the wind turbine must include storage of power and a system to distribute the generated power effectively. Operational noise level and space are other important design considerations.	This design concept is meant to be sustainable and environmentally friendly. Additionally, a wind turbine powered by artificial wind has a myriad of applications. Theoretically any moving vehicle can power the turbine such as an amusement park ride.
Wind Turbines along highways (Faculty Technology, Policy and Management,www.tbm. tudelft.nl)	The report investigates the feasibility of this new concept by using the Prins Bernardweg Zaandam to Bolswarderbaan highway in the Netherlands as a virtual case study	Multiple experts and stakeholders participated in interviews to provide expertise and validate information used in the analyze	The recommendation is to expand the concept to researching the installment of wind turbines along railroads. The electrical infrastructure is in place and trains come and go when it is not winter time in the Netherlands

6. SUMMARY AND CONCLUSION

Ongoing concerns about climate change have made 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 and

the transportation sector. Due to negative and irreversible externalities in conventional energy production, it is necessary to develop and promote renewable energy supply technologies. 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_2 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, because of their significant contribution to power generated by renewable sources.

This review of renewable energy generation and efficiency technologies has provided detailed and useful information that can be used in the decision making of different stakeholders in the rapidly developing market. Each technology has both advantages and disadvantages that vary by location, availability, the technological capability of producers, financial limitations and environmental considerations. Each municipality, region or country has different initial conditions that determine the energy mix that can be produced at the lowest cost while minimizing the harm done to the environment. Thus, there is no single solution to every energy need and problem, but rather an optimal location specific solution among a set of possible renewable solutions.

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