A Study on Charanka Solar Park and Kudankulam Nuclear Power Plant in India

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Abstract: ***Electricity generation is the process of generating electric power from different sources of energy. Nowadays electricity is very important to run each and every appliance. So, it is a big task how to generate electricity with cheaper cost to fulfill the electricity demand of the consumers. The dependence on fossil fuels, the need for reducing the carbon emissions associated with energy use and the prospects of developing a new and innovative technology sector, make solar energy increasingly attractive, However higher cost per unit of electricity is the major drawback that have held back this energy source. In India, Nuclear power holds the fourth position among the different resources of electricity, presently there are 19 nuclear power plants in India which generates 4,560 MW (2.9% of total installed base) and 4 such power plants are in the pipeline and would be generating around 2,720 MW. India's contribution in the fusion development is done through its involvement in the ITER project. This paper examines the comparative study on solar and nuclear power plant in India.***

I. INTRODUCTION

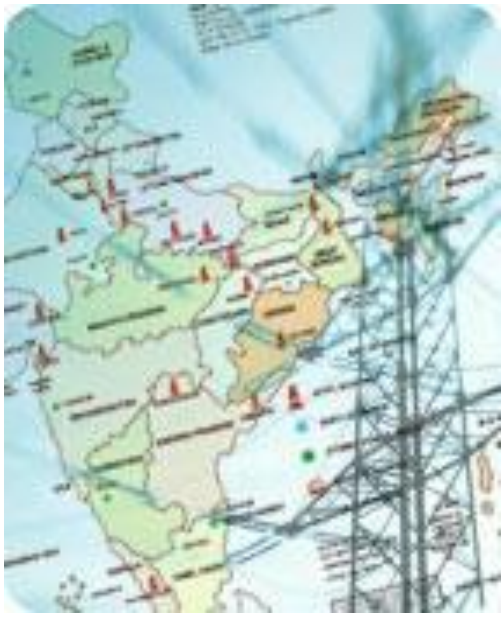
The fundamental principles of electricity generation were discovered during the 1820s and early 1830s by the scientist Michael Faraday [13]. His method is still used today for electricity generation by the movement of a loop of wire, or inserting a disc of copper between the poles of a magnet. Central power stations became economically practical with the development of production of alternating current transmission and using the power transformers to transmit power at High voltage and with low loss.

The first power plants were run on water and coal but today we rely mainly on coal, nuclear, natural gas, hydroelectric, wind power, petroleum, and also a small amount from solar energy, tidal power, and geothermal sources. Most of the electricity is generated by heat engines. And their primary source is heat. The combustion of fossil fuels supplies most of the heat to these engines, and also a significant fraction of heat from nuclear fission and some from renewable sources.

Renewable sources other than solar, wind power etc., are currently expensive to produce electricity, with advancements in technology there are making their cost of production to come down. Many governments around the world are providing subsidies to reduce the high cost and make their production economically feasible.

Power Sector at a Glance "ALL INDIA"

As on 31-01-2013
Source: CEA



Power for All by 2013

1.Total Installed Capacity:

Sector	MW	%age
State Sector	86,343.35	40.77
Central Sector	62,963.63	29.73
Private Sector	62,459.24	29.49
Total	**2,11,766.22**	

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Fuel	MW	%age
Total Thermal	**141713.68**	**66.91**
Coal	121,610.88	57.42
Gas	18,903.05	8.92
Oil	1,199.75	0.56v **n ṇṇṇ**
Hydro (Renewable)	39,416.40	18.61
Nuclear	4,780.00	2.25
RES** (MNRE)	25,856.14	12.20
Total	**2,11,766.22**	**100.00**

Renewable Energy Sources(RES) includes SHP, BG, BP, U&I and Wind Energy

SHP= Small Hydro Project ,BG= Biomass Gasifier ,BP= Biomass Power,

U & I=Urban & Industrial Waste Power, RES=Renewable Energy Sources

Note:-

1. The Hydro generating stations with installed capacity less than or equal to 25 MW are indicated under RES.

2. The installed capacity in respect of RES is as on 31.10.2012 and is based on MNRE email dated 20.11.2012 where cumulative Grid interactive power installed capacity has been indicated as 25409.33 MW. The Reconciliation of installed capacity of Hydro capacity resulted in transfer of 135 MW from conventional to SHP-RES and retrieval of installed capacity of 67.20 from SHP-RES to conventional Hydro has resulted in net addition of 67.8 MW to the SHP under RES. Also 30 MW of capacity in the nature of Waste Heat Recovery Power Plant at Goa Energy Private Limited under U&I category of RES has been added.The installed capacity due to the wind and small hydro is amounting to 508.67 MW appearing in the captive capacity has been deducted to arrive at installed capacity of utilities in respect of RES. (26267.01-508.67 + 67.8 + 30 = 25856.14).
Figures at second place of decimal may not tally due to rounding off. [14]

Nuclear Power Generation (2006-07 to 2012-13)			
Year	Gross Generation (MUs)	Capacity Factor (%)	Availability Factor (%)
2012-13 (Upto March - 2013)	32863	80	90
2011-12	32455	79	91
2010-11	26472	71	89
2009-10	18803	61	92
2008-09	14927	50	82
2007-08	16930	54	83
2006-07	18634	63	85

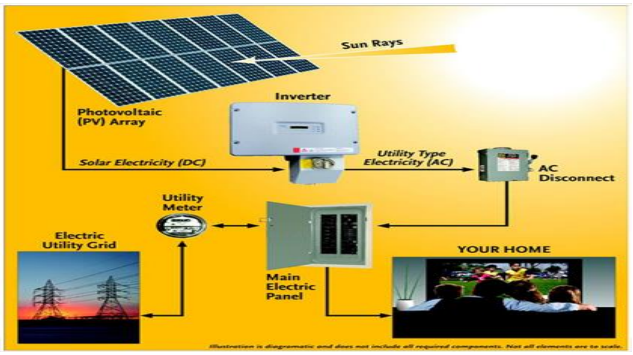
The above table shows the nuclear power generation (2006-07 to 2012-13)[18]

In this paper, the charanka solar park of Gujarat and the kudankulam nuclear power plant of Tamilnadu are compared.

II. SOLAR POWER PLANT

The first commercial concentrated solar power plant was developed in 1980's.In July 2009, India decided to produce 20GW power by 2020, but in November 2009 due to climatic changes it plans to produce 1,000MW by 2013.As by December 2010 the solar power is about 10MW. India's electric power sector had an installed capacity of 207.85GW as of September 2012 and it became the world's fifth largest. In 2012, the installed grid connected photovoltaic cells have been increased to 1040 MW. India expects to install 10,000MW by 2017 and increase is power to 20,000MW by 2022.

Item	Solar PV Power
Capacity (MW)	1
Capital Cost (Rs. in Lac/MW)	1442
Useful Life (Years)	25
Tariff Period (Years)	25
Capacity Utilization Factor (%)	19
Auxiliary Consumption (%)	--
Debt : Equity	70% : 30%
Depreciation	1st 10 years @ 7% 11th year onwards @1.33%



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A. Charanka Solar Park

Gujarat has the generation capacity of more than 14,000MW.This is the World's first Multi developer, Multi facility, Multi Technology, Multi beneficiary and eco friendly solar park. This is located near charanka village in patan district of northern Gujarat. Gujarat contributes of 2/3rd of 900MW of solar power generated in our country.

The sun is the primary energy source for almost all energy flows on the planet. It's time we started using it. Solar cells are devices that take light energy as input and convert it into electrical energy. This solar power is used to run the home appliances and lightning.

The plant consists of two phases [9]:

Phase 1: Location – Village Charanka, Taluka Santalpur, Patan district.

Objective – Dedicated > 500 MW Solar power Generation Area – Approx 2456 Ha land

Phase 2: Location – Villages Harsad, Soneth, Morwada, Dungla Dabhi&Navapura, Taluka Vav, Banaskanth district.

Building Area – Approx 1205 Ha

III. NUCLEAR POWER PLANT

India now envisages increasing the contribution of nuclear power to overall electricity generation capacity up to 9% within 25 years. [4]India's installed nuclear power generation capacity will increase to 20000 MW by 2020.

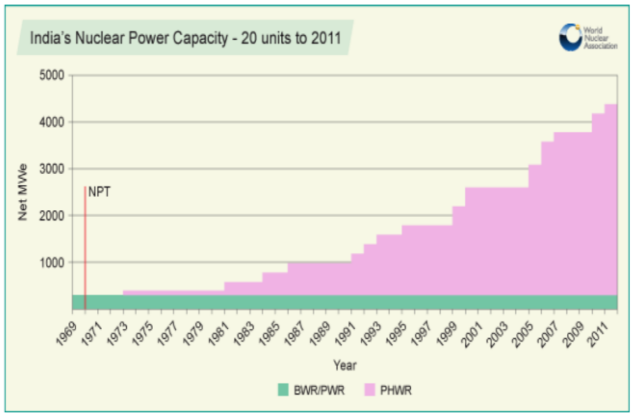
India now ranks sixth in the production of nuclear energy, behind the U.S., France, Japan, Russia, and South Korea. [4] In over 30 countries there are 439 nuclear reactors in operation around the world.

Nuclear fuel is any material that can be consumed to derive nuclear energy. The common type of nuclear fuel is fissile elements that can be made to undergo nuclear fission chain reactions in a nuclear reactor The most common nuclear fuels used for power generation are 235 Uranium and 239 Plutonium. Not all nuclear fuels are used in fission chain reaction.

A nuclear reactor is a chamber to initiate and control a sustained nuclear chain reaction. It contains moderators, control rods, coolants and supporting structures. [5]

The nuclear power plants in India are,

1. Tarapur nuclear power plant (1400MW)
2. Rawatbhata nuclear power plant (1180MW)
3. Kalpakkam nuclear power plant (440MW)
4. Narora nuclear power plant (440MW)
5. Kakrapar nuclear power plant (440MW)
6. Kaiga nuclear power plant (880MW)



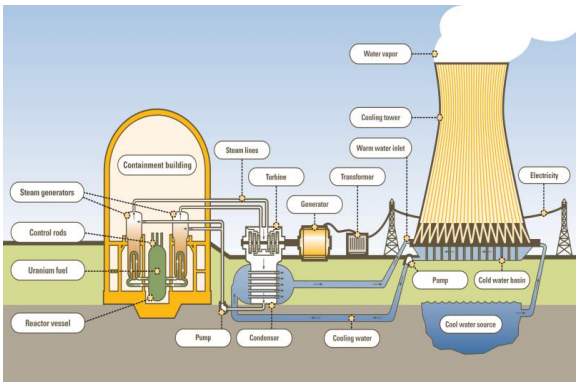
PHWR-Pressurized heavy water reactor, BWR/PWR-Boiling water Reactor/Pressurized water reactor

India has been pursuing a three stage Nuclear Power Program.

1. The first stage - Pressurized heavy water reactors (PHWRs) and associated fuel cycle facilities.

2. The second stage - Fast breeder reactors (FBRs) backed by reprocessing plants and plutonium based fuel fabrication plants.

3. The third stage – thorium -uranium-233 cycle. Utilization of thorium.



B. Kudankulam Nuclear Power Plant

Kudankulam Nuclear Power Plant is a nuclear power station in Kudankulam in the Tirunelveli district of the southern Indian state of Tamil Nadu. The Kudankulam Nuclear Power Project (KKNPP) is an Indo-Russian joint venture for establishing a nuclear power station with 2 units (KKNPP-1&2) of 1000 MW with Pressurized Water Reactor design . The construction of kudankulam plant began in1997.

The cost to India was estimated to be US$ 3 billion (Rs.13, 615 Crores) in 2001[1]. Two 1 GW reactors of the VVER-1000 model are being constructed by the Nuclear Power corporation of India Limited (NPCIL) and Atomstroy export. When completed they will become the largest nuclear power generation complex in India producing a cumulative 2 GW of electric power[2].Both units are water-cooled, water moderated power reactors[3].The first was scheduled to start operation in December 2009 and the second one was scheduled in March 2010. Currently, the official projections put unit 1 into operation in June 2011, and unit2 will go in March 2012.

The Generation power of kudankulam Nuclear power plant is 2GW.

The Thermal Power of kudankulam Nuclear power plant is 3000 MW.

In kudankulam Nuclear power plant,

The Coolant inlet temperature is 291°C

Coolant outlet temp 321°C and the

Coolant Pressure 15.7 MPa

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No. of Loops 4
No. of Control Rods 103
The Pressure is maintained by Pressurize.
The Construction:

Unit-1&2 is (2x1000 MW).The Capacity of reactor is 6800MW or 6.8GW.

There are two Reactors in kudankulam Nuclear power plant i.e., 2×1GW and the Reactor Model is VVER1000.

The Owner of kudankulam Nuclear power plant is Nuclear Power Corporation of India LTD.

Total energy = energy per fission x number of atoms

IV. COMPRARISON BETWEEN CHARANKA SOLAR PARK AND KUDANKULAM NUCLEAR POWER PLANT

A. Site Selection

SOLAR POWER PLANT:

1) Should be shade free.
2) The array should not be shaded between 9 am to 3pm
3) Receive sufficient beam of radiation.
4) Frequency of rainfall and amount of dust
5) Situated in arid to semi arid regions.

NUCLEAR PLANT:

1) Absence of natural hazards.
2) Availability of water.
3) Far from populated area.
4) Access to national grid.
5) Transportation facilities to bring large components and fuel.

B. Required Land Area [10]

The land required for constructing solar plant is approximately 2000 Ha. The land used is waste land. A large area is required for constructing Nuclear power plant. It should be located near sea or river.

C. Installation Cost[11]

The construction of solar plant started on December 30,2010. The total installation cost for this plant is about $280 million. The development cost is of about Rs.4500 crores.The installation capacity of kundankulam nuclear power plant is 136.15 million

D. Generation Capacity[11]

Charanka solar park has the total generation capacity of 590MW. The generation capacity of Nuclear power plant is 9200MW.

E. Cost Per Unit [12]

Initially the cost of the solar power is Rs.15 per unit but later it has been reduced to Rs.8.50 per unit. In future as the production of solar power increases the cost will go down at Rs.4 per unit. And may even decrease in future when the solar power generation increases. Initially the cost per unit is high in order to recover the capital.

F. The Electrical Power Produced

The Electrical Power produced in charanka solar park is 214MW at present, which is more than the China's 200 MW Golmund Solar park and the Electrical Power produced is 1000 MW.

G. Advantages And Dis-advantages Of Charanka Solar Power Park

ADVANTAGES:

1) Solar energy is completely a renewable resource.
2) It is pollution free. Since no smoke is emitted into the air. And it does not cause global warming.
3) Little maintenance is required during their life span.
4) Most of the solar energy systems have a life span of about 30 to 40 years.
5) Easy installation and no need of wires and power sources.
6) Can reduce the electricity bills
7) At present solar energy systems are designed for particular needs. And even the solar cells can be placed directly on the lights which cannot be seen.

DISADVANTAGES:

1) It is not possible to get the solar power during night time, stormy and cloudy days.
2) The PV panel should be free from dirt and dust.
3) Once the solar energy equipment is installed it is not possible to replace it for 40yrs of it life span. However the cost might might be.

H. Advantages And Dis-advantages Of Nuclear Power Plant

ADVANTAGES [8]

1) Nuclear power plants produce no air pollutants, such as sulphur and particulates.
2) There is no release of greenhouse gases
3) The High amount of energy can be generated from a single nuclear power plant .
4) Nuclear power plants are more efficient
5) Small amount of fuel is required to produce large energy
6) Running costs are relatively low.
7) Nuclear plants operate as base load plants. Therefore the plant availability factor and the load factor of the plant is quite high.

DISADVANTEGS [8]

1) Radioactive wastage and storage problem.
2) It requires large capital cost.
3) The nuclear reactors will work only as long as uranium is available.
4) It requires large mass of water for cooling

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purpose. Therefore the plant should be located near sea or river.

5) It requires large area around the plant to be isolated from living.
6) During shutdown of the reactor, decay heat is produced from the reactor due to the fission daughter product.
7) Building of a new nuclear power generation plant is in the range of 20 to 30 years.
8) Mining and transportation is costly and is dangerous.

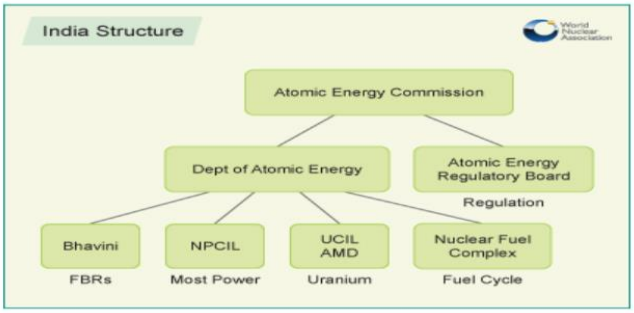
V. THE PROBLEMS WHICH ARE FACED[7]

Even now in generating power in kudankulam nuclear power plant are:

1) Protest from public
2) Fuel shortage
3) Disposal of nuclear wastages
4) Leakage of radiations
5) Safety concern

VI. REGULATION AND SAFETY

The Atomic Energy Commission (AEC) established in 1948 under the Atomic Energy Act as policy body. Then in 1954 the Department of Atomic Energy (DAE) was set up to encompass the research, technology development and commercial reactor operation. The current Atomic Energy Act in 1962, and it permits only government-owned enterprises to be involved in nuclear power.



VII. CONCLUSION

The solar plant wins every way from nuclear plant. Whether through solar power plant or through nuclear power plant, the production of power is increasing day by day. But now. the cost per unit of electricity is much less in solar when compared to nuclear power plant in India .As the fossil fuels are declining slowly the demand for the solar power will increase in future . Due to this reason Gujarat is yet to start another new solar power plant in India. If the energy demand still increases there will be solar panels in every house to meet their electricity demand. Economic feasibility is not always the determining factor in selecting a power generation system. More days has passed when the cost of conventional energy was significantly lower than the cost of solar energy. At present the coal's increased price is driving the higher cost of electricity.

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