Anjuman-I-Islam's
M. H. Saboo Siddik Polytechnic

Micro Project

Power Plant Engineering

(22566)

Topic: Comparative study of various parameters of Performance evaluation of a power plant.

Subject: Power Plant Engineering

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Semester: V

Introduction to Power Plant

A **power plant**, also referred to as a **power station** or **powerhouse** and sometimes **generating station** or **generating plant**, is an industrial facility for the generation of electric power. Most power stations contain one or more generators, a rotating machine that converts mechanical power into three-phase electric power. The relative motion between a magnetic field and a conductor creates an electrical current. The energy source harnessed to turn the generator varies widely. Most power stations in the world burn fossil fuels such as coal, oil, and natural gas to generate electricity. Cleaner sources include nuclear power, biogas and an increasing use of renewables such as solar, wind, wave and hydroelectric.

History

In 1878 a hydroelectric power station was designed and built by Lord Armstrong at Cragside, England. It used water from lakes on his estate to power Siemens dynamos. The electricity supplied power to lights, heating, produced hot water, ran an elevator as well as labour-saving devices and farm buildings.

In the early 1871s Belgian inventor Zénobe Gramme invented a generator powerful enough to produce power on a commercial scale for industry.

In the autumn of 1881, a central station providing public power was built in Godalming, England. It was proposed after the town failed to reach an agreement on the rate charged by the gas company, so the town council decided to use electricity. It used hydroelectric power for street lighting and household lighting. The system was not a commercial success and the town reverted to gas.

In 1882 the world's first coal-fired public power station, the Edison Electric Light Station, was built in London, a project of Thomas Edison organized by Edward Johnson. A Babcock & Wilcox boiler powered a 125-horsepower steam engine that drove a 27-ton generator. This supplied electricity to premises in the area that could be reached through the culverts of the viaduct without digging up the road, which was the monopoly of the gas companies. The customers included the City Temple and the Old Bailey. Another important customer was the Telegraph Office of the General Post Office, but this could not be reached though the culverts. Johnson arranged for the supply cable to be run overhead, via Holborn Tavern and Newgate.

In September 1882 in New York, the Pearl Street Station was established by Edison to provide electric lighting in the lower Manhattan Island area. The station ran until destroyed by fire in 1890. The station used reciprocating steam engines to turn direct-current generators. Because of the DC distribution, the service area was small, limited by voltage drop in the feeders. In 1886 George Westinghouse began building an alternating current system that used a transformer to step up voltage for long-distance transmission and then stepped it back down for indoor lighting, a more efficient and less expensive system which is similar to modern systems. The War of Currents eventually resolved in favor of AC distribution and utilization, although some DC systems persisted to the end of the 20th century. DC systems with a service radius of a mile (kilometer) or so were necessarily smaller, less efficient of fuel consumption, and more labour-intensive to operate than much larger central AC generating stations.

AC systems used a wide range of frequencies depending on the type of load; lighting load using higher frequencies, and traction systems and heavy motor load systems preferring lower frequencies. The economics of central station generation improved greatly when unified light and power systems, operating at a common frequency, were developed. The same generating plant that fed large industrial loads during the day, could feed commuter railway systems during rush hour and then serve lighting load in the evening, thus improving the system load factor and reducing the cost of electrical energy overall. Many exceptions existed, generating stations were dedicated to power or light by the choice of frequency, and rotating frequency changers and rotating converters were particularly common to feed electric railway systems from the general lighting and power network.

Throughout the first few decades of the 20th century central stations became larger, using higher steam pressures to provide greater efficiency, and relying on interconnections of multiple generating stations to improve reliability and cost. High-voltage AC transmission allowed hydroelectric power to be conveniently moved from distant waterfalls to city markets. The advent of the steam turbine in central station service, around 1906, allowed great expansion of generating capacity. Generators were no longer limited by the power transmission of belts or the relatively slow speed of reciprocating engines, and could grow to enormous sizes. For example, Sebastian Ziani de Ferranti planned what would have been the largest reciprocating steam engine ever built for a proposed new central station, but scrapped the plans when turbines became available in the necessary size. Building power systems out of central stations required combinations of engineering skill and financial acumen in equal measure. Pioneers of central station generation include George Westinghouse and Samuel Insull in the United States, Ferranti and Charles Hesterman Merz in UK, and many others.

WIND POWER PLANT

Wind power or **wind energy** is the use of air flow through wind turbines to provide the mechanical power to turn electric generators and traditionally to do other work, like milling or pumping. Wind power is a sustainable and renewable alternative to burning fossil fuels, and has a much smaller impact on the environment.

Wind farms consist of many individual wind turbines, which are connected to the electric power transmission network. Onshore wind is an inexpensive source of electric power, competitive with or in many places cheaper than coal or gas plants. Onshore wind farms also have an impact on the landscape, as typically they need to be spread over more land than other power station. and need to be built in wild and rural areas, which can lead to "industrialization of the countryside" and habitat loss. Offshore wind is steadier and stronger than on land and offshore farms have less visual impact, but construction and maintenance costs are considerably higher. Small onshore wind farms can feed some energy into the grid or provide electric power to isolated off-grid locations.

Wind is an intermittent energy source, which cannot make electricity nor be dispatched on demand. It also gives variable power, which is consistent from year to year but varies greatly over shorter time scales. Therefore, it must be used together with other electric power sources or batteries to give a reliable supply. As the proportion of wind power in a region increases, more conventional power sources are needed to back it up (such as fossil fuel power and nuclear power), and the grid may need to be upgraded. Power-management techniques such as having dispatchable power sources, enough hydroelectric power, excess capacity, geographically distributed turbines, exporting and importing power to neighbouring areas, energy storage, or reducing demand when wind production is low, can in many cases overcome these problems. Weather forecasting permits the electric-power network to be readied for the predictable variations in production that occur.

In 2018, global wind power capacity grew 9.6% to 591 GW. In 2017, yearly wind energy production grew 17%, reaching 4.4% of worldwide electric power usage, and providing 11.6% of the electricity in the European Union. Denmark is the country with the highest penetration of wind power, with 43.4% of its consumed electricity from wind in 2017. At least 83 other countries are using wind power to supply their electric power grids.

History:

Wind power has been used as long as humans have put sails into the wind. Wind-powered machines used to grind grain and pump water, the windmill and wind pump, were developed in what is now Iran, Afghanistan and Pakistan by the 9th century. Wind power was widely available and not confined to the banks of fast-flowing streams, or later, requiring sources of fuel. Wind-powered pumps drained the polders of the Netherlands, and in arid regions such as the American mid-west or the Australian outback, wind pumps provided water for livestock and steam engines.

The first windmill used for the production of electric power was built in Scotland in July 1887 by Prof James Blyth of Anderson's College, Glasgow (the precursor of Strathclyde University). Blyth's 10 metres (33 ft.) high, cloth-sailed wind turbine was installed in the garden of his holiday cottage at Marykirk in Kincardineshire and was used to charge accumulators developed by the Frenchman Camille Alphonse Faure, to power the lighting in the cottage, thus making it the first house in the world to have its electric power supplied by wind power. Blyth offered the surplus electric power to the people of Marykirk for lighting the main street, however, they turned down the offer as they thought electric power was "the work of the devil." Although he later built a wind turbine to supply emergency power to the local Lunatic Asylum, Infirmary and Dispensary of Montrose, the invention never really caught on as the technology was not considered to be economically viable.

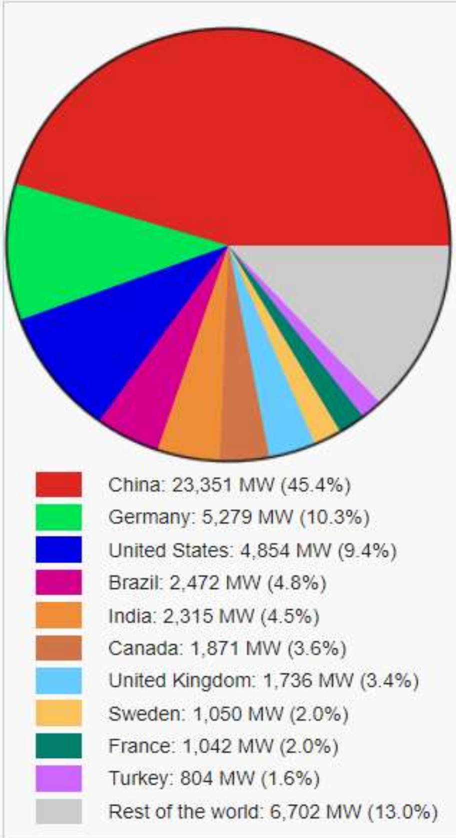
Across the Atlantic, in Cleveland, Ohio, a larger and heavily engineered machine was designed and constructed in the winter of 1887–1888 by Charles F. Brush. This was built by his engineering company at his home and operated from 1886 until 1900. The Brush wind turbine had a rotor 17 metres (56 ft.) in diameter and was mounted on an 18 metres (59 ft.) tower. Although large by today's standards, the machine was only rated at 12 kW. The connected dynamo was used either to charge a bank of batteries or to operate up to 100 incandescent light bulbs, three arc lamps, and various motors in Brush's laboratory.

With the development of electric power, wind power found new applications in lighting buildings remote from centrally-generated power. Throughout the 20th century parallel paths developed small wind stations suitable for farms or residences. The 1973 oil crisis triggered investigation in Denmark and the United States that led to larger utility-scale wind generators that could be connected to electric power grids for remote use of power. Today, wind powered generators operate in every size range between tiny stations for battery charging at isolated residences, up to near-gigawatt sized offshore wind farms that provide electric power to national electrical networks.

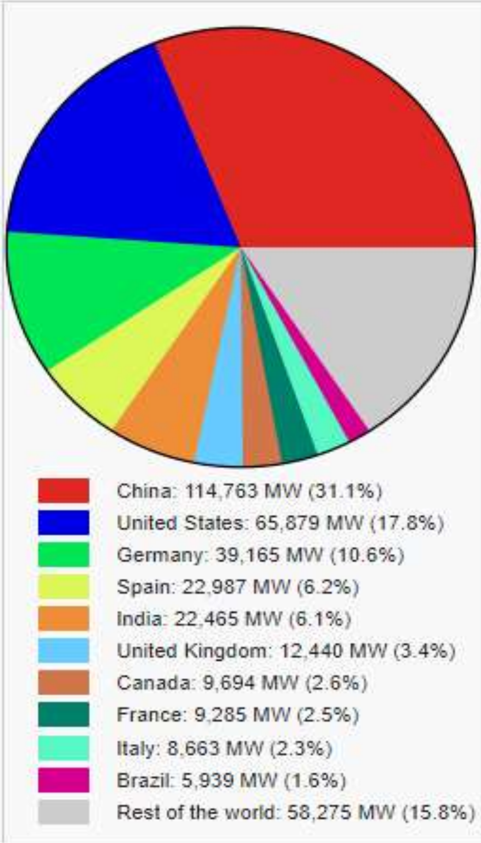
Comparison between Various Parameters of the Power Plant

Large onshore wind farms

Wind farm	Capacity (MW)	Country
Gansu Wind Farm	7,965	China
Muppandal wind farm	1,500	India
Alta (Oak Creek-Mojave)	1,320	United States
Jaisalmer Wind Park	1,064	India
Shepherds Flat Wind Farm	845	United States
Roscoe Wind Farm	782	United States
Horse Hollow Wind Energy Center	736	United States
Capricorn Ridge Wind Farm	662	United States
Fântânele-Cogealac Wind Farm	600	Romania
Fowler Ridge Wind Farm	600	United States
Whitelee Wind Farm	539	United Kingdom



Worldwide **new installed** capacity, 2014[79]



Worldwide **cumulative** capacity, 2014[79]

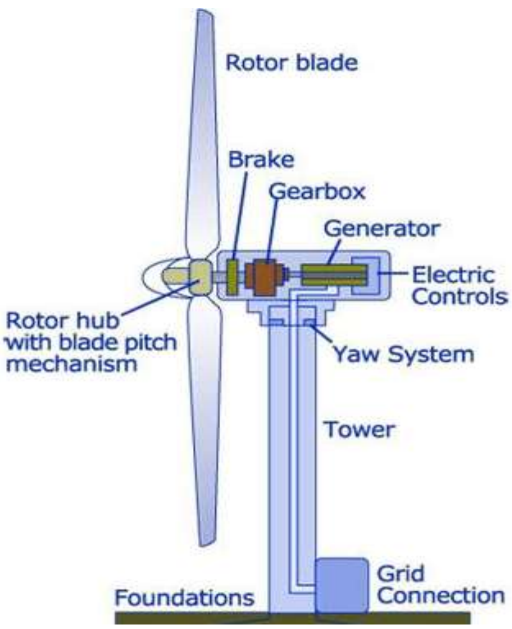
Working of Wind Power Plant

The majority of wind turbines consist of three blades mounted to a tower made from tubular steel. There are less common varieties with two blades, or with concrete or steel lattice towers. At 100 feet or more above the ground, the tower allows the turbine to take advantage of faster wind speeds found at higher altitudes.

Turbines catch the wind's energy with their propeller-like blades, which act much like an airplane wing. When the wind blows, a pocket of low-pressure air forms on one side of the blade. The low-pressure air pocket then pulls the blade toward it, causing the rotor to turn. This is called lift. The force of the lift is much stronger than the wind's force against the front side of the blade, which is called drag. The combination of lift and drag causes the rotor to spin like a propeller.

A series of gears increase the rotation of the rotor from about 18 revolutions a minute to roughly 1,800 revolutions per minute -- a speed that allows the turbine's generator to produce AC electricity streamlined enclosure called a nacelle houses key turbine components -- usually including the gears, rotor and generator -- are found within a housing called the nacelle. Sitting atop the turbine tower.

A, some nacelles are large enough for a helicopter to land on. Another key component is the turbine's controller, that keeps the rotor speeds from exceeding 55 mph to avoid damage by high winds. An anemometer continuously measures wind speed and transmits the data to the controller. A brake, also housed in the nacelle, stops the rotor mechanically, electrically or hydraulically in emergencies. Explore the interactive graphic above to learn more about the mechanics of wind turbines.



Hydroelectric Power Plant

Hydropower or **water power** (from "water") is power derived from the energy of falling or fast-running water, which may be harnessed for useful purposes. Since ancient times, hydropower from many kinds of watermills has been used as a renewable energy source for irrigation and the operation of various mechanical devices, such as gristmills, sawmills, textile mills, trip hammers, dock cranes, domestic lifts, and ore mills. A trompe, which produces compressed air from falling water, is sometimes used to power other machinery at a distance.

In the late 19th century, hydropower became a source for generating electricity. Cragside in Northumberland was the first house powered by hydroelectricity in 1878 and the first commercial hydroelectric power plant was built at Niagara Falls in 1879. In 1881, street lamps in the city of Niagara Falls were powered by hydropower.

Since the early 20th century, the term has been used almost exclusively in conjunction with the modern development of hydroelectric power. International institutions such as the World Bank view hydropower as a means for economic development without adding substantial amounts of carbon to the atmosphere, but dams can have significant negative social and environmental impacts.

Construction of Hydroelectric Power Plant

In **hydroelectric power station** the kinetic energy developed due to gravity in a falling water from higher to lower head is utilised to rotate a turbine to produce electricity. The potential energy stored in the water at upper water level will release as kinetic energy when it falls to the lower water level. This turbine rotates when the following water strikes the turbine blades. To achieve a head difference of water **hydroelectric electric power station** are generally constructed in hilly areas. In the way of the river in hilly areas, an artificial dam is constructed to create required water head. From this dam water is allowed to fall toward downstream in a controlled way to turbine blades. As a result, the turbine rotates due to the water force applied to its blades and hence the alternator rotates since the turbine shaft is coupled with alternator shaft.

The main advantage of an electric power plant is that it does not require any fuel. It only requires water head which is naturally available after the construction of the required dam.

No fuel means no fuel cost, no combustion, no generation of flue gases, and no pollution in the atmosphere. Due to the absence of fuel combustion, the **hydroelectric power plant** itself is very neat and clean. In addition to that, it does not produce any pollution to the atmosphere. Also from constructional point of view, it is simpler than any thermal and nuclear power plant.

The constructional cost of a **hydroelectric power plant** maybe higher than that of other conventional thermal power plants because of construction of a huge dam across the flowing river. The engineering cost in addition to the constructional cost is also high in a hydroelectric power plant. Another disadvantage of this plant is that it cannot be constructed anywhere according to the load centres.

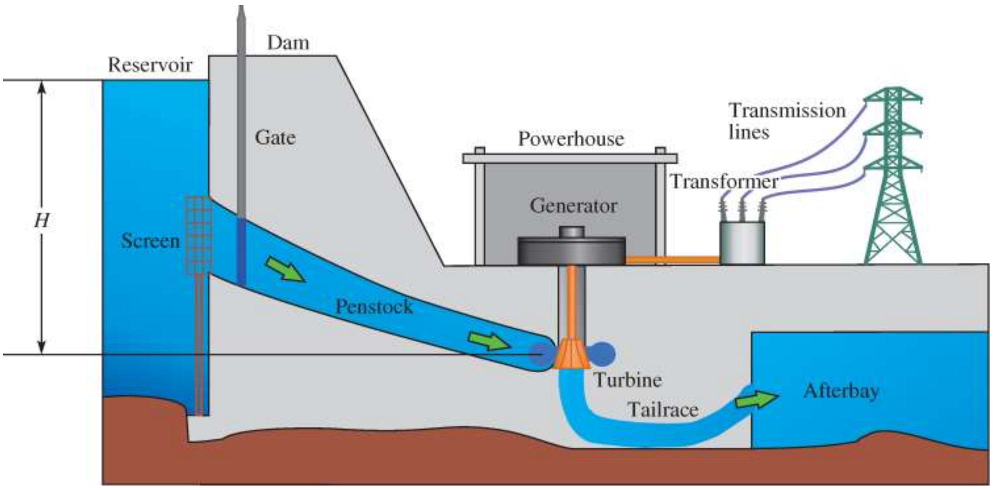
So, long transmission lines are required to transmit the generated power to the load centres.

Thus the transmission cost may be high enough.

There are only six primary components required to construct a hydroelectric power plant. These are dam, pressure tunnel, surge tank, valve house, penstock, and powerhouse.

The dam is an artificial concrete barrier constructed across the way of the river. The catchment area behind the dam creates a huge water reservoir. The pressure tunnel takes water from the dam to the valve house.
In the valve house, there are two types of valves available. The first one is main sluicing valve and the second one is an automatic isolating valve. The sluicing valves control the water flowing to the downstream and automatic isolating valves stop the water flow when the electrical load is suddenly thrown off from the plant. Automatic isolating valve is a protecting valve does not play any direct role control the flow of water to the turbine. It only operates during emergency to protect the system from burst out.

The penstock is a steel pipeline of suitable diameter connected between the valve house and powerhouse. The water flows down from upper valve house to lower powerhouse through this penstock only.
In the powerhouse there are water turbines and alternators with associated step up transformers and switchgear systems to generate and then facilitate transmission of electricity.
At last, we will come to the surge tank. The surge tank is also a protective accessory associated with **hydroelectric power plant**. It is situated just before the valve house. The height of the tank must be greater than the head of the water stored in the water reservoir behind the dam. This is an open top water tank.



Daman ganga Hydro Project.

Location

The Project “Daman Ganga SHP – I” is located 30 kms away from Vapi in Dist. Valsad, Gujarat and envisages utilisation of water from the reservoir of the Madhuban Dam built across river Daman Ganga with total catchment area of approx. 1300 sq.km shared by Maharashtra, Gujarat and Dadra & Nagar Haveli (UT)

Capacity : generating units & power

Two generating units and the capacity of the Project is 3 MW (1.5 MW X 2 Units).

Penstock

Two openings have been provided in the body of the Dam which have been further connected with the main Power House Building through 2 nos. Steel Penstocks with 1.5 M dia., 12 mm thick and 9.5 M long coupled with Butter Fly Valves of 1.6 m dia.

Power house

The Power House Building (22.5 m x 10 m) is a unique structure of about 24 m height from the deepest foundation level, fully compact and water tight, designed as to submerge in the water during high flood levels. The approach to the Power House is from the top (EL. 61.26 m) and descends at Generator Floor Level at (EL. 44.5 m) housing 2 Generating Units (Vertical Kaplan) of 1.5 MW each (Austrian make) attached with compatible Hydro Generator from France and linked with state of the art Control Panels procured locally through reputed manufacturers.

Saikothi Hydro Project

Location

Saikothi Project is conceived as a run of the river scheme across Baira Nallah, a tributary of river Ravi, located at a distance of 70 kms from Chamba and 130 kms from Pathankot (Rail end) in Distt Chamba, Himachal Pradesh.

Penstock

The Project envisages construction of 12 m high gated Barrage at the confluence of two Nallahs (Malin & Baira), an open Desilting Tank and 2.5 kms long, 3.5 m dia. Horseshoe shaped Head Race Tunnel which will feed through 270 m long penstock

Capacity : generating units & power

Three generating units of 6 MW, 6 MW and 3 MW proposed to be installed in the surface Power House proposed at village Shalli, about 900 meters down from the main road. The power generated will be evacuated through 66 kV Transmission Line at nearest Substation at 4 kms and will further be evacuated through 132 kV integrated system at receiving Sub Station at 43 kms.

Sabarmati Hydro Project

Location

The Project being developed is a canal based scheme envisaging utilization of the waters of Sabarmati Escape from Narmada Main Canal (NMC) for generation of 4 MW of Hydro power, located about 10 kms from the Ahmedabad Airport, Gujarat.

Penstock

The intake structures comprising of 20 Nos. of Steel Pipes (each of 700 mm dia) will be connected to common steel pipe which will further bifurcate into unit penstocks each of 2.3 m dia to feed 2 Nos. generating units each of 2 MW capacity. 2 Nos. Butterfly Valves of 2.3 m each is proposed to be provided to each unit penstock to control and regulate the discharges from the NMC.

Power house

The proposed Power House Building is 16.75 m long and 10.5 m wide with additional space for service bay. An outdoor switchyard is proposed near to the Power House and the power generated will be evacuated through 66 kV and delivered at the Bath Sub Station – Govt. of Gujarat at a distance of 4 kms.

Economics

The Detailed Project Report submitted is under review with the concerned authorities of Govt. of Gujarat and also maintained by them.

Thermal Power Plant

A thermal power station is a power station in which heat energy is converted to electric power. In most of the places in the world the turbine is steam-driven. Water is heated, turns into steam and spins a steam turbine which drives an electrical generator. After it passes through the turbine, the steam is condensed in a condenser and recycled to where it was heated; this is known as a Rankine cycle.

The greatest variation in the design of thermal power stations is due to the different heat sources; fossil fuel dominates here, although nuclear heat energy; solar heat energy, biofuels and waste incineration are also used. Some prefer to use the term energy center because such facilities convert forms of heat energy into electrical energy.[1] Certain thermal power stations are also designed to produce heat energy for industrial purposes, or district heating, or desalination of water, in addition to generating electrical power.

Dahanu Thermal Power Station (DTPS)

Location

Dahanu Thermal Power Station (DTPS) is a coal based thermal power plant located at coastal Dahanu town in Palghar district in the Indian state of Maharashtra[1] It was constructed by BSES Ltd Reliance Infrastructure later took over BSES. The power plant operated by Adani Electricity. The plant is located on Mumbai-Ahmedabad rail line and is 120 km away from Mumbai and 20 km away from Mumbai-Ahmedabad-Delhi National Highway 8 (India).

Capacity

It has an installed capacity of 500 MW (2x250 MW). The power plant was commissioned in 1995 and is commercially producing power since 1996.[2]

Ukai Thermal Power Station

Location

Ukai Thermal Power Station is located on the banks of the Tapi because of the water resources, along with the hydroelectric power plant with the same name.

Capacity

Ukai TPS Unit-1 is the first power station unit in India with a capacity more than 100 MW.