Ocean energy

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Manifest pedagogy

Many of questions related to renewable energy are asked both at the prelims and mains stage. The questions related to technology and phenomenon are of interest at the prelims whereas the questions related to policy are focused at the mains

In news

Ocean energy potential vs nuclear energy in India

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Content

Renewable energy comes from sources that can be replenished on a human timescale, like biomass, hydropower, geothermal, wind, tidal and solar power. Renewable energy technologies generally have fewer environmental and health impacts than non-renewables.

Different renewable energy sources

Most of these renewable energies depend in one way or another on sunlight. Wind and hydroelectric power are the direct result of differential heating of the Earth's surface which leads to air moving about (wind) and precipitation forming as the air is lifted. Solar energy is the direct conversion of sunlight using panels or collectors. Biomass energy is stored sunlight contained in plants. Other renewable energies that do not depend on sunlight are geothermal energy, which is a result of radioactive decay in the crust combined with the original heat of accreting the Earth, and tidal energy, which is a conversion of gravitational energy. Renewable energy technologies generally have fewer environmental and health impacts than non-renewables.

India is one of the countries with the largest production of energy from renewable sources. In the electricity sector, renewable energy account for 34.6% of the total installed power capacity. Large hydro contributes to 13% of the total power capacity as of 31 March 2019. India is the fourth-largest wind power producer in the world. The government target of installing 20 GW of solar power by 2022 was achieved four years ahead of schedule in January 2018, through both solar parks as well as roof-top solar panels. India has set a new target of achieving 100 GW of solar power by 2022.

What is ocean energy

Ocean energy (also referred to as marine energy) refers to the energy carried by ocean waves, tides, salinity, and ocean temperature differences. The movement of water in the world's oceans creates a vast store of kinetic energy, or energy in motion. This energy can be harnessed to generate electricity to power homes, transport and industries.

Types of ocean energy

The ocean can produce two types of energy

- Thermal energy from the sun's heat

- Mechanical energy from the tides and waves

Oceans cover more than 70% of Earth's surface, making them the world's largest solar energy collectors. The sun's heat warms the surface water a lot more than the deep ocean water, and this temperature difference creates thermal energy.

Ocean thermal energy is used for many applications, including electricity generation. Ocean thermal energy conversion (OTEC), uses ocean temperature differences from the surface to depths lower than 1,000 meters, to extract energy. A temperature difference of only 20°C can yield usable energy.

There are three types of electricity conversion systems closed-cycle, open-cycle, and hybrid

1. **Closed-cycle systems** use the ocean's warm surface water to vaporise a working fluid, which has a low-boiling point, such as ammonia. The vapour expands and turns a turbine. The turbine then activates a generator to produce electricity.
2. **Open-cycle systems** actually boil the seawater by operating at low pressures. This produces steam that passes through a turbine/generator.
3. **Hybrid systems** combine both closed-cycle and open-cycle systems.

India's maiden **Ocean Thermal Energy Conversion (OTEC)** project is coming up in **Kavaratti**, capital of the Lakshadweep archipelago, off the south-western coast. The current OTEC project is being set up to power a desalination plant. The power expected to be generated is under 200 kW.

Ocean mechanical energy is quite different from ocean thermal energy. Even though the sun affects all ocean activity, tides are driven primarily by the gravitational pull of the moon, and waves are driven primarily by the winds. As a result,

tides and waves are intermittent sources of energy. A barrage (dam) is typically used to convert **tidal energy** into electricity by forcing the water through turbines, activating a generator. Tidal energy is extremely site specific requires mean tidal differences greater than 4 meters and also favourable topographical conditions, such as estuaries and bays in order to bring down costs of dams. Since India is surrounded by sea on three sides, its potential to harness tidal energy has been recognised by the Government of India.

Wave energy describes energy generated from the power of waves near their surface. Several different types of wave energy conversion devices extract power from motion of waves. These include single point absorbers. The power take off device within these systems converts the motion of the waves into electrical energy. Wave power can also be captured through oscillating water columns, which trap waves in a column and change the air pressure in the upper portion which drives a turbine. Wave power can also be captured through an overtopping device, which traps waves in a floating pool, which is then released through turbines to generate power.

Ocean energy in India

Potential of Wave energy in India

The potential along the 6000 Km of coast is about 40,000 MW. In India, the research and development activity for exploring wave energy started at the Ocean Engineering Centre, Indian Institute of Technology, Madras in 1982. Primary estimates indicate that the annual wave energy potential along the Indian coast is between 5 MW to 15 MW per meter, however, the realistic and economical potential is likely to be considerably less.

Potential of tidal energy in India

The most attractive locations are the Gulf of Cambay and the Gulf of Kachchh on the west coast where the maximum tidal

range is 11 m and 8 m. The Ganges Delta in the Sunderbans in West Bengal also has good locations for small scale tidal power development.

Proposed tidal power projects in India

Kutch Tidal Power Project The proposed tidal power scheme envisages an installation of 900 MW project, the biggest in the world, located in the Hansthal Creek, 25 Kms. from Kandla Port in district of Kutch of Gujarat State.

Durgaduani Creek The country's first tidal power generation project is coming up at Durgaduani Creek of the Sundarbans. The 3.75 mw capacity Durgaduani Creek tidal energy project is a technology demonstration project and will span over an area of 4.5 km.

Nuclear energy

As India attained independence, in 1947, the Atomic Energy Commission was set up in 1948 for framing policies in respect of development of atomic energy in the country. The Department of Atomic Energy was established in 1954 with Dr.Homi.J.Bhabha as Secretary to implement the policies framed by the Atomic Energy Commission.

The **3-stage Indian nuclear programme** was conceived by Dr.Bhabha based on, unique sequential three-stages and associated technologies essentially to aim at optimum utilisation of the indigenous nuclear resource profile of modest Uranium and abundant Thorium resources. This sequential three-stage program is based on a closed fuel cycle, where the spent fuel of one stage is reprocessed to produce fuel for the next stage. The closed fuel cycle thus multiplies manifold the energy potential of the fuel and greatly reduces the quantity of waste generated

1st stage comprises of **Pressurized Heavy Water Reactors** fuelled by natural uranium which contains only 0.7% of Uranium-235, which undergoes fission to release energy. The remaining 99.3% comprises Uranium-238 which is not fissile is converted in the nuclear reactor, to fissile element Pu-239.

2nd stage comprises of **Fast Breeder Reactors (FBRs)** which are fuelled by mixed oxide of Uranium-238 and Plutonium-239, recovered by reprocessing of the first stage spent fuel. In FBRs, Plutonium-239 undergoes fission producing energy, and producing Plutonium-239 by transmutation of Uranium-238. Thus the FBRs produce energy and fuel, hence termed Breeders. Thorium-232, which constitutes world's third largest reserves in India, is not fissile therefore needs to be converted to a fissile material, Uranium-233, by transmutation in a fast breeder reactor. In the second stage, once sufficient inventory of Plutonium239 is built up, Thorium232 will be introduced as a blanket material to be converted to Uranium233.

Innovative design of reactors for direct use of thorium is also in progress in parallel to three stage program.

Current status of nuclear power in India

The first stage consisting of pHWRs has reached a state of commercial maturity and the second stage of Fast Breeder Reactors (FBRs) has been commercially launched with the construction of 500MWe FBR at Kalpakkam. The third stage systems (using U233 – Thorium232 obtained from spent fuel of second stage) have been developed at pilot scale. The development of commercial technology of third stage is under way currently.

As of March 2018, India has 22 nuclear reactors in operation in 7 nuclear power plants, having a total installed capacity of 6,780 MW. Nuclear power supplied 3.22% of Indian electricity in 2017.

Nuclear energy vs Renewable energy

The world's future is directly linked to the use of renewable energy. The importance of using renewable energy is the economy that is made with the use of cheaper resources and preservation of the environment, since most uses natural, abundant and reusable for electricity production means. The renewable energy sources are those in which the natural resources used are capable of regeneration, ie , are inexhaustible , unlike non-renewable resources such as oil .

There have been three arguments in favour of nuclear energy clean, cheap and can provide electricity 24×7 (base load). Clean it is, assuming that you could take care of the ticklish issue of putting away the highly harmful spent fuel.

But cheap, it no longer is. The average cost of electricity produced by the existing 22 reactors in the country is around ₹2.80 a kWhr, but the new plants, which cost ₹15-20 crore per MW to set up, will produce energy that cannot be sold commercially below at least ₹7 a unit. Nuclear power is pricing itself out of the market. A nuclear power plant takes a decade to come up, who knows where the cost will end up when it begins generation of electricity?

Nuclear plants can provide the 'base load' – they give a steady stream of electricity day and night, just like coal or gas plants. Wind and solar power plants produce energy much cheaper, but their power supply is irregular. With gas not available and coal on its way out due to reasons of cost and global warming concerns, nuclear is sometimes regarded as the saviour. But we don't need that saviour any more; there is a now a better option.

Nuclear energy despite being clean comes with lot of risk and security issues. The per unit cost of production, amount of capital involved in commissioning and decommissioning, nuclear waste disposal issues, transfer of technology to wrong hands

etc are discouraging many of developed countries look for renewable energy.

Ocean energy represents a significant opportunity to address the growing need for energy and the problems associated with traditional fossil fuels. There is significant room for innovation and for more routine engineering development in energy harvesting and conversion devices and in all of the infrastructure required to support the construction, installation, maintenance and decommissioning of these systems.The excitement about alternative energy suggests that ocean energy oriented projects might be a similar opportunity, though perhaps on a smaller scale. The technology may take decade to mature but ocean energy is an option worth pursuing.

For sure, ocean energy in India is in its nascent stage today. When technology improves and scale-effect kicks-in, ocean energy will look real friendly. Ocean energy is renewable energy sector that surely needs more research to satisfy condition of cost-effectiveness which is at this point it biggest flaw. Since oceans cover almost two thirds of earth’s surface, they truly present renewable energy source with extreme potential and one worth of further exploration