

A study on energy plus houses engineering essay

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Abstract

In this thesis the energy plus houses technologies and wind turbines were researched.

Acknowledgement

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Introduction

Energy and civilization

Energy technology plays big role in societal economic and social development. Fossil fuel-based technologies have advanced our quality of life, but at the same time, these advancements have come at a very high price. Fossil fuel sources of energy are the primary cause of environmental pollution and degradation. Global warming is a result of world's fossil fuel consumption. Our lakes and rivers are contaminated with mercury, a by-product caused by rapid industrialization. The processing and use of fossil fuels has escalated public health cost. Our relentless search for and need to control these valuable resources have promoted political strife and conflict between countries. We are now dependant on an energy source that is unsustainable and as our energy needs grow we deplete our limited resources. It will become increasingly urgent to find and use energy alternatives that are sustainable as well as safe and healthy for the environment and humanity.

Global warming

Greenhouse gases in the earth's atmosphere emit and absorb radiation. This radiation is within the thermal infrared range. Since the burning of fossil fuel and the start of the industrial revolution, the carbon dioxide in the atmosphere has substantially increased. The greenhouse gases are primarily water vapour, carbon dioxide, carbon monoxide, ozone, nitrous oxide N_2O , hydroflourocarbons HFCs, perflourocarbons PFCs and sulphur hexafluoride SF_6 . Within the atmosphere of earth, greenhouse gases are trapped. The solar radiation incident energy emitted from the sun and its energy is approximated as 343 W/m^2 . Some of the solar radiation is reflected from the earth's surface and the earth's atmosphere. The total reflected solar radiation is approximated as 103 W/m^2 . Approximately 240 W/m^2 of solar radiation penetrates through the earth's atmosphere. About half of the solar radiation, approximately 168 W/m^2 is absorbed by the earth's surface. This radiation is converted into heat energy and this process generates infrared radiation in the form of the emission of a long wave to earth. A portion of the infrared radiation is absorbed, then it is re-emitted by the greenhouse molecules trapped in the earth's atmosphere. Finally some of the infrared radiation passes through the atmosphere into space. As the use of fossil fuels is accelerated, so is carbon dioxide in the earth's atmosphere. The World Meteorological Organization (MWO) is the international body for the monitoring the climate change. The MWO has clearly stated the potential environmental and socioeconomic consequences for the world economy if the current trend continues. In this respect, the global warming is an engineering problem, not a morale crusade. Until we take serious steps to reduce our carbon footprints, pollution and the perilous deterioration of our

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environment will continue. As the ice glaciers continue to melt due to rising temperatures, over the next few centuries the sea level will also continue to rise. As a direct consequence of trapped carbon dioxide in the atmosphere, with its melting of the polar ice caps causing increased sea levels that bring coastal flooding, our patterns of life on earth will be changed forever.

EU objectives of 2020 and roadmap of 2050

Energy plus houses and zero-emission houses is a concept of the future building technology standard, to meet ambitious climate and energy targets set by the EU commission. With set three key objectives for 2020: A reduction of 20% in EU greenhouse gas emissions from 1990 levels Raising the share of EU energy consumption produced from renewable resources to 20% A 20% improvement in the EU's energy efficiency With roadmap moving forward a competitive low-carbon economy in 2050. The roadmap suggests that by 2050 the EU should cut its emissions to 80% below 1990 level. It sets out milestones with form a cost effective pathway to this goal – reductions of the order 40% by 2030 and 60% by 2040. Around 40% of total energy consumptions contributes to the buildings, so energy plus and zero emission building technology will play a big role in achievement of the milestones.

Building energy efficiency analysis

When designing buildings, energy analysis is typically done after the construction has been completed. Making design decisions, while having energy efficiency as a main factor is one way to make energy-efficient buildings. Using renewable sources of energy to fulfil the house needs and in case of energy plus houses generating more electricity than it uses, with excess power sold to the grid could save a lot of energy usage from <https://assignbuster.com/a-study-on-energy-plus-houses-engineering-essay/>

households which would decrease the emissions of carbon dioxide substantially. As a result such houses are not reliant on external suppliers which energy prices depend on the market price of fuel used. Energy analysis for a building can be done manually, this approach is time consuming and expensive, or with optimization programs to automate this process.

Wind energy

Wind energy is one of the vital inputs for the social and economic development of any nation. It supplies affordable renewable energy to the economy. It is alternative clean energy source and has been the world's fastest growing renewable energy source. Technological improvements over the last years have placed wind energy in a position to compete with conventional power generation technologies. Fossil fuels are not infinite resource and cause pollution of the atmosphere, so it is crucial to develop clean wind energy as part of an alternative source of energy. Wind energy is eco-friendly and does not pollute the atmosphere like thermal power plants.

Solar and Photovoltaic

Solar and photovoltaic (PV) energy are also important renewable energy sources. The sun, the earth's primary source of energy, emits electromagnetic waves. It has invisible infrared waves (heat), as well as light waves. Infrared (IR) radiation has a wavelength between 0.7 and 300 micrometres or a frequency range between approximately 1THz to the 430THz (Terra = 10^{12}). Sunlight is defined by irradiance, meaning radiant energy of light. One sun is defined as the brightness to provide an irradiance of about 1 kW/m^2 at sea level. One sun's energy has 523W of IR light, <https://assignbuster.com/a-study-on-energy-plus-houses-engineering-essay/>

445W of visible light and 32W of UV light. This can be used to compute the area in square meters needed to generate required amount of power. As the thermal IR radiation from the sun reaches the earth, some of the heat is absorbed by earth's surface and some heat is reflected back into space. Highly reflective mirrors can be used to direct thermal radiation from the sun to provide a source of heat energy. The heat energy from the sun – solar thermal energy can be used to heat water to a high temperature and pressurize in a conventional manner to run a turbine generator. Solar PV sources are arrays of cells of silicon materials that convert solar radiation into direct current electricity. The cost of crystalline silicon is very high, but new light-absorbent materials have significantly reduced the cost. The most common materials are amorphous silicon (s-Si), mainly O for p-type Si and C and transition metals – mainly Fe. Silicon is put into different forms or into polycrystalline materials, such as cadmium telluride (CdTe) and copper indium (gallium) , (CIS & CIGS). The front of the PV module is designed to allow maximum light energy to be captured by the Si materials. Each cell generates approximately 0.5V. Nominally 36 cells are connected together in series to provide a PV module that produces 12V.

Main text

Smart power grid systems

In a smart power grid system, a large number of microgrids operate as part of an interconnected power grid. For example, a photovoltaic (PV) based residential system with its local storage system and load would be one of the smallest microgrids in the smart power grid systems. To understand the new paradigm of the tomorrow's smart power grid design and operation, one

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needs to understand how electric power grid operates and costs of design. A basic understanding of a power grid's operation will facilitate how to design a microgrid to operate as a standalone system when it is separated from its local power grid. These concepts set the stage for the design of green energy microgrids.

Power grid operation

The operational objectives of a power grid are to provide continuous quality service at an acceptable voltage and frequency with adequate security, reliability and an acceptable impact upon the environment, without damage to power grid equipment – all at a minimum cost. Quality service that is environmentally acceptable, secure, and reliable and entails minimum cost is the main objective in power grid system operations. However during emergency conditions the system may be operated without regard for economy and environmental restrictions such as the use of a high polluting energy source, instead concentrating on the security and reliability of the service for the energy users, while maintaining power grid stability. To ensure security and reliability, power plant facilities and resources must first be planned then managed effectively. A large power grid is comprised of many elements including generating units, transmission lines, transformers and circuit breakers. As new green energy sources are adopted into the power grid and a smart power grid is put in place, additional equipment such as DC/DC converters and DC/AC converters must be integrated and scheduled for power grid operation. At the outset, power grid need to schedule power generation to supply the system loads and every second of the system's operation. The energy resources of a large power system

consist of hydro and nuclear energy, fossil fuel, renewable sources such as wind and solar energy as well as green energy sources such as fuel cells, combined heat and power (CHP – also known as cogeneration) and micro turbines. These resources must be managed and synchronized to satisfy the load demand of the power grid. The load demand of power grid is cyclic in nature and has a daily peak over the week, a weekly peak over a month, and a monthly peak demand over a year. Energy resources must be optimized to satisfy the peak demand of each load cycle, such that the total cost of the production and distribution of energy is minimized.

Basic concepts of the smart power grid

In a classical power grid, a fixed price is charged to energy users. However the cost of energy is highest during the daily peak load operation. The classical power system operations has no control over the loads except in an emergency situation, when a portion of loads can be dropped as needed to balance the power grid generation with its loads. Therefore much equipment is used for a short time during peak power demand, but remains idle during daily operations. For an efficient smart power grid system design and operation, substantial infrastructure investment in the form of a communication system, cyber network, sensors and smart meters must be installed to curtail the system peak loads when the cost of electric energy is highest. The smart power grid introduces the sensing, monitoring and control system that provides end users with the cost of energy at any moment through real-time pricing. In addition, the advanced control systems of smart metering provide the energy users with the ability to respond to real-time pricing. Furthermore, the smart power grid supplies the platform for the use

of renewable green energy sources and adequate emergency power for major metropolitan load centres. It safeguards against a complete blackout of the interconnected power grids due to man-made events or environmental calamity. It also allows for the break-up of the interconnected power grid into smaller, regional clusters. In addition, the smart power grid enables every energy user to become an energy producer by giving the user the choice of PV or wind energy, fuel cells, and combined heat and power (CHP) energy sources and to participate in the energy market by buying or selling energy through the smart meter connection. Two-way communication is a key characteristic of the smart power grid energy system. It enables end users to adjust the time of their energy usage for nonessential activities based on the expected real-time price of energy. The knowledge gained from smart meters permits the power grid operators to spot power outages more quickly and smooth demand in response to real-time pricing as the cost of power varies during the day. Historically, power grid companies have operated the power system as a public service. They have provided reliable electric power at a constant price regardless of changing conditions. Their systems used additional spinning reserve units to serve the unexpected loading and outages due to the loss of equipment. However, in the age of global climate change, this kind of service cannot be provided without severe environmental degradation. A power grid operator has to schedule generation sources based on the cost of energy. However, the weather-sensitive load component adds substantial uncertainties in planning load-generation balance. As can be expected, the least costly units are scheduled to satisfy the base loads. The more costly units are scheduled to satisfy the time-changing loads. Therefore, the price of electric energy is continuously

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changing as load demands are changing. If real-time pricing is implemented, the variable electric rates must be used for the privilege of reliable electrical service during high demand conditions.

Smart grid development

Global warming and the environmental impact of coal-based power generation are changing the design and operation of the power grid. The industry is experiencing a gradual transformation that will have a long-term effect on the development of the infrastructure for generating, transmitting and distributing of power. This change will incorporate renewable green energy sources in a new distributed generation program which is based on increased levels of distributed monitoring, automation, control as well as new sensors. Power grid control will rely on data and information collected on each microgrid for decentralized control. In return, the microgrids and interconnected power grid will be able to operate as a more reliable, efficient and secure energy supplier. The technology of the power grid and microgrids has a number of key elements: Adaptive and autonomous decentralized controls to respond to changing conditions Predictive algorithms capture the power grid state for a wide area and are able to identify potential outages The system also provides market structure for real-time pricing and interaction between customers, grid networks and power markets The smart grid provides a platform to maximise reliability, availability, efficiency, economic performance and higher security from naturally occurring power disruptions The implementation of an advanced metering infrastructure provides real-time pricing to the energy end user. In parallel, the penetration of renewable energy sources is providing a platform for autonomous control

or local control of connected microgrids to the local power grid. A distributed autonomous control will provide reliability through fault detection, isolation and restoration. The autonomous control and real-time pricing also delivers efficiency in feeder voltage to minimize feeder losses and to reduce feeder peak demand of plug-in electric vehicles. The maturing storage technology will provide community energy storage, which becomes yet another important element for microgrid control and allows the energy user to become an energy producer. These interrelated technologies require a coordinated modelling, simulation and analysis system to achieve the benefits of a smart power grid.

Wind turbines

Wind power

Wind energy as one of our most abundant resources, is the fastest growing renewable energy technology worldwide. Improved turbine and power converted designs have promoted a significant drop in wind energy generation cost making it the least-expensive source of electricity – from 37 cents/kWh in 1980 down to 4 cents/kWh in 2008 (currency USD). In 2008, wind energy systems worldwide generated 331, 600 million kWh, which is 1.6% of total electricity generation. Global wind movement is predicated on the earth's rotation, regional and seasonal variations of sun irradiance and heating. Local effects on wind include the differential heating of the land and the sea, and topography such as mountains and valleys. The average wind speed determines the wind energy potential at a particular site. Wind speed measurements are recorded for a 1-year period and then compared to a

nearby site with available long-term data to forecast wind speed and the location's potential to supply wind energy.

Wind turbine generators

Wind turbine generators (WTG) are rapidly advancing in both technology and installed capacity. Conventional geared wind generator systems have dominated the wind market for many years. Wind turbine technologies are classified based on their speed characteristics. They are either at fixed or variable speed. The speed of wind turbine is usually low. The classical WTGs are of two types: Wound rotor winding Squirrel-cage induction These systems use multistage gear systems coupled to a fixed-speed squirrel cage induction generator (SCIG), which are directly connected to the power grid.

Wind regime characteristics

Characteristics of the wind regimes can be incorporated in assessing the wind energy potential as well as estimating the output from a wind energy conversion system.

Boundary layer effect

The first factor to be considered while estimating the wind resource and wind turbine performance at a given site is the variations in wind velocity due to the boundary layer effect. Due to the frictional resistance offered by the earth surface to the wind flow, the wind velocity may vary significantly with the height above the ground. Ground resistance against the wind flow is represented by the roughness class or the roughness height (Z_0). The roughness height of a surface may be close to zero – surface of the sea or even as high as 2 – town centres.

Performance analysis

Wind power density Electricity generation Rotor power vs. Wind speed

How much energy in the wind?

The primary purpose of a wind turbine is to convert the kinetic energy of the wind into electrical energy. It is useful to begin by considering the amount of energy and power available and reviewing the difference between these two concepts. The volume of the element is the product of its area = ΔA Length normal to the disc = δx So it's mass = $\rho \Delta A \delta x$ and its KE is $\frac{1}{2} \rho \Delta A \delta x (U)^2$. The time taken for this element to cross the blade disc = δt and is given simply by $\delta x = U \delta t$. The contribution of the element to the total amount of KE that passes in δt is symbolized as ΔKE , and given by:

$$\delta(\Delta KE) = \frac{1}{2} \rho \Delta A (U)^2 \delta t$$

Summing over all elements of area that make up the disc gives the KE passing the disk as:

$$\delta(KE) = \frac{1}{2} \rho A (U)^3 \delta t$$

This equation can now be taken formally to the limit as $\delta t \rightarrow 0$, to give

$$P = \frac{d(KE)}{dt} = \frac{1}{2} \rho A (U)^3$$

Where P is the power, the time rate change (derivative) of the energy. This equation is extremely interesting because it suggests that the output power of any turbine depends of the cube of wind speed. This simple and fundamental fact must never be forgotten. The wind speed determines both the amount of energy, proportional to $(U)^2$ and the mass of air carrying that energy through the blade disk per unit time, which is

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proportional to $(U)0bot$. In practice the power output is never as great as suggested by the equation, because extraction of all the available KE would require the wind to be decelerated to rest. Furthermore a turbine cannot capture all the wind that would otherwise pass through the disk. Including the finite efficiency drivetrain and the generator, and aerodynamic losses through the action of viscosity, is reasonable to assume that the power converted into electricity is about 40% of that given by the equation.

Examples of wind turbines

Wind turbine range in power output from a few watts to few megawatts. The IEC safety standard for small wind turbines, IEC 61400-2, defines a small turbine as having a rotor swept area less than $200m^2$, which corresponds roughly to $P < 50kW$. The basic operating principles are the same for turbines of all sizes. There are operational issues that do depend on size: starting performance and cut in speed – the lowest wind speed at which power is extracted. Both of these are more important for small machines because: Small wind turbines are often located where the power required or adjacent to the owner's home which may not be the windiest location, whereas wind farms containing large turbines are deliberately sited in windy areas. The generators of small turbines often have a significant resistive torque that must be overcome aerodynamically before the blades will start turning. Pitch control is rarely used on small wind turbines because of cost. Small wind turbine aerodynamics is influenced strongly by low values of the Reynolds number, Re . Virtually all large turbines are upwind machines – the blades are in front of the tower when viewed from the wind direction and have three blades. The main differences occur in the drivetrain and generator. The most

common generator types are: Doubly fed induction generators (DFIGs) Permanent magnet generators (PMGs) DFIGs require a gearbox and are rarely used on small turbines. PMGs and less-used induction generators (IGs) do not. There is a much greater diversity of small turbine types with the number of blades varying from two to seven, and the most popular turbines being downwind machines. Most upwind small turbines have a tail fin which keeps the blades pointing into the wind. The tail fin is designed to maximise Θ , the yaw angle of the turbine defined as the angle between the turbine's axis and the wind direction. Yaw reduces the power by a factor of approximately $\cos^2\Theta$, and so is significant for even moderate values of Θ . It is important to minimise yaw. The blades of all wind turbines are composed of aerofoil sections whose purpose is to produce lift, which is the primary component of the torque about the turbine axis in the direction of blade rotation. For steady flow, the product of this torque and the blade angular velocity (Ω), gives the power extracted from the wind.

Wind turbine noise

In siting a wind turbine, the first and often far from trivial task is to determine the wind resource, which may vary significantly over short distances because of the surface roughness, the topography and proximity to buildings, trees and the like. There remain at least three further important issues: Noise Visual impact Possible restrictions on tower height The first two are often addressed for large wind farms using sophisticated software that optimises the layout of the turbines to maximise power extraction and minimise the visual impact of the turbines. Well-designed wind turbines are extremely quiet. One simple data correlation for the sound power level (L_p),

gives: $L_p \approx 10^{-7} P$ That is one-ten millionth of the turbine's power is output as noise. For this reason, a well-designed small wind turbine is almost guaranteed to be quiet. Another correlation that is more accurate in some cases is: $L_p \approx 50 \log_{10} \Omega R + 10 \log_{10} R - 1$ Where L_p is measured in the more common unit: A-weighted decibels (dBA). Recall that Ω is the blade angular velocity in rad/s, so ΩR is the circumferential velocity of the blade tips in m/s and R is measured in meters (m). L_p is the strength of the source of the sound as a multiple of the standard base level of 10^{-12} Watts. It is used, in combination with an equation for the propagation of the sound, to determine the noise level at any point around the turbine or turbines. The most common spreading equation is: $LA = L_p - 20 \log_{10}(\sqrt{h^2 + d^2}) - \alpha(\sqrt{h^2 + d^2}) - 8$ It gives the noise level on the ground at distance d from the turbine with a tower of height h . The second term is the hemispherical spreading term which is strictly valid only when $h \gg d$ and the ground is flat. The third term represents the atmospheric absorption of sound with the coefficient α typically in the range 0.002-0.005 dB/m. For a small wind turbine purposes, this term is usually negligible. On the other hand, turbines whose blades flex to unload the turbine in high winds, has a correspondingly high noise level during the resulting flutter.

Turbine operating parameters

As with any fluid machine, it is often useful to discuss wind turbine operation in term of parameter groupings that can be obtained from dimensional analysis. The most important parameter, the power coefficient (C_p), should be defined as: $C_p = P / 0.5 \rho (U)^3 \pi R^2$ the ration of the actual power produced to the power in the wind that would otherwise pass the blade disk.

Note that: C_p is dimensionless. By convention, it includes the factor of $\frac{1}{2}$ to relate power to the kinetic energy flux through the blade disk. C_p is not strictly efficiency, even though it is often treated as one. It is possible to increase C_p by increasing the velocity of the wind through the blade by surrounding the blades by a diffuser. However, C_p can be interpreted as efficiency when comparing turbines of the same type.

Example of wind turbine

Vestas V27-225kW, 50 Hz wind turbine
Air density 1.225 kg/m^3
Power

Wind speed (m/s)	Output (kW)
3	51
4	54
5	55
6	61
7	66
8	73
9	81
10	90
11	100
12	111
13	123
14	136
15	150
16	165
17	181
18	198
19	216
20	235
21	255
22	275
23	296
24	317
25	339

Yearly output according to Beldringe Site,

Denmark
Roughness class 0808, 000 kWh
Roughness class 1517, 000

kWh
Roughness class 2415, 000 kWh
Roughness class 3275, 000 kWh

It is to be noted that a 225kW wind turbine installed in a moderately high wind area generates 275MWh – 808MWh depending on the roughness class of the site of the given examples. The same amount of energy, when generated in a thermal power plant consumes about 114 tonnes of coal and emits about 360 tonnes of CO₂ and other poison gases into the atmosphere for producing 275MWh and 330 tonnes of coal and 1070 tonnes of CO₂ for producing 808MWh.

Mean monthly wind speed in Belmullet

Values from: <http://www.met.ie/climate/belmullet.asp#knotsm/s>
January 14.

77.56 February 13.97.15 March 14.27.3 April 12.26.27 May 12.46.38 June 11.

96.12 July 11.65.97 August 11.35.81 September 13.06.69 October 14.37.

36 November 13.67.0 December 14.37.36 Annual average 13.16.74

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Photovoltaic

Photovoltaic power conversion

Solar cells convert the radiation energy directly to electric energy. Solar cells, also called photovoltaic (PV) cells. A PV module consists of a number of PV cells. When sunlight strikes the PV cell, electrons are freed from their atoms. The freed electrons are directed towards the front surface of the solar cell. This process creates a current flow that occurs between the negative and positive sides.

Photovoltaic materials

The manufacture of PV cells is based on two different types of material: A semiconductor material that absorbs light and converts it into electron-hole pairs. A semiconductor material with junctions that separate photo-generated carriers into electron and electron holes. The contacts on the front and back of the cells allow the current to the external circuit. Crystalline silicon cells (c-Si) are used for absorbing light energy in most semiconductors used in solar cells. Crystalline silicon cells are poor absorbers of light energy, they have efficiency in the range of 11 to 18% of that of solar cells. The most-efficient monocrystalline c-Si uses laser grooved, buried grid contacts, which allow for maximum light absorption and current collection. Each of the c-Si cells produces approximately 0.5V. When 36 cells are connected in series, it creates an 18V module. In the thin film solar cell, the crystalline silicon wafer has a very high cost. Other common materials are amorphous silicon (a-Si), and cadmium telluride and gallium. These are another class of polycrystalline materials. The thin-film solar cell technology uses a-Si and a p-i-n single-sequence layer where: P is positive, N is negative, I is the interface

of a corresponding p-type and n-type semiconductor. Thin-film solar cells are constructed using lamination techniques, which promote their use under harsh weather conditions. They are environmentally robust modules. Due to the basic properties of c-Si devices, they may stay as the dominant PV technology for years to come. However thin-film technologies are making rapid progress and a new materials or process may replace the use of c-Si cells.

Photovoltaic characteristics

As sun irradiance energy is captured by a PV module, the open-circuit voltage of the module increases. If the module is short-circuited, the maximum short-circuit current can be measured. PV module selection criteria are based on a number of factors: The performance warranty, Module replacement ease, Compliance with national electrical and building codes. A typical silicon module has a power of 300W with 2.43 m² surface area. A typical thin film has a power of 69.3W with an area of 0.72 m². Hence the land required by a silicon module is almost 35% less. Typical electrical data apply to standard test considerations (STC). For example, under STC, the irradiance is defined for a module with a typical value such as 1000W/m², spectrum air mass (AM) 1.5, and a cell temperature of 25°. The PV fill factor (FF) is defined as a measure of how much solar energy is captured. This term is defined by PV module open circuit voltage (Voc) and PV module short-circuit current (Isc).

$$FF = \frac{V_{mpp} I_{mpp}}{V_{oc} I_{sc}}$$

And

$P_{max} = FF \cdot V_{oc} \cdot I_{sc} = V_{mpp} I_{mpp}$

Some PV modules have a high fill factor. In the design of PV system a PV module with high FF would be used. For high-quality PV modules, FF's can be over 0.85. For typical commercial PV modules, the value lies around 0.60. A typical PV module characteristic is not only a function of irradiance energy, but it is also a function of temperature.

Photovoltaic efficiency

The PV module efficiency, η is defined as:

$$\eta = V_{mpp} I_{mpp} / P_s$$

where $V_{mpp} I_{mpp}$ is the maximum power output and P_s is the surface area of the module. The PV efficiency can also be defined as :

$$\eta = FF \cdot V_{oc} I_{sc} / \int_{\lambda_{min}}^{\lambda_{max}} P(\lambda) \cdot d\lambda$$

where $P(\lambda)$ is the solar power density at wavelength λ .

Discussion

Green and renewable energy sources

To meet carbon reduction targets it is important to use sources of energy that are renewable and sustainable. The need for environmentally friendly methods of transportation and stationary power is urgent. We need to replace traditional fossil-fuel-based vehicles with electric cars, and the stationary power from traditional fuels, coal, gas and oil with green sources for sustainable energy fuel for the future.

Conclusion

Society benefit of Renewable Energy

One of the benefits of the renewable energy is the fixed cost of electricity units. When investing in wind turbines, the investment has a payback period of 5 to 8 years. The life expectation of wind turbines is around 20 years. Depending on wind speed, the power extraction of wind varies. It is more economical to build wind turbines in more windy places, but there are benefits of wind turbines in less windy areas as well. Another benefit of it is that a person can become free from energy suppliers and even producer of clean renewable energy to the grid and generate the revenue. Use of renewable energy also reduces the emission of the atmosphere caused by burning of fuels and has no carbon dioxide emissions for producing the energy, which plays big role in global warming. As it is clean and has only small environmental impact of visual and noise, the use of renewable energy technologies will gain its movement of clean energy and reduced carbon emission society.