EXPLOITATION OF NUCLEAR ENERGY FOR ELECTRICAL UTILITY

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The harnessing of the atom changed the nature of war forever and astounded the World with its awesome power. Nuclear technologies also gave us a new source of Electric power and new capabilities in medical research and imaging. Though controversial, the engineering achievement related to nuclear technologies remain the most important of the 20th century. The paper discusses the perspective concerns, attitudes and trends in exploiting Nuclear Energy for Electrical utility.

Purpose of nuclear program

The principal aim of nuclear energy program is the development and utilization of Nuclear energy for peaceful purposes such as power generation, applications in agriculture, medicine, industry, research and other areas. Nuclear power plants provide low-cost, predictable power at stable prices and are essential in maintaining the reliability of the electric power system.

The production statistics of nuclear power plants

World nuclear power status 2000, figures released by the International Atomic Energy Agency (IAEA) show that there were 438 nuclear power units in operation worldwide as of 31st December 2000. Nuclear power provides about 16% of global electricity, with some 83% nuclear capacity concentrated in ideas triolished countries. Countries generating the largest percentage of their electricity from nuclear energy were France, 76 percent; Lithuania, 74 percent; Belgium, 57 percent; Bulgaria, 45 percent; Slovak Republic, 53 percent; Sweden, 39 percent; Ukraine, 47 percent; Republic of Korea, 41 percent; Hungary, 42 percent; Japan, 36 percent; Slovenia, 36 percent; Switzerland, 36 percent. In total, 17 countries relied on nuclear energy to supply at least one-quarter of their total electricity.

Are Nuclear power systems Economical and safe in the present environment?

Nuclear power plants provide low-cost, predictable power at stable prices and are essential in maintaining the reliability of the electric power system. If we consider the case of USA, in the United States, six of the nine largest investor-owned utilities by revenue were nuclear utilities in 1998. The top investor-owned utility by profit was a nuclear utility, and eight of the next nine profit leaders were nuclear utilities.

Eight of the top ten "market value-added" energy companies between 1995 and 1998 operate nuclear plants, a measure of shareholder wealth creation, according to a study by Resource Data International and Deloitte Consulting. (Market value-added is the market capitalization of a company less the amount of capital invested in the company.)

Environmental safety

Nuclear energy is the world's largest source of emission-free energy. Nuclear power plants produce no controlled air pollutants, such as sulfur and particulates, or greenhouse gases. The use of nuclear energy in place of other energy sources helps to keep the air clean, preserve the Earth's climate, avoid ground-level ozone formation and prevent acid rain.

Of all energy sources, nuclear energy has perhaps the lowest impact on the environment, including water, land, habitat, species and air resources. Nuclear energy is the most eco-efficient of all energy sources because it produces the most electricity in relation to its minimal environmental impact.

The above statements are in good agreement with the following statistics.

1. Between 1973 and 2000, nuclear generation avoided the emission of 66.1 million tons of sulfur dioxide and 33.6 million tons of nitrogen oxides.

2. Each year, U.S. nuclear power plants prevent 5.1 million tons of sulfur dioxide, 2.4 million tons of nitrogen oxide, and 164 million metric tons of carbon from entering the earth’s atmosphere.

3. Nuclear power plants were responsible for nearly half of the total voluntary reductions in greenhouse gas emissions reported by U.S. companies in 1998, the Energy Information Administration reported on January 4, 2000. "Emission reductions from nuclear energy usage reported by the electric power sector increased by 43 percent from an estimated 70 million metric tons carbon dioxide equivalent for 1997 to 100 million metric tons carbon dioxide equivalent for 1998." That 100 million metric tons equal 47 percent of the 212 million metric tons of carbon emissions reductions reported nationwide, according to EIA.

4. Throughout the nuclear fuel cycle, the small volume of waste by-products actually created is carefully contained, packaged and safely stored. As a result, the nuclear

energy industry is the only industry established since the industrial revolution that has managed and accounted for all of its waste, preventing adverse impacts to the environment.

5. Water discharged from a nuclear power plant contains no harmful pollutants and meets regulatory standards for temperature designed to protect aquatic life.

Why should we prefer nuclear energy for production of power?

We prefer nuclear energy for power production, as it is reliable energy with economic value in this rapidly changing society.

Reliable energy

Nuclear energy is a dependable provider of electricity for the world, in part because of the large size of the plants, their long periods of operation, and the expertise with which they are run.

Economical Energy Source

Nuclear energy is efficient and cost-effective because of stable fuel prices, high plant performance, modernized plants, and renewal of plant licenses.

Quantifying Nuclear's Economic Value

Various numerical measures quantify nuclear energy's economic value, such as increasing capacity factors and electricity output and decreasing production costs.

The advantages of nuclear power

- Nuclear energy has been proven to be the cheapest, safest, cleanest and probably the most efficient source of energy. Nuclear power plants do not use as much fuel as the plants burning coal and oil. One ton of uranium produces more energy than several million tons of coal and plutonium can produce much more energy than uranium. Also the burning of coal and oil pollute our air and the last thing we need is more pollution to worsen the greenhouse effect.

- Nuclear power plants cannot contaminate the environment because they do not release any type of pollution. Plutonium can also be recycled by using an enrichment process. This will produce even more energy. Coal and oil cannot be recycled. Kilogram of plutonium consumed for three years in a reactor can produce heat to give ten million kilowatt-hours of electricity. This amount is enough to power over one thousand Australian households.

- Presented with this information, it is obvious that we should not depend upon fossil fuels to take us into the 21st century. It is clear that our future lies in the hands of nuclear reactors and the use of plutonium.

- The second major use for plutonium is for space exploration with its ability to power nuclear propulsion. Nuclear electric propulsion is using energy from plutonium to power space vehicles. One of the major goals of NASA space program is to, one day, get to Mars, and it looks like the only way it is going to happen in current fiscal condition, if plutonium used, instead of chemical fuel, to power our explorations. Nuclear electric propulsion can be defined as using small plutonium based bricks to power space vehicles for interplanetary trips.

- Nuclear electric systems provide very low thrust levels and use only very small amounts of fuel during the voyage. Using electric propulsion also allows the use of less fuel making the spacecrafts launch weight much lower than it would be with chemical fuel.

Nuclear economical energy sources and their smooth functioning in US perspective of nuclear power

Abundant fuel with low cost and stable price.

U.S. nuclear power plants use an enriched form of uranium for fuel. Uranium is a relatively abundant element that occurs naturally in the earth's crust. Uranium oxide is about as common as tin. In 1998, 16 countries produced over 99 percent of the world's total uranium production. Canada's and Australia's uranium mines account for 46 percent. Compared to natural gas, a fuel also used to generate electricity, uranium is already relatively low in cost and less sensitive to fuel price increases. And a little goes a long way: one uranium fuel pellet—the size of the tip of your little finger—is the equivalent of 17,000 cubic feet of natural gas, 1,780 pounds of coal, or 149 gallons of oil.

Improving plant performance.

Greater nuclear plant performance means more electricity for less money. Plant operators routinely take a variety of measures to increase performance, such as improving the design of systems, installing more reliable equipment, using better information systems, enhancing integration of systems and coordination of their operations, observing better work planning and work management, sharing lessons learned about plant operations throughout the industry, and providing higher levels of training.

Continual plant modernization.

Although the first commercial nuclear power plant began commercial operations in 1969, there is really no "old" nuclear power plant. Systems are continually being redesigned and replaced such that the original plant is substantially new and improved. Moreover, the collective wisdom of the entire nuclear industry is brought to bear on this

improvement process. All plant operators share best practices and operating experiences through industry wide lessons learned procedures, benchmarking projects and the Top Industry Practice Awards program.

Plant longevity through license renewal.

Nuclear power plants are a valuable asset to their owners because their initial license period can be extended. The initial license period of 40 years can be renewed for an additional 20. So far, eight plants have applied for license renewal and an additional 22 have announced intentions to do so–almost one-third of all U.S. plants. This renewed life of a plant translates into additional savings for customers because the expense of building a new power plant can be avoided.

Economies of scale through consolidation.

The deregulation of the electric power industry is resulting in changes of ownership for all types of electric generation assets. Some companies want to focus only on generation, others on transmission and distribution, and still others on all three. In addition, companies that specialize in nuclear power generation are purchasing nuclear plants, and nuclear operating companies are forming to run plants owned by different companies. This consolidation will create substantial opportunities for economies of scale and spread the expertise of successful operators over more plants, leading to further cost savings and greater performance

No greenhouse gas emissions, no compliance costs.

Nuclear power plants are not affected by escalating environmental requirements, which have significant impact on the economics of fossil-fired plants. As an emission-free source of electricity generation, nuclear energy eliminates compliance costs that would otherwise be imposed on fossil-fired plants. Moreover, the value of emission-free generation may some day be recognized monetarily.

Nuclear power program in India

India is today, globally acknowledged as one of the countries most advanced in nuclear technology. The department of Atomic energy (DAE) has fostered the nuclear technology in the county to a perfect state of self-reliance fulfilling the aims of planners, marked by overall balanced developments and growth in all the spheres of its activities.

Electric power generating capacity, as of sep, 98 stood at 97,436 MW and it represents a many-fold increase since independence. Where do we go from here? We have to look at our energy resource position and growth requirements. Our conventional resources are far from being adequate to achieve any ambitions forget in terms of per capita electricity consumption, which is established parameters with strong influence on development.

Our major energy source at present is coal about billion tones. This constitutes about six percent of the coal reserves of the world, while 16% of the world's Population lives here. Even so coal is also bound to be the main stay of our electricity Production for quite sometime depending upon postulated growth rate, one can forecast how long coal deposits are going to last estimates differ, but coal is not going to be sufficient for a long enough time. One must remember that our percapita electricity consumption is only around 400kwh/yr as against a world average of 2400 kwh/yr therefore, to reach even the world average figure of per capita energy consumption, massive increase in generation capacity is needed.

Coal deposits being limited, hydel potential even more limited, oil and gas deposits being very meager, we have to look elsewhere. Nuclear and non-conventional sources are therefore important sources, which would need to be sapped in future. So inevitably, nuclear power stations are suitable for large central generating stations.

Thorium and Uranium, are the two naturally occurring elements which have the Potential of being used as full in a nuclear power plant. India has released deposits of Natural uranium, which thorium deposits are quite vast on the basis of alone mentioned Strategy, three stages of the Indian nuclear power programs have been identified:

1. In the first stage, natural uranium based fuel is ceased in heavy water moderated and cooled pressurized heavy water reactors (PHWRS).

2. In the second stage, the fissile plutonium Contained in the spot fuel from the PHW is separated in fuel reprocessing plants.

3. In the third stage, dedicated breeder reactors based on uranium-232 and thorium are planned so be constructed.

These reactors would serve as the main stay of the Indian nuclear program. The currently known Indian thorium reserves amount to 3358,000 Giga Watts per year of electrical energy and can easily meet the energy requirements during the next century and beyond.

The plans and operations of Department of Atomic energy, India.

India's Nuclear Power Program has fourteen operating reactors including 2 Boiling Water Reactors (BWR) and 12 Pressurized Heavy Water Reactors (PHWR). It has at present two PHWRs under construction of 500 MWe capacity each at Tarapur in Maharashtra. Nuclear Power Corporation Ltd. (NPCIL) is the public sector company which owns, constructs and operates nuclear power plants in India. NPCIL which is spearheading the nuclear power program in India plans to put up a total installed nuclear power capacity of 20,000 MWe by the year 2020.

Operating Nuclear Power Reactors

Location	Type/Capacity
Tarapur	BWR/2x160 MWe
Rajasthan	PHWR/1x100, 1x200 MWe and 2 X 220 Mwe
Kalpakkam	PHWR/2x170 MWe
Narora	PHWR/2x220 MWe
Kakrapara	PHWR/2x220 Mwe
Kaiga	2 PHWR units of 220 MWe

Reactors Under Construction

Location	Type/Capacity	Expected Criticality Date
Tarapur	PHWR/2x500 MWe	• UNIT 3- July 2006 • UNIT 4- October 2005

The peaceful uses of atomic energy through nuclear power

In-depth, the theory as to how Atomic Energy has become an intrinsic part of humanity and civilization and this should not be restricted to scientists and experts alone, but on the contrary it should be spread out on a wider canvas such as students, through their teachers, for teachers are the students friends, philosophers.

The common man's perception of Atomic Energy because it has only been viewed from its destructive side. This view has got embedded in human memory because of man's greed, caprice and lust for power. Hence this conception needs to be removed from the common man's mind to foster the growth of nuclear energy for peaceful uses, at the same time we have to be careful while attending to problems connected with nuclear energy.

Nuclear Power has proved to be a boon for mankind. It generates all the power required by our industries and for numerous other uses The generation of power from nuclear energy needs to be enhanced extensively and misconceptions about nuclear energy need to be set right

Mr. Das said that energy consumption in the form of electricity is an index of development. It is needed in homes, industry, agriculture, shops and hospitals. The average electricity consumption by an individual in our country is far below that of the corresponding figures in developed countries.

Hence even to reach a reasonable level of electricity consumption, rise in the demand is bound to be steep. Important sources of energy are:

1. Thermal Power
2. Hydro Power
3. Solar Energy
4. Wind Energy
5. Petroleum.

Hydroelectric power is a clean source and we have the potential in India for its generation. However, there are environmental considerations, such as sumergence of forests and displacement of population. Research in renewable forms of energy is progressing. To meet the acute shortage of electric power in the country, every conceivable source has to be tapped. Keeping in view the limitations of fossil fuel reserves, environmental considerations and atmospheric emissions from fuels, nuclear power in India is a clean and viable option.

Concluding remarks

In the area of nuclear energy many milestones have been achieved and future strategy has been worked out to provide long form energy security to the country keeping in view our energy resource position a strong R&D base has been mastered to meet developmental needs have strategic importance.

Our technology development is reprocessing, enrichment, production of special materials, computers, casers accelerators represents acquisition of technology which world be otherwise denied to us, but are necessary for realizing full potential of our energy resources to meet future energy needs.

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Biography

Mr. KIRAN KUMAR GOUD GUNDRAI is born in 1979 at Gadwal, a small town located on the bank of Krishna River in Andhra Pradesh state in India. He received Bachelor of Technology in Electrical engineering in 2001 from Bapatla Engineering College, a privately funded college, Bapatla, Guntur District, India. He is currently working as a guest-lecturer for Artificial Intelligence at Nizam College of arts & sciences, Osmania University, Hyderabad, India.

Dedicated

This paper is whole-heartedly dedicated to Madam Marie curie and her husband, who sacrificed their lives to discover radioactive elements. They are the fair flowers of human technology who have shown another dimension to Science and technology**.**