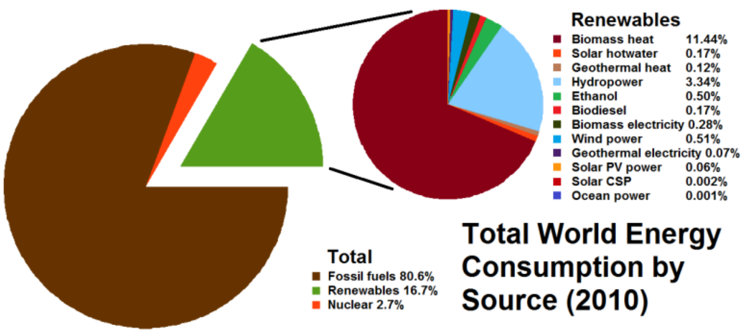
CHAPTER-1
INTRODUCTION

For every calorie of food produced in the industrial world, ten calories of oil and gas energy are invested in the forms of fertilizer, pesticide, packaging, transportation, and running farm equipment’s (Michael Rupert (2009).Collapse).The modern economies relies much on a vast energy supply to fuel everything from transportation to communication to security and health delivery systems. Energy is thus quintessential for everybody's quality of life and a crucial for economic development and progress of nations. The economic competence of nation is directly related to availability of energy resources and the effective usage of these available resources, as it fuels the economic engine.

In 2012, the IEA estimated that the world energy consumption was 155,505terawatthour(TWh),or5.598×1020joule[Oil(40.7%)Coal/Peat/Shale(10.1%)Natural Gas (15.2%)Biofuels and waste (12.4%)Electricity (18.1%)Others (renewable) (3.5%)](“2014 Key World Energy Statistics ”,IEA). In 2011, expenditures on energy totalled over 6 trillion USD, or about 10% of the world GDP. Europe spends close to one quarter of the world energy expenditures, Americans close to 20%, and Japan 6 %(Nathalie Desbrosses2011, World Energy Expenditures).World energy consumption is growing at 2.3% per year ("International Energy Annual 2006")

The twentieth century saw a rapid twenty-fold increase in the use of fossil fuels. More than three quarters of the world's energy consumption now comes from fossil fuels. The Energy Information Administration estimates that in 2007 the primary sources of energy consisted of petroleum 36.0%, coal 27.4%, and natural gas 23.0%, amounting to an 86.4% share for fossil fuels in primary energy consumption in the world. In 2012, world energy consumption by power source was oil 31.4%, coal 29.0%, natural gas 21.3%, biofuels and waste 10.0%, nuclear 5.8%, and 'other' (hydro, peat, solar, wind, geothermal power, etc.) 1.1% (2014 Key World Energy Statistics”,IAE pp. 6,24,28). Fossil fuels are widely preferred because of its abundance, High calorific value, Stability, ease of transport and storage and comparatively lower costs.

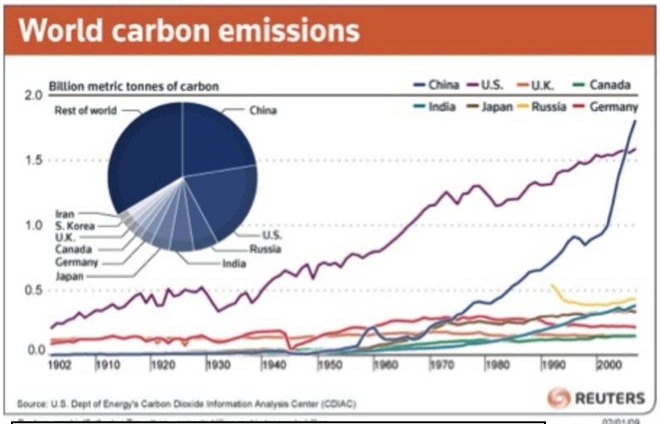


GRAPH 1.1 World energy consumption Renewables 2012 Global Status Report.

It is an incontrovertible fact that the last two hundred years of accelerated growth in mankind's numbers and achievements were only made possible by cheap, easily available fossil fuels. It is distressing fact that this propellant of progress will eventually outstrip the ability of the earth to regenerate its stores of energy. Crude oil reserves are vanishing at the rate of 4 billion tonnes a year (CIA world fact book). The global population and energy needs increase hand-in-hand, if we carry on at this rate without any increase for our growing population or aspirations, our known oil deposits, gas deposits, coal deposits will be gone by 2052,2066,2088 respectively(CIA world fact book).

The use of fossil fuels raises serious environmental concerns. The burning of fossil fuels produces around 21.3 billion tonnes (21.3 giga tonnes) of carbon dioxide (CO_2) per year, but it is estimated that natural processes can only absorb about half of that amount, so there is a net increase of 10.65 billion tonnes of atmospheric carbon dioxide per year (one tonne of atmospheric carbon is equivalent to 3.7 tonnes of carbon dioxide) ("What Are Greenhouse Gases?”. US Department of Energy). Human activities since the beginning of the Industrial Revolution (1750) have produced a 40% increase in the atmospheric concentration of carbon dioxide, from 280 ppm in 1750 to 400 ppm in 2015.(Blasing, T. J. (February 2013), Current Greenhouse Gas Concentrations),

If greenhouse gas emissions continue at the present rate, Earth's surface temperature could exceed historical values as early as 2047, with potentially harmful effects on ecosystems, biodiversity and the livelihoods of people worldwide (Mora, C (2013). "The projected timing of climate departure from recent variability". Nature 502: 183–187). According to the World Resources Institute's Climate Analysis IndicatorsTool (CAIT), the top 10 emitters contributed 78 percent of global CO2 emissions in 2011,China (23.6%),U.S (17.9%),India(5.7%) leading this list



GRAPH 1.2 World carbon emissions

Climate change and the need to manage diminishing fossil fuel reserves are, today, two of the biggest challenges facing the planet. In order to secure the future for ourselves and generations to follow, it's obligatory that we must act now to reduce energy consumption and substantially cut greenhouse gases, such as carbon dioxide. Numerous treaties and protocols have been signed in order to ensure that the countries stay together and use every available resource and techniques to tackle the problem of climate change. Climate change concerns and increasing in green jobs, coupled with high oil prices, peak oil, oil wars, oil spills, promotion of electric vehicles and renewable electricity and increasing government support, are driving increasing renewable energy legislation, incentives and commercialization. Projects are generally more likely to succeed because it's broad public support and the consent of local communities. Renewable technologies increases the diversity of electricity sources and, through local generation, contributes to the flexibility of the system and its resistance to central shocks.

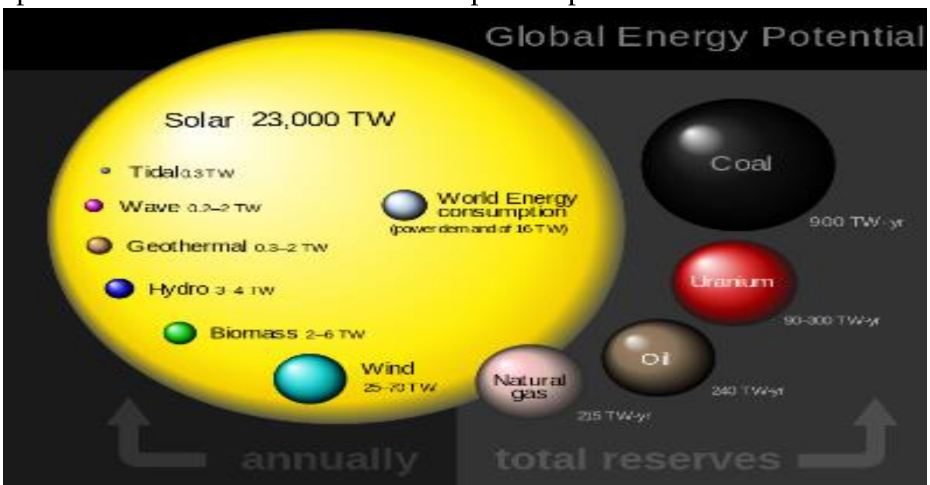
renewable energy-solar, wind, hydroelectric, geothermal and biomass-provides considerable benefits for our climate, our economy, and our health. According to data aggregated by the International Panel on Climate Change, life-cycle global warming emissions associated with renewable energy—including manufacturing, installation, operation and maintenance, and dismantling and decommissioning—are minimal. (Intergovernmental Panel on Climate Change (IPCC). 2011. IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation.) Compared with natural gas, which emits between 0.6 and 2 pounds of carbon dioxide equivalent per kilowatt-hour (CO2E/kWh), and coal, which emits between 1.4 and 3.6 pounds of CO2E/kWh, wind emits only 0.02 to 0.04 pounds of CO2E/kWh, solar 0.07 to 0.2,geothermal 0.1 to 0.2, and hydroelectric between 0.1 and 0.5.

Generating electricity from renewable energy rather than fossil fuels offers significant public health benefits. The air and water pollution emitted by coal and natural gas plants is linked to breathing problems, neurological damage, heart attacks, and cancer. Replacing fossil fuels with renewable energy has been found to reduce premature mortality and lost workdays, and it reduces overall healthcare costs. (Machol, Rizk. 2013. Economic value of U.S. fossil fuel electricity health impacts. Environment International 52 75–80.) Wind, solar, and hydroelectric sources generate electricity with no associated air pollution emissions. While geothermal and biomass energy sources emit some air pollutants, but the total air emissions are generally much lower than those of coal- and natural gas-fired power plants.

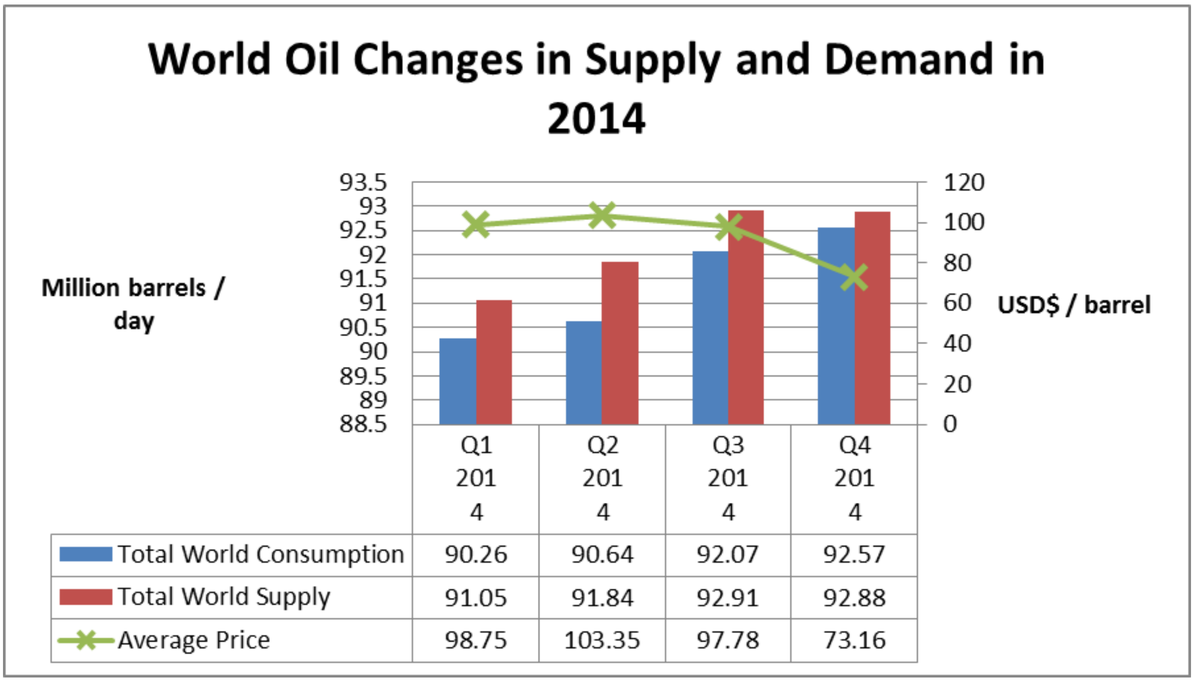
Renewable energy already supports thousands of jobs. In the United States for example, in 2011, the wind energy industry directly employed 75,000 full-time-equivalent employees in a variety of capacities, including , project development ,manufacturing, construction and turbine installation, operations and maintenance, transportation and logistics, and financial, legal, and consulting services. (American Wind Energy Association (AWEA). 2012a. AWEA U.S. Wind Industry Annual Market Report: Year Ending 2011.) Increasing renewable energy has the potential to create still more jobs. In 2009, the Union of Concerned Scientists conducted an analysis of the economic benefits of a 25 percent renewable energy standard by 2025; it found that such a policy would create more than three times as many jobs as producing an equivalent amount of electricity from fossil fuels—resulting in a benefit of 202,000 new jobs in 2025 .(UCS. 2009. Clean Power Green Jobs

In addition to creating new jobs, increasing our use of renewable energy offers other important economic development benefits. Local governments can collect property and income taxes and other payments from renewable energy project owners. These revenues can help support essential public services, especially in rural communities where projects are often located. A 2011 IEA report said: "A portfolio of renewable energy technologies is becoming cost-competitive in an increasingly broad range of circumstances, in some cases providing investment opportunities without the need for specific economic support," and added that "cost reductions in critical technologies, such as wind and solar, are set to continue."(Henning Gloystein (Nov 23, 2011). "Renewable energy becoming cost competitive, IEA says". Reuters) The cost of generating electricity from wind dropped more than 20 percent between 2010 and 2012 and more than 80 percent since 1980(AWEA. 2012b. Federal Production Tax Credit for Wind Energy.) The cost of renewable energy will decline even further as markets mature and companies increasingly take advantage of economies of scale.

Even though renewable systems require initial investments to build, once built they operate at very low cost and, for most technologies, the fuel is free. As a result, renewable energy prices are relatively stable over time. Utilising more renewable energy can lower the prices of and demand for natural gas and coal by increasing competition and diversifying our energy supplies. An increased reliance on renewable energy can help protect consumers when fossil fuel prices spike.



GRAPH 1.3 Global energy potential Perez et al., 2009, "A Fundamental Look at Energy Reserves for the



GRAPH 1.4 world oil changes in supply and demand 2014

: Source: US Energy Information Administration Database of the Short-Term Energy Outlook, January 13, 2015, http://www.eia.doe.gov/steo/cf_query/index.cfm.

Renewable energy resources and significant opportunities for energy efficiency exist over wide geographical areas, in contrast to other energy sources, which are concentrated in a limited number of countries. Rapid deployment of renewable energy and energy efficiency, and technological diversification of energy sources, would result in significant energy security and economic benefits. (International Energy Agency (2012). "Energy Technology Perspectives 2012"). The IEA 2014 World Energy Outlook projects a growth of renewable energy supply from 1,700 gigawatts in 2014 to 4,550 gigawatts in 2040

Selected renewable energy global indicators	2008	2009	2010	2011	2012	2013	2014
Investment in new renewable capacity (annual) (109 USD)[66]	182	178	237	279	256	232	270
Renewables power capacity (existing) (GWe)	1,140	1,230	1,320	1,360	1,470	1,578	1,712
Hydropower capacity (existing) (GWe)	885	915	945	970	990	1,018	1,055
Wind power capacity (existing) (GWe)	121	159	198	238	283	319	370
Solar PV capacity (grid-connected) (GWe)	16	23	40	70	100	138	177
Solar hot water capacity (existing) (GWth)	130	160	185	232	255	373	406
Ethanol production (annual) (109 litres)	67	76	86	86	83	87	94

Biodiesel production (annual) (109 litres)	12	17.8	18.5	21.4	22.5	26	29.7
Countries with policy targets for renewable energy use	79	89	98	118	138	144	164

Table 1.1 Global status report on renewables

Source: The Renewable Energy Policy Network for the 21st Century (REN21)–Global Status Report REN21 (2011). "Renewables 2011: Global Status Report"). p. 15. REN21 (2012). Renewables Global Status Report 2012 p. 17,"REN21 2013 Renewables Global Status Report" , REN21. "Renewables 2014: Global Status Report".

It is however important, to understand the environmental impacts associated with producing power from renewable sources such as wind, solar, geothermal, biomass, and hydropower. The exact type and potency of environmental impacts varies according to the specific technology used, the geographic location, and numerous other factors. By understanding the current and probable environmental issues associated with each renewable energy source, so that we can takes steps to effectively avoid or minimize these impacts to ensure that power demands are met sustainably.

There are quite few apprehensions about effectiveness and environmental impact of renewable power systems. Many fear that renewables like wind and solar and biomass will certainly play roles in a future energy economy, but those energy sources cannot scale up fast enough to deliver cheap and reliable power at the scale .

1. Reliability of Supply: One shortcoming is that renewable energy relies heavily upon the weather for sources of supply: rain, wind, and sunshine. In the event of weather that doesn't produce these kinds of climate conditions renewable energy sources lack the capacity to make energy. Since it may be difficult to generate the necessary energy due to the unpredictable weather patterns, we may need to reduce the amount of energy we use.

2. Difficult to Generate in Large Quantity: Another disadvantage of renewable energy is that it is difficult to generate large amount of energy as those produced by coal powered plants. This means that either we need to set up more such facilities to match up with the growing demand or look out for ways to reduce our energy consumption.

3. Large Capital Cost: Initial investments are quite high in case of building renewable energy plants. These plants require upfront investments to build, have high maintenance expenses and require careful planning and implementation.

4. Large Tracts of Land Required: To meet up with the large quantities of electricity produced by fossil, large amount of solar panels and wind farms need to be set up. For this, large tracts of land is required to produce energy quantities competitive with fossil fuel burning. Each turbine will need a patch of land 0.23 / km^2 (square kilometres), or 550 yards on a side. A rough rule of thumb is to figure on four large turbines per square kilometre, or ten per square mile. But before we put the numbers together, there are two more things to consider. Alternative energy faces the challenge of how to supplant a fossil-fuel-based supply chain with one driven by alternative energy forms themselves in order to break their reliance on a fossil-fuel foundation.

4. Scalability and Timing: For the promise of an alternative energy source to be achieved, it must be supplied in the time frame needed, in the volume needed, and at a reasonable cost

5. Commercialization: Closely related to the issue of scalability and timing is commercialization, or the question of how far away a proposed alternative energy source stands from being fully commercialized...

6. Substitutability Ideally, an alternative energy form would integrate directly into the current energy system as a "drop-in" substitute for an existing form without requiring further infrastructure changes...

7. Material Input Requirements: Unlike what is generally assumed, the input to an alternative energy process is not money per se: It is resources and energy, and the type and volume of the resources and energy needed may in turn limit the scalability and affect the cost and feasibility of an alternative...

8. Intermittency: Modern societies expect that electrons will flow when a switch is flipped, that gas will flow when a knob is turned, and that liquids will flow when the pump handle is squeezed. This system of continuous supply is possible because of our exploitation of large stores of fossil fuels, which are the result of millions of years of intermittent sunlight concentrated into a continuously extractable source of energy. Alternative energies such as solar and wind power, in contrast, produce only intermittently as the wind blows or the sun shines, and even biomass-based fuels depend on seasonal harvests of crops...

9. Energy Density: Energy density refers to the amount of energy that is contained in a unit of an energy form...The consequence of low energy density is that larger amounts of material or resources are needed to provide the same amount of energy as a denser material or fuel. Many alternative energies and storage technologies are characterized by low energy densities, and their deployment will result in higher levels of resource consumption...

10. Water: Water ranks with energy as a potential source of conflict among peoples and nations, but a number of alternative energy sources, primarily biomass-based energy, are large water consumers critically dependent on a dependable water supply...

11. The Law of Receding Horizons: An often-cited metric of the viability of alternatives is the expected break-even cost of the alternative with oil, or the price that crude oil would have to be to make the alternative cost competitive. Underlying this calculation, however, is an assumption that the input costs to alternative energy production would remain static as oil prices rise, thereby providing the economic incentive to development. This assumption, however, has not always proved to be the case, particularly for those alternatives for which energy itself is a major input. Because of price linkages in the energy (and now energy and biomass) markets, rising oil prices tend to push up the price of natural gas as well as coal; for processes that are heavily dependent on these fuels, higher oil prices also bring higher production costs.

12. Energy Return on Investment: The complexity of our economy and society is a function of the amount of net energy we have available. "Net energy" is, simply, the amount of energy remaining after we consume energy to produce energy. Consuming energy to produce energy is unavoidable, but only that which is not consumed to produce energy is available to sustain our industrial, transport, residential, commercial, agricultural, and military activities. The ratio of the amount of energy we put into energy production and the amount of energy we produce is called "energy return on investment" (EROI).

13. **Life-Cycle Global Warming Emissions:** While there are no global warming emissions associated with generating electricity from renewable sources, there are emissions associated with other stages of the renewable life-cycle, including manufacturing, materials transportation, installation, maintenance, and decommissioning and dismantlement. Estimate of life-cycle emissions for photovoltaic systems are between 0.07 and 0.18 pounds of carbon dioxide equivalent per kilowatt-hour. Estimates of wind turbine life-cycle global warming emissions are between 0.02 and 0.04 pounds of carbon dioxide equivalent per kilowatt-hour. To put this into context, estimates of life-cycle global warming emissions for natural gas generated electricity are between 0.6 and 2 pounds of carbon dioxide equivalent per kilowatt-hour and estimates for coal-generated electricity are 1.4 and 3.6 pounds of carbon dioxide equivalent per kilowatt-hour**(IPCC, 2011: IPCC Special Report on Renewable Energy**

Sources and Climate Change Mitigation. Prepared by Working Group III of the Intergovernmental Panel on Climate Change [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1075 pp. (Chapter 7 & 9), National Academy of Sciences. 2010. Electricity from Renewable Resources: Status, Prospects, and Impediments.)

Another main source of clean energy is nuclear power. Atoms are constructed like miniature solar systems. Nuclear energy is the energy in the nucleus, or core, of an atom. Atoms are tiny units that make up all matter in the universe. Energy is what holds the nucleus together. There is a huge amount of power in an atoms dense nucleus. The nucleus is at the centre of the atom; orbiting around it are electrons. The nucleus is composed of protons and neutrons, very densely packed together. Hydrogen, the lightest element, has one proton; the heaviest natural element, uranium, has 92 protons.

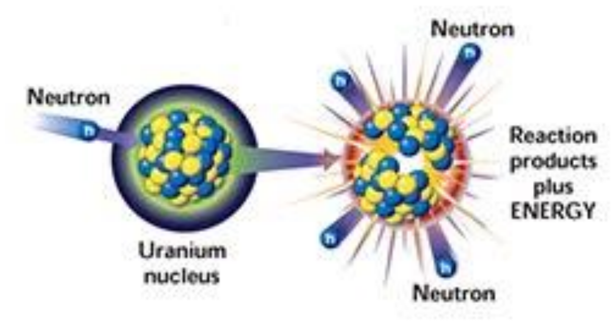


Figure 1.1 Process of fission

The nucleus of an atom is held together with great force, the "strongest force in nature." When bombarded with a neutron, it can be split apart, a process called fission (pictured to the right). Because uranium atoms are so large, the atomic force that binds it together is relatively weak, making uranium good for fission.

In nuclear power plants, neutrons collide with uranium atoms, splitting them. This split releases neutrons from the uranium that in turn collide with other atoms, causing a chain reaction. This chain reaction is controlled with "control rods" that absorb neutrons.

In the core of nuclear reactors, the fission of uranium atoms releases energy that heats water to about 520 degrees Fahrenheit. This hot water is then used to spin turbines that are connected to generators, producing electricity.

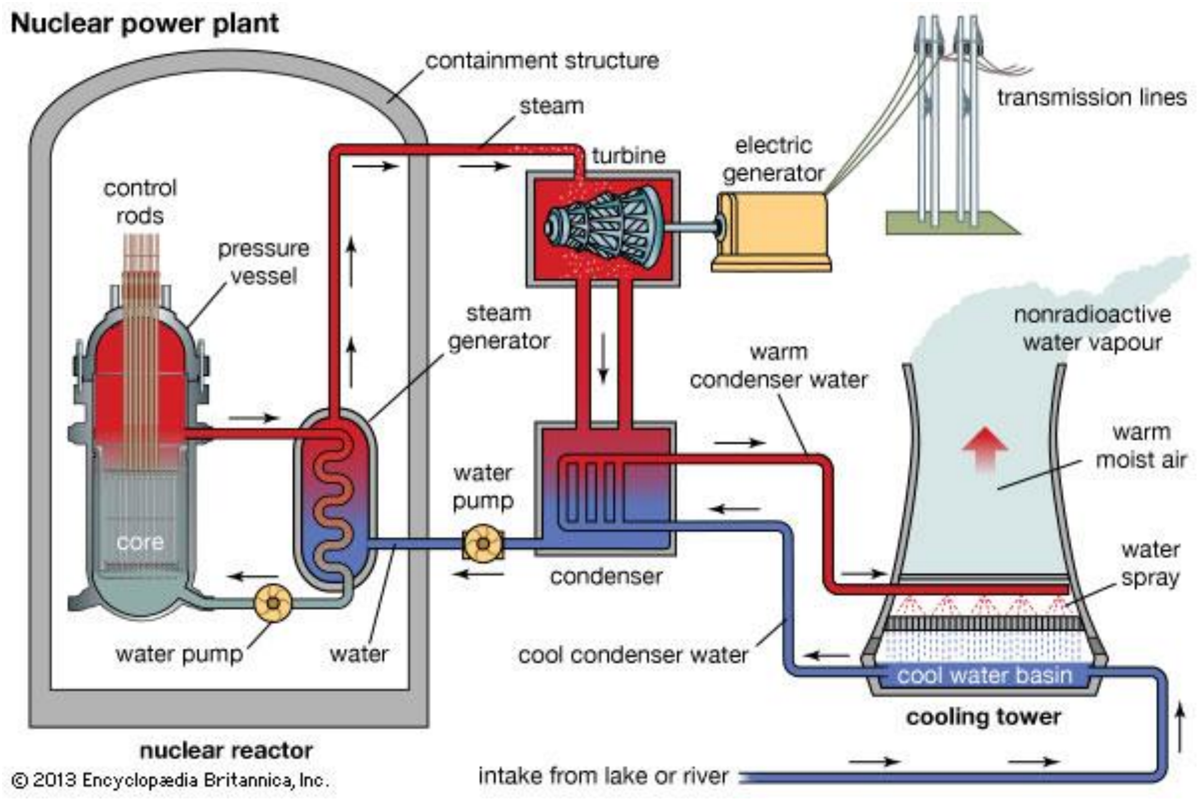


FIG 1.2 Nuclear power plant

The amount of energy released in nuclear reactions is astounding.

Material	**Energy (MJ/kg)**	**Density**	**100W light bulb time (1kg)**
Wood	10		1.2 days
Ethanol	26.8		3.1 days
Coal	32.5		3.8 days
Crude oil	41.9		4.8 days
Diesel	45.8		5.3 days
Natural Uranium (LWR)	5.7×10^5		182 *years*
Reactor Grade Uranium (LWR)	3.7×10^6		1,171 *years*

Natural Uranium (breeder)	8.1x10^{7}	25,700 *years*
Thorium (breeder)	7.9x10^{7}	25,300 *years*

Table 1.2: Energy densities of various energy sources in MJ/kg and in length of time that 1 kg of each material could run a 100W load.

Nuclear History

Early discoveries

No scientific progress every really starts. Rather, it builds on the work of countless other discoveries. Since we have to start somewhere, this story will start in Germany, in 1895, where a fellow named Roetgen was experimenting with cathode rays in a glass tube that he had sucked the air out of. At one point, he had the device covered but noticed that the photographic plates off to the side were lighting up when the device was energized. He realized that he was looking at a new kind of ray, and called it what any reasonable physicist would call an unknown: the X-ray. He systematically studied these rays and took the first x-ray photo of his wife's hand two weeks later, thereby becoming the father of modern medical diagnostics.

Soon after in France, in 1896, a guy named Becquerel noticed that if he left uranium salts sitting on photographic plates, they would expose even though no cathode ray tube was energized. The energy must have been coming from inside the salts themselves. Marie Curie and her husband Pierre studied the phenomenon and isolated two new elements that exhibited this spontaneous energy production: Polonium and Radium. They named the phenomenon "radioactivity".

In England, Ernest Rutherford starts studying radioactivity and discovers that there are two types of rays that come out that are different from x-rays. He calls them alpha- and beta-radiation. He later discovers the shocking fact that the vast majority of the mass of atoms is concentrated in their centres, and thus discovers the atomic nucleus. He is widely regarded today as the father of nuclear physics. He later discovers gamma radiation. In 1920, he theorizes the existence of a neutral particle in the nucleus called a neutron, though there is no evidence that neutrons exist yet.

In 1932, Chadwick reads some published results from the Curie's kid, Irene Joliot-Curie that says gamma radiation was found to knock protons out of wax. Disbelieving, he suspects they are seeing Rutherford's neutrons and does experiments to prove this, thus discovering the neutron.

Fission and the bomb

With neutrons around, everyone's shooting them at various nuclides. Soon enough, Hahn and Strassman shoot them at uranium atoms and see some strange behaviour which Lise Meitner and her nephew Frisch identify as the splitting of the atom, releasing much energy. They name it fission, after binary fission in biology.

Szilard recognizes fission as a potential way to form a chain reaction (which he had been considering for a long time). He and Fermi do some neutron multiplication studies and see that it is indeed possible. They go home, knowing that the world is about to change forever.

Szilard, Wigner, and Teller write a letter to President Roosevelt, warning of nuclear weapons, and have Einstein sign it and send it (he was more famous). Roosevelt authorizes a small study into uranium. In 1942, Fermi successfully created the first man-made nuclear chain reaction in a squash court under the stadium at the University of Chicago. The Manhattan project kicked into full gear. Two types of bombs were pursued simultaneously, one made with enriched uranium, and the other made with plutonium. Giant secret cities were built very quickly. The one in Oak Ridge, TN had a reactor that created the first gram-quantities of plutonium for study, but its main task was to enrich uranium. The one in Hanford, WA is the site of plutonium production reactors (the first high-power nuclear reactors) and plutonium extraction chemistry plants. Another, in Los Alamos, NM is the site where the technology that turns weapons materials into weapons is developed. Both paths to the bomb are successful. The more uncertain design, the plutonium implosion device (like Fat Man) is successfully tested at the Trinity site in New Mexico in July, 1945.

The decision is made to drop Little Boy and Fat Man on Hiroshima and Nagasaki, Japan on August 6th and 9th, 1945. The cities are devastated, with up to 250,000 people dead. Japan surrenders unconditionally 6 days later, on August 15th, 1945. This is the first time the public realizes that the US has been developing bombs.

Fission energy expands in application

An experimental liquid-metal cooled reactor in Idaho called EBR-I was attached to a generator in 1951, producing the first nuclear-generated electricity. But before civilian power plants came to be, Admiral Rickover pushed to use reactors to power submarines, since they wouldn't need to refuel, or to use oxygen for combustion. The USS Nautilus launched in 1954 as the first nuclear-powered submarine. Soon after, the Soviet Union opens the first non-military, electricity producing reactor. Based on the submarine reactor design, the Shipping port reactor opens in 1957 as the first commercial reactor in the USA.

Nuclear energy expands and stagnates

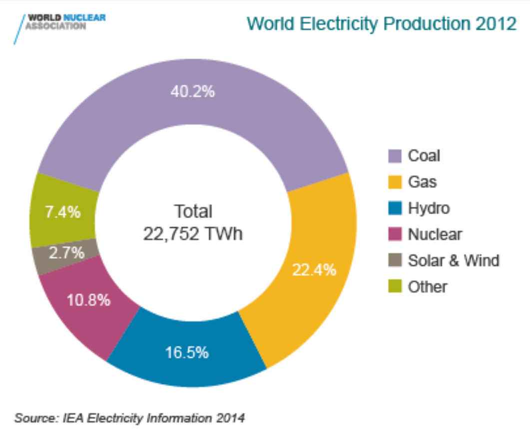
Through the 60s and 70s, lots of nuclear reactors are built for making electricity, using designs very similar to those made for the submarines. They work well and produce cheap, emission-free electricity with a very low mining and transportation footprint. A nuclear powered future is envisioned by many. In 1974, France decided to make a major push for nuclear energy, and ended up with 75% of their electricity coming from nuclear reactors. The US built 104 reactors, and got about 20% of its electricity from them. Eventually, labour shortages and construction delays started bringing the cost of nuclear reactors up, slowing their growth.

The 1979 Three Mile Island accident and the 1986 Chernobyl accident further slowed the deployment of nuclear reactors. Tighter regulations brought costs higher. The 1986 passive safety tests at EBR-II prove that advanced reactor designs (besides the ones originally used to make submarines) can be substantially safer. These tests have major failure occur with no control rods inserted and the reactors shut themselves down automatically.

In 1994, the Megatons to Megawatts treaty with Russia is signed to down blend nuclear warheads into reactor fuel. Eventually, 10% of US electricity comes from dismantled nuclear weapons.

In the late '90s and '00s, the phenomenal safety record of the US commercial reactor fleet (0 deaths) and smooth operation of reactors combined with ongoing worries of global climate change due to carbon emissions brings about substantial talk of a "nuclear renaissance", where new builds might start up substantially again. Meanwhile, strong interest in Asia strengthens and ambitious plans to build large fleets are made to satisfy growing energy needs without adding more fossil fuel.

On March, 2011, a large earthquake and tsunami inundate the reactors at Fukushima Daiichi.



GRAPH 1.5 2012 World [civil] electricity generation by fuels
(IEA 2014)"2014 Key World

Backup diesel generators fail and the decay heat cannot be cooled. Fuel melts, hydrogen builds up and explodes (outside of containment). Radiation is released, but much of it goes out to sea instead of into populated area. No people expected to die from radiation dose.

Going forward

March, 2013, famous climate scientist James Hansen co-publishes a paper from NASA computing that, even with worst case estimates of nuclear accidents, nuclear energy as a whole has saved 1.8 million lives and counting by offsetting the air-pollution related deaths that come from fossil fuel plants.

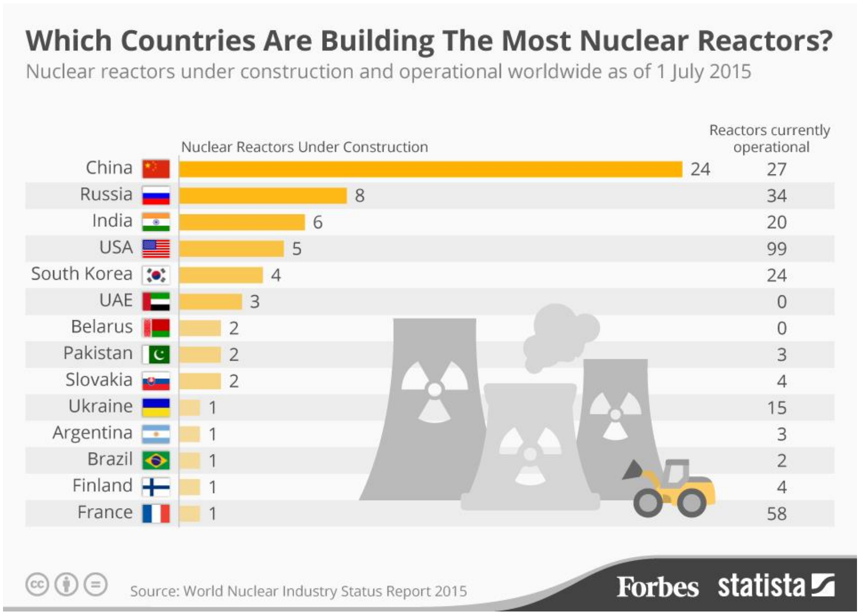
September 2013, Voyager I enters interstellar space, 36 years after its launch. It is powered by a Plutonium-238 radio isotopic thermal generator.

Civil nuclear power can now boast over 16,000 reactor years of experience and supplies almost 11.5% of global electricity needs, from reactors in 31 countries. In fact, through regional grids, many more than those countries depend on nuclear-generated power.

Today, only eight countries are known to have a nuclear weapons capability. By contrast, 56 operate about 240 civil research reactors, over one third of these in developing countries. Now 31 countries host over 435 commercial nuclear power reactors with a total installed capacity of over 375,000 MWe. This is more than three times the total generating capacity of France or Germany from all sources. About 70 further nuclear power reactors are under construction, equivalent to 20% of existing capacity, while over 160 are firmly planned, and equivalent to half of present capacity.

In 2013, the IAEA reported that there are 437 operational civil fission-electric reactors in 31 countries (**"PRIS - Home". Iaea.org.**), although not every reactor is producing electricity.[17] In addition, there are approximately 140 naval vessels using nuclear propulsion in operation, powered by some 180 reactors. ("Nuclear-Powered Ships | Nuclear Submarines". *World-nuclear.org*).

In 2015, the IAEA report that worldwide there were 67 civil fission-electric power reactors under construction in 15 countries including Gulf States such as the United Arab Emirates (UAE**).("PRIS - Home"**. *Iaea.org*.**)** Over half of the 67 total being built are in Asia, with 28 in the Peoples Republic of China(PRC), with the most recently completed



GRAPH 1.6 Nuclear reactors under construction 2015

fission-electric reactor to be connected to the electrical grid, as of August 2015, occurring in Wolseong Nuclear Power Plant in the Republic of Korea.(**http://www.nucnet.org/all-the-news/2015/07/24/south-korea-s-shin-wolsong-2-enters-commercial-operation)** Five other new grid connections were completed by the Peoples Republic of China so far this year. In the USA, four new Generation III reactors are under construction at Vogtle and Summer station, while a fifth is nearing completion at Watts Bar station, all five are expected to enter service before 2020. In 2013, four aging uncompetitive U.S reactors were closed.

Sixteen countries depend on nuclear power for at least a quarter of their electricity. France gets around three-quarters of its power from nuclear energy, while Belgium, Czech Republic, Finland, Hungary, Slovakia, Sweden, Switzerland, Slovenia and Ukraine get one-third or more. South Korea and Bulgaria normally get more than 30% of their power from nuclear energy, while in the USA, UK, Spain, Romania and Russia almost one-fifth is from nuclear. Japan is used to relying on nuclear power for more than one-quarter of its electricity and is expected to return to that level. Among countries which do not host nuclear power plants, Italy and Denmark get almost 10% of their power from nuclear.

. There are number of characteristics of nuclear power which make it particularly valuable apart from its actual generation cost per unit – MWh or kWh. Fuel is a low proportion of power cost, giving power price stability, its fuel is on site (not depending on continuous delivery), it is dispatch able on demand, it has fairly quick ramp-up, it contributes to clean air and low-CO2 objectives, it gives good voltage support for grid stability. These attributes are mostly not monetised in merchant markets, but have great value which is increasingly recognised where dependence on intermittent sources has grown. (http://www.world-nuclear.org/info/Current-and-Future-Generation/Nuclear-Power-in-the-World-Today)

Nuclear energy is a clean source of baseload, always-on electricity that promotes healthy air quality and helps meet our nation's future energy needs. It has the lowest impact on the environment of any energy source and is one of the nation's largest sources of electricity that emits virtually no greenhouse gas emissions.

Some environmentalists are enchanted by the simplicity of solar cells and the pristine elegance of wind turbines, and they refuse to accept the fact that they are quantitatively incapable of supplying the energy required by an industrial civilization.

I do not mean to say that these renewable energies should be excluded; they are useful and have important niche roles to play – in remote locations and under special circumstances. But they can make only a marginal contribution to the energy needs of a growing industrial civilization. Let me give an example. To replace just one nuclear reactor, such as the new EPR reactor which France is now building in Normandy, with the most modern wind turbines (twice as high as Notre-Dame, the Cathedral of Paris), they would have to be lined up all the way from Genoa in Italy to Barcelona in Spain (about 700 kilometres/400miles). And, even so, they generate electricity only when the wind blows (their average yield is about 25% of their rated capacity). The entire arable surface of the Earth could not produce enough biofuel to replace present oil consumption.

Nuclear power is clean, safe, reliable, compact, competitive and practically inexhaustible. Today over 400 nuclear reactors provide base-load electric power in 30 countries. Fifty years old, it is a relatively mature technology with the assurance of great improvement in the next generation

Nuclear power is a very controversial method of producing electricity,

1**. Radioactive Waste**: The waste produced by nuclear reactors needs to be disposed off at a safe place since they are extremely hazardous and can leak radiations if not stored properly. Such kind of waste emits radiations from tens to hundreds of years. The storage of radioactive waste has been major bottleneck for the expansion of nuclear programs. The nuclear wastes contain radio isotopes with long half-lives. This means that the radio isotopes stay in the atmosphere in some form or the other. These reactive radicals make the sand or the water contaminated. It is known as mixed waste. The mixed wastes cause hazardous chemical reactions and leads to dangerous complications. The radioactive wastes are usually buried under sand and are known as vitrification. But these wastes can be used to make nuclear weapons.

Category	**Examples**	**Disposal**
Low level	**Contaminated equipment, materials and protective clothing**	**They are put in drums and surrounded by concrete, and put into clay lined landfill sites.**
Intermediate level	**Components from nuclear reactors, radioactive sources used in medicine or research**	**They are mixed with concrete, then put in a stainless steel drum in a purpose-built store.**
High level	**Used nuclear fuel and chemicals from reprocessing fuels**	**They are stored underwater in large pools for 20 years, then placed in storage casks in purpose-built underground store where air can circulate to remove the heat produced. High level waste decays into intermediate level waste over many thousands of years.**

TABLE 1.3 Disposal of nuclear waste

2. **Nuclear Accidents**: While so many new technologies have been put in place to make sure that such disasters won't happen again like the ones Chernobyl or more recently Fukushima but the risk associated with them are relatively high. Even small radiation leaks can cause devastating effects. Some of the symptoms include nausea, vomiting, diarrhoea and fatigue.

People who work at nuclear power plants and live near those areas are at high risk of facing nuclear radiations, if it happens.

3. **Nuclear Radiation**: There are power reactors called breeders. They produce plutonium. It is an element which is not found in the nature however it is a fissionable element. It is a by-product of the chain reaction and is very harmful if introduced in the nature. It is primarily used to produce nuclear weapons. Most likely, it is named as dirty bomb.

4. **High Cost**: Another practical disadvantage of using nuclear energy is that it needs a lot of investment to set up a nuclear power station. It is not always possible by the developing countries to afford such a costly source of alternative energy. Nuclear power plants normally take 5-10 years to construct as there are several legal formalities to be completed and mostly it is opposed by the people who live near*by*.

5. **National Risk**: Nuclear energy has given us the power to produce more weapons than to produce things that can make the world a better place to live in. We have to become more careful and responsible while using nuclear energy to avoid any sort of major accidents. They are hot targets for militants and terrorist organizations. Security is a major concern here. A little lax in security can prove to be lethal and brutal for humans and even for this planet.

6. **Impact on Aquatic Life**: Eutrophication is another result of radioactive wastes. There are many seminars and conferences being held every year to look for a specific solution. But there is no outcome as of now. Reports say that radioactive wastes take almost 10,000 years to get back to the original form.

7. **Major Impact on Human Life**: We all remember the disaster caused during the Second World War after the nuclear bombs were dropped over Hiroshima and Nagasaki. Even after five decades of the mishap, children are born with defects. This is primarily because of the nuclear effect. Do we have any remedy for this? The answer is still no.

8. **Fuel Availability**: Unlike fossil fuels which are available to most of the countries, uranium is very scarce resource and exist in only few of the countries. Permissions of several international authorities are required before someone can even thought of building a nuclear power plant.

9. **Non Renewable**: Nuclear energy uses uranium which is a scarce resource and is not found in many countries. Most of the countries rely on other countries for the constant supply of this fuel. It is mined and transported like any other metal. Supply will be available as long as it is there. Once all extracted, nuclear plants will not be of any use. Due to its hazardous effects and limited supply, it cannot be termed as renewable.

Anti-nuclear movement

The constant fear about impending nuclear disaster, radiation, nuclear waste and shroud of secrecy that government maintain have resulted in wide spread protest against nuclear power plants. These apprehensions about safety and security fuels people's protests, raising questions about atomic energy as a clean and safe alternative to fossil fuels.

The anti-nuclear movement is a social movement that opposes various nuclear technologies. Some direct action groups, environmental groups, and professional organisations have identified themselves with the movement at the local, national, and international level. Major anti-nuclear groups include Campaign for Nuclear Disarmament, Friends of the Earth, Greenpeace, International Physicians for the Prevention of Nuclear War, and the Nuclear Information and Resource Service.

Since the splitting of atoms controversies have raged regarding the application of nuclear technology, both as a source of energy and as an instrument of war.

Anti-nuclear protests began on a small scale in the U.S. as early as 1946 in response to Operation Crossroads. Large scale anti-nuclear protests first emerged in the mid-1950s in Japan in the wake of the March 1954 Lucky Dragon Incident. August of 1955 saw the first meeting of the World Conference against Atomic and Hydrogen Bombs, which had around 3,000 participants from Japan and other nations. Protests began in Britain in the late 1950s and early 1960s. In the United Kingdom, the first Aldermaston March, organised by the Campaign for Nuclear Disarmament, took place in 1958. In 1961, at the height of the Cold War, about 50,000 women brought together by Women Strike for Peace marched in 60 cities in the United States to demonstrate against nuclear weapons. In 1964, Peace Marches in several Australian capital cities featured "Ban the Bomb" placards.

Nuclear power became an issue of major public protest in the 1970s and demonstrations in France and West Germany began in 1971. In France, between 1975 and 1977, some 175,000 people protested against nuclear power in ten demonstrations. In West Germany, between February 1975 and April 1979, some 280,000 people were involved in seven demonstrations at nuclear sites. Many mass demonstrations took place in the aftermath of the 1979 Three Mile Island accident and a New York City protest in September 1979 involved two hundred thousand people. Some 120,000 people demonstrated against nuclear power in Bonn, in October 1979. In May 1986, following the Chernobyl disaster, an estimated 150,000 to 200,000 people marched in Rome to protest against the Italian nuclear program, and clashes between anti-nuclear protesters and police became common in West Germany.

In the early 1980s, the revival of the nuclear arms race triggered large protests about nuclear weapons. In October 1981 half a million people took to the streets in several cities in Italy, more than 250,000 people protested in Bonn, 250,000 demonstrated in London, and 100,000 marched in Brussels. The largest anti-nuclear protest was held on June 12, 1982, when one million people demonstrated in New York City against nuclear weapons. In October 1983, nearly 3 million people across Western Europe protested nuclear missile deployments and demanded an end to the arms race; the largest crowd of almost one million people assembled in The Hague in the Netherlands. In Britain, 400,000 people participated in what was probably the largest demonstration in British history.

On May 1, 2005, 40,000 anti-nuclear/anti-war protesters marched past the United Nations in New York, 60 years after the atomic. This was the largest anti-nuclear rally in the U.S. for several decades. In 2005 in Britain, there were many protests about the government's proposal to replace the aging system with a newer model. The largest protest had 100,000 participants. In May 2010, some 25,000 people, including members of peace organizations and 1945 atomic bomb survivors, marched from downtown New York to the United Nations headquarters, calling for the elimination of nuclear weapons. The 2011 Japanese nuclear accidents undermined the nuclear power industry's proposed renaissance and revived anti-nuclear passions worldwide, putting governments on the defensive. There were large protests in Germany, India, Japan, Switzerland, and Taiwan

Nuclear power in India

India is the seventh largest country in the world with an area of 3.3 million sq. km. and population of about 1.2 billion (the second most populous country after China). As of today, a significant segment of this population does not have access to electricity and other clean fuels, and those who have electricity available to them face shortages of it regularly. According to the Central Electricity Authority estimates, the peaking shortage prevails in various regions of the country from 1.3% up to 26.1% (Load Generation Balance Report 2013–14).

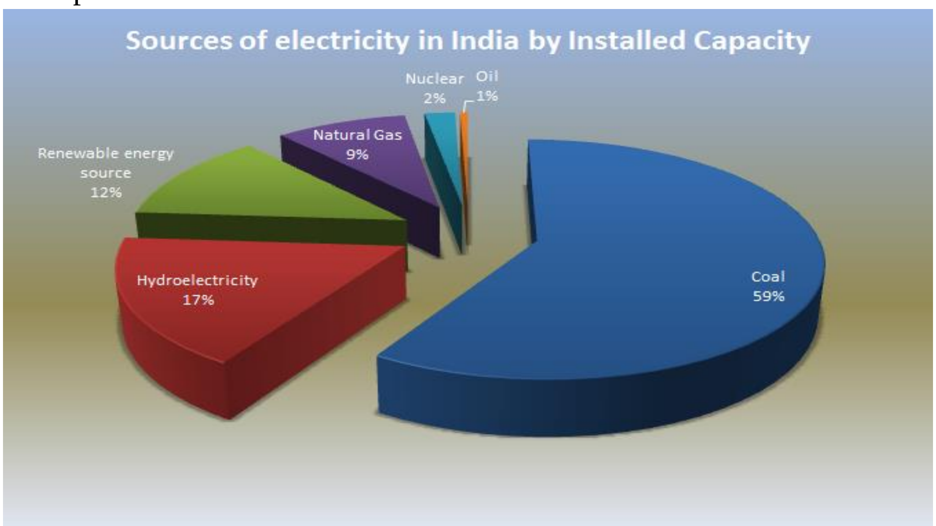
As the economy grows and more people are provided access to electricity, this gap between demand and supply will further increase. The population of India is expected to increase to about 1.5 billion by 2050.Concurrently, India is also economically growing in terms of

GDP rapidly at a rate of about 6–8% a year. Sustaining the economic growth at current rate is essential to meet the country's primary objectives of poverty alleviation and improving the quality of life. For its growing population, increased attention needs to be paid to provide energy, especially electricity supply. It has been reported that a correlation exists between energy/electricity consumption and the indices of quality of life of a country's population like the human development index (HDI) (Leung 2005; Human Development Reports).

Due to rapid economic expansion, India has one of the world's fastest growing energy markets and is expected to be the second-largest contributor to the increase in global energy demand by 2035, accounting for 18% of the rise in global energy consumption.(" India Raises Renewable Energy Target Fourfold "WSJ.COM) Given India's growing energy demands and limited domestic fossil fuel reserves, the country has ambitious plans to expand its renewable and nuclear power industries.

Nuclear power is the fourth-largest source of electricity in India after thermal, hydroelectric and renewable sources of electricity. As of 2013, India has 21 nuclear reactors in operation in 7 nuclear power plants, having an installed capacity of 5780 MW and producing a total of 30,292.91 GWh of electricity, while 6 more reactors are under construction and are expected to generate an additional 4,300 MW. In October 2010, India drew up "an ambitious plan to reach a nuclear power capacity of 63,000 MW in 2032". ("India eyeing 64,000 MW nuclear power capacity by 2032: NPCIL". *The Economic Times. 11 October 2010.)* India also envisages to increase the contribution of nuclear power to overall electricity generation capacity from 4.2% to 9% within 25 years. ("Slowdown not to affect India's nuclear plans". *Business-standard.com. 2009-01-21*.)

India's domestic uranium reserves are small and the country is dependent on uranium imports to fuel its nuclear power industry. Since early 1990s, Russia has been a major supplier of nuclear fuel to India. Due to dwindling domestic uranium reserves, electricity generation from nuclear power in India declined by 12.83% from 2006 to 2008. Following a waiver from the Nuclear Suppliers Group in September 2008 which allowed it to commence international nuclear trade, India has signed bilateral deals on civilian nuclear energy technology cooperation with several other countries, including France, the United States, the United Kingdom, Canada and South Korea. India has also uranium supply agreements with Russia, Mongolia, Kazakhstan, Argentina and Namibia. Large deposits of natural uranium, which promises to be one of the top 20 of the world's reserves, have been found in the Tummalapalle belt in the southern part of the Kadapa basin in Andhra Pradesh in March 2011



GRAPH 1.7 Sources of electricity

Nuclear Power Generation (2006-07 to 2015-16)			
Year	**Gross Generation (MUs)**	**Capacity Factor (%)**	**Availability Factor (%)**
2015-16 (Upto Aug - 2015)	16311	78	82
2014-15	37835	82	88
2013-14	35333	83	88
2012-13	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

TABLE 1.4 Nuclear power generation in India 2006-2007-2015-2016
Source: npcil.nic.in/main/AllProjectOperationDisplay.aspx

GRAPH 1.8 Indian Nuclear energy consumption

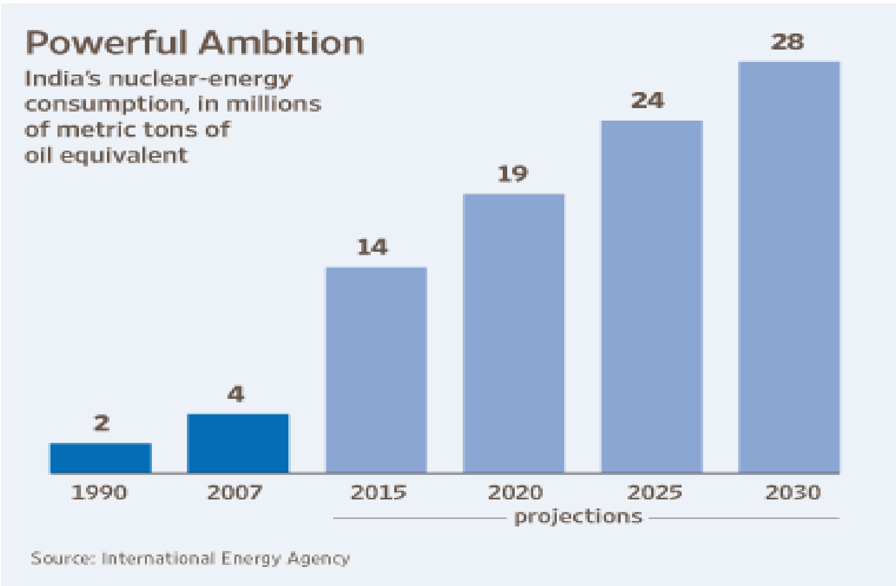


FIG 1.3 India's current and proposed nuclear power plants

.

Plant	**Unit**	**Type**	**Capacity (MWe)**	**Date of Commercial Operation**
Tarapur Atomic Power Station (TAPS), Maharashtra	1	BWR	160	October 28, 1969
Tarapur Atomic Power Station (TAPS), Maharashtra	2	BWR	160	October 28, 1969
Tarapur Atomic Power Station (TAPS), Maharashtra	3	PHWR	540	August 18, 2006
Tarapur Atomic Power Station (TAPS), Maharashtra	4	PHWR	540	September 12, 2005
Rajasthan Atomic Power Station (RAPS), Rajasthan	1	PHWR	100	December 16,1973

Rajasthan Atomic Power Station (RAPS), Rajasthan	2	PHWR	200	April 1,1981
Rajasthan Atomic Power Station (RAPS), Rajasthan	3	PHWR	220	June 1, 2000
Rajasthan Atomic Power Station (RAPS), Rajasthan	4	PHWR	220	December 23, 2000
Rajasthan Atomic Power Station (RAPS), Rajasthan	5	PHWR	220	February 4, 2010
Rajasthan Atomic Power Station (RAPS), Rajasthan	6	PHWR	220	March 31, 2010
Madras Atomic Power Station (MAPS), Tamilnadu	1	PHWR	220	January 27,1984
Madras Atomic Power Station (MAPS), Tamilnadu	2	PHWR	220	March 21,1986
Kaiga Generating Station (KGS), Karnataka	1	PHWR	220	November 16, 2000
Kaiga Generating Station (KGS), Karnataka	2	PHWR	220	March 16, 2000
Kaiga Generating Station (KGS), Karnataka	3	PHWR	220	May 6, 2007
Kaiga Generating Station (KGS), Karnataka	4	PHWR	220	January 20, 2011
Kudankulam Atomic Power Project, Tamilnadu	1	VVER - 1000 (PWR)	1000	December 31, 2014
Narora Atomic Power Station (NAPS), Uttarpradesh	1	PHWR	220	January 1,1991
Narora Atomic Power Station (NAPS), Uttarpradesh	2	PHWR	220	July 1,1992
Kakrapar Atomic Power Station (KAPS), Gujarat	1	PHWR	220	May 6, 1993
Kakrapar Atomic Power Station (KAPS), Gujarat	2	PHWR	220	September 1,1995

TABLE 1.5 OPERATIONAL NUCLEAR POWER PLANTS IN INDIA
Source: npcil.nic.in/main/AllProjectOperationDisplay.aspx

The Kudankulam Nuclear Power Plant (KNPP) is under construction 650km south of Chennai, in the Tirunelveli district of Tamil Nadu, India. It is being developed by the Nuclear Power Corporation of India (NPCIL).

Two 1,000MW pressurised water reactor (PWR) units based on Russian technology are being erected in phase one of the project. An additional four units are scheduled to be added as per the agreement signed between India and Russia in December 2008.

Construction of units three and four is scheduled to start in 2016 with the aim of making them operational by March 2021.Atomstroyexport, a subsidiary of the Russian State Nuclear Energy Corporation Rosatom, is the supplier of equipment and fuels for the nuclear power project.

Kudankulam nuclear power plant construction and protests

Concrete work for units one and two started in March 2002 and July 2002 respectively. NPCIL started commercial operations of unit 1 from midnight of 31 December 2014, while unit two is expected to be completed and commissioned for operations in May 2015.

Following the March 2011 Fukushima nuclear disaster in Japan, populations around proposed Indian NPP sites have launched protests that had found resonance around the country. There have been mass protests against the French-backed 9900 MW Jaitapur Nuclear Power Project in Maharashtra and the Russian-backed 2000 MW Koodankulam Nuclear Power Plant in Tamil Nadu. The Government of West Bengal refused permission to a proposed 6000 MW facility near the town of Haripur that intended to host 6 Russian reactors. But that now is disputed: it's possible for Bengal to have its first nuclear power plant at Haripur despite resistance.

The construction work on-site was stopped in October 2011 because of protestors. However, it resumed in March 2012 with the permission of the Tamil Nadu Government.

In May 2013, the Indian Supreme Court dismissed the petitions by nuclear activists questioning the safety of the nuclear power plant and granted the go-ahead for the commissioning of the first two units.

A Public-interest litigation (PIL) has also been filed against the government’s civil nuclear programme at The Supreme court. The PIL specifically asks for the "staying of all proposed nuclear power plants till satisfactory safety measures and cost-benefit analyses are completed by independent agencies".

Energy deeply influences people’s lives. It is central to practically all aspects of human welfare, including access to water, agricultural productivity, health care, education, job creation, climate change, and environmental sustainability. Ensuring total access to energy is arguably one major challenge India faces today. India’s substantial and sustained economic growth is placing enormous demand on its energy resources. The demand and supply imbalance in energy sources is pervasive requiring serious efforts by Government of India to augment energy supplies as India faces possible severe energy supply constraints.

As on 31st August 2013, a total of 32,227 villages of India are yet to be provided with electricity access. Out of a total of 593,732 inhabited villages as per the 2001 census, as on 31st August 2013, a total of 561505 villages were electrified.

The total installed capacity for electricity generation in the country has increased from 145755 MW as on 31.03.2006 to 284,634 MW as on 31.03.2014, registering a compound annual growth rate. Total Electricity generation in the country, from utilities and non-utilities taken together during 2013-14 was 11, 79,256 GWh. Out of this 8, 53,683 GWh was generated from thermal and 1, 34,731 GWh was from hydro and 34,200 GWh was generated from nuclear sources. Total output from non-utilities was 1, 56,642 GWh.

Although India has considerably improved its generating capacity, it still has difficulty in meeting demand and there are persistent power shortages which constrain India's economic growth. With the development of the industrial and commercial sectors as well as the wider use of electrical equipment, electricity demand keeps increasing. Moreover, approximately 30 percent of India's generated power is lost in transmission.

The Government of India intends to draw twenty-five per cent of its energy from nuclear power by 2050. This plan includes 20,000 MW of installed capacity from nuclear energy by 2020, and 63,000 MW by 2032.

Achieving energy security in this strategic sense is of fundamental importance not only to India's economic growth but also for the human development objectives that aim at alleviation of poverty, unemployment and meeting the Millennium Development Goals (MDGs).

AIM/OBJECTIVES OF THE RESEARCH:

1. To study the genesis and development of Kudamkulam anti-nuclear movement.
2. To study popular and governmental response to Kudamkulam anti-nuclear movement.
3. To study the effectualness of Kudamkulam anti-nuclear movement in generating public awareness against nuclear disasters.

JUSTIFICATION:

Kudamkulam anti-nuclear movement is a movement which grabbed much public and media attention globally. The people in this region continue their protest against the nuclear power plant even after repeated assurances of safety and compensation by the government and operator. The successive governments even though faced with widespread dissent is determined to materialize this ambitious project. A comprehensive analysis is imperative to allay fears or else would be an impediment to progress of our nation

HYPOTHESIS:

1. Kudankulam anti-nuclear movement is a forerunner for anti-nuclear movements in India and would, serve as an inspiration for similar movements.
2. It is lack of government's effective communication and transparent procedures that fuels these movements

METHODOLOGY:

Research comprises "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of humans, culture and society, and the use of this stock of knowledge to devise new applications and solve existing problems."

RESEARCH DESIGN:

A detailed outline of how an investigation will take place is Research Design. A research design will typically include how data is to be collected, what instruments will be employed, how the instruments will be used and the intended means for analyzing data collected.

The methods followed in this project are both descriptive and historical research.

QUALITATIVE RESEARCH/DESCRIPTIVE RESEARCH:

Descriptive Research is by definition exploratory and it is used to define a problem or developed an approach to the problem. It is used to gather descriptive information about Kudamkulam nuclear agitation and evaluate its influence.

HISTORICAL RESEARCH:

Historical research is the study of the past records and other information sources with a view to reconstruct and development of an institution or a movement or a system and discovering the trends in past.

Therefore its objective is to collate information about Kudamkulam anti-nuclear movement from the past in order understand the present reality with clarity and to examine the influence of the movement which was first of its kind and may serve as inspiration for similar movements.

DATA COLLECTION:

The data collection is purely based on secondary data. Secondary data is a data which have been collected and compiled for future uses. In other words it is a readily available veritable information and already compiled statistical statements and which is used for this study.

SCOPE:

The scope of the project is to serve as source of authentic information for those interested to know about Kudamkulam anti-nuclear protest and its influence. It l also enable other researcher to continue on further studies elaborately on this topic without focusing on the basic information of the movement.

LIMITATION:

There are various problems or limitation face by the researcher during the research process. Some are listed below:

1. There is limitation of time to do the project for the researcher, so in depth analysis is beyond the bounds of possibility.

2. The data is completely collected from a secondary sources and not primary sources.

3. Difficulty to deduce truth from extremely biased opinions.

4. Too much of scientific terms in published documents.

CHAPTER 2
INDIAN NUCLEAR ENERGY PROGRAM

India is the seventh largest country in the world with an area of 3.3 million sq. km. and population of about 1.2 billion (the second most populous country after China). As of today, a significant segment of this population does not have access to electricity and other clean fuels, and those who have electricity available to them face shortages of it regularly. According to the Central Electricity Authority estimates, the peaking shortage prevails in various regions of the country from 1.3% up to 26.1% (Load Generation Balance Report 2013–14).

As the economy grows and more people are provided access to electricity, this gap between demand and supply will further increase. The population of India is expected to increase to about 1.5 billion by 2050. Concurrently, India is also economically growing in terms of GDP rapidly at a rate of about 6–8% a year. Sustaining the economic growth at current rate is essential to meet the country's primary objectives of poverty alleviation and improving the quality of life. For its growing population, increased attention needs to be paid to provide energy, especially electricity supply.

It has been reported that a correlation exists between energy/electricity consumption and the indices of quality of life of a country's population like the human development index (HDI) (Leung 2005; Human Development Reports 2007). The Human Development Index is a way of measuring development by combining indicators of life expectancy, educational attainment and income into a composite human development index, the HDI of a country. Correlation between Human Development and Per Capita Electricity Consumption (figure 1) indicates that 4,000 kWh per person per year is the dividing line between developed and developing countries. In comparison, India at present has about 700 kWh per capita per year availability of electricity. In order to improve the HDI, India needs to augment its installed capacity base at a faster pace.

Alleviation of the poverty and enhancing the standard of living of the large population are the objectives of national policies and programmes. All key drivers for sustaining the growth, particularly energy/electricity, have acquired a focused attention of planners, policy makers and the Government.

India's nuclear energy resource profile, indicates that nuclear power offers the most potent means for long-term energy security. Currently, the nuclear energy share in electricity generation is about 3%. The nuclear share in total primary energy mix is expected to grow, as the installed nuclear power capacity grows. The Integrated Energy Policy of India estimates the share of nuclear power in the total primary energy mix to be between 4.0 and 6.4% in various scenarios in the year 2031–32 (Integrated Energy Policy 2006).

Nuclear power is an intense source of energy and the transport infrastructure needed for nuclear fuel is very small. 10,000 MWe nuclear power capacity needs only about 300–350 tons of enriched fuel per annum, as against 35–50 million tons of coal needed for a coal fired thermal power station of the same capacity requiring about a shipload or 20 trainloads per day to transport the coal. The pressure on rail, port and other infrastructure will be immense when large thermal capacity is added, apart from emissions arising out of transporting such large quantities of coal. The land needed for setting up a nuclear power station is also less when compared to thermal coal-fired power stations and hydroelectric stations which involve large submergence of land.

Climate change arising out of Green House Gas Emissions is among the most important challenges facing the world today. The effects of climate change are expected to be catastrophic, with crop losses, sea-level rise, extreme weather events and other losses predicted by various models. In terms of economic losses, the Stern Report (2007) had predicted losses to the tune of 20% of the global GDP on account of climate change by 2050, if action is not initiated immediately. Although India's per capita emissions are among the lowest in the world, in absolute terms, the emissions are sizeable (at 4.8% of global emissions) on account of the large population. Emissions in future are projected to grow rapidly in India and China. The power sector contributes significantly to Green House Gas emissions, estimates of which vary from 40 to 50% of total emissions of Green House Gases. De-carbonisation of the energy/power sector is one of the key recommendations made by various reports like the recent Intergovernmental Panel on Climate Change (IPCC) report in this regard (Pachauri and Reisinger 2007).

Nuclear power is environmentally benign and the life cycle Greenhouse Gas emissions of nuclear power are comparable to that of wind and solar photovoltaic power. The life cycle emissions (from mining of ore to waste disposal) of nuclear power are very low, between 2.5 and 5.7 gCeq/kWh (grams of Carbon Equivalent per unit of electricity) as against 206 to 357 gCeq/kWh in case for coal and 106 to 188 gCeq/kWh for gas technologies (IAEA 2000).

The base line CO_2 emissions in India from the predominant technology, coal, are about 1 kg/kWh. Thus every unit of nuclear power generated saves 1 kg of CO_2 emissions. Thus nuclear power in India, which has generated about 284 billion units so far, has saved the earth of 284 million tons of CO_2. Every 1000 MWe nuclear power station to be set-up in future will save about 7 million tons of CO_2 emissions every year. Nuclear power can be a major facilitator in de-carbonising the energy sector and the same has been well recognized in the country's Integrated Energy Policy.

Thus, Nuclear energy, in view of its huge potential and techno-commercial viability, will play an increasingly important role in the future. The rate of growth of nuclear share at the primary level is expected to be rapid as conventional fossil fuel sources, particularly coal, approach exhaustion, or their extraction tends to become uneconomical.

ATOMIC ENERGY IN INDIA

India's Atomic Energy programme has been a mission-oriented comprehensive programme with a long-term focus. From its inception the guiding principle of this programme has been self-reliance through the utilization of domestic mineral resources, and building up capability to face possible restrictions in international technology and the exchange of resources. The events of the last 50 years have, in fact, validated this approach.

HISTORY

NUCLEAR ENERGY PROGRAM TIMELINE

Nuclear program started in 1944 when Homi J. Bhabha founded the Tata Institute of Fundamental Research.

- On Nehru's initiative, India passed Atomic Energy Act of 1948 focused on peaceful development of nuclear technology.

- 1954: Establishment of DAE with first secretary Homi Bhabha

- In 1954, India reached a verbal understanding with the United States and Canada under the Atoms for Peace program by which US and Canada co-operated with India for establishment of CIRUS reactor.

- In 1955 construction began on India's first reactor, the 1 MW Apsara research reactor, with British assistance.

- The Atomic Energy Establishment, Trombay was formally inaugurated by PM Nehru on 20 January 1957. It acquired its present name Bhabha Atomic Research Centre (BARC) on 12 January 1967.

- In 1968 NPT was opened for signature but India refused to sign it.

- Under the rule of Indira Gandhi nuclear test was conducted at Pokhran in Rajsthan which is called as smiling Buddha on 18 May 1974.

- The instant international reaction resulted in formation {nuclear supplier group to check international nuclear proliferation by controlling the export and re-transfer of materials that may be applicable to nuclear weapon development and by improving safeguards and protection on existing materials} India is not a member of NSG till now.

- In 1986, India joined the Five-Continent Six-Nation Initiative for Nuclear Disarmament and in 1988 put forward the Rajiv Gandhi Plan for the elimination of nuclear weapons in the UN.

- Though first nuclear test was conducted in 1974 delivery system was developed during in 1986.

- Second nuclear test was conducted again in Pokhran in May 1998. It was known as operation Shakti.

- Sharp international reaction resulted in economic sanctions by US and Japan. While Pakistan carried out nuclear testing under the codename Chagai-I on 28 May 1998 and Chagai-II on 30 May 1998

- India adopted a "no first use policy" after its nuclear tests in 1998.NFU helped India get civil nuclear technology, despite being a non-member of NSG and non-signatory of NTPT.

- India signed a framework for civil nuclear cooperation agreement with US in 2005 but it is still in progress.

- France was the first country on 30 September 2008 after the complete waiver provided by the NSG to sign the civil nuclear deal in 2008 followed by eight other countries. These are Russia, Mongolia, Namibia, Argentina, UK, Canada, Kazakhstan and South Korea that promised to supply fissile material / technology / both.

- India signed a civil nuclear cooperation agreement with Australia in 2014 as negotiations on the deal since 2012, when Australia reversed its policy on nuclear sales to India. The policy was based on India's refusal to sign the Nuclear Non-Proliferation

- Australia is the third largest producer of uranium in the world. The agreement allows supply of uranium for peaceful generation of power for civil use in India

Department of Atomic Energy

The Department of Atomic Energy (DAE) came into being on August 3, 1954 under the direct charge of the Prime Minister through a Presidential Order. According to the Resolution constituting the AEC, the Secretary to the Government of India in the Department of Atomic Energy is ex-officio Chairman of the Atomic Energy Commission.

DAE has been engaged in the development of nuclear power technology, applications of radiation technologies in the fields of agriculture, medicine, industry and basic research.

DAE comprises five research centres, three industrial organizations, five public sector undertakings and three service organizations. It has under its aegis two boards for promoting and funding extra-mural research in nuclear and allied fields, mathematics and a national institute (deemed university).

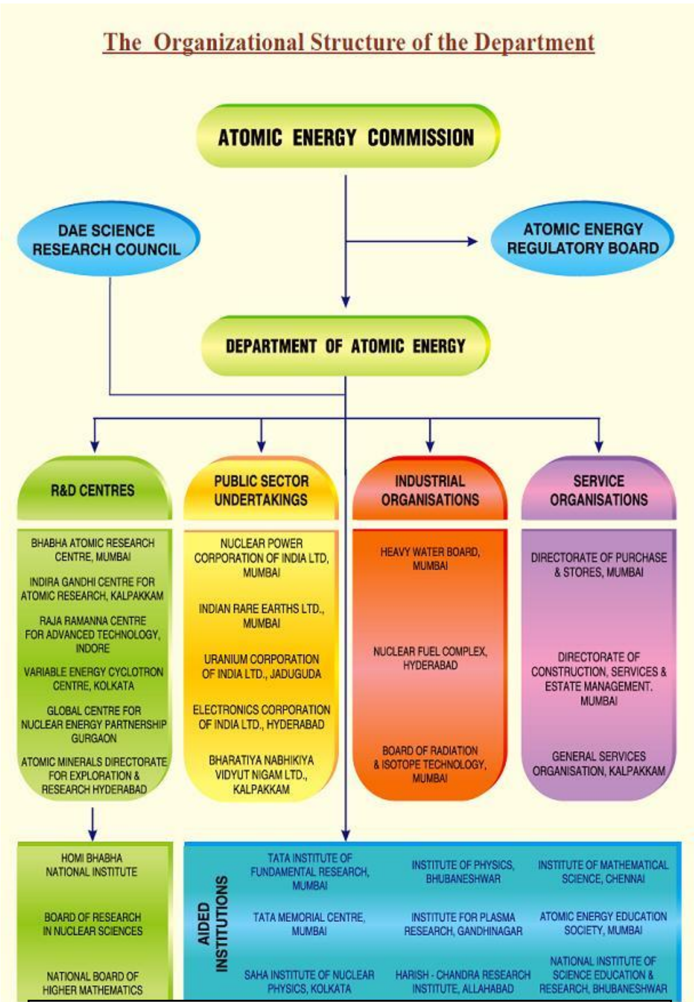


Fig 1.4 The organisational structure of DAE

FIGsource:http://www.dae.nic.in/?q=node/634

It also supports eight institutes of international repute engaged in research in basic sciences, astronomy, astrophysics, cancer research and education.

HOMI.J.BABA

India’s three-stage nuclear power programme

Homi Bhaba devised India's three-stage nuclear power program in the 1954. It was formulate to provide energy security to India. The main aim was to capitalize on India’s vase thorium reserves while accounting for its low uranium reserves. India has only about 2% of the global uranium reserves but 25% of the world’s thorium reserves.

The three stages are:

1. Natural uranium fuelled Pressurized Heavy Water Reactors (PWHR)
2. Fast Breeder Reactors (FBRs) utilizing plutonium based fuel

3. Breeder reactors

Bhabha summarised the rationale for the three-stage approach as follows:

The total reserves of thorium in India amount to over 500,000 tons in the readily extractable form, while the known reserves of uranium are less than a tenth of this. The aim of long range atomic power programme in India must therefore be to base the nuclear power generation as soon as possible on thorium rather than uranium… The first generation of atomic power stations based on natural uranium can only be used to start off an atomic power programme… The plutonium produced by the first generation power stations can be used in a second generation of power stations designed to produce electric power and convert thorium into U-233, or depleted uranium into more plutonium with breeding gain… The second generation of power stations may be regarded as an intermediate step for the breeder power stations of the third generation all of which would produce more U-233 than they burn in the course of producing power. In November 1954, Bhabha presented the three-stage plan for national development, at the conference on "Development of Atomic Energy for Peaceful Purposes" which was also attended by India's first Prime Minister Jawaharlal Nehru. Four years later in 1958, the Indian government formally adopted the three-stage plan.

STAGE 1 :Pressurised Heavy Water Reactor using

Natural UO_2 as fuel matrix
Heavy water as moderator and coolant

Natural U isotopic composition is 0.7 % fissile U-235 and the rest is U-238.

The first two plants were of boiling water reactors based on imported technology. Subsequent plants are of PHWR type through indigenous R&D efforts. India achieved complete self-reliance in this technology and this stage of the programme is in the industrial domain.

The future plan includes

Setting up of VVER type plants based on Russian Technology is under progress to augment power generation.
MOX fuel (Mixed oxide) is developed and introduced at Tarapur To conserve fuel and to develop new fuel technology.

Reprocessing of spent fuel » By an Open Cycle or a Closed Cycle mode.

"Open cycle" refers to disposal of the entire waste after subjecting to proper waste treatment.

This Results in huge underutilization of the energy potential of Uranium (~ 2 % is exploited)

"Closed cycle" refers to chemical separation of U-238 and Pu-239 and further recycled while the other radioactive fission products were separated, sorted out according to their half-lives and activity and appropriately disposed off with minimum environmental disturbance.

Both the options are in practice.
As a part of long – term energy strategy, Japan and France has opted "closed cycle"
India preferred a closed cycle mode in view of its phased expansion of nuclear power generation extending through the second and third stages.
Indigenous technology for the reprocessing of the spent fuel as well as waste management programme has been developed by India through its own comprehensive R&D efforts and reprocessing plants were set up and are in operation thereby attaining self - reliance in this domain.

STAGE 2 : Fast Breeder Reactor

India's second stage of nuclear power generation envisages the use of Pu-239 obtained from the first stage reactor operation, as the fuel core in fast breeder reactors (FBR). The main features of FBTR are

Pu-239 serves as the main fissile element in the FBR
A blanket of U-238 surrounding the fuel core will undergo nuclear transmutation to produce fresh Pu-239 as more and more Pu-239 is consumed during the operation.
Besides a blanket of Th-232 around the FBR core also undergoes neutron capture reactions leading to the formation of U-233. U-233 is the nuclear reactor fuel for the third stage of India's Nuclear Power Programme.
It is technically feasible to produce sustained energy output of 420 GWe from FBR.
Setting up Pu-239 fuelled fast Breeder Reactor of 500 MWe power generation is in advanced stage of completion. Concurrently, it is proposed to use thorium-based fuel, along with a

small feed of plutonium-based fuel in Advanced Heavy Water Reactors (AHWRs). The AHWRs are expected to shorten the period of reaching the stage of large-scale thorium utilization.

STAGE 3 :**Breeder Reactor**

The third phase of India's Nuclear Power Generation programme is, breeder reactors using U-233 fuel. India's vast thorium deposits permit design and operation of U-233 fuelled breeder reactors.

U-233 is obtained from the nuclear transmutation of Th-232 used as a blanket in the second phase Pu-239 fuelled FBR.
Besides, U-233 fuelled breeder reactors will have a Th-232 blanket around the U-233 reactor core which will generate more U-233 as the reactor goes operational thus resulting in the production of more and more U-233 fuel from the Th-232 blanket as more of the U-233 in the fuel core is consumed helping to sustain the long term power generation fuel requirement.
These U-233/Th-232 based breeder reactors are under development and would serve as the mainstay of the final thorium utilization stage of the Indian nuclear programme. The currently known Indian thorium reserves amount to 358,000 GWe-year of electrical energy and can easily meet the energy requirements.

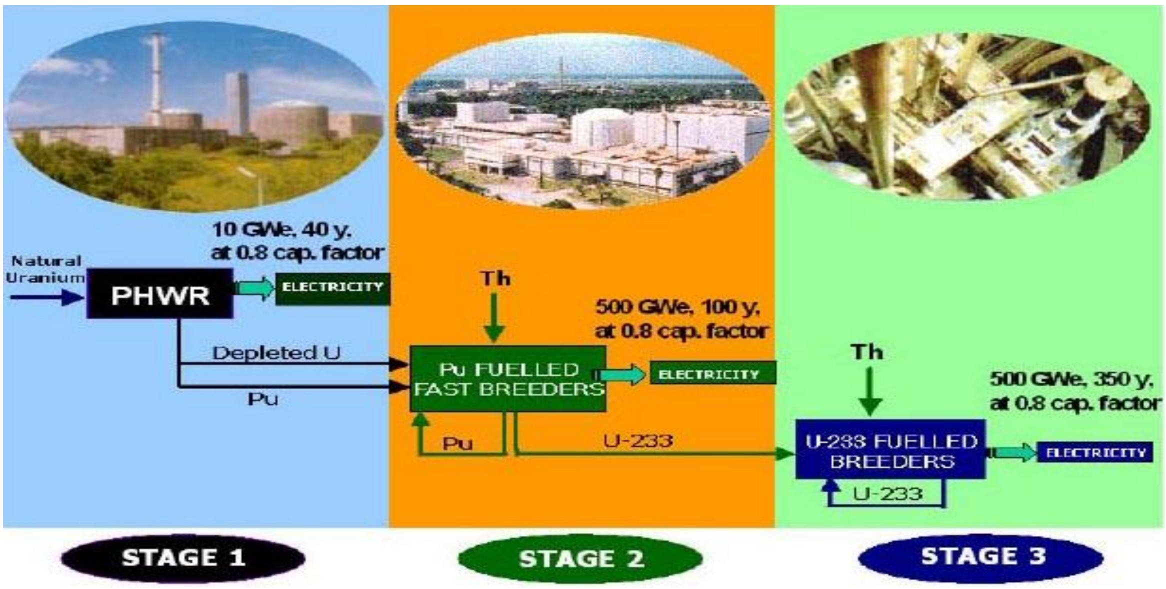


FIG 1.5 Stages of indian nuclear program

EVOLUTION OF THE INDIAN NUCLEAR PROGRAMME

Homi Jehangir Bhabha formulated this strategy nearly 40 years ago, when India possessed hardly any infrastructure to support the nascent nuclear technology. The first Prime Minister of India, Jawaharlal Nehru, helped Bhabha lay the foundations of the Indian atomic energy programme, with self-reliance as the motto. Accordingly, a large R&D establishment, named Atomic Energy Establishment, Trombay, was progressively set up. This was renamed the Bhabha Atomic Research Centre (BARC), after India tragically lost Bhabha in an air crash in 1966. It incorporates research reactors, basic facilities for nuclear research, supporting infrastructure, and trained human power in all disciplines dealing with nuclear energy.

The Indian nuclear power programme commenced in 1969 with the building of the twin reactor units of the Tarapur Atomic Power Station (TAPS), employing Boiling Water Reactors (BWRs), with American assistance. The reasons for this choice lay in favourable performance guarantees for these reactors, and the need to gain experience quickly in running nuclear power plants. The construction of the first two Indian PHWRs, RAPS-1 and RAPS-2, was a joint venture project with Canada. In parallel, the DAE set up facilities for fabrication of fuel, zirconium alloy components, manufacture of precision reactor components, and for production of heavy water. The import content of RAPS-1 was 45 per cent and half of its first core fuel charge was imported. Commercial operation of RAPS-1 commenced in

December, 1973. In the year 1974, India conducted the peaceful nuclear experiment at Pokhran. The Canadian support was summarily withdrawn while RAPS-2 was still under construction. France too, followed suit by refusing to supply fuel for the Fast Breeder Test Reactor (FBTR) which was then under construction with French cooperation. The USA expressed its inability to continue fulfilling its contractual obligations to supply fuel for TAPS. The era of technology control regimes had begun for the Indian nuclear programme.

COPING WITH THE POKHRAN-I FALL-

The abrupt withdrawal of foreign technical co-operation and supplies following the Peaceful Nuclear Explosion Experiment of 1974, could have caused a serious setback to the Indian nuclear programme. This did not happen on account of the nation's determination to face the challenges head-on with the help of the R&D infrastructure already created to develop self-reliance, and the support of Indian industry. India's stakes lay not only in the continuation of the ongoing activities without external help, but also in the pursuit of the originally stipulated long-term strategies. To cut a long story short, although delays were caused in some ongoing projects, the embargoes spurred the growth of indigenous capability for developing substitutes for the denied products, technologies and knowhow. RAPS-2 started commercial operation in 1981; FBTR went critical in 1985, using indigenously made plutonium-uranium mixed carbide fuel; and India developed a plutonium-uranium mixed oxide fuel, as well as the facilities for its industrial scale production, as an alternative to the enriched uranium based fuel for TAPS. India has not looked back since, and has continued to proceed on its chosen path without depending on external help.

In 1947, when India emerged as a free country to take its rightful place in the comity of nations, the nuclear age had already dawned. Our leaders then took the crucial decision to opt for self-reliance, and freedom of thought and action. We rejected the Cold War paradigm whose shadows were already appearing on the horizon and instead of aligning ourselves with either bloc, chose the more difficult path of non-alignment. This has required the building up of national strength through our own resources, our skills and creativity and the dedication of the people. Among the earliest initiatives taken by our first Prime Minister Pt. Jawaharlal Nehru, was the development of science and inculcation of the scientific spirit**.**

Kudamkulam:

Geography, Demography and Topography

Site Location and Description

The site of the proposed Units 3 to6 is located next to the KKNPP Units 1&2 and is 4 km south of Kudankulam village. The site is on the shore of Gulf of Mannar and is located near the South-Eastern tip of India. It is located in Radhapuram taluk of Tirunelveli – Kattabomman district in the state of Tamilnadu. The town of Kanyakumari is about 27 km away from the project site. There are two railway stations (Broad Gauge) near the site, one at Kanyakumari, which is at a distance of 27 km to the South-West of the site, and the other at Vadakku Valliyur at a distance of 27 km to the North of the site. The nearest National Highway (NH- 7) passes through Anjugramam village and is at a radial distance of 15 km from the site. A Major District road runs along the coast at a distance of 3 km from the site and passes through Kudankulam village. The nearest sea port is at Tuticorin which is at a distance of 100 km from the site. The nearest airports are at Trivandrum and Tuticorin, which are about 90 and 100 km from the site respectively.

The proposed KKNPP units 3-6 are accommodated towards west of the KKNPP 1&2 units. Reactor buildings of KKNPP units 3-6 are oriented in line with the Reactor buildings of units 1&2. The total plant area for units 1to 6 is 1053.25 hectares. The site is bounded by 3 m high R.R masonry wall with 0.6 m high barbed wire all along the 2 km radius property boundary measured from the centre of Reactor Buildings. The exclusion radius for the purpose of calculating the doses to the public is 1.5 km from the centre of reactor units.

The NPP site is situated in the coastal track at an elevation of +3.0m to +45.0m above MSL forming the southern fringe of soil covered plains. These plains extend up to the east of Western Ghats which rise up to a height of 1679.8m above MSL. The Hanuman Nadi and the Nambiar River rise in the eastern slopes of the Western Ghat range and flow in E, SE and SSE direction in the coastal areas both entering the Gulf of Mannar at about 5 km West and 9 km NE of the site respectively. Rivers in the area are seasonal. There are no major lakes or dams within 20 km radius around project site except some local rain fed tanks, which serve the local needs.

There are no industrial, commercial, institutional, recreational or permanent residential structures within the site area.

Within the 2 Km radius about 34% of the area falls in the sea. Remaining constitutes barren land, agricultural land and unirrigated cultivable wasteland amounting to about 7%, 1% and 58 % respectively.

Within 30 Km radius about 50 % of the area falls in the sea. The remaining area consists of agricultural and barren lands. The main agricultural crops are paddy, grams, millets, groundnut, coconut and chilies. The subsidiary crops are tobacco, pulses, cotton, and oil seeds.

The other cultivation is mainly for vegetables like brinjal, cluster beans, banana, ladies finger, drumstick, ash gourd, pumpkin etc.

Being a coastal site, fishing is the main source of livelihood in the immediate vicinity of the site area. There are three fishing villages viz. Idinthakarai, Koothankuzhi, and Perumanal at distances of 4 Km, 10 Km and 6 Km respectively from the site. Common diet of the people in the area is rice, fish and vegetables.

The total number of population involved in fishing activity is 9523 within 16km radius from the plant. Marine production in these areas is 11,600 tonnes per annum

General climate

The climate of the area is arid. The site experiences a tropical climate with relative humidity ranging from 20% to 100%. The site experiences mainly winter monsoon during the months of October, November and December. The air masses are mainly of tropical nature with wind speeds in the range of 5 to 30 km/hr. Atmospheric air temperatures range from 18.5 to C to 39.6o C. The precipitation is low, the yearly average being around 700 mm.

Severe weather phenomena such as hurricanes, tornados, waterspouts, and hail do not occur in the site region. Similarly freezing rain and dust storms do not occur at or near the site region. The region does not experience any snowfall. Average daily evaporation worked out from the Thiruvananthapuram data for the period 1969 to 1996 is 4.00mm per day. With this rate of evaporation, the annual evaporation per year will be about 1.5m.

Summary of population details up to a radius of 32 km around site (as per 2001 census)

Population within 2 km radius : 0

Population between 2 and 5 km radius : 19,497

Population between 5 and 8 km radius : 12,238

Population between 8 and 16 km radius : 86,745

Population between 16 km and 32 km : 7, 50,499

The cumulative population within 32 km radius as per 2001 census works out to 868979. Considering the population growth rate same as that for the State of Tamilnadu i.e. 11.72% as per census 2001 data, total population within 32 km radius as on 2009 works out to 950455.

Population Density within 10 km radius as per 2001 census

Population = 48206 Area = 157.07 sq.km Density = 307 persons per sq.km.

WHY KUDANKULAM?

Koodankulam is a rather big village with a population of 11,029 by 2001 census with 2,386 households of which 944 belong to Dalits. It is situated in the southern part of Tamil Nadu in Tirunelveli district and is part of the state's coastal line. Although, Koodankulam falls under the Tirunelveli Kattabomman district, it is very close to the famous tourist spot of Kanyakumari. Edinthakarai is another village located close to the nuclear plant and falls under the Vijayapati panchayat. The main occupation of the people of this village is fishing on shores and the deep sea. In Koodankulam around 80 per cent of the employable workforce is jobless while in Edinthakarai 60 per cent are involved in fishing (Moorty, 2000). The womenfolk in Koodankulam make a living by rolling *beedi* (Ibid).

When government plans for a nuclear power plant it searches for perfect location, often not finding one they tend to choose least populated sea facing regions so that in case of disasters or malfunction the effect would be greatly reduced.it also considerably reduces amount to be paid for large tracts of land that is required for construction. And India government when the proposal from Russian came was quite sure were to build one.

Given below is report of the land assessment committee who found the land suitable for nuclear power generation due to some specific features (Land assessment report Kudankulam reactor 1 &2)

The acceptability of a site for locating a Nuclear Power Plant is dependent not only on site characteristics, related primarily and directly to safety, but also on a large number of other aspects which are only indirectly related to safety. These include the reliability and stability of the electrical grid, the adequacy of communications etc.

The siting of Nuclear Power Plant (NPP) generally involves studies in three stages, namely:

1) Site survey stage: The purpose of a site survey is to identify one or more preferred candidate sites after both safety and non-safety considerations have been taken into account. This involves the study and investigation of a large region. It results in the rejection of unacceptable sites, and is followed by systematic screening, and comparison of remaining sites.

2) Site evaluation stage: This stage involves the study and investigation of one or more of the preferred candidate sites to evaluate their acceptability from various considerations, and in particular from the safety considerations. The site-related design bases are established at this stage. Subsequent to this a preliminary safety analysis report is submitted for clearance before site construction is started.

3) Pre-operational stage: This stage includes studies and investigations of the selected site after the start of construction and before the start of operation in order to complete and refine the assessment of site characteristics and to confirm assumptions made in the safety analysis of the reactor as a part of the final safety analysis report. The base line data on environment are also established at this stage.

population and industrial growth and other proposed facilities at and around the site in addition to safety related aspects like seismo-tectonic environment, geology, hydrology, extreme meteorological phenomenon etc. The site is evaluated from the following consideration.

1. Effect of the region of the site on the plant.
2. Effect of the plant on the region.
3. Population considerations.

While the first of the above factors decide the safety of the plant due to site related natural and man-induced events, the second factor influences the potential radiological impact from the plant on the environment. Population consideration is important for emergency planning.

The acceptability of a site for a particular NPP depends on the existence of engineering solution to site related problems which gives assurance that the proposed plant can be built and operated within acceptably low risk to the population of the region.

SALIENT FEATURES OF KUDNKULAM SITE CONSIDERED DURING SITE EVALUATION

SR.NO.	SITE CHARACTERISTICS INFLUENCING THE NPP	SPECIFICATIONS/ DESIRABLE CHARACTERISTICS	OBSERVATIONS FOR KUDANKULAM SITE	REMARKS
1	2	3	4	5
1	**TOPOGRAPHY**	Plain Topography.	Elevation + 3 m to 45 m above M.S.L. Area measuring 1 km x 2km available.[3] [6]	Terrain suitable Sufficient land available for future expansion.
2	**ACCESSIBILITY**			Recommendation for ODC transport: 1)All consignments /equipments with weight <30 ton : USSR-Tuticorin :by ship, Tuticorin –site: by road or on barges by sea route 2)All consignments > 30 tons USSR – site: by ship and barges. To be unloaded at Jetty within the plant.
	i) Nearest Broad gauge rail head.		Kanyakumari (27km), Valliyur (27km)	
	ii)Nearest national high way		NH 7 at Kanyakumari 27km, Valliyur (27km)	
	iii)Nearest sea port		Tuticorin (100km)	
	iv)Nearest district road		Coastal road from Kanyakumari (4km)	
3	**CONSTRUCTION FACILITIES**			
	i) Construction materials		Coarse aggregates available at Anjugramam(4 km). Sand available at Hanumanathyovari Road (7km). Bricks available at Panagudi(27km)	More sources will be established at construction stage
	ii) Construction Power	26 MVA + 2 MVA for township	Panagudi sub-station (27km)-110 KV line exists. 110 KV line from Kodyar Power Station is also being considered.	Required power will be made available.
	iii) Construction water	3.5 Cu. sec (350cu.m per hour)	Initially limited supply to be tapped from ground water sources. Subsequently the demand will be met from Pechiparai dam.	Quality of construction water is likely to be acceptable. Analysis of water will be carried out.
	iv) Infrastructure facilities (e.g. minor workshop etc.)		Nagercoil (30km) and Tuticorin (100km)	
4	**AVAILABILITY OF POWER SUPPLY AND TRANSMISSION LINES**			
	i) Start-up power	60 MVA per unit	Available from main state grid and Tuticorin Thermal Power Station (Plant capacity 630 MWe) 220 KV line to be drawn from Tuticorin.	
	ii) Power evacuation scheme		Feasible as per preliminary study conducted by CEA. Detail study is in progress.	Present grid capacity 12832 MWe. Nuclear 470 MWe. Projected capacity in 1995 will be 27541 MWe. Nuclear 1910 MWe.

SITE CHARACTERISTICS AFFECTING SAFETY OF PLANT

SR.NO.	SITE CHARACTERISTICS INFLUENCING THE NPP	SPECIFICATIONS/ DESIRABLE CHARACTERISTICS	OBSERVATIONS FOR KUDANKULAM SITE	REMARKS
1	2	3	4	5
1	GEOLOGY			
	i) Foundation conditions depths of bed rock and type		Bed rock at 5- 16 m below ground. Biotite granite gneiss with lenticular bodies of charnockites or quartzites	
	ii) Strength	Maximum intensity of loading 6 kg/sq.cm at RB.	Dry strength:650 kg/sq.cm Wet strength:450 kg/sq.cm.(5)	
	iii) Ground water	Below >1m	5-8m below ground-gradient towards Sea.(5)	
2	NATURAL EVENTS			
	i) Coastal erosion		Erosion insignificant with respect to life of station. Nearest main plant structure from shore about 120 m away from the sea base line.	Layout for the main plant still under consideration. figure of 120 m estimate on the basis of 7 m as the ground elevation at main plant building.
	ii) Flood		Maximum flood level considering tidal range wave run-up and maximum storm surge 5.9 m above chart datum of 0.0. Exposed structures placed well above this level.(7)	Grade level around Reactor Building will be above 7 m from M.S.L. Revised report on MFL from CWPRS awaited. Grade elevation will be charged if necessary.
	iii) Tsunami		Not significant as per preliminary report of CWPRS.	1m height of wave considered due to tsunami effect.
	iv) Wind, storm, cyclone		Maximum speed of storm: 112	Engineering capability to design

5	**AVAILABILITY OF WATER**			
	i) Condenser cooling	6000 cu. sec (on once-through basis)	Sea water cooling on once-through basis. Silt content:60-100 ppm. Particle size: 75 microns. Temperature:26-29 deg C(5)	No constraint. Titanium tubes will be used. Study on biofouling and jelly fish that may affect the water supply will be taken at design stage. Model study will be taken up for intake and outfall structure(5)
	ii) Fresh water for make-up and domestic use	10 cu. sec	Assured by State Government. One pipe line from Pechiparai dam (at 65 km) to be laid. pH: 7, Dissolved solids: 25 mg/liter, Suspended solids: negligible, Turbidity: 5 mg/liter.(5)	Dam storage 4.45 TMC ft. Dead storage can account for 3 years drought.(5)
6	**TOWNSHIP**	400 acres	400 acres of land identified near	

			km/hr Storm surge accounted for in flooding. Exceedance probability 5% as per preliminary report from CWPRS	for wind load exists.
	v) Slope instability		Not applicable for rocky substrata	
	vi) Soil liquefaction		Not applicable for rocky substrata	
	vii) Siesmotectonic Environment	No active fault within 5 km of NPP. Engineering capability for stipulated earthquake acceleration should be possible	No active fault within 5 km. Site is in seismic zone II as per IS-1893; 1984. Nearest epicenter at Trivandram (90km). Earthquake in the region; Magnitude 6 at Coimbatore (8Feb, 1900) (300km). Estimated peak horizontal acceleration for SSE is 0.15 g and for OBE is 0.06 g.	Engineering capability to design for such earthquake loads exists. Seismic evaluation report finalized after discussion with GSI and Soviet Specialists. Further ground checks have confirmed the assumptions regarding the nearest lineament.
	viii) Site surface collapse, subsidence or uplift.		Not applicable for rocky substrata	
	ix) Failure of cooling water supply			
	a) Fresh Water pipe rupture		Storage for safety related system will be provided at site for prolonged safe shut down of reactor.[5]	Plant operating procedures and pond capacity will be decided to ensure water requirement for decay heat removal from the two units for a prolonged period. Ground water source will also be explored as standby back-up arrangement.
	b) Failure of upstream dam		Flooding not of consequence as site is far away (50km), and the site is not in the course of the main channel. Intake well at Pechiparai	

			dam to be provided and supply to be taken from upstream Kodyar storage for extreme contingency. Site storage is to be provided for safety related systems.	
3	**MAN-INDUCED EVENTS AFFECTING SAFETY OF THE PLANT**			
	i) Aircraft impact			
	a) Nearest Airport	SDV 8 km	Trivandrum (90 km)	
	b) Nearest Air Strip	SDV 4 km	----do-----	
	c) Military Airport	SDV 15 km	-----do----	
	ii) Toxic gas release	SDV 5 km	No industry using explosives or having potential for explosion within 10 km	
	iii) Chemical explosion	SDV 5 km	No industry using explosion or having potential for explosion within 10 km.	
	iv) Industrial or military accident		No industry or military establishment within 10 km.	
	v) Surface vehicle impact or explosion.		No national highway or railway siding within 10 km. Coastal road from Kanyakumari to Tuticorin is about 4 km from the site	
4	**METEOROLOGY**			
	i) Wind speed and direction		Observation at Kanyakumari: Variation of daily average velocity:6-30 km/hr. Direction: From West (44.5%) and N.E. (16.2%).	
	ii) Rain		Annual average rainfall: 810 mm.	

	[illegible]		Extreme : 19.2-36.8 deg C	
	iv) Humidity		Monthly average: 65 - 80% R.H. Extreme: 60-85% R.H.	
	v) Atmospheric stability		Environmental survey laboratory Observation will be available for detailed evaluation. Not a constraint during site selection.	Instruments are being installed at site to collect site data.
5	**USE OF LAND**		Within the exclusion zone: 34 % of area lies in sea. Remaining 650-750 Ha. of land (no forest), mostly private owned, is barren and unirrigated / poorly cultivable. Extremely limited agriculture. Annual yield: 20 Te. of Millet and 2 Te. of Cotton. Within 10 km radius area: 60% of area lines in sea. Remaining land is barren or used for agriculture. Annual yield Paddy 14400 Te, Millet 4300 Te, chilli 3000 Te. Tobacco 380 Te, pulses 850 Te, Cotton 250Te, Oilseeds 70 Te. (4)	A lime stone quarry of about 70 acres falls within the sterilized zone. The lease for this area expires in 1994. Termination of the lease beyond the period has been requested.
6	**USE OF WATER**		Ground water, limited in supply, is used for drinking and has a gradient towards the sea. No salt pans within 5 km. The degree of development of fisheries is as common as in a coastal belt. In the nearby area, Idinthakarai, Koothapuzh, Koothankuzhi and Purumanal are the fishing villages within 20 km and annual fish produce of about 4000 Te in the area is reported. About 3900 fisherman in these villages are engaged in fishing as per information furnished in 1982. At Chinnamuttam near Kanyakumari, a fishing harbour is being developed.(4)	
7	**DISPOSAL OF RADIOACTIVE WASTE FROM THE NPP**			
	i) Solid Waste		Low level solid waste to be buried-within exclusion zone in leak-proof RCC Vaults/trenches/tile Holes. 160-180 m.cu per year of cemented waste including spent absorption materials, 40 m cu/yr of compacted waste and 5 m cu/yr of cemented ash will be generated from one reactor.(5)	Bore wells surrounding the solid waste burial area will be provided for monitoring migration of activities.
	ii) Liquid waste	To be diluted to 2 x 10E-7 micro Ci/ml when discharged into the sea.	Most of the radioactivity in the liquid is removed in the Ion Exchange resin and as evaporator concentrate. After above processing the liquid effluent from two units is estimated as 6000 m Cu/year with activity levels lesser or equal to 10E-9 Ci/l. This will be further diluted by condenser cooling water to meet the limits	6000 cu secs of sea water available for dilution while sea water less than 1 cu sec required to achieve the specified limits.

		allowed by AERB.	
iii) Gas release		Stack height is 100 m. Use of high efficiency (0.3 micron) particulate absolute filter will help to comply with authorized limits for particulate activity. The estimated gaseous discharges from two units as following: Nuclides : Average daily release Ci/day Noble gases : 2200 I-131 : 30x10E-4 Long life Nuclides : 0.012 Short life Nuclides : 0.26	It is understood that specific detailed information regarding waste and radioactive released will be available along with PSAR for review.
RADIOLOGICAL IMPACT			
i) During normal operation	AERB prescribed limits	Based on releases vide para 7, preliminary estimates indicate very low dose rates 11.24 mrem/yr. to the individual at 1.6 km exclusion radius. Both the water and air routes have been considered in the above estimates.	
ii) During design basis accident conditions	10 rem: for whole body, 50 rem: for child thyroid at exclusion radius	For all design basis accidents adequate engineering safety features shall be provided to meet the specified requirements	DBA calculations will be carried out at the design stage.
THERMAL POLLUTION		Not significant. Intake and outfall will be well separated. Depth of sea water and large dilution due to	Model studies will be carried out at CWPRS Pune. The requirements of Tamil Nadu

			sea will avoid thermal pollution.	Pollution Control Board should be met.
10	**STORAGE AND TRANSPORTATION OF FRESH AND SPENT FUEL**		Space for storage of fresh fuel for 5 years plus one core charge will be provided. Each unit layout can store spent fuel of 5 reactors years in the spent fuel pool located inside the containment. Besides this, space will be available to unload one core inventory.	50 Ton of spent fuel will be discharged annually from the two reactors. After adequate cooling inside the pool, it will be shipped to Soviet Union by sea route in hermatically sealed casks. Special jetty provided within the plant area will be used for transfer of cask to the Soviet ships so that spent fuel remains within plant boundary at all stages during the process of shipment of irradiated fuel.
11	**FUEL REPROCESSING FACILITY**		Reprocessing not planned at this site	
12	**POPULATION CONSIDERATIONS**			
	i) Population within 2 km radius exclusion zone	No habitation	No resident population	
	ii) Population within 5 km radius sterilized zone	Less than 20,000 population density < 2/3 state average	Total population: 15,000 3 villages in this area Kudankulam, Idinthakarai and Erukkanthorai	Tamilnadu legislation to control population growth beyond natural growth within the sterilized zone to be implemented.
	iii) Population within 10 km radius zone	No centre >10,000	No population centre with more than 10,000 people. Total population 40,842 (1981 census). Population density:130 persons / sq.km	
	iv) Population within 30 km radius zone	No centre >1,00,000	No population centre with more than 1 lakh people. 11 centers have	

			population more than 10,000 . Nagercoil (at 30 km) has a population of 1,71,641.	
	v) Population within 50 km radius zone		33 population centers with population more than 10,000.[4]	
13	**EMERGENCY – PREPAREDNESS CONSIDERATIONS**		3 routes – for possible evacuation. Schools and other public buildings exist for adequate temporary shelter. Nagercoil (30 km), Tirunelveli(100 km) and Tuticorin (100km) can provide communication medical facilities and administrative support.	Draft proposal on off site emergency preparedness plans already submitted to AERB.
14	**ADDITIONAL STATUTORY REQUIREMENTS OF THE CENTRAL AND STATE GOVERNMENT**		Clearance for the following has been obtained: Tamilnadu Pollution Control Board, Shore Protection Committee of T.N. Government, State Committee on Environment, Ministry of Environment, Ministry of Environment and Forests [Government of India]	Stipulation made in the clearance documents should be adhered to.

Kudankulam was chosen as the site for nuclear power plant after much deliberation and study, India government envisages to meet its 25% of electricity generation from nuclear energy, government wants to leverage all available opportunities to achieve the but unfortunately sometimes governments fail to address the doubts of the people ,leading to mass movements against these projects further delaying them.

CHAPTER 3
HISTORY OF KUDANKULAM POWER PROJECT

The Kudankulam nuclear power plant has its roots in the 1974-Pokhran tests conducted by India. Soon after the tests India was isolated by the West and came under the influence of the Soviet nuclear establishment. The US stopped fuel shipments to the Tarapore nuclear power plant after the 1974 test. In 1979 during Morarji Desai regime the nuclear deal with the Soviet Union was discussed. The deal was finally concluded when the then Soviet President Mikhail Gorbachev and the then Indian Prime Minister, the late Rajiv Gandhi, signed the Kudankulam Nuclear Power Project deal in 1988.

Chronology of events:

18/5/1974

Pokhran tests conducted by India

12/79*

During a visit of Indian Prime Minister Morarji Desai to Moscow, Soviet Prime Minister Aleksei Kosygin makes an offer to supply India with a 1,000 MW nuclear power plant.[13]

1981

The USSR reiterates its offer to set up a 1,000 MW nuclear power plant in India.[14]

9/82

During a visit by Indian Prime Minister Indira Gandhi to Moscow, the Soviet government of Leonid Brezhnev offers to cooperate with India on a nuclear energy utilization program. The Soviet Union reiterates its offer of a 1,000 MW nuclear power plant.[15]

Late 1/83

Chairman of India's Atomic Energy Commission (AEC) Homi N. Sethna visits Moscow to continue talks on the Soviet supply of a 1,000 MW nuclear power plant.[16]

Late 1983

The USSR accepts an Indian suggestion to negotiate for two 440 MW units, rather than a 1,000 MW LWR, which the Soviet Union originally offered.[17]

12/83

Chairman of India's AEC Raja Ramanna leads a five man delegation to Moscow to meet with officials from the Soviet economic, energy, and scientific communities to discuss the offer to supply India with a nuclear power station.[18]

1984

Indian and Soviet teams make three reciprocal visits to discuss the Soviet Union's offer to supply India with a nuclear power plant.[19]

1985

During a visit to Moscow, Indian Prime Minister Rajiv Gandhi renews discussions of the possible supply of a nuclear power plant to India.[20]

7/4/85*

The issue of safeguards appears to be the stumbling block to the consummation of the USSR offer to supply India with two 440 MW or one 1,000 MW nuclear reactor and power station.[21]

8/23/86*

India's DAE denies reports that it has turned down the Soviet offer to supply two 440 MW reactors to India.[22]

10/26/86*

The USSR presses India to accept its nuclear power plant offer so it can announce the deal as a notable example of increased Indian-Soviet economic cooperation during Mikhail Gorbachev's visit in November 1986.[23]

11/86

Chairman of India's AEC Raja Ramanna announces creation of the Nuclear Power Corporation (NPC), a financial organization that will raise funds from capital markets for the construction of 500 MW heavy water, natural uranium reactors.[24]

11/4/86

AEC Chairman Raja Ramanna announces that India has acquired the capability to enrich uranium, and that the Bhabha Atomic Research Centre (BARC) is already enriching uranium on a pilot scale.[25]

11/27/86*

The USSR offers to provide India with a 2 billion ruble credit (loan) against its purchase of a nuclear power plant and hydro-electric project. The offer renews discussions of a nuclear power plant purchase from the USSR. The long-term, low interest rate loan would be repayable in rupees.[26]

1/30/87*

Indian Prime Minister Rajiv Gandhi's government bypasses India's DAE and appoints an expert committee, led by Scientific Advisor to the Prime Minister M.G.K. Menon, to examine (in the context of expanding Indian power generation) the Soviet offer to supply a nuclear power plant on easy credit terms. The "Menon Committee" concludes that India should not import items that would require it to sign the NPT and that the requisite safeguards should not hinder the country's nuclear power generation program.[27]

2/87

Indian Nuclear Power Board Chairman Malur Srinivasan replaces Raja Ramanna as chairman of India's AEC.

Director of BARC P.K. Iyengar, who favors indigenous development of India's nuclear power sector, resigns over the appointment of Srinivasan, who favors foreign imports.[28]

5/7/87*

Indian Minister of State for Science and Technology K.R. Narayanan says India has a high opinion of Soviet nuclear technology and that it would carefully consider foreign offers to supply a nuclear power plant with safeguards.[29]

6/87

India makes a gesture to accept the Soviet offer if the requirement for safeguards is dropped and a guarantee of an uninterrupted fuel supply is added.[30]

6/87*

India is reported to be constructing a gas centrifuge plant near Karnataka.[31]

7/87

Officials from the USSR and India hold another round of talks to discuss the purchase of two 440 MW reactors from the USSR. Indian officials want the reactors sold with fuel supplies guaranteed and without comprehensive safeguards, but reports suggest that the USSR is unlikely to accede to such conditions. Financial arrangements include a low interest (2.5 percent) 20-year loan with an initial three-year payment waiver.[32]

7/16/87*

Chairman of India's AEC Malur Srinivasan says that foreign reactors will not be imported at the expense of India's traditional nuclear policy of self-reliance, its stance on the NPT, and its determination not to accept full-scope safeguards. Srinivasan justifies the use of foreign reactors by citing India's need for a rapid increase in the country's capacity to generate power.[33]

8/28/87*

India's parliament approves a nuclear energy bill that enables the government to designate the NPC or a government-owned company to design, construct, and operate nuclear power plants. According to Minister of State for Science and Technology K.R. Narayanan, such an organization is essential if India is to achieve its objective of generating 10,000 MW of nuclear power by the year 2000.[34]

9/87*
The USSR and India are reported to be close to reaching agreement on the export of two 440 MW reactors to India. Ongoing negotiations include the following: a less than full-scope safeguards agreement covering only the plant and the materials supplied under the agreement; an uninterrupted supply of fuel; the return of irradiated fuel to the USSR for reprocessing and waste disposal; and the design and financing of the plant.[35]
10/28/87*
Renewed discussions between India and the USSR result in a Soviet offer to supply a 2 billion ruble credit with the condition that safeguards be worked out with the
IAEA.[36]
11/87
Soviet Prime Minister Nikolai Ryzhkov proposes selling India a uranium enrichment plant as a means of allaying India's misgivings about the possibility that the USSR would stop promised enriched uranium fuel supplies for the Soviet-supplied reactors.[37]
2/18/88*
The 440 MW reactors the USSR is offering India are reportedly modified versions that include containment structures.[38]
4/21/88*
Chairman of India's AEC Malur Srinivasan visits Moscow to continue negotiations over the Soviet supply of a two-unit nuclear power station to India. Following two rounds of negotiations, Soviet officials waive a number of safeguard requirements. Srinivasan expresses optimism over the negotiations.[39]
4/28/88*
Secretary of India's AEC K.V. Mahadeva Rao says that the financing terms offered by the Soviet Union are almost irresistible. But India's Atomic Energy Regulatory Board continues to have misgivings about the safety of Soviet reactors.[40]
7/88*
Indian Minister for Defence Production Shivraj Patil tells parliament that the government is on the verge of making a decision to purchase two 1,000 MW reactors from the USSR. Soviet General Secretary Gorbachev is expected to sign the agreement with Indian Prime Minister Gandhi during his visit to India in November 1988.[41]
9/88
India obtains consent from the IAEA Board of Governors for the application of safeguards pursuant to the Soviet supply of two 1,000 MW LWRs to India. The supply-related safeguards agreement contains a "no weapons use" stipulation, provisions for the application of safeguards only to the reactors and Soviet-supplied nuclear fuel, and a provision covering the return of spent fuel to the Soviet Union. Outgoing IAEA Board Chairman Reinhard Loosch says that the Indian-Soviet reactor agreement is "superficially unusual" because of a clause providing for safeguards on spent fuel from the reactors to terminate once the fuel reaches the Soviet border.[42]
10/18/88*
In anticipation of the signing of the Indian-Soviet LWR deal by Indian Prime Minister Gandhi and Soviet General Secretary Gorbachev in November 1988, the Indian government sanctions advance procurement of key components for the Soviet-supplied nuclear power plant. Chairman of India's AEC Malur Srinivasan says that health and safety aspects of the plant must be examined by experts from India's DAE before approval for a site can be given.[43]
11/20/88
In India, Soviet General Secretary Gorbachev and Indian Prime Minister Gandhi sign an agreement that will provide India with a multi-billion dollar credit toward the purchase of two 1,000 MW LWRs from the Soviet Union. The Soviet vendor Atomenergoexport will supply the reactors, which will be constructed on a turnkey basis. A team of Indian experts will be

trained in the USSR to operate the Soviet-built nuclear power plant. Under the agreement, the USSR will supply enriched uranium fuel to India for the operational life of the nuclear power plant.
Construction will begin in 1992.[44]
11/26/88
At a news conference given by Governor of Madras P.C. Alexander and experts from India's DAE, Alexander expresses his concern for the safety of the area surrounding Koodankulam, where the new nuclear power plant will be built.[45]
12/9/88*
India announces its decision to return spent fuel from the Soviet-supplied reactors to the USSR for reprocessing and waste disposal for reasons related to safety, fuel storage, and safeguards.[46]
2/6/89*
V. Gulko, president of the Soviet nuclear export firm Atomenergoexport, says the Soviet-built 1,000 MW nuclear reactor, the type which will be supplied to India, has safety features that make it one of the most reliable of its kind in the world. The Soviet development of the 1,000 MW nuclear reactor included special emphasis on safety.[47]
2/16/89
Finnish contracting firm Imatran Voima Oy (IVO) signs a contract with India to participate in the construction of the two Soviet-supplied 1,000 MW LWRs in
Koodankulam. IVO will assist India's NPC in establishing technical specifications for the plant.[48]
2/29/89*
At a seminar organized by the Department of Polymer and Environmental Sciences of Madras University, the DAE, and University Students Advisory Bureau, V.S.G. Rao, project director of the Kudankulam Project for India's NPC, says that the quality of life in the surrounding community will not be affected by construction of the new nuclear power plant. Rao says the USSR will use Indian contractors and laborers even though the reactors will be supplied on a turnkey basis.[49]
10/12/89*
The signing of a contract for the USSR to construct two 1,000 MW LWRs for India at Kudankulam is delayed over questions of financing and for other reasons. Although the two parties signed an intergovernmental agreement (November 20, 1988) for the preparation of a project report (i.e., a detailed design study), a contract for preparation of the report must still be signed. Chairman of India's AEC Malur Srinivasan said that the signing of the contract for turnkey execution of the project would come only after the design study is completed.[50]
10/14/89
An Indian-Soviet working group of the Kudankulam project advances completion of the two 1,000 MW Soviet-built reactors by one year. The new schedule envisages completion of the first station by 1998, and the second by 1999. The working group decides that all equipment and subsystems for both reactors will originate from the
USSR.[51]
Early 11/89
Representatives from India and the USSR meet to discuss financing terms for the Kudankulam project. Construction of the first unit is expected to begin in 1990.[52]
12/89*
In response to pressure from anti-nuclear demonstrators, the Indian government agrees to set up a panel of scientists and ecologists to evaluate environmental and social aspects of the Kudankulam nuclear power plant project.[53]
2/1/90
Director of BARC P.K. Iyengar replaces Malur

Srinivasan as chairman of India's AEC. Unlike Srinivasan, who pushed for importation of foreign technology, Iyengar favors indigenous development of nuclear technology.[54]
3/90*
Indian-Soviet negotiations on the details of the Kudankulam project continue. The issues in question include work schedules, training of Indian operators, and storage of spent fuel.[55]
6/90*
Disagreement over the price of the 1,000 MW reactors the USSR will supply to India slows negotiations.[56]
9/4/90
Chairman of India's AEC P.K. Iyengar says that most of the land acquisition for the two Soviet-supplied 1,000 MW reactors has been completed in Koodankulam. Completion of the project report (see October 1989) is anticipated for October 1990.[57]
11/8/90*
As part of ongoing negotiations, Iyengar says that the USSR has agreed to reduce installation costs of the two
VVER-1,000 nuclear reactors.[58]
4/4/91*
Iyengar says that India and the USSR have agreed on "specifications, some details of the schedule, and on the maximum cost" of the two 1,000 MW reactors. Construction is expected to begin in 1992.[59]
9/91
Iyengar says that a final agreement on design and financing of the Soviet-supplied reactors has not been reached, even though an initial agreement covering installation was signed in November 1988. Iyengar says that the reactors will contain a Western-style control system, and that India has budgeted $250 million for Western "equipment and expertise." Most electrical systems and software will be developed in India.[60]
1/92*
"Preliminary work" on the proposed Soviet-supplied nuclear power plant comes to a halt because of political instability in the former Soviet Union and Indian environmental concerns.[61]
1/23/92*
India has reportedly given up hope of receiving aid from Russia. Instead, it now plans to build two indigenously designed nuclear reactors.[62]
3/92
Russian President Boris Yeltsin signs a decree requiring foreign acceptance of full-scope safeguards as a condition for nuclear material and equipment sales.[63]
4/3/92
Russia signs the NSG "Guidelines for Transfers of Nuclear-Related Dual-Use Equipment, Material and
Related Technology" and the "List of Nuclear-Related Dual-Use Equipment and Materials and Related Technology."[64]
4/23/92*
Chairman of India's AEC P.K. Iyengar reports that Russia may not allow the shipment of a VVER-type nuclear power plant to India without payment in U.S. dollars.[65]
10/92
Iyengar says that the deal between India and the former Soviet Union to build two VVER-1,000 reactors has completely collapsed because the Russian Federation does not have sufficient capital for the project. However, the deal has not been formally cancelled. Iyengar laments that one of the main attractions of the deal was its deferred payment schedule. The Indian government simultaneously signals its intent to "transfer nuclear plant construction to the private sector."[66]

1/93
Russia and India sign a "Treaty of Friendship and Cooperation." Under Article IV, the two parties agree that the process of nuclear and conventional disarmament, including the reduction and ultimate elimination of weapons of mass destruction, should be accelerated.[67]
Late 1993
Russian President Yeltsin visits India to discuss the possibility of reviving the original Indian-Soviet agreement to construct a nuclear power plant at Koodankulam.[68] 3/29/94
Managing Director of India's NPC S.K. Chatterjee says that India is again considering the plan to construct a nuclear power plant consisting of two Russian-supplied 1,000 MW units at Koodankulam.[69]
6/94
A "final" round of discussions between Indian and Russian representatives is scheduled to consider the possibility of Russian-supplied reactors for Koodankulam.[70]
Late 1994
Russian Prime Minister Viktor Chernomyrdin signs a government-to-government economic cooperation agreement during a visit to India.[71]
1/95
A *Rossiiskaya gazeta* article quotes Russian Minister of Atomic Energy Viktor Mikhailov as saying that the Indian-Russian reactor deal is worth $2.6 billion, 15 percent of which will be paid in hard currency and the remainder in four-percent-per-year credits. Mikhailov says the deal is the largest contract signed by Minatom in 1994. Construction of the nuclear power station is expected to take eight years, beginning in 1995. About 1,000 Russian nuclear experts will work on the project. Russia is expected to begin shipping equipment to India in 1996.[72]
1/12/95*
Members of the NSG ask the Russian government to clarify unconfirmed reports that Russian Minister of Atomic Energy Viktor Mikhailov signed a contract with India in late 1994 to build two 1,000 MW reactors at Koodankulam. An unofficial report from Moscow said that the deal is valued at nearly $2 billion, about $1.7 billion of which will be provided in the form of countertrade. A Russian government official says that the Ministry of Foreign Affairs confirmed the reactor deal, and that it would take place only "on the basis that India comply with full-scope safeguards."[73]
2/22/95
Minatom announces that a detailed contract for the supply of an additional reactor to India will be signed in the near future. Minatom says that NSG concerns about India not being a party to the NPT are baseless because the reactor's design will not allow the "industrial production of [weapons-grade] plutonium."[74]
8/4/95
Following a meeting with his Indian counterpart, Pranab Mukherjee, Russian Foreign Minister Andrei Kozyrev says that "our cooperation is based on our own regulation and our own laws, and we take into account the interests of the non-proliferation of nuclear weapons and weapons of mass destruction."[75]
9/95
A group of Russian officials visits India to consider reviving the project to construct two Soviet 1,000 MW reactors at Koodankulam. Existing proposals suggest that Russia will equip the plants with essential components, and India will undertake construction, perhaps providing instrumentation as well.[76]
10/95
A Russian delegation visits India and signs a Memorandum of Understanding with India's NPC concerning Russian-supplied nuclear reactors.[77]
12/95

Russian government officials say that until India provides guarantees that it has sufficient funding to complete the nuclear power plant at Kudankulam and receives approval for changes to the sales agreement, Russia will not continue with the project. Although Managing Director of India's NPC Y.S.R. Prasad says that the final agreement will involve Russia's provision of a long-term loan, Russia refuses to accept India's proposed interest rate and partial countertrade proposal. According to Russian officials, India no longer wants a turnkey operation, as was originally agreed. Instead, India wishes to obtain pressurized water reactor technology that would allow it to build its own plant "like China."[78]

4/23/96*

Under pressure from the U.S. administration, Russia reportedly intends to renegotiate the terms of the November 1988 Indian-Soviet agreement. The new terms could include the shipment of all "fissile material produced from the nuclear power reactors" to Russia.[79]

6/24/96*

Russian First Deputy Minister of Atomic Energy Lev Ryabev says that Russia will not link Indian-Russian nuclear cooperation with India's position on the Comprehensive Test Ban Treaty.[80]

10/28/96

During a visit by Russian Minister of Foreign Economic Relations Oleg Davydov and other Russian officials to India to discuss the 1,000 MW reactor deal with Indian officials, Davydov announces at a press conference that the two sides are close to signing an agreement.[81]

2/11/97*

During talks with Indian Minister of Foreign Affairs Inder Kumar Gujral, Russian First Deputy Prime Minister Viktor Ilyushin says Russia plans to go ahead with its sale of two 1,000 MW LWRs to India. Russia has offered a $2.6 billion credit for the purchase of the reactors.[82]

2/15/97*

Russian Deputy Foreign Minister Grigoriy Karasin affirms Moscow's intention to build two 1,000 MW LWRs in India. Karasin says that construction is a "bilateral issue" and that Russia's participation in the project "does not contradict Russian law, nor does it conflict with Russia's international obligations."[83]

3/25/97

During talks with Indian Prime Minister H.D. Deve Gowda in Moscow, Russian President Yeltsin agrees "in principle" to the sale of two LWRs to India. Moscow and New Delhi have been unable to agree on how India will repay a low interest loan of $2.6 billion at four percent over a 12-year period. Moscow and New Delhi have also been at odds over where nuclear waste produced by the reactors will be stored.[84]

6/23/97*

According to Russian Minister of Atomic Energy Viktor Mikhailov, disagreement between Russia and India over financing will be resolved "within a month."[85]

7/3/97*

In an effort to attract private investment, the Indian government decides to open nuclear power generation to the private sector. Persistent funding shortfalls are cited as the cause. India is reportedly "extremely uncertain" as to whether the Indian-Russian deal to construct LWRs at Kudankulam will come to fruition.[86]

8/8/97

Apparently referring to the United States, newly-appointed Indian Prime Minister Inder Kumar Gujral says: "Some countries are not positive towards India getting nuclear power technology (from Russia) and are coming in our way." Gujral says India will not be "deterred in following [its] nuclear policy whether there is pressure direct or indirect, from any quarter."[87]

9/8/97

During a “working visit” to New Delhi, Russian Minister of Atomic Energy Viktor Mikhailov says technical parameters for the Kudankulam project have been “fully agreed upon.” Negotiations related to the conditions of repayment of the low-interest loan Moscow has offered New Delhi are “being tackled” and should be resolved within six to eight weeks, making it possible to begin construction of the nuclear power plant this year. Mikhailov says: “The implementation of this project is putting cooperation between [Russia and India] into a qualitatively new orbit.”
Note: An “*” indicates that the event was reported on that date. This chronology relies principally on materials drawn from the available secondary sources.

An Inter-Governmental Agreement (IGA) on the project was signed on 20 November 1988 by then Prime Minister Rajiv Gandhi and then Soviet head of state Mikhail Gorbachev, for the construction of two reactors. The project remained in limbo for a decade due to the dissolution of the Soviet Union.

There were also objections from the United States, on the grounds that the agreement did not meet the 1992 terms of the Nuclear Suppliers Group (NSG).The project was revived on 21 June 1998.

The Kudankulam project began with the first pour of the concrete taking place on March 31, 2002.

Major Milestones

Activity	Unit No.	Completion Month
Removing of dummy fuel from RPV	2	Sep-2015
Hot run of Nuclear Steam Supply System (NSSS) (Phase A-3 Commissioning)	2	Apr-2015
Individual function test of equipment / systems (phase A-1, commissioning)	2	Jan-2015
Containment pressure boundary test (Phase A-2 Commissioning)	2	Feb-2014
Hydro test & circular flushing of primary circuit	2	July-2014
Commissioning of Compressors	2	Dec-2010
Reactor Checkup and Assembly for "Stage Hydraulic Test"	2	Jan-2014

Dummy fuel loading	2	July-2013
Spillage to open reactor	2	Apr-2013
Putting Turbine on Barring Gear in TB	2	June-2015
Pre-stressing of RB Inner Containment (IC) Dome	2	July-2009
Commissioning of Trestle Crane	2	Mar-2010
Commissioning of DM Plant	2	Apr-2009
Charging of Reserve Power Supply System (RPSS)	2	Sep-2011
Commissioning of 220 KV GIS System	2	Nov-2008
Erection of Turbine & Generator	2	Aug-2010
Erection of NSSS Equipment & pipelines (MCP)	2	Apr-2009
Construction of Outer Containment (OC) Dome	2	Oct-2008
Construction of RB Inner Containment (IC) Dome	2	July-2008
Commissioning of Polar Crane	2	Dec-2007
Construction of Main Control Room and Auxiliary Building (up to 22.8 M)	2	Oct-2006
Construction of Emergency Power Supply and Control Building	2	Sep-2008
Construction of Turbine Building up to 36.5 M Including Crane beam.	2	Jan-2007
Construction of Primary Containment of RB Wall upto 43.9M	2	Nov-2005
Construction of Switchyard Control Building	2	Oct-2004
Construction upto RB + 5.4 Slab	2	Dec-2003
Completion of RB 0.00m Slab	2	June-2003
Completion of RB Foundation Slab	2	Sep-2002

First Pour of Concrete	2	July-2002
Ground Break	2	Sep-2001

TABLE 1.6 Milestones of Kudankulam nuclear power plant
Source : http://www.npcil.nic.in/main/ConstructionDetail.aspx?ReactorID=77

PLAN AND DIGRAM OF KUDANKULAM PLANT

A Nuclear Power Project is being set-up at Kudankulam in the state of Tamil Nadu, India in collaboration with the Russian Federation. The project comprises of two units each of 1000MWe VVER type reactor. The design of the plant and supply of all the major equipment is in the scope of the Russian Federation while development of infrastructure and project construction is in Indian scope of works. The VVER (Version V-412) reactor that is under construction at KudanKulam site is an advanced PWR, which incorporates all the features of a modern PWR as per the current Russian, Western and IAEA standards. The KudanKulam site in the southern Indian state of Tamil Nadu was one among the several sites evaluated by the Site Selection Committee, which cleared KudanKulam site for setting up an installed capacity up to 6000MWe. The design, construction and operation of the plant meets the regulatory and licensing requirements of Russian regulatory body "RTN" as also India's Atomic Energy Regulatory Board.

Main parameters of Kudankulam-VVER

Reactor thermal power	3000MW
Electrical	1000MWe
Number of circulating loops	4
Working pressure in primary circuit Rated coolant temperature	15.7MPa
At reactor inlet	291◦C
At reactor outlet	321◦C
Coolant flow rate through reactor	86,000m^3/h

Main coolant pump head	0.64MPa
Steam generator (horizontal)	4
Steam pressure	6.27MPa
Steam flow	408.33×4kg/s

Pressurizer 1
Normal steam volume 24m
Normal water volume 55m

Reactor coolant pipe, diameter		850mm
Reactor pressure vessel		SS clad low alloy steel
Diameter (inside)		4134mm
Total height		11185mm
Number hexagonal fuel assemblies		163
Reactor internals (core barrel, core baffle) and protective tube assembly		Austenitic SS
Numbers of control rods		121
Life time		40 years
Containment		Double with primary steel lined
Turbo-generator		1000MWe (3000rpm)

TABLE 1.7 Salient features of Kudankulam reactor

Salient features of VVER

VVER Is an acronym for "Voda Voda Energo Reactor" meaning water-cooled, water moderated energy reactor. This type of reactoruses3.92%enricheduraniumasfuel.TheVVERreactors belong to the family of the pressurized water reactors (PWRs), which is the predominant type in operation, world over. The advanced 1000MWe design of VVER (VVER-1000) has many variants in different countries, which are derived from the basic VVERmodelV-392.Themodelsoftheseplantshavesomemodifications based on the client–country requirement (Information, 1998; KK-Proj. Tech. Assign., 1998). The VVER reactor that is under construction at KudanKulam site is an advanced PWR, i.e., VVER NSSS model Version V-412, which incorporates all the features of a modern PWR as per the current Russian, Western and IAEA standards (Seminar, 1998).

The KK-VVER has a 3 year fuel cycle. This reactor requires annual refuelling of one-third of the core, i.e., approximately 55 fuel assemblies. The reactor plant consists of four circulating loops and a pressurizing system connected to the reactor with each loop containing a horizontal steam generator, a main circulating pump and passive part of emergency core cooling system (accumulators). The loops are connected with the reactor pressure vessel assembly by interconnecting piping. The reactor plant also consists of a reactor protection and regulation system, engineered safety features, auxiliary system, fuel handling and storage system, etc. (KK-PSAR, 2002).

Reactor Building

The 88 meters tall structure of the main Reactor building has been done with a novel raft design for the reactor structure. The reactor building raft has a foundation at 8.85 meters below the ground level. The thickness of the raft foundation is 4.6 meters at the end and 1.6 meters in the middle. The containment base slab is at 1.1 meters above ground level and 5.35 meters above the foundation which is of 1800mm thick and the total concrete quantity of this slab is 6000 cum. The containment base slab supports the core of the nuclear reactor placed in the reactor cavity at the centre of the containment structure.

Inner Containment Structure

Ÿ Inner containment wall starts from +5.35 M above ground level and goes up to +43.9 meters as cylindrical part with a diameter of 44 meters. . The hemispherical dome starts from +43.9 meters with radius of 22 meters. .the top of Inner Containment Dome is +67.10 meters. Ÿ. The inner containment wall is 1200mm thick and outer containment wall is 600 mm. The annular space between inner containment and outer containment is 2200 mm.

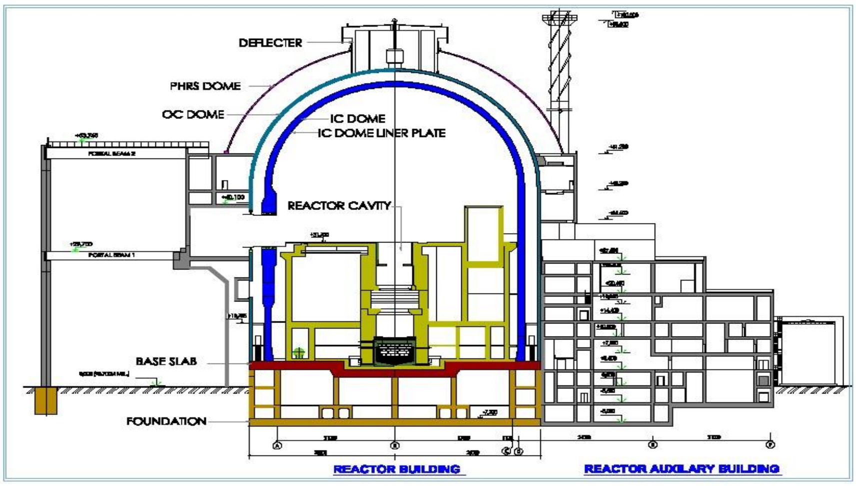


FIG 1.6 Inner containment structure

Unique features of project

The Main Reactor Buildings are the heart of each unit designed to produce 1000 MW power each – by far the largest Reactors ever built in India. These are not only the largest but the first to have the following construction features

The inner and outer containment structures have complete hemispherical dome. The outer containment dome is further protected by a PHRS (Passive Heat Removal System) dome.

The inner containment floor, wall and dome are completely lined with steel liner on the inner face.

The inner containment also has 45 steel brackets; over which 15 steel beams of box section ultimately supports 30 rails. This rail of 21m radius is provided for supporting a 350t capacity Polar Crane.

The inner containment structure is pre-stressed by 55C15 type tendons, each tendon constituting 55 HDPE sheathed strands of 15.7mm nominal diameter. This is the first time in the World that an un-bonded pre-stressing system has been adopted for a reactor containment

Potential of Kudankulam:

The first pair of Reactors in Kudankulam are VVER-1000(1000MW reactor) which has multiple cooling circuits and has a full lifetime of 35 years. This reactor can be extended after a 35 year usage to an additional usage of 10 years or replaced by a newer version. Kudankulam is the first Indian Nuclear Power Plant to use the VVER class reactor. With a pair of VVER-1000 reactors, Kudankulam will be able to take up to 1.8 GW of peak load. This is Phase-I of the project which can now be commissioned. The start of reactors will happen in two stages, starting unit 1 first, unit 2 next and subsequently all installed units in sequence.

The VVER-1200 and MIR-1200 are immediate successors to the VVER-1000. Consequently Kudankulam will be the VVER-1200which has a peak load capacity of 1173 MW. The safety standards adhered to are maximized and match the MIR-12000 (Modern International Reactor) which is built in conjunction with Skoda Engineering, Czech.

Kudankulam will have 4 units of VVER-1200 generating power withstanding peak load of 5.8 GW. In conjunction. This is Phase-II of the "Kudankulam" Project.

If Kudankulam is fully operational, this power plant alone will produce 7.6 GW of power after Phase-II is rendered operational. The initiation of Phase-II is dependent upon the success of Phase-I. Under present assumptions all Phase-II should be completed before 2013-2014 and be fully operational and could also include the expansion related to Phase-III. As the reactor complex is already complete, these deployment decision will be made by Nuclear Power Corporation of India.

Phase-III would deploy two addition VVER-1200 reactors with more safety standards surpassing MIR-1200 projections. This would provide a stable capacity of handling a total of 9.8 GW at a total sunk-investment of*Rs.14,000 Crores*.

Operational costs for cooling and personnel shall be minimal as the reactor cores themselves address several safety issues including coolant poisoning, the ability to withstand earthquakes up to 7 on the Richter scale (which is logarithmic).

The VVER reactors have been in use by Russia and Iran. India has agreements permitting extremely close cooperation in the building and technological development of the new series of VVER reactors, namely the VVER-1200 to MIR-1200 transition,

Based on Technology this will stand as the greatest achievement of India in satisfying its own power requirements in the recent millennium and put Tamil Nadu ahead of all states of India in its capacity to produce and internally provide power to neighbour states.

State of Tamil Nadu - Power Requirements (Power demand (The Hindu))
Presently the state of Tamil Nadu in India requires a peak of 11.6 GW of power.

NTPC who primarily produces power using Coal/Lignite or in some cases Diesel, takes peak load of 2.8 GW in Tamil Nadu. This production is from "Central Stations."

We have independent power generation sources providing 1180MW load capacity. These would include Hydel and Hydel supplementary plants that run on Diesel to keep the power grid fed well.

Wind power installation in Tamil Nadu being the highest in India has a capacity of 6.4 GW. However 300 MW capacity is unused due to distribution anomalies (lack of transformer sites to distribute the power as people refuse to relocate.)
This leaves the plant 6.1 GW load capable until that issue is resolved. As a result the maximum production is 6 GW. However our maximum production has been close to *4100*

MW and minimum *2100 MW* due to seasonal and climatic variations. This has not been a reliable source of power and is also insecure and vulnerable in emergency situations.

Power deficit of a minimum of 2 GW and a maximum of 4 GW is incurred depending on conditions. This deficit is handled by purchasing power from neighbouring states.

Table Detailing Power Requirement versus Power Produced and Surplus/Deficit Result

All numbers in the following table are in MW (thousands of Watts)

	TN needs	*9500*	11600 (unpredictable)
Power Source	Installed (MW)	Load Capacity (MW)	Worst-case (MW)
NTPC	2861	2800	400
Wind Power	6400	4100	2000
Other Sources	1200	1180	800
Kalpakkam	440	400	200
(cumulative)	10901	8480	3400
Surplus	-699	-3120	-8200
KNPP Phase 1	2000	1980	990
(cumulative)	12901	10460	4390
KNPP Phase 2	4800	4200	2100
(cumulative)	17701	14660	6490
KNPP Phase 3	2000	1980	990
(cumulative)	19701	16640	7480
Surplus / deficit	8101	5040	-4120

TABLE 1.8 Power requirement VS Power produced in state of Tamilnadu
(The above table is based on information provided on public websites and press releases by National Ministries concerned.)

KNPP with just Unit 1 and Unit 2 operational will leave TN with a surplus of 300MW
As you can see, KNPP if completed within the present day will create a surplus of 8101 MW, however future power requirements have to be taken into account.
Today, *Without KNPP*, but Hydel and all other sources working, we must buy a minimum of 3120 MW of power or 8200 MW of power to provide uninterrupted power to the people.
TN's power requirement is *11.6 GW*, KNPP with 6 reactors will produce 9.8 GW power capacity. The mathematics is now easy. Power distribution to industrial estates nearby would allow Neyveli to concentrate on more Northern Geographies within the state.

This would make Tamil Nadu a heaven for industry which needs power to operate as opposed to the blackouts we have been facing frequently due to multiple issues. It is in the best interest of the central and state governments of India to have Kudankulam operational. Kudankulam is a power gold-mine, the first of its kind Nuclear power complex that will produce power, provide jobs in the vicinity, result in industrialization, provide hospitals for medical care, schooling as the entire *local* community becomes realigned to power production from the primitive methods of fishing that are being practiced in the area.

Out of 2,000 MWe generated from the two reactors at Kudankulam, Tamil Nadu’s share will be 925 MWe. Karnataka will receive 442 MWe, Kerala 266 MWe, Puducherry 67 MWe and the unallocated share will be 300 MWe.

Land acquisitions

The Nuclear Power Corporation of India Limited (NPCIL) acquired around 929 hectares of land for the project and another 150 hectares for the township. NPCIL acquired land in excess of what is actually required for the construction of two reactors. During this time the NPCIL promised jobs for the local people along with overall growth and development of the region. It also promised the people that it would use sea water for cooling the reactors by recycling it instead of drawing water from the Pechiparai reservoir. Land for the KNPP was acquired in the late-1980s. Many people sold their land for a paltry Rs 2,000 per acre and Rs 100 per cashew tree. For many, it was the only land they owned and they had tamarind trees on their land, for which no compensation was paid. Many sold their land in the hope that they would get jobs and sub-contracts in the plant.

Although Kudankulam nuclear reactor is state of the art he concerns of local communities surrounding the Kudankulam Nuclear Power Plant gone unaddressed for two decades. People living around the nuclear plant have strong reservations to its presence and have voiced their opposition to it. However ever since the plant was commissioned, any activities critical of the plant were countered by strong reaction as if even talking about the subject was seditious and against the State.

CHAPTER 4
KUDANKULAM ANTI-NUCLEAR PROTEST

Anti-nuclear protests in India:

In the early days of the nuclear programme, general public opinion was almost unanimous as to its desirability. This was the one programme of the government to which people looked with pride. It was the one field where India was in the front rank and people felt that its success would show that Indian scientists and engineers were second to none.

Initially there was opposition amongst the scientific community as to the way the programme was proceeding and especially the fact that a lot of resources which could have supported other useful research were being diverted to it. However, Dr Bhabha was able to convince Nehru that it was necessary and that universities were not in a position to do first rate research and that lot of red tape would stifle scientific creativity. As a result in 1957, the Atomic Energy Commission was reconstituted and Bhabha got everything that he wanted and nuclear energy became the only subject where the scientists were given a free hand and were not subject to usual bureaucratic controls.

Awareness about the need for a balanced ecology that spread throughout the world had its echoes in India too. The 'Chipko' movement in the north and the 'Silent Vally' movement in the South were manifestations of this. Kerala, with the highest literacy rate in the country and a strong peoples' science movement took the lead in opposing the siting of a nuclear reactor in its territory. The Organisation for the Protection from Nuclear Radiation successfully opposed the government’s plan of siting the reactor at Kothamangalam in South Kerala.

The Groups

Before the disaster at a Union Carbide pesticide factory in Bhopal there had been individuals who had opposed different aspects of the programme and especially the fact the performance had been poor, and the plants were "dirty" by international standards. The disaster at Bhopal shocked some people out of their slumber.

In 1985 a group of Gandhian activists and intellectuals gathered together to question the wisdom of establishing the Kakrapar reactor. Two demonstrations took place at Kakrapar and Surat in May and August respectively. The agitation attracted wide public support a year later in August '86. Sampoorna Kranti Vidyalaya and Anu Urja Jagruti were able to organise a massive rally near the plant site inspite of the government's efforts to prevent it. The repressive measures included promulgation of laws forbidding assembly of more than four persons, stopping of all vehicular traffic, stick wielding and mounted police let loose on the people, and use of tear gas to disperse the crowd. Unfortunately, the rally, which included thousands of local Adivasi’s (tribals) did not remain entirely peaceful and a section of it indulged in stone throwing and causing damage to public property. The Gandhian leadership of the movement later fasted for two days as an expression of their opposition to government provocation and of regret for their inability to control the crowd. The government persisted in its efforts of trying to terrorise the people even to the extent of resorting to firing the next day in which one boy of 13 was killed and another injured. These events received wide publicity in the local press and questions were raised in the state legislature.

The proposal to site a reactor at Kaiga in Karnataka also mobilised a number of environment-lovers to organise an agitation against it. A great moment of this agitation occurred in 1988 when hundreds of women jumped into the foundations of the reactor which was being built. The Kaiga groups also challenged the siting of the reactor on environmental grounds in the Supreme Court which directed the government to take the points raised by the agitation into consideration.

There was also protest led by groups from Delhi at Narora in the neighbouring state of Uttar Pradesh. The decision by the government to order two Soviet built VVER–1000 reactors for the extreme south of the country at Kudankulam also led to protest over there. However, these protests became dormant after the collapse of the Soviet Union. (Recently the government has again reached agreement with Russia to build these plants). Similarly there were protests in the southern state of Andhra Pradesh against the proposed reactors at Nagarjunasagar.

In August 1986, these various groups came together at a seminar on "Atom in India" in Bombay. Here it was decided that the movement should continue on the local level with various independent groups conducting their own forms of protest, but attempts should be made to help each other and that there should be more communication amongst the various groups. A bimonthly journal—Anumukti (Atomic Liberation) started publication in August 1987 and is still going strong.

Forms of Protest

Public education through posters, films, discussion groups, leaflets and articles in newspapers and magazines has been one of the major activities of the groups. There have also been sit-ins, demonstrations, and debates with nuclear authorities. In 1988 after a lot of demonstrations the state Government of Karnataka organised a debate between antinuclear groups and the atomic energy establishment. This was covered widely by the press and the media. But after the debacle at this debate, the nuclear establishment has tried to avoid coming into face to face public confrontation with the critics.

There have been two forms of protest, which deserve special mention. One is what are called cycle 'yatra'. These are long (more than 1000 to 1500 kilometres) marches with about 20 to 25 cyclists going from place to place meeting, talking, singing and doing street theatre with small groups (50–200) of people at street corners. Many such yatras have been done and they have been very successful in terms of raising people's awareness regarding nuclear dangers.

The other 'protest' activity has been to organise door to door scientific surveys of the effects of nuclear power plants on the lives of the people living in the vicinity. These have been very effective in showing the people what price they have had to pay in terms of health. In fact, in Rawatbhata, where a nuclear plant had been in operation for 17 years without much protest, after the survey people took out a demonstration on their own initiative and asked the government to shut the plant down. Interest in doing these surveys has spread to other groups and surveys are now being conducted around Kakrapar and Kaiga plants. There is also a survey being conducted in the uranium-mining region of Jharkhand in the northern state of Bihar.

Opposition to uranium mining activity has been a recent feature. In January this year hundreds of tribels gathered together to protest against the government’s action of demolishing houses in Chatikocha village to accomodate a new tailing's pond.

Stories of success and failures:

Most of the protests though they were successful in raising people's awareness, were unsuccessful in shaking the resolve of the government to build the plants. The protests could not be sustained year after year and the government just waited for the protest to die down. However, protests did cause delays and this ultimately had the effect of making the projects even more unviable. It has also made governments vary of siting new facilities at new sites. Today all the new construction that is going on or is even proposed is at sites that already have nuclear facilities. Also the financial backing of the government to nuclear industry has become much less than in the past and this has resulted in scaling down of many of the projects and some have been abandoned. For example although permission had been previously granted for building of four 500 Mwe reactors at Rawatbhata, this has now been withdrawn, though work is continuing on two 220 Mwe which were in the works.

One of the undoubted successes of antinuclear protest has been the abandonment of a proposed reactor at Peringome in northern Kerala. Here a Marxist government was strongly in favour of building the plant but gave up the idea when they saw that this would lead to a strong erosion in popularity which would affect electoral chances.

A sixty kilometre march from the proposed plant site to the district headquarters in Kannur was organised in which hundreds of people participated. Even members of Marxist trade unions defied party leadership and took part.

One of the interesting facts about antinuclear groups in India is that they have amongst them people from all shades of political opinion. From communist trade unionists to right wing nationalist with Gandhian social activists, all have cooperated and learnt to work together.

The overall aim of the movement is to have people oriented and people controlled development which would also be ecologically sound. In recent years there has been an awareness regarding this amongst many groups working on various issues in India and as a result a number of such groups are coming together on common platforms.

KUDANKULAM ANTI-NUCLEAR MOVEMENT:

WHY THE PROTEST?

People have been opposing the Kudankulam Nuclear Power Project (KNPP) ever since it was conceived in the mid-1980s. The people of Kudankulam village themselves were misled by false promises such as 10,000 jobs, water from Pechiparai dam in Kanyakumari district, and fantastic development of the region. We tried in vain to tell them that they were being deceived. Without any local support, we could not sustain the anti-Koodankulam movement for too long. Now the people of Kudankulam know and understand that this is not just a fisher folk problem, they may be displaced, and they have to deal with radioactive poison. Their joining the movement in 2007 has invigorated the campaign now. And almost all of us here in the southernmost tip of India oppose the Kudankulam NPP for a few specific reasons:

1. The KNPP reactors are being set up without sharing the Environmental Impact Assessment (EIA), Site Evaluation Study and Safety Analysis Report with the people, or the people's representatives or the press. No public hearing has been conducted for the first two reactors either. There is absolutely no democratic decision-making in or public approval for this project.

2. The Tamil Nadu Government G.O. 828 (29.4.1991 – Public Works Department) establishes clearly that "area between 2 to 5 km radius around the plant site, [would be] called the sterilization zone." This means that people in this area could be displaced. But the KNPP authorities promise orally and on a purely ad hoc basis that nobody from the neighbouring villages would be displaced. This kind of ad hocism and doublespeak causes suspicion and fears of displacement.

3. More than 1 million people live within the 30 km radius of the KNPP which far exceeds the AERB (Atomic Energy Regulatory Board) stipulations. It is quite impossible to evacuate this many people quickly and efficiently in case of a nuclear disaster at Koodankulam.

4. The coolant water and low-grade waste from the KNPP are going to be dumped in to the sea which will have a severe impact on fish production and catch. This will undermine the fishing industry, push the fisher folk into deeper poverty and misery and affect the food security of the entire southern Tamil Nadu and southern Kerala.

5. Even when the KNPP projects function normally without any incidents and accidents, they would be emitting Iodine 131, 132, 133, Cesium 134, 136, 137 isotopes, strontium, tritium, tellurium and other such radioactive particles into our air, land, crops, cattle, sea, seafood and ground water. Already the southern coastal belt is sinking with very high incidence of cancer,

mental retardation,down syndrome, defective births due to private and government sea-sand mining for rare minerals including thorium. The KNPP will add many more woes to our already suffering people.
6. The quality of construction and the pipe work and the overall integrity of the KNPP structures have been called into question by the very workers and contractors who work there in Koodankulam. There have been international concerns about the design, structure and workings of the untested Russian-made VVER-1000 reactors.

7. The then Minister of State in the Ministry of Environment and Forest Mr.Jairam Ramesh announced a few months ago that the central government had decided not to give permission to KNPP 3-6 as they were violating the Coastal Regulation Zone stipulations

8. Many political leaders and bureaucrats try to reassure us that there would be no natural disasters in the Kudankulam area. How can they know? How can anyone ever know? The 2004 December tsunami did flood the KNPP installations. There was a mild tremor in the surrounding villages of Kudankulam on March 19, 2006. On August 12, 2011, there were tremors in 7 districts of Tamil Nadu.

9. Indian Prime Minster himself has spoken about terrorist threats to India's nuclear power plants,On August 17, 2011, Minister of State for Home, Mr. Mullappally Ramachandran said: "the atomic establishments continue to remain prime targets of the terrorist groups and outfits."

10. The important issue of liability for the Russian plants has not been settled yet. Defying the Indian nuclear liability law, Russia insists that the Inter -Governmental Agreement (IGA), secretly signed in 2008 by the Indian and Russian governments, precedes the liability law and that Article 13 of the IGA clearly establishes that NPCIL is solely responsible for all claims of damages.

11. In 1988 the authorities said that the cost estimate of the Koodakulam 1 and 2 projects was Rs. 6,000 crores. In November 1998, they said the project cost would be Rs. 15,500. In 2001, the ministerial group for economic affairs announced that the project cost would be Rs. 13,171 crores and the Indian government would invest Rs. 6,775 crores with the remainder amount coming in as Russian loan with 4 percent interest. The fuel cost was estimated to be Rs. 2,129 crores which would be entirely Russian loan. No one knows the 2011 figures of any of these expenses. No one cares to tell the Indian public either.
What do you think?

12. The land to construct the nuclear project at Kudankulam was seized from farmers at pretty low compensations. For most of them, it was the only asset and mode of livelihood. They were promised jobs in the construction of the plant. Slowly, they were receiving intimidations of displacement. The plant was constructed in violation of the rule that there should be no human habitation up to 30 kms of its vicinity.
What do you think?

13. The equipment and subparts for the construction of the nuclear plant was supplied by Russian based companies Atomstroyexport and ZiO-Podolsk. In 2012, the Russian government slapped accusations on ZiO-Podolsk for manufacturing sub-standard equipment for both domestic and foreign customers. The director Sergei Shutov has been arrested for purchasing low quality material at low cost and bagging the difference in the amount. Following this development the Prime Minister, the Atomic Energy Regulatory Broad (AERD) and

Department of Atomic Energy received many letters questioning the safety of the project and recommendations to stop the construction. But, the authority as high as PMO is silent about the issue.
What do you think?

14. In India, the project is owned by the Nuclear Power Corporation of India Limited (NPCIL). According to our constitution, a public sector unit has the responsibility and accountability to make transparent and fair purchases in public interest which the board has failed to oblige.

15. The power that would be generated through the commissioning of this plant would serve up to 20 years of requirement. The cost and method of decommissioning the plant has not been discussed.
What do you think?

16. The problem of management of radioactive waste has not been discussed.
What do you think?
What do you think?

17. When countries like Germany, Italy and Switzerland have scraped their plans to build Nuclear power plants, why India is batting over the issue so insensitively?
What do you think?

18. The government has not answered on what would happen to the biodiversity of the Gulf of Mannar and the aquatic life in the sea with the release of hot water. Fishermen would be deprived of their livelihood.

People opposing the Kudankulam Reactors:
Those who are displaced by the project and who have not been adequately compensated due to the existing archaic compensation packages

The fishermen who have apprehensions about
The fishing rights in that area.
The possibility of radiation getting into the fish.
The possibility of reduction in fish growth due to the rise in temperature of sea water locally

People of the area fearing a nuclear disaster or leakage of nuclear waste contained

The Kudankulam timeline:

November 20, 1988: The Soviet Leader Mikhail Gorbachev and the then Indian Prime Minister Rajiv Gandhi signed the Kudankulam Nuclear Power Project deal in Delhi.
December 19, 1988: The proposed foundation laying ceremony was put off indefinitely due to widespread opposition to the project among the local public. The opponents of the Kudankulam project took out a massive rally at Tirunelveli.
January 11, 1989: Another massive rally was held at Nagercoil against the project.
May 1, 1989: The coastal march "Protect Waters, Protect Life" held at Kanyakumari was broken up by driving a local transport bus into it. Six fishermen were badly injured in police firing and false cases were slapped on the protesters.
August 27, 1989: Over 120 organizations representing farmers, fish workers, women, students, environment groups, and representatives of various political parties (except the Communist

Party of India and the Communist Party of India-Marxists) organized a meeting in Kanyakumari district.
April 29, 1990: Several organizations and the public demonstrated in Nagercoil against using Pechiparai dam water for the Kudankulam reactors.
January 30, 1991: A bicycle rally organized by Murpokku Manavar Sangam (Progressive Students' Association) and Murpokku Ilaigner Ani (Progressive Youth League) started in Madras and went through Vellore, Dharmapuri, Coimbatore, Ramanathapuram and Madurai.
February 10, 1991: The rally concluded with a public meeting followed by a cultural program.
1989-1991: Soviet Union collapsed; Gorbachev lost power; Rajiv Gandhi was killed; and Kudankulam project was shelved.
March 21, 1997: The American President Bill Clinton reportedly put pressure on his Russian counterpart, Boris Yeltsin, at their Helsinki Summit to refrain from building the nuclear reactors in Koodankulam.
March 25, 1997: Indian Prime Minister H. D. Deve Gowda and the Russian President Boris Yeltsin signed an agreement, a supplement to the 1988 agreement, to commission a detailed project report on the Kudankulam project.
April 15, 1997: The Kudankulam project's cost estimate in 1988 was Rs. 6,000 crores. The present start-estimate (as opposed to the end- cost) today is an alarming sum of Rs. 17,000 crores.
September 5, 1997: The goal of producing 20,000 Megawatt nuclear power by the year 2020 was said to have been established by the Indian nukedom in a "Vision 2020" seminar.
September 9, 1997: Dr. Hans Blix, the Director General of the International Atomic Energy Agency (IAEA), said that India's refusal to subject all its atomic installations to an IAEA governed international inspection regime was likely to stand in the way of India's imports of nuclear technology from the Nuclear Suppliers Group (NSG).
October 6, 1997: It was reported that the Russians "seem to agree to take back the (spent) fuel," but a clear agreement was yet to be reached.
December 20, 1997: It was reported that Dr. Alexy Yablokov, Chairman of the Russian National Ecological Security Council, stated that the Russian reactors were "highly unsafe."
January 23, 1998: Agreement on financial terms was reached. India had suggested that a major part of the payment would be made in hard currency (dollar) and the rest in Rupees, but Russians insisted on making the whole payment in hard currency. It was agreed finally that the entire payment would be in hard currency with some compromises on the payment mechanism.
June 21, 1998: Russian Atomic Energy Minister, Yevgeny Adamov, and Indian Atomic Energy Commission Chairman, R. Chidambaram signed a supplementary accord in Delhi to go ahead with the Kudankulam project. Chidambaram told the press that a detailed project report for the construction would be prepared in the next two years and the actual construction work would take another six years after the report submission.
June 24, 1998: The US said that the Russian decision to build two nuclear reactors in Kudankulam was not good news and that it sent the "wrong signal at the wrong time." [The reference was to India's May 1998 nuclear tests.]
July 4, 1998: A Frontline report ("Koodankulam is back" by T. S. Subramanian in issue dated July 4, 1998) mentions: "The [Nuclear Power Corporation] sources said that up to six reactors could be built at the site. The area where the first two reactors would come up had been identified and the Russians were satisfied with it."
October 18-22, 1998: The National Alliance of People's Movements (NAPM) organized a workshop at Nagercoil on Kudankulam and related issues.
November 4, 1998: Russian and Indian nuclear engineers started working on a $57 million Detailed Project Report (DPR). The reactors are expected to be ready by 2006 and the cost would be roughly $3.1 billion.

November 5, 1998: The Indian nukedom organized a seminar in Chennai to take public into confidence on Koodankulam. The Atomic Energy regularly Board (AERB) Chairman, P. Rama Rao, said, without disclosing details, that "the site evaluation for Kudankulam had been done."
December 5, 1998: The National Alliance of People's Movements (NAPM) organized a seminar in Chennai (Madras) on "Today Pokhran, Tomorrow Koodankulam" with a lot of activists, journalists, researchers and the public.
January, 1999: The National Alliance of People's Movement (NAPM) organized workshops on the dangers of the VVER 1000 reactors (to be used in Koodankulam) with the help of an Australian scientist John Hallam at Nagercoil, Tirunelveli and Madurai. Several Kanyakumari district residents held individual consultations to initiate a mass movement against the project.
February 21, 1999: The Madras High Court upheld release of water from Pechiparai dam in Kanyakumari district to the Kudankulam Atomic Power Plant (KAPP).
April 21, 1999: Private sector participation in nuclear power generation in India was welcomed by the NPC and AEC officials. In order to meet the 20,000 megawatt nuke power by 2020, they needed Rs. 80,000 crores and hence this plan.
July 28, 1999: The Indo-Russian Inter-Government Commission discussed ways and means of expanding bilateral trade and utilizing the funds for investments in Indian projects. Russia would open a rupee account with the Reserve Bank of India to utilize the debt funds for investments in India such as the Kudankulam project.
November 14, 1999: The opponents of the Kudankulam project met in Nagercoil, decided to revive the struggle against it, and founded the "Anumin Nilaya Ethirpu Iyakkam" (Nuclear Power Project Opposition Movement). The group started sending postcards to the Chief Minister of Tamil Nadu requesting him to stop the project.
December 26, 1999: The "Anumin Nilaya Ethirpu Iyakkam" (Nuclear Power Project Opposition Movement) organized a seminar at Nagercoil against the Kudankulam project.
January, 2000: Several hundred organizations and individuals from around the world appealed to the Indian and the Russian authorities in a well-document sign-on letter to scrap the Kudankulam nuclear power project. Copies of the letter were sent to the Presidents of Sri Lanka and the Maldives also.
June 9, 2001: Twelve Russian experts concluded two-day visit to Kudankulam to finalize tender document.
June 23, 2001: Indian Government sanctioned Rs. 125 crores for carrying out the excavation work in Koodankulam. The Centre approved 229 MV third and fourth units at Kaiga.
September 3, 2001: NPCIL (Nuclear Power Corporation of India Ltd.) acknowledged that the company received a budgetary support of Rs. 586 crores to meet capital expenditure. Russian credit of Rs 134 crores for Detailed Project report work of the Kudankulam project was also received. The company raised Rs. 659.50 crores from the market and Rs. 145 crores through infrastructure bonds. Russians would provide all materials, equipment, spares and fuel.
November 3, 2001: The Cabinet Committee on Economic Affairs (CCEA) according financial sanction to commence work on Kudankulam NPP. It is expected to cost Rs. 13,171 crores. India would spend Rs. 6,755 crores and the remaining would be Russian credit (at 4 percent interest). Rs. 2,129 crores was allocated to procure fuel (initial core and five reloads). Out of this, Rs. 367 crores would be in equity form and the rest Russian credit.
November 3, 2001: Russia offered earlier this year to build four more reactors at Koodankulam. Although India welcomed it, Russia must overcome Nuclear Suppliers Group (NSG) restriction. NGS, a 27-member group, calls Russian cooperation in Kudankulam a violation of NSG guidelines on technology transfers. The guidelines require recipient country to accept complete international control over its nuclear program. But India has refused to place its nuclear program under "full-scope safeguards" of IAEA.

November 6, 2001: Prime Minister Mr. A. B. Vajpayee signed final agreement on Kudankulam NPP.
November 10, 2001: A broad umbrella organization, People's Movement against Nuclear Power (PMANP), was founded at Madurai.
February 28, 2002: A one-day seminar on "Health Hazards of Radiation" was organized at Nagercoil by the Nuclear Power Awareness Committee. Kudankulam project director Mr. S. K. Agrawal undertook publicly at a national seminar on "Health Hazards of Radiation" held at Nagercoil that he would share the Environmental Impact Assessment (EIA), that is said to have been done in 1988, and the Kudankulam site evaluation report with the public. He also expressed willingness to let a few people see the safety analysis report in Mumbai office.

February 29, 2002: A few PMANP leaders were shown around the Kudankulam project site by its director Mr. S. K. Agrawal. He said he would share the EIA and other reports as soon as he came back from his Mumbai trip.
April 26, 2002: A one–day fast at Kanyakumari Collector office (by Nuke Power Awareness Committee).
July 27, 2002: In a major policy shift, NPC has decided to go for 700 MW plants from now on. These plants will come up near existing facilities in Narora, Kakrapar and Kota. Power Minister Mr. Suresh Prabhu said by the end of eleventh plan, nuclear power generation would be about 15,000 MW and in another ten years, it would be 40,000 MW.
September 20, 2002: KKNPP Director Mr. Agrawal announced in a local college seminar that a mini port would be built at Kudankulam in order to bring the heavy equipment from Russia.
October 19, 2002: Mr. Anil Kakodkar said there are no plans to set up power plants in new sites as there is enough space in existing sites.
October 22, 2002: PMANP leader Mr. Gomez met Sri Lankan Minister for Environment and Forestry, Mr. Rukman Senanayake in Colombo about the dangers of the Kudankulam project to people in southern India and Sri Lanka.
November 9, 2002: PMANP Conference Planning meeting was held at Koodankulam. Some 100 people attended the meeting and several committees were constituted.
January 30, 2003: An NAPM rally and public meeting was held at Nagercoil under the leadership of Medha Patkar.
January 20, 2004: A one day hunger-strike was held at World Social Forum, Mumbai by PMANP.
February 15, 2007: One-day Hunger Strike - Some 7000 men, women and children from 175 fishing and farming villages of Tirunelveli, Thoothukudi and Kanyakumari district fasted together. They all demanded immediate closure of the ongoing projects (I and II) and the planned projects (III, IV, V and VI).
March 17, 2007: The people of Kudankulam took out a massive rally demanding a CBI enquiry into the quality of the nuclear power plants construction. The people felt that the material used for the construction was of very poor quality and hence the safety and security of the people will be compromised.
March 24, 2007: Idinthakarai Fast - Some 6000 to 7000 people came together for a day-long fast and protest against the Kudankulam nuclear power project at Idinthakarai village near Koodankulam.
November 12, 2007: Letters were written to Indian MPs requesting them to oppose the Indo-US nuclear deal.

September 22, 2008: Nagercoil - The People's Movement Against Nuclear Energy organized a one-day hunger strike in front of the Kanyakumari District Administrator's office at Nagercoil with the three demands that the Kudankulam nuclear power project must be stopped immediately, that the nuclear agreements India had signed with the US, Russia and France be scrapped, and that the nuclear weapons program of India be wrapped up completely.

September 29, 2008: Nagercoil - Scores of school children from all over Kanyakumari district, who are members of the Children's Panchayat, made a representation to the Kanyakumari District expressing their fear that the Kudankulam nuclear plant would give rise to dangerous radiation that will spread through air and water and damage the health and well-being of all the people, especially the young children and their futures.

October 11, 2008: Alatthankarai (Near Rajakkamangalam, Kanyakumari District) - The People's Movement Against Nuclear Energy organized a one-day hunger strike with the same three demands which were made at Nagercoil.

November 13, 2008: The People's Movement against Nuclear Energy (PMANE) organized a one-day hunger strike from 10 am to 5 pm at Marthandam, Kanyakumari district.

November 21, 2008: The People's Movement against Nuclear Energy organized a one-day hunger strike in front of the Thoothukudi District Administrator's office.

November 25, 2008 to December 10, 2008: A fourteen-day awareness-raising tour was organized by the Organization Against Violence on Women to point out that the "development" project such as the Kudankulam nuclear power plant would cause immense damage to women in the form of radiation illnesses, abortion, cancer, birth of deformed and mentally-retarded children and so forth.

September 2011: The resistance of people against Kudankulam Nuclear Power Plant led the way to halting of project for time being.

September 10, 2011: Many of the organizers gathered at Idinthakarai village and started preparing for planned hunger strike from following day i.e. September 11, 2011. Police started arresting some of activists at Kudankulam village. Some 500 women blocked the road and demanded their immediate release. The police relented and the women also dispersed. The authorities invited 10 people for the talks but later foisted cases on 510 people. Several cases were filed against many people.

September 11, 2011: Considering the Fukushima nightmare, the police harassment and the DAE Chief's announcement that the Kudankulam Nuclear Power Project (KKNPP) would go critical in September, activists decided to embark on an indefinite hunger strike. Some five to seven thousand people from Thoothukudi, Tirunelveli and Kanyakumari districts gathered in front of the St. Lurdes's church at Idinthakarai.

September 12, 2011: People started pouring in from all parts of southern Tamil Nadu from 9 am. There were some 12 to 15 thousand people around 11 am.

September 13, 2011: No government official came to see the indefinite hunger strikers even after three days of fasting. Angry and agitated about this gross callousness of the authorities, some 500 women resorted to block the road and halted the vehicles on the road.

September 15, 2011: CM Jayalalitha assigned her three cabinet ministers to resolve the issue by holding talks. Delegation of ministers comprising Hindu Religious and Charitable Endowment Minister Shanmuganathan, Labour Welfare Minister Chellapandian and Khadhi and Village Industries Minister Chendur Pandian discussed the matter with PMANE leaders and requested organizers to call the fast off.

September 16, 2011: CM Jayalalithaa too favored the project by assuring the safety measures of Plant and requested people to co-operate in building the plant. This led protestors more furious and they intensified fast.

September 20, 2011: Learning the intensity of agitation after holding the talk with PMANE organizers CM promised to look into the grievance and decided to pass a resolution in Assembly requesting PMO to halt the project. The breakthrough came after Minister of State in PMO V Narayanasamy called on Jayalalithaaa to brief her on his visit to the protest site on Tuesday after being rushed as the Prime Minister`s emissary in the wake of a strongly-worded letter by her demanding halting of the project work.

September 21, 2011: The 11-day-old fast by locals demanding scrapping of the Kudankulam nuclear power project was on Wednesday called off after Tamil Nadu Chief Minister Jayalalithaa agreed for a cabinet resolution to request the Centre to halt the project.

October 18, 2011: An indefinite relay fasting began after the state government, which had resolved in favor of halting construction activities at KKNPP, went back on its Cabinet decision and supported the commissioning of the Kudankulam Nuclear Power Project

March, 2012: Thousands of activists and others across the country answered the 'Koodankulam chalo' call and gathered at Idinthikarai. Police repression on the people protesting against the commissioning of the nuclear power plant at Kudankulam started. Many agitators were arrested and were being charged with sedition and waging war against the state. Water supply was cut off and other essential supplies to Idinthakari village were blocked.

August 10, 2012: Atomic energy regulatory board (AERB) gives a go-ahead for loading the Kudankulam reactors.

August 31, 2012 – The Madras High Court has given the go ahead to operationalize the Kudankulam Nuclear Power Project (KNPP).

September 9, 2012: Thousands of villagers and activists stage a protest at 500 mts distance from the plant, along the sea shore.

September 10, 2012: Police lathi-charge the protestors to disperse them. This triggers protests along other coastal hamlets. One protestor dies in police firing as the protests turn violent.

September 11, 2012: S. P. Udaykumar gives a statement that he is likely to court arrest. Youth from Idinthikarai and Kuthikuzhi take Udaykumar and Pushparayan hostage. Protest spreads to Chennai and other cities across the country.

September 12, 2012: Arvind Kejriwal expressed solidarity with the Kudankulam struggle and persuaded Udaykumar not to court arrest. The Supreme Court was moved against the High Court order on green signal to Kudankulam nuclear power plant.

The People's Movement against Nuclear Energy (PMANE):

The People's Movement against Nuclear Energy is an anti-nuclear power group in Tamil Nadu, India, founded by S.P. Udayakumar. Since September 2011 the aim of the group is to close the Kudankulam Nuclear Power Plant site and to preserve the largely untouched coastal landscape, as well as educate locals about nuclear power. S P

Udayakumar, a teacher, is leader of the group. He lives in a village around 30km (18 miles) from the plant site. Udayakumar believes nuclear power benefits only "industrial India", and not the common man. He says the movement has a clear aim: "Our end game is to close down this nuclear power plant. We think that this will have a disastrous impact on our livelihood, on our future generations. Because the Indian government never talks about waste, never talks about decommissioning. It does not tell us the full story." Pmane was born out government callousness to genuine demands of people. Pmane tries ensure a voice those people suppressed by the government

The Kudankulam anti –nuclear movement was very unique movement, it was unlike any other anti-nuclear movement India had witnessed. It received much public support and global media coverage, A careful examination reveals that people's fears are real ,although government find them unscientific ,they are yet to convince people and garner there support, the movement have not ebbed ,the people continue their protest for closure of nuclear power plant that would ruin their lives.

CHAPTER 5
REACTION OF
CENTRAL AND STATE GOVERNMENTS

Kudankulam might have been appropriately chosen as the site for nuclear power plant, with a multitude of technical criteria, including site ecology, geology and seismic activity, local population density, land use, and the closeness to sea. Anti-nuclear protest from the local population and administration, however, has made it extremely difficult to carry out the government plan.

Since August 2011, the state of Tamil Nadu in south India has been witnessing renewed protests against the commissioning of the first of two 1,000 megawatt (MW) power plants as part of the Kudankulam Nuclear Power Project (KKNPP). While protests against the project have been occurring since the proposal was mooted in 1988, the impending commissioning of the reactors has rightly triggered a wave of concern in Tamil Nadu and throughout India, especially in light of the devastating and uncontrollable nuclear meltdown in Fukushima, Japan.

People from the Kanyakumari, Tirunelveli and Thoothukudi districts of Tamil Nadu have been protesting against the KKNPP for over two decades now. People in and around Kudankulam (also spelled Koodankulam) are worried that the hot water discharged from the plant into the sea will adversely affect the marine life and fish catch. Nearly 100,000 people living within a sixteen kilometre radius of the plant fear displacement. And people are immensely concerned about nuclear risk and radiation in the event of accidents at the plants or during the movement and storage of radioactive material.

The People's Movement against Nuclear Energy (PMANE), spearheading the movement, has put forward a comprehensive criticism of the project on environmental, safety, economic and human grounds, but the mainstream media and policy makers continue to see it as merely a public relations (PR) problem. Calling the people's assertion in Kudankulam an overreaction to Fukushima, the 'experts' show themselves to be detached from the life of this country and are only insulting the struggling masses. While urging the national government to halt the construction work, Tamil Nadu's Cabinet has only requested the national government to 'allay the apprehensions of the people' before proceeding. From the beginning, the fight against the plant has been more than just 'fear' and 'apprehensions.' The people's movement against the plant started in the late 1980s when the plan was disclosed. Now it has grown into a strong mass movement centred in Idinthakarai and adjacent villages and has adopted democratic means of protest such as hunger strikes, relay-fasts and road blockades.

Fishing communities living in Idinthakarai village in Kudankulam, who are at forefront of the struggle, have been keeping up a brave front for more than two decades to save their lives, their livelihoods, and their natural surroundings, with which they have inextricable links. These fish workers continue to demonstrate against the project and are afraid to leave their village for fear of being arrested and jailed. Many of them are still languishing in jail, and their bail is being denied or delayed.

While the nuclear accident in Fukushima did have a deep impact and reinforced the urgency to fight, the people of Kudankulam people have, over the years, learned about the harmful effects of the nuclear fuel cycle and the insurmountable risks inherently attached to nuclear technology. In the past, they have attended public hearings and other meetings in large numbers and have presented informed questioned to the authorities. Their lifestyle provides a sense of belonging, and they are the ones who are able to identify their real priorities. The Kudankulam movement is their struggle for alternative development.

Repression by that state

The Tamil Nadu police are abusing legal tools and employing force to subvert the movement, which has engaged only in peaceful protest. Not a single instance of violence has been reported since the first phase of the indefinite strike began in September 2011.

False cases have been filed against the protesters, as their leaders have been charged with sedition and waging war against the government. Prohibitory orders have been issued within a seven kilometre radius of the plant. The police shot down an unarmed man named Anthony John in the coastal village of Manappadu. Several people including a small baby are said to be missing. The police station has registered fabricated cases against more than 50,000 people. At least twenty-one sections of the Indian Penal Code (IPC) have been used, including Section 121 (Waging War against the Government of India), which has been used against 3,600 people and Section 124A (Sedition), which has been used against 3,200 people. These arrests have led to a number of disturbing effects. In some instances, both parents were arrested, leaving the children alone. A mentally challenged person was arrested despite documentary evidence of his mental illness. The aged and the physically challenged too were taken into custody; no one was spared.

A fact-finding team led by B. G. Kolse Patil, a former Bombay High Court judge, slammed Tamil Nadu police for desecrating Saint Lourdes Matha Church in Idinthakarai by breaking an idol of Mother Mary and urinating inside the church premises.

In its most damning finding, the team, which included Kalpana Sharma, a senior journalist, and R. N. Joe D'Cruz, a noted Tamil writer, said that the desecration of a church by the police was a "dangerous and deplorable act." Police officers had barged into the church looking for protesters there.

The team said that the use of force against peaceful protesters was unjustified. Police had used their batons to beat protesters who wanted work on the nuclear plant to be stopped. The team also found that police, while trying to control the agitation, looted and damaged private and public property.

Justice Kolse Patil's team also said that charging the protesters with sedition and waging war against the state was irrational and that police action had created a 'fear psychosis' in Idinthakarai, especially the Tsunami Colony neighbourhood, as well as in Vairavikinaru, Kudankulam and the Juvenile Home in Palayamkottai.

In the Tsunami Colony, the fear was palpable. Most houses were locked as people were afraid to return to their homes. Villagers showed their houses, whose window panes had been broken, cupboards ransacked and doors damaged allegedly by the police who entered the village on September 10, 2012. For the next several days, a police force camped in the village. As a result, even today many of the residents of the village are afraid to spend the night there and instead sleep in the tent outside the Lourdes Matha Church in Idinthakarai.

Fear was also evident in Vairavikinaru village, where villagers showed the evidence of the destruction to houses when the police party raided the village on September 10. Nine people were arrested including a 16-year-old boy and a 75-year-old man who was almost blind. Villagers in Kudankulam were even more terrified as they live closest to the Kudankulam Nuclear Power Project. On September 10, a large police contingent entered the village, arrested 34 people, broke into houses where the frightened residents hid, and destroyed property and vehicles. Now, villagers said they are so afraid that they lock their doors after dark. Many cannot sleep and are fearful when they hear a vehicle entering the village.

In all these villages, one common factor was that each of those arrested was charged under identical sections. These included 124A (Sedition), 121A (Waging War against the State), and others.

The other more disturbing testimony was from the women in all four villages. They spoke of the abusive and sexist remarks of the police when they came to their village and also when some of the women went to the police station. One disabled woman gave evidence of physical molestation and another, who was part of a protest on the beach near the plant, spoke of police chasing the women into the sea and making obscene gestures.

Despite this situation, villagers expressed their determination to oppose the project. In addition, they repeatedly asked why no one from the government or from the Nuclear Power Corporation of India Limited was prepared to hold a proper public hearing in which they heard the apprehensions of the villagers and presented their point of view. They asserted that as the people living closest to the nuclear plant they had a right to question and to know all the facts.

India's chest-thumping "nucleocracy" wants to play the death game, with peasants and fisher folk as pawns in the gamble. The staunch and united protests by farmers, traders and fish workers in Tirunelveli, Kanniyakumari and Thoothukudi have scared the nuclear establishment.

Faced with the real prospect of having to abandon the project, the government, is doing what it does best: divide and rule; set different communities against each other; and allege that foreign hands are at play.

At different times, the nuclear establishment and India's former Prime Minister Dr. Manmohan Singh have said different things: that Tamil Nadu's industrialisation will falter without the project; that India cannot do without nuclear energy; that our nuclear plants are 100% safe; that abandoning the project at this stage could prove dangerous.

When it comes to explaining the consequences of a major disaster, Indian scientists, including former President Dr. A. P. J.Abdul Kalam, have behaved more like astrologers than rationalists. How can anyone predict that no major earthquake will hit this area or that this human-made technology cannot fail?

The fears of Fukushima and the fears about continued electricity shortages have raised a number of conflicting emotions and doubts in people's minds. The conclusion of this article aims to dispel some of the misconceptions about the safety of nuclear energy, and answer some frequently arising questions.

On 20th November 2012, the Supreme Court made it clear to the government that all safety measures for handling disaster must be put in place at the Kudankulam nuclear power plant before it is operationalised, saying there can be no compromise on this issue.

A bench of Justices also asked the government to submit a disaster management plan and directed the Tamil Nadu Government to carry out mock drills covering all the 40 villages situated within a 16-kilometer radius of the nuclear plant. The justices added that these drills must be repeated after every two years, and all 40 villages have to be part of the disaster management scheme. The bench made it absolutely clear that all the guidelines and safety measures for handling disaster must be put in place before the plant is commissioned. The apex court's observation was based on reviewing many petitions filed by anti-nuclear activists challenging commissioning of the plant on the ground that all the safety measures have not been put in place.

Nuclear power is not the only option for generating electricity. There are a number of conventional and non-conventional sources of energy that can be explored for generating electricity. It is a fact that in more than 60 years of post-independence industrialisation and modernisation, the contribution of nuclear energy to the total electricity generation is less than 3%.

Renewable energy sources already contribute more than 10% of India's electricity and large hydroelectricity projects deliver about 22%. Large dams, though, have exacted a devastating toll on the environment and lives of adivasi (indigenous) communities.

For India to emerge as a true leader, we have to be careful not to destroy our natural capital: our waters, lands, air and people. By saying "No" to dangerous, risky and expensive technologies like nuclear power, we create opportunities to develop cleaner, saner and less dangerous forms of electricity generation.

Increasing the available electricity can also be achieved by conservation and demand-side management strategies. For every 100 MW of electricity generated in India, more than 40 MW is lost because of inefficient transmission and distribution (T&D).

Industrialised countries like Sweden have a T&D loss of less than 7%. In other words, of the total 180,000 megawatts of electricity generated in India, 72,000 megawatts (40%) is lost, wasted. That is equivalent to shutting off all power plants in the states of Maharashtra, Gujarat, Tamil Nadu, Andhra Pradesh and Karnataka.

If efficiency were to be increased to, say 90%, the savings would be the equivalent of setting up a 60,000 MW power plant – or about 60 plants the size of the Kudankulam plant that is currently at the heart of a controversy – with a fraction of the investment, and none of the risks.

Kudankulam might have been appropriately chosen as the site for nuclear power plant, with a multitude of technical criteria, including site ecology, geology and seismic activity, local population density, land use, and the closeness to sea. Anti-nuclear protest from the local population and administration, however, has made it extremely difficult to carry out the government plan.

Kudankulam anti-nuclear movement unlike movements in the past evoked much popular response. Reeling under power deficit government tried hard to make the project happen, but even the measures intended to gather public support became reason for public ire due to aggressive and expeditious implementation.

From the beginning the government tried to quieten the vociferous crowd by its brutal hand of suppression, failing to stand the massive protest and popular dissent against the power plant the government changed its tone. Government tried to amass public support by voicing the need of a nuclear power plant with huge power generation potential in a power deficit country like India and the encumbrance it causes to Indian economic progress.

Government emphasised the need for India to augment its power generation facilities and build new one to increase the total power generation capacity.

People directly affected was not convinced at all, even the assurances from the popular scientific minds did not decelerate the momentum of anti

–nuclear protest. Whenever a milestone for nuclear power plant was achieved people directly affected and the supporters flocked to the nuclear power plant in huge numbers Post fukushima the anti-nuclear movement got a new strength, people braved the oppression and forces of government.

It is the sheer determination, able leadership and fear of loss of livelihood and peaceful existence that keeps fuelling the movement even when faced with brutal governmental oppression

The nature of the protest movement is likely to be determined by the forms of protest organizations, which can be classified into the following categories:

(1) **Those based upon existing local organizations and their routine intermediary sub organizations**; Murpokku Manavar Sangam, Anumin Nilaya Ethirpu Iyakkam

(2) **Those deviating from or having no connections with existing local order and sub organizations**. Like national alliance of peoples movement (NAPM) founded by Meda Phatkar

(3) **Those which are formed through the rearrangement of routine intermediary sub organizations.** People's Movement against Nuclear Power (PMANP)

Later on from 2011 people's movement against nuclear energy took up the fight under leadership Dr S.P.Udayakumar and was successful enough in drawing wide attention towards the flaws and dangers of e nuclear installation.

The governments have tried clearing doubts about the movement through various platforms, but did not strike a chord with protesters. The NPCIL the Indian public sector company entrusted with task of implementation tries every time to explain the merits and safety features of the project.

The governments and NPCIL feel that it is vested interest groups backed by foreign aid spreading unscientific and incorrect information about the nuclear power plant fuelling apprehensions and fears about power among the masses. They constantly try to educate people about necessity of such power plants

-Facts on Kudankulam Nuclear Power Project (http://npcil.nic.in/pdf/Facts_on_KK_Project)

1. Site Clearance for Kudankulam-1&2 (KK-1&2)

The sites offered by the states for setting up nuclear power projects are evaluated by the Site Selection Committee (SSC) of the Government. The SSC evaluates the sites in line with the criteria laid down in the AERB Code of Practice on Safety in Nuclear Power Plant Siting, which inter alia, gives the mandatory and desirable requirements of the site from safety considerations. These include assessment of seismicity, location of faults, geology, foundation conditions, meteorology, potential of flooding (from tsunami, storm surge, etc. at coastal sites and from rain, upstream dam break, etc. at inland sites), proximity to airports, military installations, facilities storing explosive and toxic substances, etc. The environmental setting comprising of bio-diversity, including flora and fauna, marine ecology etc. in the region is also evaluated. In addition, availability of land, water, electricity demand in the region and the availability of other energy options also form the basis for evaluation. The SSC submits its recommendations to the Government. The Government after due process, accords „in principle‟ approval for the site.

Kudankulam site was also evaluated by the then Site Selection Committee and approved after due process then prevalent.

Ministry of Environment & Forest (MoEF) and other statutory Clearances

On receipt of „in principle‟ approval, pre-project activities including obtaining environmental clearance from MoEF and site clearance from AERB are taken up, in parallel with preparation of detailed project report.

The Environmental Clearance for KK-1&2 was obtained after following the due process then prescribed by the MoEF. An Environment Impact Assessment (EIA) had been carried out. The MoEF notification for environmental clearance process then in force did not envisage public hearing. However, subsequently, while obtaining the environmental clearance for KK 3&4, Environment Impact Assessment (EIA) as per EIA notification, public hearing including the responses to stakeholders, review by expert appraisal committee of MoEF as per the prevalent notification of 2006 was carried out. Detailed studies comprising Geo-technical examination, Seismo-tectonic, Safe grade level, meteorological and other studies were carried out by the expert agencies of organizations specializing in these. Based on these studies, the detailed site evaluation report was submitted to Atomic Energy Regulatory Board (AERB), who after a detailed review, accorded site clearance for Kudankulam site. The project financial sanction based on the Detailed Project Report (DPR) prepared was obtained in February 2001 and the work on the project was started after obtaining necessary clearances by following the due processes in place at that time.

Exclusion Zone and Sterilized Zone

According to the AERB code an area in the radius of 1.5 km, called exclusion zone, around the reactors is established, where no human habitation is permitted. This area forms the part of the project and is included in the land acquired. The AERB Code of Practice on Safety in Nuclear Power Plant Siting states:

An exclusion area of appropriate size (at least 1.5 km radius from the reactor centre) shall be established around the reactor and entry to this is to be restricted to authorized personnel only. Thus the population falling within the exclusion zone, if any, is only resettled.

The sterilized zone is the annulus between the exclusion zone and an area up to 5 km from the plant. The AERB code states in this regard:

“A sterilised area up to 5 km around the plant shall be established by administrative measures where the growth of population will be restricted for effective implementation of emergency measures. Natural growth, however, is allowed in this zone”.

Thus, there is no displacement involved in the sterilized zone. In fact, there are no restrictions on natural growth of population in the sterilized zone. The administrative measures are put in place to ensure that there is no large increase in the population due to say setting up of an industry involving large labour force, etc.

3 Population Distribution

The AERB Code of Practice on Safety in Nuclear Power Plant Siting lays down desirable criteria for population for selection of a site as follows:

“Other desirable population distribution characteristics in plain terrain are:

i) Population centers greater than 10000 should not be within 10 km of the plant.

ii) The population density within a radius of 10 km of the plant should be less than 2/3 of the state average.

iii) There should be no population centres more than 100000 within 30 km from the plant.

iv) The total population in the sterilised area should be small, preferably less than 20000.”

It may be reiterated that these are only desirable criteria and are prescribed to enable easy emergency planning.

For the purpose of planning for serious accidents, if any, an area of 16 km around the plant is considered as the Emergency Planning Zone. The AERB Code of Practice on Safety in Nuclear Power Plant Siting states:

During emergency, availability of transportation network means of communication, etc. which are of significance during emergency condition shall be checked. A radial distance of 16 km from the plant may be considered for this purpose.

It may be, however, noted that in the KK reactors design, many advanced safety features are deployed. These include the passive heat removal system (PHRS), which will ensure cooling of the fuel under the most stressed condition of non-availability of power supply and cooling water and further also there is the provision of core catcher to contain the molten material and the radioactivity within the reactor, even under the most severe accident resulting into the fuel meltdown. Such and other safety provisions strengthen the plant such that the intervention in the public domain beyond exclusion zone will not be required even in case of a severe accident.

4 Effect on Fishing

Requirement of cooling water is not unique to nuclear power plants. The generation of electricity using heat in the form of steam from fossil fuels like coal, gas, oil, etc. involves condensing of steam in a power condenser, which requires cooling water. In a similar manner, the generation of electricity from nuclear source also uses steam and thus needs cooling water. Ships, submarines and motorboats also use the seawater for cooling their engines.

The cooling water temperature observed at the outlet of the power plant condenser is slightly higher than the ambient temperature of the water, which is, in fact, lowered at the discharge point by employing systems/engineering solutions so as to be within the limit stipulated by the Ministry of Environment & Forests (MoEF). The effect of this discharge water on the marine life has been studied extensively and validated.

Based on these thermo-ecological studies, Ministry of Environment & Forests (MoEF) has stipulated as follows:

Quote:

"The thermal power plants using sea water should adopt suitable system to reduce water temperature at the final discharge point so that the resultant rise in temperature of receiving water does not exceed 7°C over and above the ambient temperature of the receiving water bodies."

Unquote:

The operation of nuclear power plants in the country at the coastal locations at TAPS, Tarapur in Maharashtra and MAPS at Kalapakkam in Tamilnadu has also not shown any adverse effects on

marine life including the fish.

At Department of Atomic Energy-Board of Research in Nuclear Sciences (DAE-BRNS) Thermo-ecology study was carried out at Kalpakkam and Kaiga stations with several experts from institutions like National Institute of Oceanography (NIO), Central Electro Chemical Research Institute (CECRI) Fish catch at Kalpakkam

and several universities of the country. These studies have not found any adverse effect on marine ecology around the nuclear power plant sites.

Kudankulam nuclear power project cooling water system also provides for fish protection, which ensures fish are not sucked into the intake.

5. Radiation in the Surrounding Area

Utmost attention is given to safety of the environment and the public in all aspects of nuclear power from siting, design, construction, commissioning, and operation and up to decommissioning. The entire effort is to ensure that release of any radioactivity or radiation in the public domain affecting the public and the environment is minimized to be well within the prescribed regulatory limits. A principle of "As Low as Reasonably Achievable (ALARA)" is adopted in this regard. The radiation dose from nuclear power plants in operation in India has been found to be a negligible fraction of the naturally existing background radiation.

The details are:

An Environmental Survey Laboratory (ESL) is set up at the site before the start of operation of the reactors, which collects data of several environmental matrices like air, water, soil, vegetation, crops, fish, meat, etc. It establishes a baseline. Subsequent to start of operation of the station, the ESL monitors the environmental matrices even beyond emergency planning zone of 16 km (usually up to 30 km of the site) for radioactivity (elements like Iodine-131/133 Strontium-90 etc) and radiation levels. The experience over the last 40 years has been that at such distances no significant increase in radiation levels above the baseline data is found at Indian nuclear power plant sites.

6. Assurance of Quality

The Assurance of Quality is accorded highest attention in all activities of nuclear power plants from design, construction, commissioning and operation. The construction works are carried out in accordance with a Quality Assurance Manual. The quality assurance plans in line with the manual are prepared for each activity. In respect of civil construction, the materials used are tested for every batch at the concrete testing laboratory at the site. The construction QA personnel inspect the works as per the QA plan and the works carried out after approval of the QA staff. The records of testing and inspections, which are extensive, are well documented. The regular reviews of the quality are carried out by internal audit teams within NPCIL.

The quality of construction of civil works and piping has been proven at Kudankulam. The reactor building containment has withstood the structural integrity and leak rate test at the test pressure, which is much higher than the design pressure. The pressure test of various piping systems and the hot run has also established the excellent quality of construction at the site.

7. Coastal Zone Regulation

The coastal zone regulations as applicable have been meticulously followed by NPCIL. In case of KK-1&2, the approval for CRZ was under the Prime Minister Office (PMO). Due diligence studies were carried out and clearance obtained. In respect of KK-3&4 CRZ clearance, the required data and information, as required by the expert appraisal committee of the MoEF, have been submitted.

8. Safety Features of KK-1&2

The Kudankulam project consists of two units of advanced model of Russian VVER-1000 MW Pressurised Water Reactor, which is a leading type of reactor worldwide. The design has been evolved from serial design of VVER plant, of which 15 units are under operation for last 25 years. These reactors fall in the category of advanced Light Water Reactors being developed by various West European countries and Japan. The salient safety features incorporated in plant at Kudankulam are:

- Passive heat removal system to provide cooling for removal of decay heat
- Higher redundancy for safety systems
- Double containment
- Larger numbers of control rods
- Additional shutdown systems for the reactor like second quick-acting shutdown system and quick boron-injection system
- Advanced instrumentation systems of advanced technology for Reactor Systems and Balance of Plant as well as for Plant Computer System

The design of KK reactors also incorporates features such as core catcher, Hydrogen management system to mitigate severe accident scenario as witnessed at Fukushima in Japan.

Safety review on setting up this project is carried out by AERB over and above the regulatory review carried out for these reactors in the Russian Federation.

The safety features of Kudankulam project have been comprehensively reviewed by a task force of NPCIL in the context of the recent Fukushima accident and it has been found that the safety features of the reactor are adequate to withstand such extreme natural events. The report of the task force is available on websites of NPCIL and DAE.

9. Seismic Considerations

Kudankulam site is located in the lowest seismic hazard zone of the country, Zone-II. The nearest epicentre of a recorded earthquake was located near Trivandrum, which is situated at a distance of 88 km north northwest of the Kudankulam site, where two earthquakes corresponding to 4.3 magnitudes on Richter scale, were recorded. The Kudankulam site has a much lower seismic hazard when compared to Fukushima in Japan.

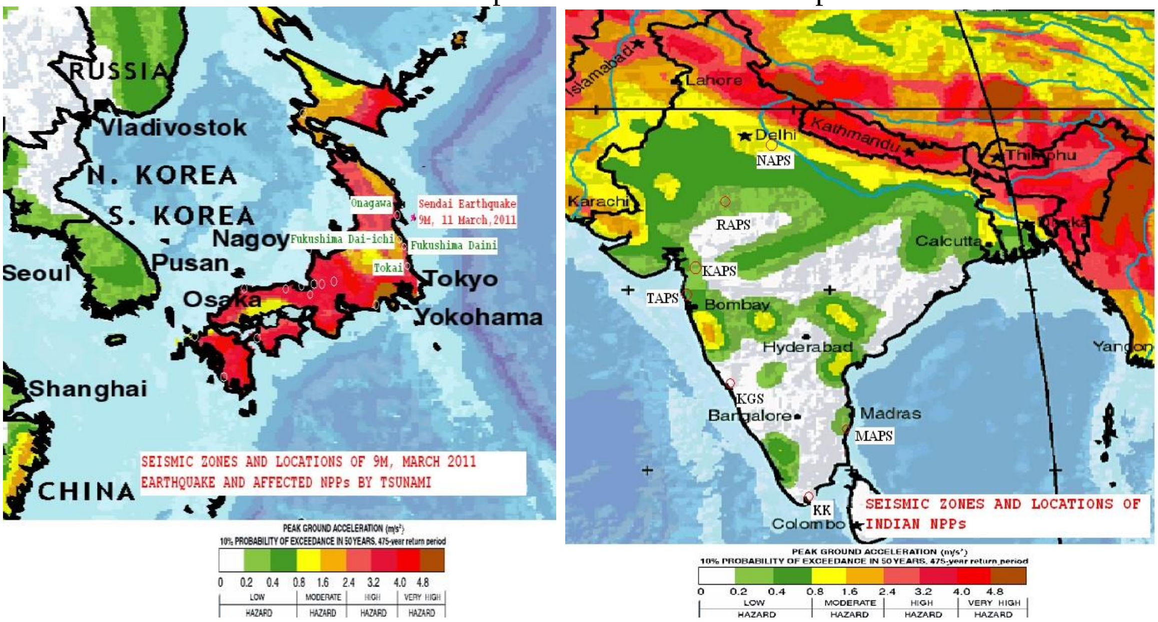


FIG 1.7 Seismic hazard comparison between fukushima npp and Indian npp

The Kudankulam plant buildings have been designed for much larger earthquakes. The structures, systems and equipment of plant are designed for an earthquake magnitude of 6.0 on Richter scale with a peak ground acceleration of 0.15 g. An evaluation of the plant based on allowable stress values of materials has indicated that it can withstand significantly higher peak ground acceleration (of up to 0.6g).

Tsunami

Kudankulam site is located far off (about 1500 km) from the tsunami genic fault (where tsunamis originate). Thus a tsunami would take time and lose some of its energy by the time it strikes Kudankulam site.

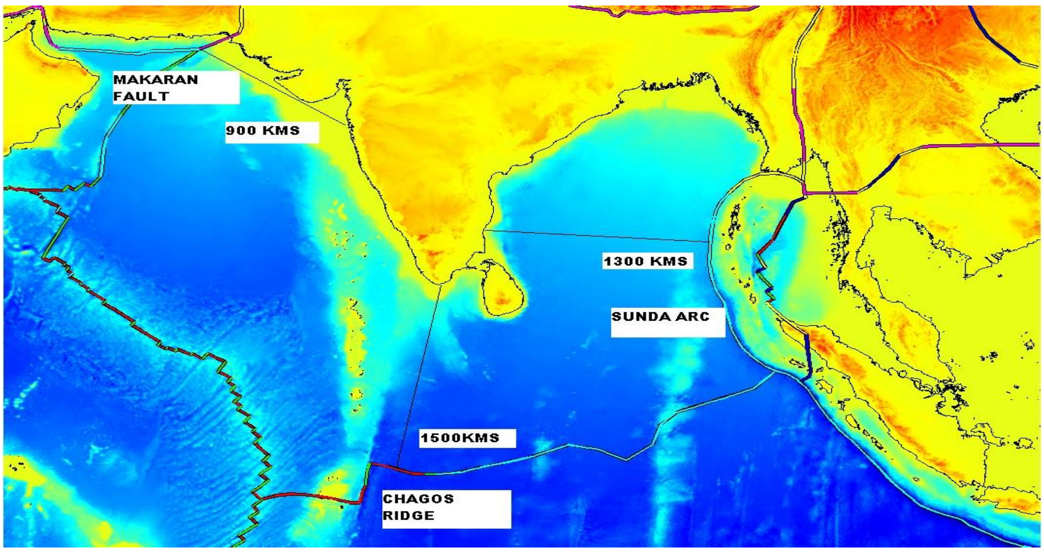


FIG 1.8 tsunami faults near Kudankulam

As against this, the tsunami genic fault was only about 130 km away at Fukushima.

The Kudankulam site was not affected by the 2004 Indian Ocean tsunami due to its design of higher finished floor level. The water level experienced at the site due to December 26, 2004 tsunami triggered by a 9.2 magnitude earthquake was 2.2 m above mean sea level.

There is also a shore protection wall and important buildings are located higher than the flood level arising out of tsunami, storm surge, wave run up and tides. The buildings housing emergency power supplies are located further higher.

The sketch below shows the levels of important buildings and the design flood levels.

In addition to location at higher elevations, all the safety related buildings are closed with double gasket leak-tight doors. Hence, water entry into these buildings is extremely remote even in case of sea water level surge reaching up to their elevations.

These aspects have been comprehensively reviewed by a task force of NPCIL in the context of the recent Fukushima accident. The report of the task force is available on websites of NPCIL and DAE.

10. Cost of the Project

The approved cost of the project is Rs. 13171 crore. The expenditure figures are submitted to the various monitoring agencies of the project like DAE, MOSPI and Parliamentary Committees and are thus in the public domain

The tariff of electricity generated by the project will be competitive with other sources in the region and expected to be around Rs 2.50 per unit.

12. CSR Activities

With an objective of inclusive growth of the surrounding population and community development in the neighbouring villages around the Kudankulam project, through well-structured CSR programs, NPCIL has taken several initiatives:

Infrastructure Development:

Some of these initiatives include, construction of class room buildings, compound Walls of schools, providing the drinking water facilities like bore wells with pump & low level Sintex water tanks, water pipeline scheme for providing water from Rukandurai village to Panchal village (about 3.5.km), providing computers with accessories to a large number of village schools/Panchayat Offices, providing fire extinguishers to schools, providing electrification and tiled flooring to the Mercy Home for Disabled persons, providing solar street lights and sodium street lights to the villages, construction of Lavatory for the use of schoolchildren, construction of two bus shelters at Perumanal & Kuttapuli Village, providing furniture & other items for the community hall constructed by the Panchayat Union, improvement of building for mentally retarded children and Panchayat Office building in Chettikulam Panchayat, etc.

About 17.6 km of road leading from Levinchipuram to Kudankulam was also developed by NPCIL.

Health Care:

Several medical Camps have been organized in the surrounding villages. Hepatitis 'B' Vaccine was administered to the school/village children, hearing aids to the schools for hearing-impaired have also been provided.

Education Support:

Provided laboratory items at Govt. Higher Secondary School, Kudankulam, ceiling fans to Govt. Higher Sec. School, Chettikulam, and provided uniforms to School Children.

A Talent Nurture Program to provide quality education to the bright and talented children of the rural/ economically backward class living in the vicinity of KKNPP has been instituted. Atomic Energy Education Society (AEES) has offered to admit the students from the nearby areas. Under this programme, economically backward children from the neighbouring villages with rural background will be selected based on merit for admission to Standard - I in AEC School, Anuvijay Township.

Support to Community at Coastal Villages:

Tsunami Relief Activities were carried out in the year 2004-05 in the nearby coastal villages such as Idinthakarai, Perumanal, Kuthenkuzhi and Kutapuzhi such as distribution of Dress Materials, Bed Sheets, Biscuits, Sugar, Milk Powders, Food Pockets, Soaps and Garments, Mobilization of Local to safe places & financial assistance to Purchase of Land for Re-Construction of Houses.

The neighbourhood welfare activities are continuing and will be further enhanced in future in line with the objective of inclusive growth.

12. Public Awareness Activities

A public awareness programme regarding various safety features of Kudankulam Nuclear Power Project to the nearby villages was started in the early 1990s. Many schools and colleges have been visited by KKNPP officials and explained the various features of the Kudankulam Project.

In addition, around 200 villagers from the nearby villages like Kudankulam, Chettikulam, Idinthakarai, Vijayapathy, Erukkanthurai villages, etc., were taken to Madras Atomic Power Station, Kalpakkam, to have a realistic understanding of the benefits of the Nuclear Power Station, followed by interaction with MS Swaminathan Foundation on Marine Life.

Since the project started in 2001, the Public Awareness Campaign has been taken up in an elaborate way.

Brief details of Publication Awareness and Communications Initiatives Press and Media Relations:

In 2001, two Journalists Workshops were conducted for around 150 Journalists and Media Personnel from Tirunelveli and Kanyakumari Districts.

Organised an interactive workshop for Journalists at Tirunelveli followed by site visit to KKNPP on December 2007. About 50 journalists, both print and electronic media, including state-owned press like PIB and AIR have participated.

Regular interaction with the local/national press and media persons.

Public Communication:

Technical Debate with Nature Trust Members at Nagercoil with participation of more than 100 professionals including students. It was organized by one Mr. Lal Mohan, who is one of the anti-nuke activists in Nagercoil. A Fishermen Workshop at Vallioor was arranged in coordination with Rotary Club, Vallioor in the year 2001, wherein fishermen from Idinthakarai, Vijayapathy, Perumanal, Kuttapuli, Kuthenkuzhi, Thomayarpuram etc., have taken part.

In the year 2002, a Public Awareness Seminar was conducted at Radhapuram Panchayat Union Office wherein the Panchayat Union Chairman/Vice-Chairman, Block Development Officer (BDO), Panchayat Presidents and Union Councillors from Radhapuram Panchayat Union have participated.

Around 45 Village Representatives, including Panchayat Union Chairman, Vice-Chairman, Village Presidents, Councilors and other members have been taken to RAPS on Nuclear Plant familiarization programme in the year 2002, followed by the second batch of 30 people, including District Chairman, Tirunelveli District, Panchayat Union Chairman/Vice-Chairman, Village Presidents and Councilors from Radhapuram and Vallioor Panchayat Unions were taken to Rajasthan Atomic Power Station (RAPS) in 2005.

Around 2000 nos. of Villagers/School children from the nearby villages like Chettikulam, Kudankulam, Idinthakarai, Erukkandurai, Perumanal, Kuttapuli Radhapuram villages etc., have been brought to site either for a site visit followed with the Public Awareness Programme or on an interactive programme to understand the welfare requirement and creating awareness at various stages of the Project.

A presentation and detailed discussion was arranged with the Arch Bishop of Tuticorin and the Diocese team along with the Priest/Father of Coastal Villages around 30 visitors such as Idinthakarai, Perumanal, Kuttapuli, Kuthenkuzhi, Thomayarpuram, Ovari etc. During this meeting they have been explained about various safety features of the project and taken them to the site and clarified various doubts to their satisfaction.

A discussion and Site Visit was also arranged in the year 2007 with the Anti- Nuclear Activists like Shri S.P. Udayakumar, Shri Lal Mohan etc. They have been explained in detail about the various advanced safety features incorporated taking care of the post Chernobyl requirement and the tsunami events.

The Project has allowed 350 students from various Universities to undertake the In-Plant Training/Project Work as a part of the Public Awareness Programme with main focus to give a detailed brief about the art of technology and the safety aspects of the Nuclear Power Plants.

The officers at various levels have visited the various colleges (about 20) in Tirunelveli, Nagercoil, Tuticorin and Madurai Districts with an intention give brief about the salient features and safety aspects of KKNPP.

A permanent Exhibition Hall has been set up at District Science Centre, Tirunelveli as a part of Public Awareness Programme.

Around 500 Tirunelveli District Officials from various Departments like Revenue, Health, Fisheries, Agriculture, Animal Husbandry, Forest, Electricity Board, Transport, Irrigation and Fire and Rescue Personnel etc., have been given Public Awareness Programme and Emergency Preparedness Training Programme in the year 2011.

A Self Help Group (SHG) and a local body of around 100 people have been trained on Public Awareness Programme.

Publications:

A comprehensive booklet "From Volga to Ganga, the story of Kudankulam" has been published to highlight technical and general aspects of KKNPP a publication "Metamorphosis – the changing skyline of Kudankulam" has been made based on the CSR activities done by the KKNPP management. Published "Thiruvallar Muthu – Story of a Prosperous Village" in Tamil to clear the apprehensions of village people. Published several technical articles in Nu-Power and other journals about KKNPP.

Multimedia/Short Film:

Produced an infotainment film "Thiruvallar Muthu" in Tamil using animated and cartoon characters to provide true picture of radiation and other aspects of nuclear power for general public, particularly pre-literate. Produced a short film (English) on the bio-diversity richness of Indian nuclear power plants, including KKNPP.

"Environmental Stewardship Programme":

NPCIL has taken up a voluntary programme, „Environmental Stewardship Programme (ESP)" for the study of flora and fauna in and around the exclusive zones of Indian nuclear power stations. Under the ESP, a nature club "Pelican Nature Club" has been formed at KK site to carry out the nature conservation activities regularly.

Following are some of the activities carried out at KKNPP:

A workshop on nature conservation has been conducted at KKNPP during September 25 – 27, 2006. About 60 persons including forest department officials, college students and professors, local NGO members, volunteers of KKNPP, etc.

A survey of wetlands and water birds has been conducted during February 2008 and September 2011 in and around KKNPP to study wetlands and wetland birds.

The volunteers of Pelican Nature Club have been regularly monitoring the birds and its habitats in and around KKNPP.

Published several articles in Nu-Power and other journals about the environment of KKNPP.

More recently, people from Jaitapur (Maharashtra), Mithi Virdi (Gujarat), Kovvada (Andhra Pradesh), Gorakhpur (Haryana), Chutka (Madhya Pradesh) and Haripur (West Bengal) have waged relentless struggles against these anti-people and unsafe nuclear power projects being promoted by the Nuclear Power Corporation of India Ltd (NPCIL). Their massive peaceful protests have been met with callousness and brutal repression on the part of the government. Communities near the existing nuclear facilities in Tarapur, Rawatbhata, Kalpakkam, Kaiga, Kakrapar and Hyderabad have also been raising voices against radiation leaks and their harmful effects, which are often hushed up by the authorities. Existing and proposed new uranium mines in Jharkhand, Andhra Pradesh and Meghalaya have also met with massive protests. In the recent past, these voices of protest have received solidarity and support from the wider democratic sections of Indian society. Intellectuals, policy experts, scientists, social activists, writers, artists and people from all walks of life have come out and backed these movements.

Nuclear energy is today widely seen as posing a threat to the life, livelihoods and the environment, not least because it can have irreversible catastrophic consequences and radiation effects spanning across generations. Chernobyl, followed by the Fukushima nuclear accident in Japan has led to global rethinking on the pursuit of nuclear energy with many countries reversing and phasing out their nuclear energy programs. Owing to its inherent safety problems, exorbitant costs and secretive nature, it has been invariably thrust on people against their will through pressure tactics and often violent repression of local communities.

CONCLUSION:

Energy is the most fundamental requirement of every society or nation as it progresses through the ladder of development. Of course, once it reaches a relative degree of development, the energy demand becomes more stable. There is a distinct and categorical correlation between the energy consumption and income of a nation — each reinforcing the other. Look around you: every step into progress comes with an addition of demand for energy — cars, ships and aircraft to move, hospitals to give quality healthcare, education, as it follows the model of e-connectivity, production of more and better goods, irrigation for better farming. In fact, every element of our lives is increasingly going to become energy-intensive — that is a necessary prerequisite for development. This is clearly reflected in the average energy consumption per person across nations — for instance, an average American consumes more than 15 times the energy consumed by an average Indian

Today, India finds itself going through a phase of rapid ascent in economic empowerment. Industries are evolving at a significantly higher rate since liberalisation. Our focus for this decade will be on the development of key infrastructure and the uplifting of the 600,000 villages where 750 million people live, as vibrant engines of the economy. In 2008, we crossed the trillion-dollar mark, and it took more than six decades for us to reach that milestone. However, it is predicted that the Indian economy will double again, to reach the $2-trillion mark by 2016, and then again redouble, to reach the $4 trillion milestone by 2025. All this economic growth will need massive energy. It is predicted that the total electricity demand will grow from the current 150,000 MW to at least over 950,000 MW by the year 2030[vi] — which will still be less than one-fourth of the current U.S. per capita energy need. In fact, by 2050, in all likelihood the demand could go even higher, and the per capita energy demand would be equal to the current French or Russian figure of about 6000 W per capita. Rapid economic growth has created a growing need for dependable and reliable supplies of electricity. Due to the fast-paced growth of India's economy, the country's energy demand has grown an average of 3.6% per annum over the past 30 years. The total demand for electricity in India is expected to cross 950,000 MW by 2030. To meet the target all the energy resources need to be extracted.

Every single atom in the universe carries an unimaginably powerful battery within its heart, called the nucleus. This form of energy, often called Type-1 fuel, is hundreds of thousands, if not millions, of times more powerful than the conventional Type-0 fuels, which are basically dead plants and animals existing in the form of coal, petroleum, natural gas and other forms of fossil fuel. To put things in perspective, imagine a kilometre-long train, with about 50 freight bogies, all fully laden with the most typical fossil fuel — about 10,000 tonnes of coal. The same amount of energy can be generated by 500 kg of Type-1 fuel, naturally occurring Uranium, enough to barely fill the boot of a small car. When the technology is fully realised, one can do even better with naturally occurring Thorium, in which case the material required would be much less, about 62.5 kg, or even less according to some estimates, and thus enough to fit in a small bag.

It is worth mentioning that country’s power generation needs to be methodically diverse. The failure to supply of fuel (in case of conventional power plants) or lack of operating media (wind and sunlight in case of renewable energy) should not affect the country’s power generation capacity. Power scenario in India cannot be compared with The West, India is a power hungry country whereas in West, demand is saturated and they have many other options. India has shortage of fossil fuel, windmill and solar power need huge land requirement with low availability factor, whereas 1.21billion population which may touch to 1.5 billion in 2030, sparing precious land will be out of question.

The great visionary, Dr. Homi Bhabha had envisaged a three stage nuclear program to meet energy demand of India. The present PWR, BWR and PHWR reactors come under first stage, Fast Breeder Reactor using Plutonium fuel is the second stage reactor which also converts Thorium to U233 during second stage (which is under construction at Kalpakkam) and third stage is in R&D phase, which will be using U233 as fuel .When all three stages are under operation, the used fuel material will be recycled and fed in subsequent stages, so that high utilization and efficiency can be achieved.

Nuclear power plants are constructed and operated with stringent quality control and it is under the continuous review of Regulatory Body. Multi-tier safety systems, even for a hypothetical accident conditions are built in nuclear plants which is not the case with other industries. Nuclear power safety record is remarkable when compared with other major sources of power. Already safely providing power worldwide, nuclear reactors can drastically reduce the environmental impact of power generation worldwide. The operation of nuclear plants does not threaten birds or wildlife and does not alter ecosystems. Nuclear power generation costs fewer human lives than virtually any other source of power in history. Most importantly, increasing the amount of nuclear power production could rapidly reduce a country's reliance on foreign oil, gas and other energy sources improve current account situation

But the fear of nuclear disasters like one in fukushima or Chernobyl is major deterrent in adoption of the nuclear program, the high economic cost of construction, inadequate compensation, secretive and ambiguous procedure and the governments hastiness in completion of multibillion power projects without addressing the fears and concerns of the common man who is much affected in case of untoward incident has been the fuel for anti-nuclear movement. The repeated assurances of safety and compensation fail to quell these movements.

Kudankulam anti- nuclear agitation has been functional since the start of the negotiations for nuclear power plant in Kudankulam. The residents of the region have apprehensions about environmental, safety, safety and security of the plant and the livelihood. They are committed to completely remove what they believe as a threat to their lives.

Unfortunately eager to recover the invested capital governments anyhow wants the project to be completed, and continuously fails to address the fears of the people. Occasionally when public vent their anger against the callousness of the government, they are termed as anti-national and are incarcerated, many protesters are falsely charged with offences and leaders are arrested on charges sedition and referred as terrorist or naxalites, the protest are brutally oppressed and media severely censored from carrying news in favour of protestors, which not how a responsible democratic government function.

The stories of oppression, police brutality and their relentless struggle have inspired others to raise their voices against nuclear power projects and educated the masses about danger of meddling with uncontrollable nuclear power. The anti-nuclear agitations in Jaitapur (Maharashtra), Mithi Virdi (Gujarat), Kovvada (Andhra Pradesh), Gorakhpur (Haryana), Chutka (Madhya Pradesh) and Haripur (West Bengal) have been greatly influenced by Kudankulam nuclear agitation. The people's movement against nuclear energy the group spear heading the protest is working in close association with these movements.

Quite unusual in India anti-nuclear protest have seen increase in participation recently mostly due to popularity of Kudankulam agitation. The recent protest in Kudankulam have seen participants from various places around India, it is noted that participation young people and youth groups have greatly increased. The PMANE has received support from famous personalities like prashant bhushan, V.S Achuthandan (Kerala opposition leader) and from political parties like aam admi party and various other pressure groups.

The PMANE have seen a rise in contribution to their activities from all parts of the world, definitely signalling its popularity within country and abroad.

The government of Kerala have decided not allow any nuclear power plant seeing the public anger against plant in neighbouring Kudankulam

These instances definitely points to the fact that Kudankulam anti-nuclear protest has been effective in generating public opinion against nuclear power plants in India

Being a democratic country for every development work in India, whether it is an expansion of National Highway, construction of flyovers in a city, construction of hydro dam, construction of chemical industry, construction of thermal plant, construction of automobile industry, erection of Windmills, construction of nuclear plant, even for making a flyover for railway level cross requires public support without which implementation is impossible. It is essential for the fast phase of growth for our country, we should have firm Government policies and fool proof mechanisms for its implementation not to suppress the dissent of the people but to ensure there doubts, fears and aspirations are addressed.

Nuclear energy generation has its own merits, but the danger of accidents and public opinion against it make it quite unsuitable for any country, the governments in India have to deprioritise nuclear power and make effective strides in the direction of tapping renewable energy sources because democracy is by the people, for the people, of the people it must be public opinion and consensus that need determine development goals not the governmental agreements or goals. Because it is ultimately for the people of the country and will be in their backyards.

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