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Opportunities and Challenges of Wind and Tidal Energy Technology in India and around the world

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***Abstract* - Due** *to the increasing requirement of energy as a result of the growth of population and a gradual decline of conventional resources, there is an immediate requirement for development of non-conventional resources. One of the most underutilized resources in the world is Tidal and Wind energy which can provide a plethora of energy if harnessed properly. Wind energy is the kinetic energy possessed by the wind caused by heating of the atmosphere due to the solar radiation. Uneven pressure gradient is produced which results in wind motion. Tidal energy is the energy transferred by the surface wind to the water in the sea. Over the course of time, there has been a remarkable development in the technology to harness the wind energy and the tidal energy all around the world, however, plenty of scope remains for it's optimal use.*

***Keyword* -** *Wind Energy, Tidal Power, electricity, Rance Tidal Power Station, Muppandal Wind Energy Farm.*

CHAPTER 1

A. Introduction

Wind is a solar energy by-product. About 2% of the energy of the sun, reaching the earth, is converted into wind energy. The earth's surface heats and cools unevenly, creating atmospheric pressure zones which causes the air to flow from high to low-pressure areas. In the history of human civilization, wind has played an important role. The first known wind consumption dates back to as early as 5,000 years ago.

The first true windmill could have been built as early as 2000 B.C., a machine with vanes attached to an axis to produce circular motion in the Babylon of old. By the 10th century A.D., in the areas of eastern Iran and Afghanistan, windmills with wind-catching surfaces 16 feet long and 30 feet high were grinding grain. The earliest written references to wind machines operating in the West world dates from the 12th century.

Tidal power or tidal energy is a form of hydro power that converts tidal energy into useful forms of power, mainly electricity. Although not widely used, there is potential for future generation of electricity from tidal energy. Wind and sun are more predictable than tides. Tidal energy has traditionally suffered from relatively high costs among renewable energy sources and limited availability of sites with sufficiently high tidal ranges or flow speeds, thus limiting their total availability. However, there are many recent technological developments and improvements in both design (such as dynamic tidal power, tidal lagoons) and turbine technology (such as new axial turbine). Historically, tide mills were used in Europe as well as on North America's Atlantic coast. The incoming water was contained in large storage ponds, and as the tide went out, waterwheels turned into mill grain using the mechanical power it produced.The earliest occurrences date from the Middle Ages, and even from the Roman times. The process of using falling water and spinning turbines to generate electricity was introduced in the U.S. and Europe in the 19th century. In terms of output, it was the largest tidal power plant until Sihwa Lake Tidal Power station inaugurated in August 2011 in South Korea. Sea wall defense barriers are used by the Sihwa station with 10 turbines generating 254 MW.

B. World Energy Scenario

For wind energy though, According to the Renewables 2018 Global Status Report “Wind power had a relatively modest year in comparison to 2015 and 2016, but still saw its third strongest 12-month period, with more than 52 GW added globally in 2017.

1. Cumulative capacity increased nearly 11%, to around 539 GW.

2.As in 2016, a decline in Chinese installations accounted for much of the contraction, while several other markets, including Europe and India, had record years.

3 By the end of 2017, more than 90 countries had seen commercial wind power activity, and 30 countries – representing every region – had more than 1 GW in operation.

4 Nevertheless, for the first time in at least a decade, the trend towards greater diversification of markets reversed, with a concentration of new wind power capacity in a smaller number of markets

.5 Strong growth in some of the largest markets (e.g., Germany, India and the United Kingdom) was driven by significant policy and regulatory changes, which pushed many developers to commission projects quickly to take advantage of expiring support

schemes; elsewhere, deployment was driven by wind energy’s cost-competitiveness and its potential environmental benefits and more.
6 Rapidly falling prices for wind power, both onshore and offshore, have made it the the most inexpensive option for new power generating capacity in a large and growing number of markets.
7 Around the world, wind power is quickly becoming a mature and cost-competitive technology.
8 Asia was the largest regional market for the ninth consecutive year, representing nearly 48% of added capacity (with a total exceeding 235 GW by year’s end), followed by Europe (over 30%), North America (14%) and Latin America and the Caribbean (almost 6%).
9 China retained its lead for new installations, despite a second year of contraction, and was followed distantly by the United States, Germany, the United Kingdom and India.
10 Others in the top 10 for additions were Brazil, France, Turkey, South Africa and Finland.

Tidal stream energy has been estimated to supply more than 150 TW / h per annum theoretically, well beyond all domestic electricity consumption in the UK. This represents a potential total global capacity-generating market size of up to 90 GW. The UK’s tidal power resource is estimated to be more than 10 GW, representing about 50 percent of Europe’s tidal energy capacity. 25 percent of Europe’s tidal energy potential resources come from Scotland. The Pentland Firth, widely considered to be one of the world’s best sites for tidal power, could provide half of Scotland’s electricity, according to study recently completed by Oxford University.It's about the world's tidal stream power, Oxford University's Thomas Adcock said,“The water flow is fast there because a narrow eight-mile channel forces the tide from the Atlantic to the North Sea”. The Oxford University engineers calculated that a maximum of 1.9 GW of power could be generated by underwater turbines strung across the Firth's entire width, averaged over the fortnightly tidal cycle. That is equivalent to 16.5 TW/h of electricity a year, almost half Scotland’s entire annual electricity consumption in 2011. As Scotland already produces 14.6 TW/h a year of renewable energy, a fully exploited Pentland Firth would bring Scotland close to meeting its aim of 100% by the year 2020

Some popular Tidal Energy Generation Plants are given below:

STATION	CAPACITY (MW)	COUNTRY	COMM
RANCE TIDAL POWER STATION	240	FRANCE	1966
ANNAPOLIS ROYAL GENERATING STATION	20	CANADA	1984
JIANGXIA TIDAL POWER STATION	3.2	CHINA	1980
KISLAYA GUBA TIDAL POWER STATION	1.7	RUSSIA	1968
STRANGFORD LOUGH SEAGEN	1.2	UNITED KINGDOM	2008
ULDOLMOK TIDAL POWER STATION	1	SOUTH KOREA	2009

C. Indian Energy Scenario

Atlantis Resources, a British tidal energy company, is expected to set up a tidal power plant in the Gulf of Kutch or Khambhat with a capacity of over 250 MW. India's first attempt to harness tidal power for electricity generation would be in the form of a proposed three MW plant at the Durgaduani creek in West Bengal's Sundarbans delta. The Gujarat Gulf of Kutch and Gulf of Cambay and the Sunderbans Ganga delta, the largest mangrove in the world, are the three sites identified as potential tidal power generation areas.

According to an article in downtoearth.org.in, the Gujarat government is all set to develop India’s first tidal energy plant. The state government has approved Rs 25 crore for setting up the 50 MW plant at the Gulf of Kutch. It will produce energy from the ocean tides.

The state government signed a Memorandum of understanding with Atlantis Resource Corporation last year to develop the plant. “The proposal was approved in this year’s budget session,” says Rajkumar Raisinghani, senior executive with Gujarat Power Corporation Limited (GPCL). Atlantis Resource Corporation is a UK-based developer of tidal current turbines. “The equipment has been imported and work will start anytime soon. We are awaiting Coastal Regulation Zone clearance from Ministry of Environment and Forests, which is expected soon,” adds Raisinghani.

According to the GPCL officials, if this 50 MW plant is successfully commissioned, its capacity will be increased to 200 MW. As per a study conducted by Atlantis Resource Corporation and the state government two years ago, the Gulf of Kutch has a total potential of 300 MW. The biggest operating tidal station in the world, La Rance in France, generates 240 MW.

According to the estimates of the Indian government, the country has a potential of 8,000 MW of tidal energy. This includes about 7,000 MW in the Gulf of Cambay in Gujarat, 1,200 MW in the Gulf of Kutch and 100 MW in the Gangetic delta in the Sunderbans region of West Bengal.

But despite the huge potential, India has no policy on tidal energy. “A clear policy is very important for developers to have clarity on tariff and commercial development of tidal energy in the country,” says Aditya Venketesh, executive director, Urja Global Limited, an Indian company which works in the field of renewable energy. The government must also provide subsidy to reduce the cost of importing tidal technology so that consumers can get the cheapest rate on per unit consumption, he adds. The Gujarat government last year approved a 10 MW tidal energy plant proposed by Urja Global Limited in association with a US-based company Ocean Energy Industries. But no date has been given for starting the project yet.

“The Ministry of New and Renewable Energy should prepare a proper policy on tidal energy since the development of this sector is primarily their responsibility,” says an official of the GPCL, wishing anonymity. “No developer will come forward unless policy shows assured benefits” he adds

CHAPTER 2

A review of the literature

A. Innovations and Development in Wind and Tidal Energy

People used wind energy as early as 5,000 BC to propel boats along the Nile River. By 200 BC, simple wind-powered water pumps were being used in China and grain was being grinded in Persia and the Middle East by windmills with woven raised blades. Eventually new ways of using wind energy were spread all over the world. By the 11th century, wind pumps and windmills were extensively used by people in the Middle East to make food. Wind technology was brought to Europe by merchants and the Crusaders. The Netherlands developed large wind pumps in the Rhine River Delta to drain lakes and marshes. Immigrants from Europe eventually took to the Western Hemisphere wind energy technology. Windmills were used by American colonists to grind grains, to pump water andin sawmill to cut wood. Thousands of wind pumps were installed by homesteaders and ranchers as they settled the western United States. Small wind power generators (turbines) were also widely used in the late 1800s and early 1900s. When power lines were constructed in the 1930s to transmit electricity to rural areas, the use of wind pumps and small turbines began to decline. Some ranches, however, still use wind pumps to supply livestock with water. Small wind turbines are again becoming common, primarily for electricity supply in remote and rural areas.

The oil shortages of the 1970s changed the U.S. and world energy environment. Oil shortages have created an interest in developing ways to generate electricity using alternative energy sources, such as wind energy. The U.S. federal government supported large-scale wind turbine research and development. Thousands of wind turbines were installed in California in the early 1980s, largely due to federal and state policies promoting the use of renewable energy sources.

In the 1990s and 2000s, in response to a renewed concern for the environment, the U.S. federal government set incentives to use renewable energy sources. Furthermore, the federal government provided funding for research and development to help reduce wind turbine costs and offered tax and investment incentives for wind energy projects. Additionally, state governments have demanded new electricity generation requirements from renewable sources, and electricity marketers have begun to offer their customers electricity generated from wind and other renewable energy sources (sometimes called green power). These policies and programs led to an increase in wind turbine numbers and the amount of energy generated from wind turbines.The proportion of U.S. wind power generation in 1990 was less than 1 %. .In 2018, the share of U.S. wind power generation was almost 7%. Incentives in

Europe resulted in a significant expansion of the use of wind energy. China invests heavily in wind energy and now has the largest capacity to generate wind electricity in the world.

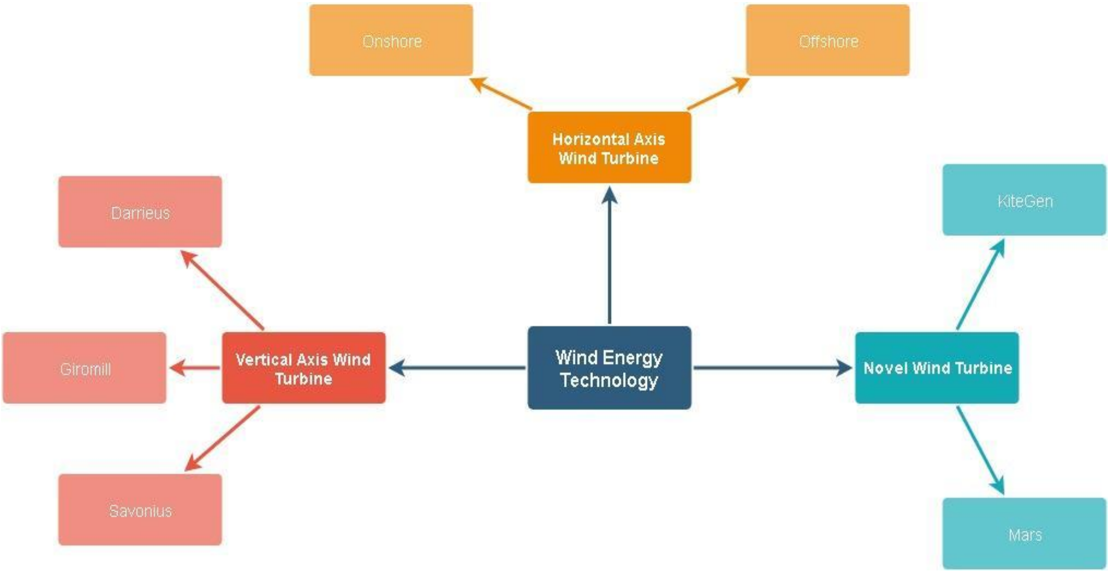
The brothers Joe Jacobs and Marcellus Jacobs opened a factory in Minneapolis in 1927 to produce generators of wind turbines for farm use. These would typically be used on farms outside the reach of central-station electricity and distribution lines for lighting or battery charging. The company produced about 30,000 small wind turbines in 30 years, some of which ran in remote locations for many years.The Darrieus wind turbine was invented in 1931, with its vertical axis providing a different mix of design trade offs from the conventional wind turbine on the horizontal axis. The vertical orientation accepts wind from any direction without any need for adjustment, and the heavy generator and gearbox equipment can rest on the ground rather than on top of a tower. In 1941, in Castleton, Vermont, United States, the world's first megawatt-sized wind turbine was connected to the local electrical distribution system on the mountain known as ‘Grandpa's Knob’. It was designed and manufactured by the S by Palmer Cosslett Putnam. Company of Morgan Smith. This 1,25 MW Smith –Putnam turbine was operating for 1100 hours before a blade failed at a known weak point that was not reinforced due to shortages of wartime material. For about forty years, no similar unit was to repeat this "bold experiment"

The U.S. government worked with the industry from 1974 through the mid-1980s to advance the technology and allow large commercial wind turbines. As part of a program to create a utility-scale wind turbine industry in the United States, NASA wind turbines were developed. A total of 13 experimental wind turbines were put into operation in four major wind turbine designs with funding from the National Science Foundation and later from the U.S. Department of Energy (DOE). This research and development program has pioneered a lot of today's multi-megawatt turbine technologies, including steel tube towers, variable speed generators, composite blade materials, partial pitch control,as well as design capabilities in aerodynamic, structural and acoustic engineering. Based on this effort, the large wind turbines set several world records for diameter and power output. In 1981, the three turbines MOD-2 wind turbine cluster produced 7.5 megawatts of power. The MOD-5B was the world's largest single wind turbine with a rotor diameter of almost 100 meters and a rated power of 3.2 megawatts in 1987. It showed 95 percent availability, an unparalleled level for a new wind turbine in the first unit. The MOD-5B had the first variable speed drive train on a large scale and a sectioned, two-blade rotor that enabled easy blade transport.

For over 20 years, the 4 megawatt WTS-4 has held the world record for power output. Despite the later units being commercially sold, none of these two-bladed machines have ever been put into mass production. Since 1980 through the early 1990s, when oil prices declined by a factor of three, many turbine manufacturers, large and small, left the business. For example, NASA / Boeing Mod-5B commercial sales came to an end in 1987 when Boeing Engineering and Construction announced that they were "planning to leave the market as low oil prices keep windmills uneconomical for electricity generation."

In 1956, on the Nova Scotia side of the Bay of Fundy, utility Nova Scotia Light and Power of Halifax commissioned a couple of studies on the feasibility of developing commercial tidal power. The two studies independently concluded by Stone & Webster of Boston and the Montreal Engineering Company of Montreal that millions of horsepower could be harnessed from Fundy, but that development costs at that time would be commercially prohibitive

In 1966, on the Rance River estuary in Bretagne, Électricité de France opened the Rance Tidal Power Station. It was the first tidal power plant in the world. The plant has been the world's largest tidal power plant by installed capacity for 45 years. Its 24 turbines reach a peak output of 240 megawatts (MW) and an average of 57 MW, a capacity factor of around 24%.



CHAPTER 3

Wind Energy Technologies

A. Horizontal Axis Wind Turbine:

Horizontal axis wind turbines are at the top of a tower with the main rotor shaft and electrical generator, and must be pointed into the wind. A simple wind vane placed square with the rotor (blades) points out small turbines, whereas large turbines usually use a wind sensor coupled with a servo motor.Most large wind turbines are equipped with a gearbox that turns the rotor's slow rotation into a faster rotation that is better suited to driving an electric generator. Because a tower generates turbulence behind it, the tower's turbine is usually pointed upwind. Wind turbine blades are made rigid to prevent high winds from pushing the blades into the tower .In addition, the blades are placed in front of the tower at a considerable distance and are sometimes tilted up a small amount. Despite the turbulence problem, downwind machines have been built because they do not need an additional mechanism to keep them in line with the wind and because the blades can bend in high winds, reducing their sweeping area, and therefore their wind resistance. Because turbulence leads to fatigue failures and reliability is important as most HAWTs are upwind machines. HAWT wind farm facilities types are:

On-Shore: these farms were originally set up by mountains and hilly areas. Individual wind turbines contribute to the generation of 100 MW or more power at these farms. The land that the wind parks occupy is often used for farming or grazing animals. Denmark, Spain and Portugal are among the leading onshore wind farms producing electricity.

Offshore wind farms are the outcome of revolutionary technology that encouraged man to set up farms on the water surface to harvest wind energy. In addition to oceans, lakes also serve as sites for wind park installation. An advantage of offshore wind farm is that it uses powerful winds that blow across the surface of the water. In addition, large parts of a wind turbine can be easily transported to offshore sites using large ships and vessels. Some of these farms' other advantages include noise mitigation due to land distance and higher capacity factors. The United Kingdom is the nation that uses offshore wind parks to generate electricity.

B. Vertical Axis Wind Turbine

VAWTs have vertically arranged the main rotor shaft. The main advantage of this arrangement is that it is not necessary to point the wind turbine into the wind. This is an advantage at sites with highly variable wind direction or turbulent winds. The generator and other primary components can be placed near the ground with a vertical axis so that it does not need to be supported by the tower, also facilitates maintenance. A VAWT's main drawback is that when it rotates into the wind, it generally creates drag. It is difficult to install vertical-axis turbines on towers, which means that they are often installed closer to the base on which they rest, such as the ground or a building tower.Therefore, these models are not frequently used for offshore installations that, if used, may require waterproof enclosures that would incur additional costs. Offshore facilities also require very high height towers. The wind speed at a lower altitude is slower, so for a given size turbine there is less wind energy available. Air flow near the ground and other objects can create a turbulent flow that can lead to vibration problems, including noise and wear that can increase maintenance or shorten service life.When a turbine is mounted on a rooftop, however, the building usually redirects wind over the roof, which can double the turbine wind speed. If the rooftop mounted turbine tower is about 50% of the building height, this is nearly the optimum for maximum wind energy and minimal wind turbulence. Different VAWT types are:

Darrieus wind turbine: turbines called "Eggbeater," or Darrieus turbines, have been named after Georges Darrieus, the French inventor. They have good efficiency, but they produce large ripple torque and cyclic stress on the tower, which contributes to poor reliability. They also generally require some external power source or an additional Savonius rotor to turn, as the starting torque is very low. By using three or more blades, the torque ripple is reduced, resulting in greater rotor solidity. Solidity is measured by area of the blade divided by area of the rotor. Newer Darrieus type turbines are not held up by guy - wires but are connected to the top bearing with an external superstructure.

Giromill: A Darrieus turbine subtype with straight, rather than curved, blades. The variety of cycloturbines has variable pitch to reduce the pulsation of the torque and is self-starting. Variable pitch advantages are: high starting torque; wide, relatively flat torque curve; lower blade speed ratio; higher performance coefficient; more efficient operation in turbulent winds; and lower blade speed ratio that lowers blade bending stress. It is possible to use straight, V, or curved blades.

Savonius wind turbine: these are two (or more) scoop drag-type devices used in anemometers, Flettner vents (commonly seen on bus and van roofs),And in some low - efficiency turbines with high reliability. If there are at least three scoops, they always start on their own.

Tidal Energy Technologies

Currently,in the present state tidal energy is being harnessed by the utilization of two systems

1. Barrage System:Tidal barrier is a generally built structure across the estuary mouth through which the water flows into and out of the basin. The tidal barriers have sluice gates that allow water to flow into and out of the basin. During high tide, the water flows into the bay and is retained by closing at the beginning of low tide the sluice gates. The dam gates are controlled by knowing the location's tidal range and operating it at the correct tidal cycle times. At the sluice gates there are turbines that generate electricity when the gates are opened during the low tide.

The advantage of using barrage as a method to generate electricity compared to fossil fuels is that it reduces the greenhouse effects in order to aid to betterment of the environment. Tidal power plant in La Rance, France is an example of a dam method. At the top of the dam there is a four-lane highway that cuts 35 km of distance between the towns representing Saint Malo and Dinard.

2. Tidal Stream System:Tidal power in the early 1990s focused primarily on harnessing the tidal flow and generating energy through potential storage rather than tidal stream. Over the past decade, tidal stream technologies have made massive progress towards marketing. Extensive research on tidal stream energy is being conducted in UK waters. UK has a target of achieving 20% of its demand for electricity through ocean resources by 2020. About 40 machines are being developed to convert energy and prototypes are being tested in UK laboratories and waters (Irena, 2014). Because tidal energy is still an emerging technology, there are no standardizations, however, various devices are being developed to utilize the flow of water to extract electricity. The efficiency of each device must be examined perfectly by extensive testing in order to select the appropriate device for a specific location.

Calculation of Tidal Energy available from dams

The energy available from the dam depends on the water volume. The potential energy contained in a volume of water is:

$$E=1/2\ Apgh$$

where: h is the vertical tidal range, A is the horizontal area of the dam basin, rho is the water density= 1025 kg per cubic meter (seawater varies between 1021 and 1030 kg per cubic meter) and g is the Earth's gravity acceleration= 9,81 meters per second square. The factor half is due to the fact that the hydraulic head above the dam decreases as the basin flows empty through the turbines. The maximum head is only available when the water is low, assuming there is still a high water level in the basin.

Calculation of Wind Energy available

There are many complicated calculations and equations involved in understanding and constructing wind turbine generators, however, the layman does not need to worry about most of these and should instead ensure they remember the following vital information: 1) The power output of a wind generator is proportional to the area swept by the rotor - i.e. double the swept area and the power output will also double. 2) The power output of a wind generator is proportional to the cube of the wind speed.

$$\text{Kinetic Energy} = 0.5 \times \text{Mass} \times \text{Velocity}^2$$

where the mass is measured in kg, the velocity in m/s, and the energy is given in joules. Air has a known density (around 1.23 kg/m3 at sea level), so the mass of air hitting our wind turbine. (which sweeps a known area) each second is given by the following equation:

Mass/sec (kg/s) = Velocity (m/s) x Area (m2) x Density (kg/m3).

Therefore, the power (i.e. energy per second) in the wind hitting a wind turbine with a certain swept area is given by simply inserting the mass per second calculation into the standard kinetic energy equation given above resulting in the following vital equation:

Power = 0.5 x Swept Area x Air Density x Velocity^3

where Power is given in Watts (i.e. joules/second), the Swept area in square meters, the Air density in kilograms per cubic metre, and the Velocity in meters per second.

The equation for wind power(P) is given by

$P= 0.5 \times \rho \times A \times Cp \times V^3 \times Ng \times Nb$

where, ρ = Air density in kg/m3 , A = Rotor swept area (m2). Cp = Coefficient of performance V = wind velocity (m/s) Ng = generator efficiency Nb = gear box bearing efficiency. The world's largest wind turbine generator has a rotor blade diameter of 126 meters and so the rotors sweep an area of PI x $(\text{diameter}/2)^2$ = 12470 m^2 ! As this is an offshore wind turbine, we know it is situated at sea-level and so we know the air density is 1.23 kg/m^3 . The turbine is rated at 5MW in 30mph (14m/s) winds, and so putting in the known values will give, Wind Power = 0.5 x 12,470 x 1.23 x (14 x 14 x 14), which gives us a wind power of around 21,000,000 Watts. Why is the power of the wind (21MW) so much larger than the rated power of the turbine generator (5MW)? Because of the Betz Limit, and inefficiencies in the system. The Betz law means that wind turbines can never be better than 59.3% efficient. The law can be simply explained by considering that if all of the energy coming from wind movement into the turbine were converted into useful energy then the wind speed afterwards would be zero. But, if the wind stopped moving at the exit of the turbine, then no more fresh wind could get in - it would be blocked. In order to keep the wind moving through the turbine, to keep getting energy, there has to be some wind movement on the outside with energy left in it. There must be a 'sweet spot' somewhere and there is, the Betz limit at 59.3%.

CHAPTER 4

Case Studies

A. Rance Tidal Power Station,France

After a development stage enduring five years, the Rance Tidal Power Station was opened on the 26th November 1966. This was the main power station to exploit tidal water stream to create power (tidal vitality). In order to have the capacity to develop the structure over the estuary, two dams must be worked to obstruct the Rance waterway during the initial two years of the development stage to guarantee that the estuary was totally depleted.

The reason that the Rance River estuary was picked was because of its extensive tidal range; it really has most noteworthy tidal range in France. It has a normal tidal scope of 8m among low and elevated tide, while the spring and neap range can be as large as 13.5m.

Rance Tidal Power Station and the Tidal Flow

At the point when the tide is coming in, the water on the ocean side of the flood is higher than the estuary side; along these lines water will spill out of the ocean side through the turbine into the estuary. At the point when the tide is going out, the definite inverse happens. In that capacity, the turbines that were introduced in the Rance Power Station have the ability to deliver control in either bearing.

The Rance Barrage is 750m long and 13m high, while the genuine power producing part of it is 330m long. This area houses 24 Bulb power turbines each appraised at 10MW so the greatest limit of the power station is 240MW. By and by the measure of intensity it really delivers is about 96MW, providing roughly 600GWh every year to the framework, which would control around 130,000 houses per year

One of the significant downsides about tidal vitality is that it is anything but a steady wellspring of power. There are two tides per day, when the tidal range is the most and the creating limit will be the busiest, and there are times when the water level on either side will practically be equivalent, so it will deliver no power.

The benefit of tidal vitality and along these lines the power plant at Rance, is that the tides are absolutely unsurprising, so you can all around effectively calculate this the vitality blend, while other irregular sustainable power sources, for example, sun based PV and wind ranches are significantly less unsurprising.

Rance Power Station Cost

The Rance Power plant was costly to work in its day and took around 20 years to really pay for itself. This is one of the real reasons the proposed £30bn Severn Barrage has not proceeded, it is essentially too costly to even consider undertaking this sort of developmental challenge in these extreme prudent occasions. Anyway, the venture is being taken a gander immediately again to check whether it tends to be developed at a lower cost.

Since the power plant was developed however in 1965, it has created roughly 27,600 GWh of power.

At the present costs, that amount of power would cost £3.30bn.

Rance Tidal Power Station Environmental Assessment

Since the tidal torrent development expected to deplete the estuary in the underlying years after the development was finished, extreme repercussions were suffered by the neighborhood condition; though 10 years after the fact it was viewed as that the Rance estuary by and by had a rich assorted variety of sea-going life.

The floodgate doors and the lock (worked to enable pontoons to get past the torrent) permit a genuinely simple change from one side to the next for every single amphibian creature, so this did not have any genuine effect on species there either. The one effect it had was that the mud pads were seriously lessened so winged animals that utilized the mud pads as a chasing ground needed to adjust or move somewhere else to bolster.

Rance Tidal Power Station Final Assessment

Upon reflection it must be perceived that building the Rance Power Plant was an incredible designing feat, and one that maybe in the Western world won't be repeated, not even with the new tidal vitality arrangements. The reality it produces ample, 100% clean power 46 years after development and has turned into a vacation destination in its own privilege has demonstrated why it was such a reasonable undertaking to begin in any case.

B. Gulf of Kutch Project,Gujarat

An announcement was made in 2011 that a tidal power plant was being considered in Gujarat's Gulf of Kutch. It was eventually to be expanded to 200 MW with an initial capacity of 50 MW. There was news in 2016 that the government would be collaborating with an Israeli company to set up tidal power stations in Goa. Mr Nitin Gadkari, the shipping minister, quoted saying, "I've been constantly pursuing for the last two years whether we can generate electricity using tides in the sea. I have come to know today that we can begin experimenting with this by using Israeli technology that will help generate power through tides".

C. Muppandal Wind Energy Farm,Kanyakumari

Tamil Nadu is invested with three unmistakable passes having high wind potential, due to the burrowing impact amid south west storm. The present investigation is directed in a wind ranch arranged in and around the Aralvoimozhi Pass, Kanyakumari District, Southern Tamil Nadu. The yearly normal breeze speed (km/hour) in this pass extends between 19 what's more, 25 km/h. Kanyakumari region is arranged in southernmost tip of Indian territory and its topographical directions are Kanyakumari that is situated at scope 8º05'N and 8°08'N and longitude of 77º34'E and 77°57'E. The normal height of Kanyakumari is zero meters. The chose breeze ranch in Kanyakumari locale lies in the scope of 3.44– .18 m/s wind speed with wind control thickness going from 193.3 W/m2 to 558.4 W/m2 at 30 m center point stature.The unit cost of electricity produced from windmills depends on the annual energy output of the windmills. . The output for all windmills is calculated by taking the average capacity factor of 33%. It can be observed that the mean annual power output ranges from 433,620 kW/year to 1,445,400 kW/year. It is interesting to note that wind turbine with the highest rated power of 750 does not produce the maximum output. The most efficient systems are with rated power 600 kW and 500 kW. This means that in this area wind farms should be trying to install wind turbines with 500 kW and 600 kW rated power. But this alone cannot be taken as a single factor for making investment in wind turbines. Other factor like turbine cost and unit cost of electricity also largely influence the selection of a particular wind turbine

CHAPTER 5

A. Current global production of Wind and Tidal Energy

According to information provided by the National Energy Board of Canada, South Korea is leading the way globally with a total installed tidal capacity of 511MW. France with 246MW is followed by South Korea and 139MW by the United Kingdom. Canada ranks fourth in the world in installed tidal power with a total capacity of approximately 40MW, followed by Belgium at 20MW, China at 12MW, and Sweden at nearly 11MW. The 2015 Annual Report of Ocean Energy Systems has been listed by the National Energy Board of Canada as a source for its calculations, which also includes installed and approved tidal power projects.-Some are in the demonstration phase, some are short-term test programs and some are prototypes entering the marketing phase. Canada's capacity is located in Nova Scotia alone and includes projects such as the 20MW Annapolis Tidal Power Plant and the Fundy Ocean Energy Research Center (FORCE) test site projects developed by Minas Tidal, Black Rock Tidal Power, Atlantis Operations Canada and Cape Sharp Tidal Venture.

According to the National Energy Board of Canada, the California-based Electric Power Research Institute (EPRI) has identified Nova Scotia's Bay of Fundy as one of the best potential tidal power generation sites in North America. EPRI estimated nearly 300MW of potential in the Minas Passage alone, which is sufficient to power about 100,000 homes. Additional research at Acadia University now suggests that the Minas Passage has more than 7,000 MW of potential, of which 2,500 MW has commercial potential without significant effects on peak tide height.

Virtually everywhere on Earth, wind energy is available, but wind strength and consistency vary widely. One estimate suggests that 1 million GW of wind energy is available from the Earth's overall land coverage, and if only 1 percent of this land were used for achievable efficiencies, this would meet global demand for electricity. Although most wind energy is currently obtained onshore, offshore wind farms are becoming more popular as a larger resource area with low environmental impact (particularly considering noise and visual pollution).

At the end of 2015, worldwide wind power generation capacity reached 435 GW, about 7% of total global power generation capacity. Global generation of wind power in 2015 amounted to 950 TWh, almost 4 percent of total global generation.

The wind power market can be divided into large onshore winds (422 GW, approximately 210,000 machines), small onshore winds (less than 1 GW installed at the end of 2015, over 800,000 machines) and offshore winds (approximately 12 GW installed at the end of 2015, approximately 4,000 machines). Typically, large wind turbines onshore and offshore are arranged in a wind park. The largest wind parks exceed 1 GW in size, such as Gansu Wind Farm in China, Muppandal Wind Park in India or Alta Wind Energy Center in USA.

China has the largest installed capacity of 145 GW, followed by the United States with 73 GW, Germany with 45 GW, India with 25 GW, Spain with 23 GW and the United Kingdom with 14 GW. A site is considered ideal for the production of wind energy if winds exceed 6.9 m / s at 80 m above ground level are present. Wind data on installed capacity (MW) and annual output (GWh) is sourced from the International Renewable Energy Agency (2016) and represents values at the end of year 2015.

B. Financial Benefits of Wind and Tidal Energy

Capital costs of wind farms are assumed to be $600 000 per MW for wind, and $1800 000 per MW for tidal.The capital costs are amortized over 25 years at an interest rate of 6%. The fixed O&M costs are assumed to be $45320/MW for wind and $61714/MW for tidal based on the UK tidal resource study figures . Although the ‘fuel’ for the wind and tidal power generation is free, the capital cost will grow as renewable penetration increases. Capital costs for generators other than the wind farm are not included because new wind capacity is introduced at varying levels into a pre-existing mixture. Electricity costs per megawatt hour are calculated by summing all the fuel, variable and fixed O&M costs of the thermal sources individually for each hour and adding them to the O&M costs and amortized capital costs of the wind and tidal farms. This is then divided by the sum of all electricity produced over the year. Since capital costs for the traditional thermal sources are ignored, the resulting cost will be biased downward; therefore, we record the change in cost as penetration increases. This will allow us to conclude which generating mixes experience the sharpest change in electricity costs when tidal and wind power are added to the projects.

CONCLUSION AND FUTURE RECOMMENDATION

In contrast to Tidal Energy, it is observed that wind energy is a more widespread alternative method of producing energy. Currently, a single wind turbine,designed optimally can be used to power 500 homes.Wind energy is a rapidly growing source of renewable energy which is currently responsible for more than 435GW of energy produced, we still have been able to harness less than 1% of the available wind energy available to us. A more focused research towards achieving wind energy at higher efficiencies can help help the demand for electricity supply globally . Some countries utilise wind energy to supply almost 20% of their total energy requirements .Also the current cost of producing electricity from wind mills is too high and needs to be brought down substantially in order to promote the use of wind energy. Although there are various wind farms present in India such as Muppandal, Jaisalmer, Brahmanvel and Dhalgaon wind farms, the wind energy potentially of India is substantially more than what is being utilized currently. Tamil Nadu is the leading state in terms of production of wind energy. It amounts for almost 29% of India’s total wind power with the largest wind farm in Kanyakumari. As of December 2018,the wind energy capacity of India is 35.299 GW, which is the 4th highest in the world.Various incentives and tariff are provided on the utilization of wind energy resources in India.such as ED exemption, CCD & SAD exemption on specified parts and components , Feed-In-Tariff (FiT) by State Regulators ,Accelerated Depreciation at 80% or Generation Based Incentive @ Rs. 0.50/unit with cap of Rs. 10 million per MW , Income Tax Holiday for 10 years. Apart from the above stated policies,the government should also provide tariff on the transmission of electricity amongst various states in order to facilitate interstate energy transmission

In comparison to wind energy ,the tidal energy is not as widespread in India or globally as They change the movement of water into and out of estuaries, which can disrupt certain marine life's life cycles. They can prevent fish and other wildlife from moving in and out of estuaries that can disrupt spawning. Turbines are able to kill wildlife trying to swim through them. Spinning blades can kill marine wildlife. Migration and other aspects of marine life can be affected by acoustic disturbances.Various other factors such as cost, aesthetics, transmission difficulties, maintenance, corrosion etc. is preventing the widespread utilization of Tidal energy despite of abundance of potential as water covers almost 70% of the Earth’s surface and hence can be utilized to satisfy our electricity needs. The government should make policies that promote the utilization of tidal power by providing tariff on the various parts and transmission of the harnessed tidal power.Although the project in the Gulf of Kutch has been setup in order to facilitate the harnessing of tidal power,it is not sufficient. More projects such as these need to established in order to fully utilize the tidal energy potential of India (given that India is a peninsular country covered by water bodies on three sides with the Indian Ocean in the south,Bay of Bengal in the east and Arabian Sea in the left). The country has a potential of 8,000 MW of tidal energy, according to the Indian government's estimates. This includes approximately 7,000 MW in the Gujarat Gulf of Cambay, 1,200 MW in the Kutch Gulf and 100 MW in the Gangetic Delta in the West Bengal Sunderbans region.

Given the current pattern of non renewable energy resources and the perpetually growing population, development of renewable energy resources such as wind energy and tidal energy is not only an option but the need of the the hour. They provide a cleaner more efficient and an economical way of producing power. There has been remarkable development in recent times in the fields of tidal and wind energy but the potential for growth is still tremendous.

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