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Manpower Development in Nuclear Technology

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Abstract

Energy is a basic necessity for social and economic development of a country. An improved access to electricity leads to improvement towards health, education, agriculture and economic empowerment. The energy challenges are due to: increase in energy demand, mostly due to population increase, rise in the living standards and also due to increased expectations of the people. The only attractive option to meet the increasing energy demand is to produce it from Nuclear sources. There are mainly two challenges in this area: resources–material (nuclear fuel) and human i.e. manpower and we discuss here the manpower part. Success of any Nuclear Power project depends mainly on availability of qualified manpower, which can ensure the success of various stages of a nuclear power project such as planning, construction, operation, safety and power production. Safety of nuclear plants is of greatest concern; skilled and qualified manpower can help in preventing accidents or help in proper handling if they do occur. The shortage of skilled and qualified manpower is a major limiting factor in development of nuclear technology particularly in developing countries. Understanding the dire need of the manpower shortage, and utilizing the vast potential of human resource at Universities, some universities in India have started a new course in Nuclear Technology during the last few years. However, this effort by a few Universities is not enough to answer our manpower needs. Worldwide, there is increasing demand for nuclear engineers since new reactor plants are coming up. We discuss below some measures to be adopted to address the problem of manpower shortage in Nuclear Technology.

I.Introduction

Energy is a basic necessity for social and economic development of a country.An improved access to electricity leads to improvement towards health, education, agriculture and economic empowerment.India's development is showing a rising graph due to its (a) large Industries, (b)a well-developed service sector and (c) an impressive growth rate. The primary requirement for the above need energy to sustain, advance and compete on a global scale.Human development index [1] is directly proportional to energy consumption, as shown in Fig. 1.The larger the energy consumption, the larger the economic development.Even average lifespan of individuals in a country depends upon the average power consumption. Fig 2 shows the life expectancy as a function of primary energy, trillions of gas equivalent per yearper capita[2]. For a large country like India, with huge future energy requirements, depending largely upon import of energy resources and technologies is neither economically sustainable nor strategically sound for energy security.India is the 3rdlargest producer of electricity in the world with total electricity production of 1,102,900 GWh in the year 2013 & has a 4.8% share of global electricity production [3]. This translates into poor energy production per capita due to over 1.2 billion population of the country. The current energy sources are [4]:Thermal (Coal, Gas & Diesel) :70%, Hydro: 16%, Nuclear: 2% and Others: 12%. From 2010 onwards, we have begun to fall short of our energy needs. From the year 2050 onwards, we will need an enormous amount of 700 million tons of coal in case we do not develop alternate energy sources. Fig 3 shows the installed enegy capacity and projected requirement [5] from year 2010 upto 2050. It is clear from Fig. 3that the only way to fulfill the energy requirement is to use Nuclear Energy.

The energy challenges are due to increase in demand of energy mostly due to population increase, rise in the living standards and also due to increased expectations of the people. There will be 3 billion more people on earth by 2050. The economic growth in developing countries like India, China, Brazil etc. is an important

factor for driving the energy demand apart from other countries which are aspiring at better living conditions. Growth in developed countries, widespread use of computers, air-conditioning, etc. are also pushing demand.

The only attractive option to meet the increasing energy demand in India is to produce it from Nuclear sources. Of course, there are two chief challenges in this area: Resources–material (Nuclear Fuel) and human i.e. manpower. Regarding the Nuclear Fuel, situation eased after Indo-US Nuclear deal and we have started to import Uranium. We will discuss the human resource in this work.

There are 439 nuclear reactors worldwide and 69 reactors are under construction. [6] This clearly shows a renaissance of nuclear power. The successful operation of Nuclear power plant is dependent chiefly on skilled manpower, who can ensure the success of a nuclear power plant from first to last stage. The first stage is planning, followed by construction, operation, safety and finally power production. Safety of nuclear plants is of greatest concern (Three mile island and Chernobyl are sad reminders and latest was Fukushima!); skilled and qualified manpower can not only help in preventing accidents but also provide proper handling in case of accidents.

The shortage of skilled and qualified manpower is a major limiting factor in development of nuclear technology particularly in developing countries.

The Organization for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA) has explored seven activities related to nuclear generation of electricity: Front-end, Back-end, Plant Operation and Maintenance, Design, Manufacturing and Construction, Regulation, R&D and Education, and 'Others'.Occupations in these major sectors were further classified as: Engineers (nuclear and chemical), Scientists, Managers, etc. For all the above, we need qualified manpower. Shortage of skilled manpower is the main problem facing the expansion of Nuclear Program all over the Globe.

India is planning to add several more reactors to the presently available 21 reactors [5]. There is a serious shortage of skilled manpower worldwide and India is no exception inspite of being over a billion people! According to OECD study for UN, we need 900 technical/scientific personnel for each nuclear reactor. Where do we get such numbers for our reactors? The only option is to follow an aggressive strategy to increase the Nuclear Engineering Manpower. The implementation of a training program requires : Financial support and organization for strengthening the education infrastructure. This is true for developed& developing countries.

The Bhabha Atomic Research Centre Training Schools in India and its affiliates conduct one year Orientation Course for Engineering graduates and Science post-graduates (OCES). Under a new scheme, called Graduate Fellowship Scheme, Masters students are admitted with the twin objectives of human resource development and collaborative research. Understanding the dire need of the manpower shortage, and utilizing the vast potential of human resource at Universities, some universities such as University of Delhi, Delhi, University of Petroleum & Energy Studies, Dehradun, Mody University, Rajasthan, Pandit Deendayal Petroleum University, Gandhinagar and Jadavpur University, Kolkata have started a new course in Nuclear Technology during the last few years. However, this effort is not enough to answer our manpower needs.We discuss below the global manpower needs and the measures to be adopted for overcoming this lacunae.

II.Issues& Solutions In Nuclear Engineering

The major problems in Nuclear Engineering course in any University / Institute are listed as under.

(a) Enrollments

Enrollments for Nuclear Engineering (NE) departments do not show any significant increase while demand from industry and government is expected to increase. This increase is due to building up of new reactor plants. The number of new Nuclear Engineering/ Nuclear Technology departments in India has increased to four in last five years. A manpower crisis seems to be developing that needs to be communicated to the Govt; Industry and Universities. The decision makers do not seem to realise the implications of manpower shortage.With the increase in new reactor plants, there will be an increasing demand for nuclear engineering graduates in Industry and Govt. Universities will need graduate students for research and new faculty for

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hiring. These issuescan be addressed by increasing the number ofUniversities/ Institutes where we should start the nuclear engineering program. There are two important issues to be resolved while expnding the NE program in universities. One is the hiring of competent & experienced faculty for teaching the various courses. Secondly, building up of Nuclear, Plasma and Fluid Dynamics laboratories for teaching the graduate students. For the first issue, we can have international collaborations whereby we can send our students to other countries for course work. This will be discussed in section (c).For the second issue, we need to develop the necessary infrastructure of labs.

(b) Course Curriculam

In order to get students interested in Nuclear Engineering we should introduce subjects like Nuclear Power & radiation right at the school level. The students must be informed that during undergraduate studies in this area, they can do internship at reactor sites. Internship during summer can be an attractive incentive for students wishing to study this course. This will also enlarge the vision of the students. Care needs to be taken to match the course curriculum with the demands of the employment agencies. An integration of both theoretical & practical aspects may be the best option. There should be exchange of students & faculty from different Universities in a country or from different countries for cross – fertilization of ideas and also to make the course interesting. The best course would be a common minimum course curriculam so that the students can transfer easily from different Universities.

(c) International Collaboration with France

France is one of the most active country in the world in developing nuclear technology. France derives over 75% of its electricity from nuclear energy. France is the world's largest net producer of energy due to its very low cost of generation and gains over EUR 3 billion per year from sale of nuclear energy. Given the enormous contribution of France towards harnessing nuclear energy, it is only but natural that we seek to train our Masters students in laboratories in France. This kind of training will afford the students an opportunity to get the state of art knowledge in nuclear technology and will be beneficial for future trade between the two countries in this area. Presently, several Universities such as Mody University, Rajasthan, University of Petroleum & Energy Studies, Dehradun, Pandit Deendayal Petroleum University, Gandhinagar and Jadavpur University, Kolkata etc. send M.Tech students to France for one year of course work and internship. They have entered into an academic collaboration agreement with IMT Institut Mines-Télécom, Nantes, France. The students work in two specializations:Advanced Nuclear Waste Management or Nuclear Energy Production and Industrial Applications.

We are confident that this collaboration will be a trend-setter and many more Universities in India will also join the bandwagon. India and European Union have created a partnership for Research and Development through Erasmus Mundus – External Cooperation Window, India. This has been done through a mobility scheme among participating institutions that will result in "Brain Circulation" instead of Brain Drain. This involves mobility, flows of undergraduates, Masters and Doctoral level students both ways. The ultimate aim is to establish long-lasting structures that will sustain themselves beyond the life of this particular scheme. We would like to follow a similar pattern in Indo-French Collaboration in Nuclear Engineering.

(d) Public perception and outreach

The general public does not have a correct picture of Nuclear Engineering. A poor image of Nuclear Engineering is present among the general public, students and parents. Nuclear Engineering departments are perceived to focus on nuclear power, even when the students are trained in diverse areas such as Nuclear Plant Design, Nuclear Operations, and Nuclear Waste Management etc. The range of opportunities in the nuclear industry to attract new employees and prospective students is not known to public. Compared to other areas such as Business Management, Finance, the "glamour factor" is working against nuclear energy as it is perceived to be a field with a limited future and dim prospects for responsible and high paying jobs. Firstly, Nuclear Engineering community must inform the public the need for nuclear energy. Secondly, prospective students must be informed the wide range of challenging career opportunities in industry, research, and government that are available today and will show an increasing trend in future. Undergraduates Engineering

students are a large and readily available source of qualified students for Masters program. They should be encouraged to get involved in real research projects. Highly visible events such as popular talks by eminent Nuclear scientists, colloquiums etc. will help a lot to improve public perception for nuclear energy. We need to inform the public about the security concerns and the response of the Nuclear Scientific Community to allay the public fears.The advantages and viability of the Nuclear Power option over other alternative energy sources should be explained, both qualitatively and quantitatively.

III. Conclusion

Employment opportunities need to be communicated to all graduating students. A central jobs/graduates website for potential employers and graduating students could be considered. There needs to be concerted action by leaders of industry, national laboratories, universities and institutes and the government to support actions to address this manpower crisis. The industry and academia should work together and they could develop the course curricula to suit the industry requirements. The central government should be urged to recognize and accept its critical role to nurture and sustain for long-term an adequate supply of expertise in nuclear – related fields, including nuclear energy, nuclear plant design, waste management, health physics, and nuclear operations.

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Figure Captions

Fig. 1 – Human Development Index as a function of Per Capita Electricity Consumption (Kwh/year)

Fig. 2 – Life Expectancy in years vs Primary Energy trillions of oil equivalent per capita.

Fig. 3 – Installed Energy Capacity from various sources –Non conventional, Coal, Hydrocarbon and Nuclear from the years 2008 to 2050. The solid line shows the projected requirement.

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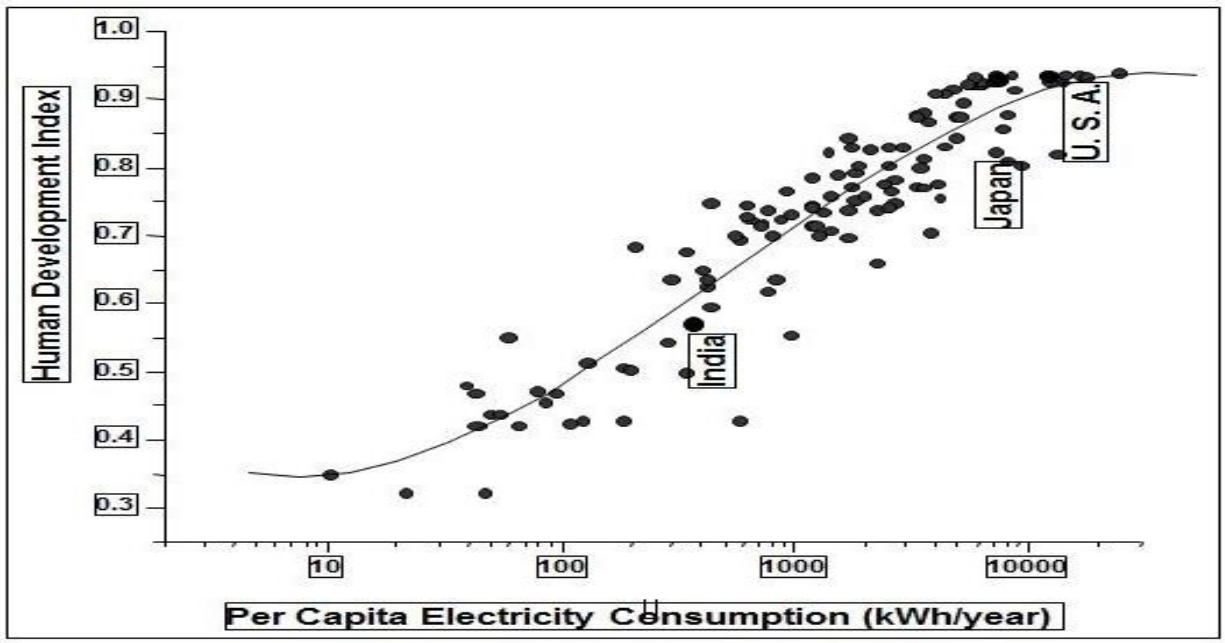
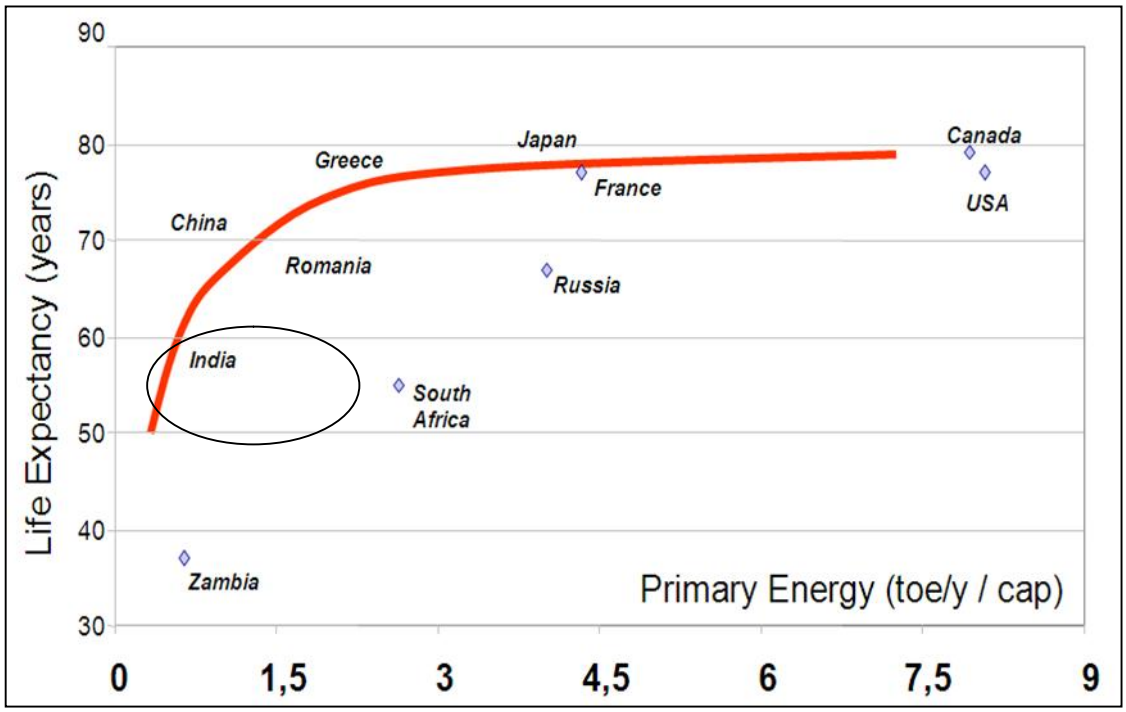


Fig. 1



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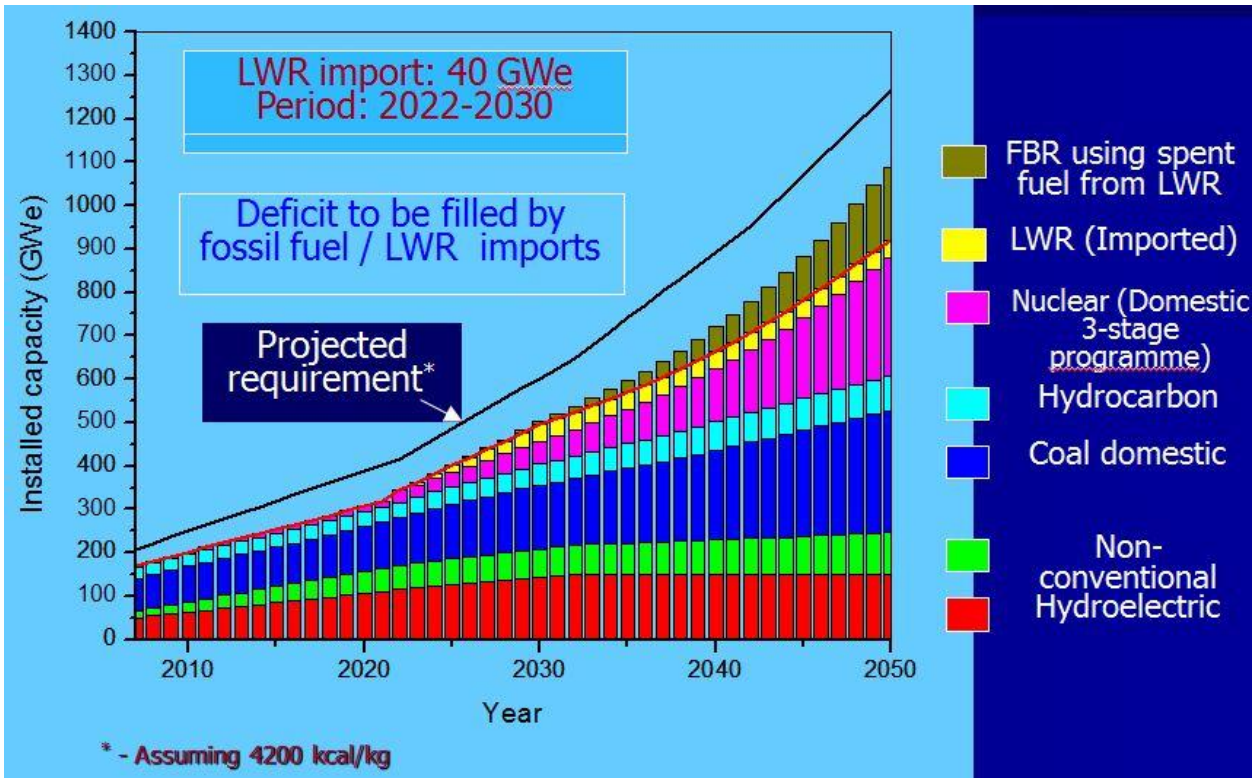

Fig. 3

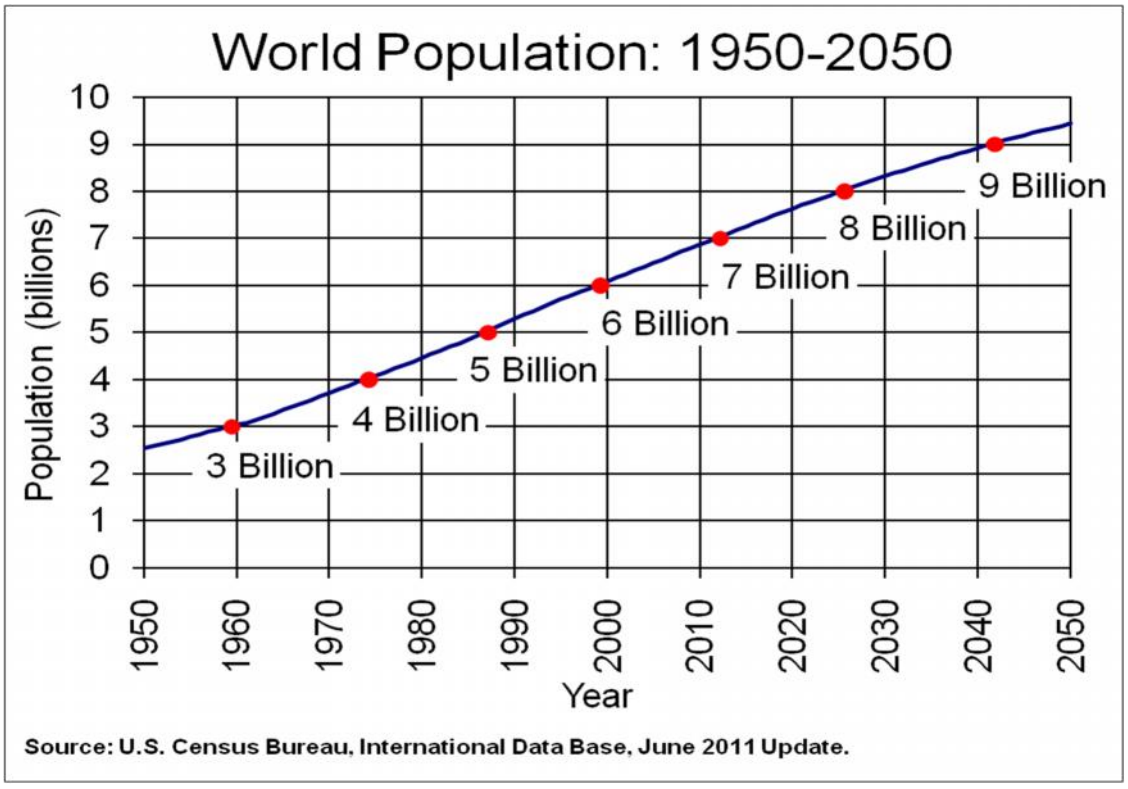

Fig. 4

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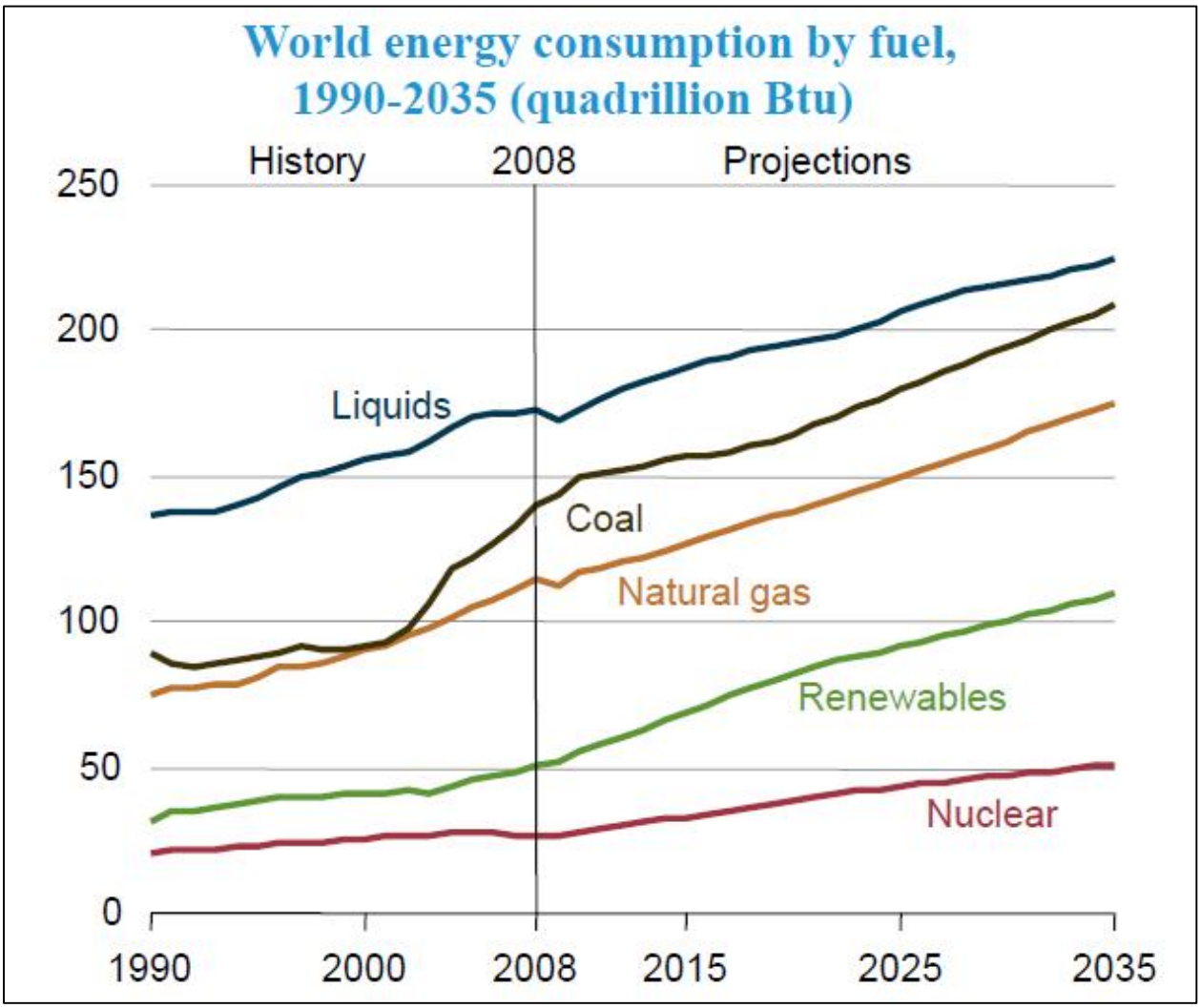

Fig. 5