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Greener Energy Future and Smart Grid

Abstract

There are advantages and disadvantages of the green power generation technologies using Renewable Energy Sources (RES) such as solar, wind energy, fuel cells, and biomass power generation, which can be used for generating distributed power. RESs cannot directly replace the existing electric energy grid technologies. The latter are far too well established to abandon, while the new RES technologies are not sufficiently developed to meet the total energy demand. Therefore, it is sensible to gradually infuse RES into existing grids and transform the system over time.

In this paper, there is a full exploitation of RES components which are critical to managing carbon emission and the limitations of the current grid to the new RES technologies, which face barriers to full-scale deployment as a conclusion.

I. Introduction

Modern power distribution systems made abundant energy reliably available and relatively independent from the plant location. More than two centuries of past industrialization exploited nonrenewable energy resources, however, often with undesirable side effects such as pollution and other damage to the natural environment. In the second half of the 20th century, extraction of energy from nuclear processes grew in popularity, relieving some demands on limited fossil fuel reserves, but at the same time, raising safety and political problems. Meeting the global demand for energy is now the key challenge to sustained industrialization. Industrialization and economic development have historically been associated with man’s ability to harness natural energy resources to improve his condition.

Issues such as reliability and efficiency in power processing systems allow exploitation of the enormous potential of the renewable sources by transforming the maximum available power into an electrical one, fed into the grid or converted into a high density energy for being stored and used in another place or at another time, when the primary source is not available is one of the main issues discussed in Smart Grid. In 2008, emissions of carbon dioxide from fuel burning in the United States were down 2.8%, the biggest annual drop since the 1980s [1]. The Smart Grid enables grid operators to see further into the system and allows them the flexibility to better manage the intermittency of RES. This in turn surmounts a significant barrier, enabling wind and solar to be deployed rapidly – and in larger percentages to have a green Smart Grid.

Going Green through the use of RES and make the planet sustainable and by so doing improve the air quality and environment. US government has required that by the year 2030 that 20% of the electrical energy generated in the U S will be from RES. There are many different types of RES such as hydroelectric, biomass, wind, solar, wave, tidal and geothermal. The key to the usage of renewable resources is that they are replenished by nature. In addition, they also have the advantage of having low or no emissions of carbons which make them more environmentally friendly than the old energy sources such as fossil fuel.
The concept of Smart Grid was first put forward in 2003. In accordance with the IBM, the "Smart Grid" has three characteristics: first, a higher degree of digitalization, containing a variety of intelligent sensors, such as electrical equipment, control systems, application systems, etc, and connecting more devices; second, it is based on a unified information platform, which can finish the integration of data and application automatically; third, it is based on business intelligence analysis system, and has the capabilities of assisting decision support for data analysis, that is, to optimize the operation and management according the correlation analysis of existing power grid data.

The discussion of RES will bring many issues to the table such as: efficiency, reliability and cost of the energy conversion, capability to forecast energy production, safe connection to the electric grid and/or capability to manage Microgrids. All of these issues are needed to have a better performance grid, efficient energy storage and transport with low environmental impact, development of advanced control and monitoring systems, networking of the sources/consumers, and availability of good tools for the study and research of RES.

The most exploited RESs are hydroelectric, photovoltaic (PV), and wind. In 2007, the world’s renewable energy production share has been calculated as 19%. However, 16% is due to hydroelectric energy production, where wind and PV energy production is still very modest. PV and wind energy are the most promising renewable energies but have different requirements to be produced and incorporated in the new system. In 2009, wind energy became well established with 1% of world energy production, while PV energy is experiencing an impressive growth. Other emerging renewable technologies include wave and tidal energy conversion, biomass energy conversion with focus on combined heat and power (CHP), and small-scale hydroelectric plants (less than 10 MW per site). The wind energy production forecast for 2011 is more than 200 GW. On the other hand, PV industry is growing at more than 30% per year, and the cost of PV energy will reach the break-even point very soon in many countries.

The electrical infrastructure of today’s grid was designed over half a century ago. The load demand is increasing continuously whereas our electrical grid is becoming dated. Each year according to Energy Information Administration (2008), there is a 1.3 and 3.5 percent increase in energy consumption.

II. Benefits of Greener Power Smart Grid

The term green power is used in a number of different ways. In the broadest sense, green power refers to environmentally preferable energy and energy technologies, both electric and thermal. This definition of green power includes many types of power, from solar photovoltaic systems to wind turbines to fuel cells for automobiles. From a financial point of view green power can offer organizations a variety of environmental, stakeholder relations, economic development, and national security benefits. It will also provide a hedge against risks posed by electricity price volatility. Purchasing electricity generated by RES may provide the buyer protection against unstable or rising fossil fuel prices, for example through long-term, fixed-price supply contracts directly with developers or generators. Organizations can also encourage stable electricity prices by supporting new renewable power resources on the local grid, thereby diversifying the energy mix with resources that are not subject to the rise and fall of fuel costs.

On-site renewable generation can reduce the risk of disruptions in fuel supplies, resulting from transportation difficulties or international conflict. To address global climate change and regional air quality issues, federal and state regulations could effectively increase the price of conventional electricity, making green power financially more attractive and it will be additional environmental regulation.
Green power generates less pollution than conventional power and produces no net increase in greenhouse gas emissions, helping protect human health and the environment.

There are many other benefits for green power such as meet organizational environmental objectives, demonstrate civic leadership, generate positive publicity, improve employee morale, differentiate products or services, economic development and National Security, stimulate economies, increase fuel diversity, reduce infrastructure vulnerability, and economies of scale (potentially lower prices).

Green power can be priced differently from standard power sources. It has usually been more expensive than conventional electricity sources, largely due to the relative newness of renewable technologies and their gradual diffusion into mainstream markets, compared with conventional electricity. The actual price for green power depends on a number of factors, including the availability and quality of the resource, manufacturing capacity and world demand for the technology, the availability of subsidies to encourage green power, and the quantity purchased and terms of the contract.

III. Renewable Energy Sources (RES)

Distributed Generation (DG) or Distributed Resource (DR) generally refers to small generating units or DG plus Energy Storage (ES) that are connected in the vicinity of the user side to meet the demand of some end-users. Their capacity is generally small size, which range from a few Kilowatts to Megawatts. DR can make use of various energy technologies. Generally speaking, DR systems are directly connected to 380 V or 10kV distribution network systems or operate independently.

The main significance of the development of DR lies in the following aspects:

1) Economic: Compared to traditional large power plants, DR generation system has the features of low investment costs, small risks, covering less area, and the short construction period. Also transmission distribution loss is low, and it can decrease the huge investment and power loss due to long-distance transmission because these systems are built near the load center. No need for building costly power transmission network and substations. A great lot of nearby power supply can reduce the construction of large-capacity long-distance high-voltage transmission line, which will not only reduce the electromagnetic pollution due to high voltage transmission lines, but also can reduce the land area and line corridors of high-voltage transmission. It can reduce the tree felling, which is conducive to environmental protection.

2) DR can use a variety of energy, such as clean energy (gas), new energy (hydrogen) and RES. At the same time, it can provide users with cold, heat, electricity and other energy applications. So it is a good way to solve the energy crisis and energy security issues and be a diversity of energy user.

3) DR generation systems are independent. In case of power grid failure, DR can guarantee its users power supply, and avoid some disastrous consequences. At the same time, many DR power generation and integration technology generation system connect to the power grids, which can provide the protection when the DR cannot normally operate due to its own problems. Therefore, DR generation system built near the user and connected with the large power grid can greatly enhance the operation security and reliability of entire energy system, especially the power system which we are all demanding.
4) Many remote and rural areas are far from the power grid, and it is difficult to supply from the power grid. Therefore, it may be an optimal way to make use of the Stand-alone System applying solar, wind power and biomass power generation.

IV. Energy Storage

RES can be categorized into two major categories: dispatchable and nondispatchable. Hydroelectric, biomass and geothermal are dispatchable resources, whereas, wind, solar and tidal waves would be classified as non-dispatchable resources. The key difference between the two categories is the controllability of electric power. The dispatchable resources, in general, have the energy stored, and could therefore be called upon at any given time to produce power. The non-dispatchable resources, on the other hand, inherently do not have any control of the input energy for later use when needed. One of the main concerns about using RES such as wind, solar and tidal is their inability to dispatch power on demand. For example the wind can stop blowing or the sun can go behind a cloud which can significantly affect the power output. By their very nature these RES are more variable than fossil fuel, nuclear, biomass, and hydroelectric power plants. This lack of control over the input is what causes the variability in power output. This basic principle of dispatchable versus non-dispatchable without any storage is one of the key concerns for researchers and engineers.

Energy storage can be defined as the stockpiles of fuel such as coal, oil, natural gas, diesel and gas or the storage of energy in electrical, chemical or mechanical form. By using more RES in the system it is assumed that less energy storage will be consumed by traditional power generating facilities. However the amount of saved energy storage produced by having RES generating power are not equivalent to a direct replacement of the fossil fuel generators. Their inability to supply real and reactive power on demand like traditional generators require that other generators be held as spinning reserve to compensate for this issue. However one solution to this issue is to store the energy generated by the RES and save it for later use. This would require the addition of Electrical Energy Storage Systems such as Battery Energy Storage System (BESS), Flywheel Energy Storage System (FESS), Superconducting Magnetic Energy Storage (SMES), Pumped Hydro Storage, Compressed Air Energy Storage (CAES) and the Supercapacitor. In fact, other than pumped hydro there are no other energy storage facilities that can currently store the large amount of energy that could be created by a large wind or solar installation. The other electrical energy storage device that is currently available and can be installed almost anywhere in the power distribution system is the Battery Energy Storage System (BESS). Even if connected to the utility grid, RESs are usually coupled with other energy sources to improve robustness against intermittent outages.

The popular approaches include the use of fossil fuel-driven generators (diesel), batteries, flywheels, supercapacitors, and compressed air systems. Their environmental impact is important, since the use of RESs is strictly related to providing a more sustainable energy processing. An ad hoc hydrogen network in parallel to the electric grid may offer an effective storage system, leading to the use of RESs directly producing hydrogen and fuel cells as a transportable storage.

V. Res Systems

A. Solar Energy

Solar energy, that is inexhaustible and no pollution, is the optimal energy that people are looking forward to. Solar power generation technology includes two kinds of solar thermal power generation and PV power generation. The thermal power from solar is generated by heating some medium with solar
energy gathered and directly or indirectly generating steam to drive a turbine generator. The main form of solar power is the photovoltaic power generation, where PV cells, use the photovoltaic effect, and directly translating solar energy into electricity.

Solar systems can be configured to almost any size from a few kilowatts up to several megawatts. On-site PV systems may be situated on schools, homes, community facilities, and commercial buildings. They can be integrated into a building, displacing other building material costs, such as for roofing shingles or car park shading. PV installations are growing rapidly in developed countries, but the US lags far behind Germany and Spain. These two European countries lead Europe (and the rest of the world) in total generating capacity of PV energy systems. With regard to installed capacity, Germany is clearly the leader, holding more than 85% of Europe’s total capacity (in excess of 1,500 MWp) ³. The best locations for the best PV solar resources are shown in Fig. 1.

![U.S. Photovoltaic Solar Resource, NREL](image)

There are many advantages of solar energy such as inexhaustible of solar energy, no environmental pollution, without geographical restrictions, and with great convenience. PV cells can be used as independent power systems (Microgrid) and also connected to the power grid. However, if the solar power systems can be successfully applied to DR system some issues can be resolved, such as how to further reduce costs, how to resolve the low energy density of the sun, the change of the radiation strength during 24 hours, and how to solve the problem of the smooth power ⁴.

As for the cost aspect, current literature indicates that the future of PV dedicated conversion systems is in the adoption of transformerless topologies, with additional benefits in terms of conversion efficiency. The main sources of power loss are the converter switching and conduction loss as well as the energy losses in the output filter. Drop in crystalline cells’ prices in 2009 has boosted the sales of large PV power plants as well as domestic installations, with a growing trend in 2010. However, the pay-back plan benefit of tariffs for the produced energy still remains high with respect to the forecast for future years [5]. Fig. 2 shows clearly that PV cost is the highest among all other RES.
B. Wind Energy

Wind power is a tremendous and renewable energy without compensation. The comparative advantages of wind power embodied in: environmental protection, renewable energy, no fuel consumption, polluting the environment. The wind field can be built on the beach (shallow water) or desertification without accounting for arable land. Its technicality is mature, and the development of wind power only second to the small hydropower. Although the prospect of wind power applied in DR system is broad, there are still many key technologies to be resolved, such as the sitting, the volatile of the power from the wind generation, and the economics of wind power generation equipment relation with the single capacity and so on.

Wind turbines vary in size. A typical small unit provides 100 kilowatt (kW) or less, whereas large turbines range from 500 kW to more than 3 MW. It is usually require approximately 1 acre of land per turbine and wind speeds that average 15 mph at a 150-foot height.

Modern wind turbines are a higher density energy source than direct PV conversion. Based on 2007 production levels, Germany (20,622 MW) and Spain (11,615 MW) were generally acknowledged to be the world’s leaders in total wind power generation. Wind power could be generating up to 16% of Europe’s electricity by 2020. On the other hand, in the US, total estimated wind power capacity exceeded 20,000 MW in 2008 and is growing explosively from 2007 levels. The Horse Hollow Wind Energy Center is believed to be the world’s largest wind farm when it was completed (735 MW) and comprises 420 turbines across 19,000 hectares (47,000 acres) of Texas. Fig. 3 shows the Midwest of US in general is the best resource for Wind energy. While wind power accounts for less than 1% of US electricity generation, the total amount of electricity that could potentially be generated from wind in the US has been estimated at 10,777 billion kWh annually—three times the current total electricity generated in the country.
Some of the most relevant goals of present research include an increase in the power production of each wind turbine (more than 5 MW), an increase in the penetration of small wind-turbine systems (tens to few hundreds of kilowatts), and the creation of wind plants or farms whose behavior with respect to the grid emulates that of traditional oil and gas powered plants. The latter may be possible due to wind forecast and proper control strategies. The increase in wind turbine size involves research on high power converters based on modular technology, or multilevel, reliability, and on the associated control problems.

C. Geothermal Energy

In 2009, US had 2,800 MW installed, 500 MW new contracts, and 3000 MW of electrical power under development from geothermal systems. Below, Fig. 4 indicates that the west of US is very rich in geothermal energy.
Department of Energy’s cost goal is $<5\text{\,\,\,c/kWh}$ for typical hydrothermal sites, $5\text{\,\,\,c/kWh}$ for enhanced geothermal systems with mature technology. Recent MIT analysis shows for long term potential for 100,000 MW installed Enhanced Geothermal Power Systems by 2050, and will be cost-competitive with coal-powered generation [10]. Enhanced Geothermal Systems (EGS) has few challenges, such as site selection, exploration techniques for EGS, and EGS paradigm shift from hydrothermal. Creating EGS in variety of geologic environments create a subsurface fracture system to enable extraction of heat: sufficient flow rates ($80\text{\,\,\,kg/sec}$), heat exchange volume (recoverable energy) and surface area (recovery rate) as well as minimal loss of injected fluid. Few EGS field experiments are yet to be conducted worldwide, therefore experimental evidence of EGS well productivity is not well established and heat exchange volume and longevity is lacking [10]. As Fig. 5 shows the main steps for EGS, start from locating the site, creating the reservoir, and ending with completing and verifying circulating loop.

D. Biomass (biological and chemical process)
Because of its global importance, renewable energy is being examined far beyond electrical engineering fields. In the biological and chemical sciences, systems based on biomass (trees and other agricultural products) are being studied [2].

Biomass is plant material burned in a boiler to drive a steam turbine to produce electricity. This system is good for producing combined heat and power (CHP) at facilities with large thermal loads. Biomass projects are best suited to locations with abundant biomass resources (often using waste products from the forest industry or agriculture) as in Fig. 6 [3].
FIGURE 6. U.S. BIOMASS RESOURCE, NREL

Methane gas derived from landfills or sewage treatment plants can be used to generate electricity. Methane gas also may be generated using digesters that operate on manure or agricultural wastes. The methane gas is then converted to electricity using an internal combustion engine, gas turbine (depending on the quality and quantity of the gas), direct combustion boiler and steam turbine generator set, microturbine unit, or other power conversion technologies. Most methane gas projects produce from 0.5 to 4 MW of electrical output.

E. Fuel cells

Fuel cells (FC) are another way of producing power. They emit essentially no air pollution and are more efficient than other forms of generation, but they cannot be considered a renewable resource unless they operate on a renewably generated fuel, such as digester gas or hydrogen derived from PV or wind power.

Fuel cells use hydrogen directly from fuels (natural gas, gas, oil, etc.) to react with oxygen in the air by the help of electrolyte, and form the water at the same time generating electricity. Materially it is a course from chemical energy to power. It is simple and more efficient as directly changing chemical energy into electrical energy, rather than the traditional thermal power generation using chemical fuel energy. The fuel cell has advantages, such as the great energy conversion efficiency, zero emissions, no noise, no vibration, the provincial water, stable and reliable power output, with a strong ability to load changes. Research more key technology to improve the manufacturing level, increase production scale, and improve the degree of automation and less cost. Fuel cell development is at the forefront of both chemical and materials sciences.

Among the existing FC technologies, each type can be configured in a system focusing on the market segments that match its characteristics most favorably. Because of their quick start-up potential, low-temperature FCs [alkaline FCs and polymer electrolyte FCs (PEFCs)] are being considered for portable, residential power and transportation applications. Higher temperature FCs [phosphoric acid FCs, molten carbonate FCs, and solid oxide FCs (SOFCs)] are often considered for stationary power generation.
Nevertheless, because of their solid electrolyte, SOFCs are also considered for transportation applications by some car manufacturers or car suppliers. Of course, considering the whole FC system, the gains in terms of both energy savings and pollutant emissions depend greatly on whether this whole FC system is well designed or not and on whether global optimization has been performed on this system or not. Accordingly, a great number of technological challenges have to be solved before efficient, competitive, reliable FC power generators can be actually seen on the market.

F- Hydro-Wave Energy

Oceans cover approximately 75% of our planet’s surface, and renewable energy comes from the planet in different forms: waves, currents, thermal gradients, salinity gradients, and tides. Until now, more than 1,000 patents have been dedicated to wave energy converters aimed at exploiting this energy. Wave Dragon, Fig. 7, is an overtopping device consisting of two wave reflectors, a main platform—body, hydroturbines (lowhead type), electrical generators, and finally, power electronic converters (ac–dc–ac). The Wave Dragon offshore wave energy converter is a slack-moored, floating overtopping device. The design of such a system has attracted many researchers who are active in different research fields to solve problems related to body and wave reflectors construction, hydro-turbines, power electronics, electrical machines, and control.

FIGURE 7. WAVE DRAGON

The relationship between power generated in kW, wave peak period in seconds and wave height are shown in Fig. 8. The higher and the longer the wave will yield in more power generated.

VI. Challenges to RES Technologies and Grid

A global concern about greener Earth is related to a better and efficient method to generate and transmit energy and electric power. With the initiation of renewable energy generators, a green smarter, more efficient and customer-friendly power grid is essential. Smart grids represent the most useful and efficient way of integrating renewable energy generation in the main grid. Power converters are the technology that enables efficient and flexible interconnection of different players (producers, energy storage, flexible transmission, and loads) to the electric power system. Power electronics is needed not only to connect RESs, distributed power generation system (DPGS), and storage systems to the power system but also to load, to regulation capability, and transmissions systems [high voltage dc transmission (HVDC) and flexible ac transmission (HVAC)].
As mentioned before, RESs are much smaller than traditional utility generators. The small size of the present RESs simultaneously presents new challenges and opportunities. To collect sufficient energy to meet the demand, the concept of energy farms has become well known. Farms of energy sources constitute their own grid, different in both scale and dynamic characteristics compared to the traditional utility grid. On the other hand, the small size of RESs makes it increasingly feasible to produce electric power in countryside areas and other locations previously deemed economically infeasible. Connecting hundreds and thousands of RESs to the utility network introduces different dynamics to the system. If the distributed sources are not properly controlled, the grid can become unstable and even fail. The challenge of connecting a renewable source to the utility network is largely solved by electronic power converters that handle two main tasks; first, maximum power transfer and power limit, secondly, active/reactive power control and power quality control.

The relatively small size of many RESs makes it feasible to develop smaller-scale networks for geographically remote or isolated areas not previously served by a traditional utility network. Combinations of sources can be grouped together, forming a Microgrid. Issues such as load sharing, power factor control, and power quality management are common research themes today. Small-scale RESs for isolated, remote locations are generally more expensive than traditional systems. Smart Microgrids are usually operated with connection to distribution grids but have the capability of automatically switching to a stand-alone operation if faults occur in the main distribution grid and then reconnecting to the grid at a later time. The safe operation in any condition (grid connected or stand alone) relies also on good simulation tools to predict the behavior of the overall system considering the specific operation of the RESs. The operation of a smart Microgrid (Fig. 9) can result in higher availability and quality compared with strictly hierarchical management of power generation and distribution. The security of the system can be improved by quickly reacting to short-term demand variations and redispersching energy feeds to final users. Such ability allows operators to reduce risks and consequences of blackouts while also avoiding the need to increase global production.
Electronic power converters are the essential commodities of RESs. Energy sources such as the PV module produce dc energy that must be converted to ac form to connect to the utility grid. In addition, RESs typically produce low levels of power compared to traditional generation, so some means of collecting the outputs of many sources is required. Sources such as wind turbines operate at frequencies that are different from the grid, and speeds can vary significantly. Accommodating the differences in frequency is possible only through the modern electronic power converter. RESs are more intermittent in operation than traditional generators, so it is common to supplement their operation with other sources—power converters provide the means to physically combine the outputs of different sources.

![FIGURE 9. TODAY’S GRID AND FUTURE SMART GRID](image)

As renewable sources are being integrated to the grid, the dc transmission system is being revived as an alternative transmission scheme for several reasons. PV systems are inherently dc sources. In wind turbine systems, the dc link is a popular way to decouple the fixed frequency of the grid from the variable frequency of the generator. With state-of-the-art dc transmission for crossing long distances and/or the sea, the skin effect losses of ac power are eliminated, so cable losses are reduced.

Oracle conducted telephone and online interviews with 150 North American C-level utility executives in January 2010. Here are some of the key findings for Smart Grid (Tables 1, 2 and 3) for the next 10 years.

<table>
<thead>
<tr>
<th>#</th>
<th>Smart Grid Priorities for the Next 10 Years</th>
<th>%</th>
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<tbody>
<tr>
<td>1</td>
<td>Improving service reliability and operational efficiency</td>
<td>45</td>
</tr>
<tr>
<td>2</td>
<td>Implementing smart metering</td>
<td>41</td>
</tr>
<tr>
<td>3</td>
<td>Developing demand response and energy efficiency programs</td>
<td>37</td>
</tr>
<tr>
<td>4</td>
<td>Updating physical infrastructure</td>
<td>23</td>
</tr>
<tr>
<td>5</td>
<td>Offering real time pricing options</td>
<td>17</td>
</tr>
</tbody>
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TABLE 2. SMART GRID COMPONENTS

<table>
<thead>
<tr>
<th>#</th>
<th>Utility adoptions of Smart grid components</th>
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<tbody>
<tr>
<td>1</td>
<td>Smart metering</td>
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<tr>
<td>2</td>
<td>Demand response and critical peak pricing</td>
</tr>
<tr>
<td>3</td>
<td>Smart distribution and/or transmission operation devices</td>
</tr>
<tr>
<td>4</td>
<td>Integration of renewable</td>
</tr>
<tr>
<td>5</td>
<td>Increase in smart sensors on the network</td>
</tr>
<tr>
<td>6</td>
<td>Accommodation of plug-in hybrid electric vehicles</td>
</tr>
</tbody>
</table>

TABLE 3. NEXT STEP FOR UTILITIES INDUSTRY

<table>
<thead>
<tr>
<th>#</th>
<th>What is “next big thing” for the utilities industry</th>
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<tbody>
<tr>
<td>1</td>
<td>Clean energy (including nuclear, solar and wind power)</td>
</tr>
<tr>
<td>2</td>
<td>Energy storage and distributed generation</td>
</tr>
<tr>
<td>3</td>
<td>Automated meter readings</td>
</tr>
<tr>
<td>4</td>
<td>Rate structured changes</td>
</tr>
<tr>
<td>5</td>
<td>More transmission lines</td>
</tr>
<tr>
<td>6</td>
<td>CO2 legislation</td>
</tr>
<tr>
<td>7</td>
<td>Overall conservation efforts</td>
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</table>

In terms of Energy Challenges, we can safely mention Security of the grid (secure supply, reliable infrastructure) is on the top of the list, followed by economy (economic development, energy price volatility, affordability) and environment (carbon mitigation, land and water use). Today’s US energy system has the following characteristics, dependent on foreign sources, subject to price volatility, increasingly unreliable, 2/3 of source energy is lost, and produces 25% of the world’s carbon emissions. Issues imperative for the transformation from the old to the new energy system define the end states, reduce new technology risk, and accelerate the adoption of all new outcomes and technologies. To have a sustainable energy system, the following should be satisfied and accounted for: carbon neutral, efficient, diverse supply options, minimal impact on resources, create sustainable jobs, accessible, affordable and secure.

VII. Conclusion
The technology of DG is an emerging technology. It can be accompanied by the development of renewable energy technology. The reform of the electricity market will promote the development of DG technology. There are many advantages such as its low-cost, high conversion efficiency, the allocation
flexibility of capacity and power generation mode, reliability, economy and better environmental protection for this technology. This is the new green power generation technology. After further optimization and improvement, it can be expected to be the new direction of development in the field of clean energy.

In this article, a short summary of some publications has been given. The contributions have been mainly focused on green power and RES, pointing out some aspects related to efficiency, reliability, and grid integration.

Also it examines the integration of new sources of renewable energy into the power systems challenges. In this respect, drivers towards Greener Smart Grids and key challenges for the future are critically assessed.

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