WORLD NUCLEAR UNIVERSITY

WNU Nuclear Olympiad 2016 Report

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1.Objective

The WNU Nuclear Olympiad is a World Nuclear University international nuclear communications challenge for undergraduate and graduate students who are passionate about nuclear science and technology. The 2016 challenge required students to research two nuclear related topic; the first, the production of radionuclides, and the second, effective communication on nuclear energy. The World Nuclear University Olympiad reached thousands of students and their supporters worldwide, showcasing the work of the competitors in an international setting. This is a unique opportunity for students to showcase originality, creativity, and knowledge on nuclear sciences and applications and how these enhance the quality of life. By participating in the WNU Nuclear Olympiad, students have the opportunity to connect with nuclear organizations and helping them pave the way forward to a bright career.

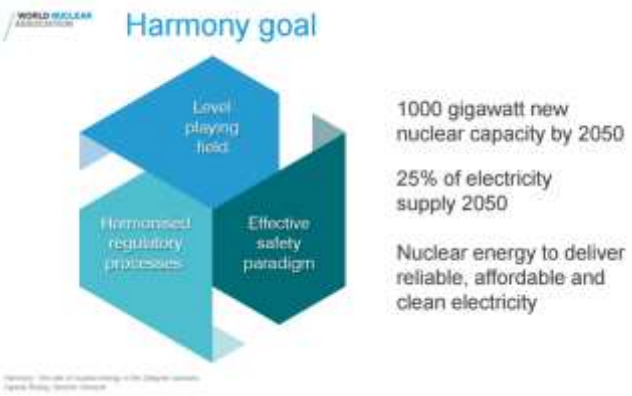
2. Introduction

Running from March to August the WNU Nuclear Olympiad wrapped up for 2016 at the World Nuclear Association Symposium with the winner's award delivered by Director General, Agneta Rising. Team Amity from India won the 2016 challenge and was represented at the award ceremony by team leader Dhruv Dharamshi and his professor Dr Amar Nath Garg, with travel sponsored by the World Nuclear Association. For the final stage, Team Amity proposed 3 effective messages to communicate to decision makers the need to expand nuclear capacity in order to hold global warming below 2°C that can be found on the WNU website. These messages align with the World Nuclear Association Harmony programme. Earlier stages of the competition called upon students to create a short video and post it on YouTube. By September these videos had reached 55,000 views and more than 32,000 'likes' on YouTube.

2.1 The 2016 challenge

The WNU Nuclear Olympiad 2016 had several stages of competition:

- Firstly, students were asked to post to YouTube, or YouKu in China, a video of 1 minute on the topic of Production of Radionuclides for Global Development before 11 March 2016, with a detailed description of about 500 words explaining the content of the video. The following terms were used in this text to identify the videos: "nuclear sciences and applications", "radioisotopes", "reactors", "particle accelerators".
- On Thursday 19 May 2016, the WNU verified the number of 'likes' and the authors of the videos with the highest number went through to the second stage of the competition. All together the 9 most liked videos had reached 28,946 views, with 14,319 likes.
- These finalists were then interviewed by telephone about the topic of their video, evaluating their knowledge, communication skills and motivation.
- For the final evaluation, finalists were asked to elaborated 3 effective messages to communicate to decision makers the need to expand nuclear capacity in order to hold global warming below 2°C by 15 July 2016.



On the day of World Nuclear Association Symposium 2016, Dhruv Dharamshi, the winner, and his professor Amar Nath Garg were invited to attend, his video was showcased at WNU booth at the Symposium and three messages distributed to the audience during the award ceremony.

2.2 History of the Nuclear Olympiad

Over the last 12 years, WNU programmes have reached students, young professionals and future nuclear leaders with a number of programmes on both nuclear energy and on the radiation technologies. The WNU Nuclear Olympiad is

aimed at university students, giving them the opportunity to showcase their work in the nuclear area and to open future career opportunities.

The first international WNU Olympiad was held in 2011 in South Korea. It was a contest to develop a national plan for effective communication about nuclear energy. In 2015, participants were asked to create a video and essay and presentation on nuclear techniques for global development. The final stage was held as a side event to the General Conference at the IAEA headquarters in Vienna. This year the candidates for the Nuclear Olympiad 2016 carried out research into the production of radionuclides for global development and then secondly communication messages for nuclear energy.

3. Finalists

3.1 Judges

The following judges evaluated the communication messages of the WNU Nuclear Olympiad finalists based on the following criteria: clarity of the text; logical organization; well-developed points that are supported with specific evidence; creativity; and innovative approach. These judges were selected for their wealth of experience in the nuclear area but also their experience in communicating on nuclear topics.

Miranda Kirschel, UK Energy Advisory team, Chair of the UK branch of Women in Nuclear

Miranda works in Energy Advisory for EY (formerly Ernst and Young) first entered the nuclear industry in 2001 at the Nuclear Industry Association and following her time as Head of Corporate Affairs there moved on to work with CH2MHill and Atkins before joining EY in 2015. She has been joint President of WiN UK from its formation in early 2014 since when it has grown to over 1,000 members.

Jeremy Gordon, UK, Director Information Management and WNN at World Nuclear Association

Jeremy has spent more than ten years as a communicator in the nuclear industry. Beginning as Deputy Editor of Nuclear Engineering International magazine he joined the World Nuclear Association in 2006 and launched its independent World Nuclear News service the following year. This remains the world leader in public information on the current affairs of the global nuclear industry and Jeremy now heads the team that produces WNN as well as the WNA's Information Library and Reactor Database. Jeremy grew up and was educated in London, earning a Bachelor's degree in Artificial Intelligence from the University of Westminster and graduating with honors in 2000. He is a WNU Summer Institute 2006 Fellow.

Kirsty Gogan, UK, Co-Founder, Executive Director Energy for Humanity

Kirsty Gogan, Co-Founder and Executive Director of Energy for Humanity is an established expert in climate and energy communications with extensive experience as a senior advisor to UK Government, industry, academic networks and non-profit organizations. She created the Low Carbon Alliance. Leading the Government's public consultation into the UK's new build program she addressed public concerns about nuclear power and engaged anti-nuclear campaigners in a constructive dialogue process with Government that continues to this day. As Deputy Head of Civil Nuclear Security, Kirsty reviewed the UK national communications response to Fukushima, made a number of recommendations, and implemented them.

Fidelma Di Lemma, Italy, Post PhD fellow in Japan and Active Member of Young Generation.

Fidelma Di Lemma is a nuclear scientist with international experience in experimental research, focused on Fission Products Behavior, Severe accidents, Aerosols. Main activities involved simulated tests, characterization of materials, analyses of gases, and development of novel experimental instrumentation. Fidelma is actively involved in communicating science to the public, and in activities to improve knowledge transfer between peers and different generations.

Kangjun Lee, Korea Electric Power Corporation (KEPCO)

Kangjun Lee has been working as a Visiting Research Officer in the World Nuclear Association since January 2016, seconded from Korea Electric Power Corporation (KEPCO) in Korea. He has more than 10 year experience in developing overseas civil nuclear new build projects worldwide, and now works as a staff of Supply Chain Working group at World Nuclear Association. He is a WNU Summer Institute 2014 Fellow.

Betty Bonnar del-Azzarelli, AB5 Consulting, ex-WNTI

Betty Bonna is a senior professional with extensive international experience in the energy, nuclear, transport, satellite, aerospace and defense industries, for both public and private sectors. Betty has strong skills and experience in regulatory management, highly complex and technical project/programme management, contract and bid management, and change and risk management experience. Betty is an effective negotiator and is creative, result-driven and focused. She is multi-lingual and multicultural and has high ethical standards.

3.2 Top teams

Each finalist showed their enthusiasm during the competition for pursuing internships and professional opportunities in the nuclear field. Despite having one common topic, each one minute video had an individual approach. Dhruv Dharamshi, the winner of the Olympiad, took a general outlook, presenting application of nuclear in the field of medicine, industry and agriculture. Asmi Amalia, emphasized the benefits of nuclear science which have extended far beyond the original research, often in completely unexpected ways. Sachin Singh, whose title was Nuclear Techniques for Global Development, mainly focused on nuclear technology applications in agriculture and medicine.

The teams reaching the final stage were as follows:

Team "A Bee girl"
Nurul Asmi Amalia

At the time of the competition he was studying nuclear energy at the engineering department in Hacettepe University, Turkey. He often takes part in and has won various competitions such as the physics Olympiad, essays, etc.

He is really addicted in energy stuff because energy empowers our lives. He is curious about the world and people, he loves traveling and is obsessed with filling his passport with stamps, vowing always to be his outrageous self. He likes to join conferences, workshops, and training. Last year he joined International Student Energy Summit (ISES) in 2015, in Bali, Indonesia, as well as The 3rd Asia Pacific Student Forum (APSF) in 2015, in Jakarta, Indonesia.

Team Amity
Dhruv Dharamshi (Team Leader)

Jagriti Dhingra
Jeet Sah
Mayank Singh
Sonakshi Singh
Pundir

In 2016, Dhruv Dharamshi was a final year Master's student at Amity Institute of Nuclear Science and Technology, Amity University. He has had the privilege of making it to the final round in the WNU Nuclear Olympiad 2015 (Vienna – Austria). He has participated in several workshops, conferences and internship programs like the Nuclear Security Training Series 2015 (June-July, 2015; Texas, New Mexico, Tennessee, California - USA); Institute of Nuclear Materials Management 56th Annual Meet (July, 2015; California – USA); 14th International Congress of the International Radiation Protection Association (May, 2016, Cape Town – South Africa). He is also the winner of the Nuclear Security Multimedia Competition 2015 hosted by PNS and CRDF Global. He has an internship scheduled at the Federal University of Rio de Janeiro, Brazil in the summer of 2016, and a poster presentation at the INMM 57th Annual Meet in Atlanta – USA.

Team C + I + J
Camille Francesca Simon (Team Leader)
Isabella Del Castillo

Camille Francesca Simon is a third year student of De La Salle University Manila where in 2016 she was earning a Bachelor in Science in Pre-med Physics. At this time she was conducting a research project on breast cancer aiming to discover a more economical yet efficient treatments for her graduate thesis with her partner, Isabella Del Castillo. She intends to pursue a career in the medical field specializing in Radiation Oncology.

Team DIKSHA
Diksha Sharma

In 2016 she was pursuing her third year of a Bachelor of Technology in Nuclear Science and Technology. Her professional ambition is to expand her knowledge in the world

of nuclear science and emerging techniques while producing high impact and developing new applications to enhance quality of life globally. Also, she wishes to establish a new mark of excellence in the field of radiation safety, nuclear techniques, nuclear security, particle physics and techniques of development of life globally.

Team Hacettepe
Gamze Bozkurt
(Team Leader)
Alp Tezbasaran

During her undergraduate study, Gamze worked at Hacettepe Energy Community as an active member and she is one of the founders Hacettepe International Project Community. Also she is taking part of TED x Hacettepe University in Sponsorship Crew. In 2015, she participated in an Erasmus project called as 'I Love Europe' in Poggiardo, Italy. Also she got the DynEd English certificate during her English preparatory training. She did an internship 18 Mart Çan Thermal Reactor for about one month in 2015. She gained organizational and interpersonal skills that develop her academic studies and demonstrate her creativity under favour of these projects and organizations.

Team Food Irradiation: A plan to end world hunger
Andre Soares

He is a 20-year-old nuclear engineering undergraduate student at Federal University of Rio de Janeiro. His studies in college have started since 2014 when he changed his course from Physics to Nuclear Engineering. He had been a member of an advanced student group of physics there. They could learn more about physics and develop ideas and experiments. The main idea which had been established was about particle physics. He is passionate about this field of study. As a nuclear engineer, he would like to research technology, innovation and of course, public acceptance of nuclear. In his free time, he usually travels with his girlfriend to relax and enjoy the sights. Also, he has been working as an English Teacher in a private course inside college.

Team PDPU TITANS
Bharat Singh Rawat
(Team Leader)
Vivek Pachchigar

Bharat Singh Rawat is pursuing his M.Tech in the Department of Nuclear Engineering at Pandit Deendayal Petroleum University (PDPU). He completed his high school from St. Xavier's High School (2009) after which he decided to pursue a Bachelor's Degree in Engineering. He completed his Bachelors of Engineering from Hasmukh Goswami College of Engineering (2013). In his course he learned about the nuances of design and engineering and came to realize that it was both challenging and fascinating to be a Mechanical Engineer. He decided to pursue a Master Degree in Nuclear Engineering because he sees a lot of scope in the field of food irradiation in his state which might give me a chance to contribute to the betterment of his people.

Team SSachin
Sachin Singh (Team Leader)
Suraj tyagi

After securing excellent marks in his high school examination Sachin Singh was motivated by global development. He believed that sustainability is the only vital route through which the world can survive. And this was his main aim behind taking up a bachelor's degree in Nuclear Science and technology. During his fourth semester he was enlightened by the Prof

A.N Garg on the subject of applications of radioisotopes. The numerous applications of nuclear technology once again boosted his ambition to learn more.

Team The Alpha and Beta

Usama Shahid (Team Leader)
Fadime Ozge OZKAN

In 2016 Usama Shahid was an undergraduate student in Hacettepe University Ankara, Turkey. He was born in Muzaffargarh, Punjab, Pakistan on Dec 05, 1992. On October 2012, he was successful in getting Turkish Government Scholarship for his undergraduate studies in Nuclear Engineering at Hacettepe University. Along with his studies, he joined International Student Commission in University. He became the General Secretary of commission in 2015 and organized bi-lingual debate competition for the first time in university. He organized Football World Cup in the university among different nationalities students. He did his first internship at a thermal power plant KAPCO in Aug 2013 and 2nd internship in nuclear research facility CANEM, Istanbul in Aug 2015.

4. Videos

Team A Bee Girl: Nuclear Improves the Quality of Our Lives - 761 likes

Radioisotopes both occur naturally and are artificially with nuclear reactors, cyclotrons, particle accelerators or radionuclide generators. Basic research in nuclear science has engendered benefits that extend far beyond the original research, often in completely unexpected ways. Nuclear sciences and applications continue to have a major impact in other areas of science, technology, medicine, energy production and national security. Water, Food, Energy, Health form the corner-stones of modern daily life. They can be protected, provided and preserved through the use of nuclear technologies. The IAEA supports the use of these techniques throughout the world.

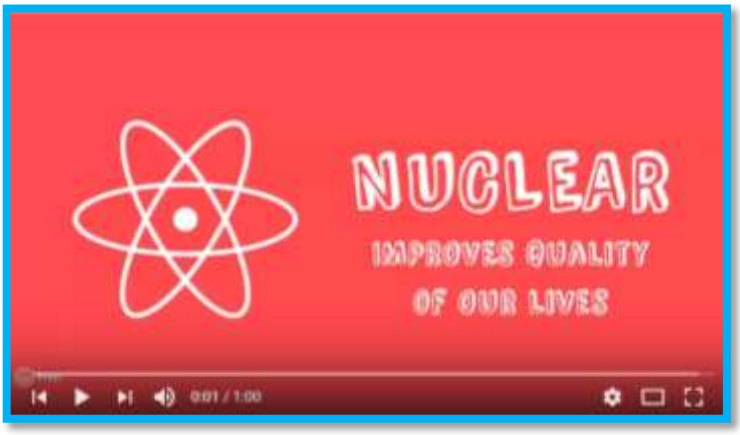
Water - Freshwater is a limited resource, one that we use wastefully, over exploit and pollute. Using nuclear science, countries can manage their scarce water resources better. The oceans provide us with so much, but we use them as a dumping ground for the pollution, rubbish and waste we create on land. Scientists at the IAEA's laboratories in Monaco use nuclear techniques to study the key threats to the marine environment. They advise countries on how to prevent pollution and mitigate its consequences. A quarter of CO_2 emissions are absorbed by the oceans. Once in the water, the carbon dioxide is transformed into acid — leading to ocean acidification. Scientists are researching how this acidification is damaging coral reefs and threatening marine life and seafood.

Food - The IAEA operates projects that use nuclear techniques to improve crop varieties and soil quality. This leads to more crops and better food. It promotes the use of a technique to control pests that can destroy fruit and kill livestock, and methods to diagnose and prevent animal disease.

Energy - As populations grow, countries develop and industries boom, demand for energy continues to increase. Many countries see nuclear power as a way of meeting their electricity needs, while reducing their C02 emissions. The IAEA provides assistance at all stages of a nuclear power programme. It advises nations that are considering introducing nuclear power, constructing their first plant or building new ones. It offers services for the safe and sustainable operation of reactors and helps countries to develop safe and secure control systems for radioactive sources. These are used widely in medicine, industry and agriculture.

Health— Nuclear techniques are used to support national nutritional programmes. Irradiation can make food safer by killing contaminants that can cause food poisoning. And nuclear techniques can check whether agrochemicals have been used properly and pose no health risks. Radiology is used to diagnose and manage disease, and radiotherapy to treat and cure it.

LET'S SUPPORT ATOM FOR PEACE AND DEVELOPMENT!"



Team Amity: Preeminent Nuclear Techniques for the Modern Age - 4,951 likes

Nuclear sciences and applications play a critical role in driving sustainable global development. A few of the methods applied in the fields of medicine, industry and agriculture via the use of radioisotopes have been discussed in greater detail below.

CANCER THERAPY (Bi-213; produced artificially in particle accelerators):

Bismuth-213 is used for targeted alpha therapy (TAT) as it has a high energy (8.4 MeV).

Technetium-99m is used to image the skeleton and heart muscle in particular. It is produced from Mo-99 in a generator and is the most common radioisotope for diagnosis, accounting for over 80% of scans.

SMOKE DETECTORS (Am-241):

Americium-241, with a half-life of 432 years, was the first americium isotope to be isolated, and is the one used today in most domestic smoke detectors.

In combination with beryllium, Am-241 is also used as a neutron source in non-destructive testing of machinery and equipment, and as a thickness gauge in the glass industry. Beryllium produces neutrons as it captures the alpha particles from AmO_2. AmBe neutron sources have many applications including measuring soil moisture.

However, with constraint on the supply of Pu-238 alternative, the European Space Agency is now planning to use Am-241 in radioisotope thermoelectric generators (RTGs) for space missions, and the National Nuclear Laboratory in UK is gearing up to supply it in multi-kilogram quantities from aged civil plutonium, where it is a decay product of Pu-241.

STERILE INSECT TECHNIQUE (Co-60; produced artificially in nuclear reactors):

Countries from around the world are showing increased interest in the use of the sterile insect technique (SIT) to suppress the populations of mosquitoes that transmit, among others, the Zika virus A cobalt-60 gamma cell irradiator is an essential component in the use of SIT, a form of pest control that uses ionizing radiation to sterilize male insects mass-produced in special facilities. Once released, these males mate with wild females who do not produce any offspring, effectively suppressing the insect population over time. The technique can be potentially used to control the Aedes aegypti mosquitoes that carry the Zika virus.

RADIOISOTOPE THERMOELECTRIC GENERATOR (Pu-238, Sr-90, Po-210, Am-241):

A radioisotope thermoelectric generator (RTG) is an electrical generator that uses an array of thermocouples to convert the heat released by the decay of a suitable radioactive material into electricity by the Seebeck effect. RTGs have been used as power sources in satellites, space probes, and unmanned remote facilities such as a series of lighthouses built by the former Soviet Union inside the Arctic Circle. RTGs are usually the most desirable power source for unmaintained situations that need a few hundred watts (or less) of power for durations too long for fuel cells, batteries, or generators to provide economically, and in places where solar cells are not practical. Safe use of RTGs requires containment of the radioisotopes long after the productive life of the unit.”

Team C + I +J: International Development Through Nuclear Energy – 750 likes

Improving Nuclear Presumptions Through the Impacts of Radioisotopes

The world mainly relies on fossil fuels to supply majority of the world's energy demands. Fossil fuel is used as the major source of energy used to power vehicles, provide electricity, and manufacture goods. The scarcity of the amount of fossil fuels as well as its hazardous effects to the environment created a need to find a better source of energy.

From Rutherford's first artificial radionuclide in 1908 to the production of radioisotopes in particle accelerators or nuclear reactors, advances in nuclear science led to more opportunities for its applications in different fields such as medicine, archaeology, food industry, research, and energy.

This one-minute graphic animation focuses on the nuclear sciences and applications, specifically Uranium-235, in the field of energy. The mechanism of nuclear fission paves the way to a better source of energy in terms of power output, source availability, and environmental impacts. Our video presents the use of nuclear energy as the best solution in solving our energy crisis. The video begins by stating the problem with fossil fuels and then presenting nuclear energy as the solution. The mechanism of nuclear bombardment of U-235 was explained briefly and then the power output of a nuclear reactor was compared to that of a fossil-fuel reactor with nuclear reactors yielding to a far higher output with a much smaller source. The socio-economic benefits of nuclear energy include the creation of more job opportunities (from the construction of the reactor until the management of the structure), and provides a more stable economy because it decreases the dependency on fossil fuels as nuclear energy does not fluctuate with the prices of coal and gas. Operating costs of a nuclear power plant are lower as well which makes it a cheaper option in the long run. Unlike fossil fuel, which is limited, high-cost, and hazardous to the environment, nuclear energy is abundant, cheap, and cleaner making it a better alternative in providing our world's energy demands. As of now, there are over 116 nuclear power plants operating by nuclear fission and we hope that the number will increase significantly in the near future.

Even though the word "nuclear" still has a negative ring to majority of the population, this video aims to educate and raise awareness on the global impacts, particularly, the socio-economic and technical aspect of nuclear energy to the society made possible through the production of radionuclides to change the presumptions of the general public.

Team DIKSHA: Nuclear Technology empowers global development – 743 likes

Nuclear technology is an emerging field leading to the global development of nuclear sciences and applications. Radioisotopes play a very important role and are used in nuclear reactors, particle accelerators for example.

Food irradiation is the process of exposing foodstuffs to ionizing radiation. Ionizing radiation is energy that can be transmitted without direct contact (radiation) capable of freeing electrons from their atomic bonds (ionization) in the targeted food. This treatment is used to preserve food, reduce the risk of food borne illness, prevent the spread of invasive pests, and delay or eliminate sprouting or ripening. Irradiated food does not become radioactive. The radiation can be emitted by a radioactive substance or generated electrically. Irradiation is also used for non-food applications, such as medical devices.

Nuclear medicine is a branch of medical imaging that uses small amounts of radioactive material to diagnose and determine the severity of or treat a variety of diseases, including many types of cancers, heart disease, gastrointestinal, endocrine, neurological disorders and other abnormalities within the body.

Team Hacettepe: Radionuclides and Nuclear Medicine for Global Development – 1496 likes

Radioactive forms of elements are called radionuclides. Some occur naturally in the environment while others are man-made either deliberately or as products of nuclear reactions. All radionuclides commonly administered to patients in nuclear medicine are artificially produced. Most are produced by particle accelerators (mainly cyclotrons), nuclear reactors, radionuclide generators. Radioactive isotopes are useful because they produce alpha, beta and gamma rays. The radiations' penetrating power depends on its energy, particle mass and the object's density. These properties lead to many practical applications in science, medicine and industry. Radioisotopes are used today for a variety of purposes - in science, medicine, industry, agriculture and environment.

When it comes to the field of nuclear medicine, it was developed in the 1950s by physicians with an endocrine emphasis, initially using iodine-131 to diagnose and then treat thyroid disease. In recent years specialists have also come from radiology, as dual CT/PET procedures have become established. Nuclear medicine uses radiation to provide diagnostic information about the functioning of a person's specific organs, or to treat them. Diagnostic procedures using radioisotopes are now routine.

Powerful gamma rays emitted from radioisotopes are used to sterilize syringes and other medical tools Radionuclides are used to hemopoietin forms of tumors. Diagnostic techniques in nuclear medicine use radioactive tracers which emit gamma rays from within the body. These tracers are generally short-lived isotopes linked to chemical compounds which permit specific physiological processes to be scrutinized. They can be given by injection, inhalation or orally. In most cases, the information is used by physicians to make a quick, accurate diagnosis of the patient's illness. Tens of millions of nuclear medicine procedures are performed each year, and demand for radioisotopes is increasing rapidly. Nuclear science and technologies contribute in many ways to the health, development and security in countries worldwide. The effective development of new technologies and their applications, as well as the safe and economical maintenance of existing technologies, rely on a thorough understanding of the underlying nuclear science principles, related physio-chemical processes and nuclear data.

Team Food Irradiation: A plan to end world hunger – 2,702 likes

The production of radioisotopes is very important to nuclear techniques applications. Food irradiation is an example of nuclear technique that uses a radioisotope as a source of radiation. Radionuclides can be created in particle accelerators or nuclear reactors. In general, an element is bombarded with neutrons to become an unstable radionuclide. "By bombarding cobalt 59 with neutrons, in a nuclear reactor, an additional neutron can be captured by the nucleus converting it into cobalt 60. Placing this non-radioactive, Cobalt-59 pellets into a nuclear reactor creates deliberately produced cobalt-60. Over time cobalt-59 absorbs a neutron to become cobalt-60. After removal from the reactor the cobalt-60 is double enclosed in stainless steel sealed sources." (Radioactive Isotopes)

Food irradiation is a process to improve food's quality. "Food irradiation kills bacteria, insects and parasites that can cause food-borne diseases. By doing this, irradiation also: extends the shelf life of food, by destroying the micro-organisms that cause spoilage, and by slowing the ripening process and inhibiting the sprouting of root vegetables such as potatoes and onions; makes food safe to eat by destroying parasites and micro-organisms that cause trichinosis and salmonella poisoning; and ensures that insects are not transported across borders, through quarantine treatments of fruits and vegetables" (CNA, 2015).

In Brazil, 50% of our food production is wasted. About 30%, more than a half is wasted because this food needs to be transported long roads for long hours. Of course, during the transportation, a lot of food is spoiled. Now, imagine there are food irradiators near all centrals of food distribution in Brazil. We could export it. We have potential to feed 19 millions of people.

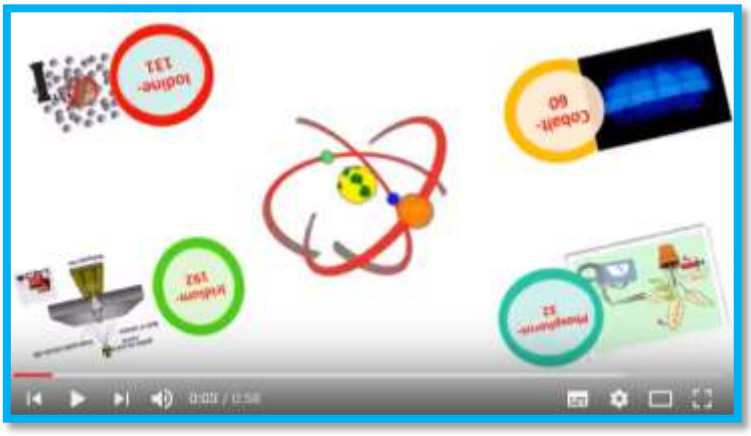
Team PDPU TITANS: Radionuclides for Peaceful Nuclear Applications – 800 likes

TRIGA, MTR and Swimming Pool Type reactors are source of neutrons for Radio isotope production. Radioisotopes can be produced by irradiating some elements inside these reactors. The global radioisotope market was valued at $3.8 billion in 2012, and is poised to reach about $ 5.5 billion by 2017.There are about 1500 radioisotopes of which 60 can be found in nature. Medical radioisotopes accounts for about 80% of the market, mainly for diagnostics.

Radioisotopes have applications in different fields. Like, in food and agriculture Gamma Rays and X-Rays are used for food preservation and Irradiation. Cobalt -60 and Cesium-137 are used as sources for the production of Gamma rays. Gamma Irradiators are used on Industrial scale to irradiate food products, medical sterilization etc. The time of Irradiation is directly proportional to the strength of the gamma source. The stronger the source lesser will be the time required. A low gamma dose of less than 0.15 kGy is used for inhibiting sprouting, insect disinfection and destruction of parasites. A medium dose (1-10 kGy) is used for elimination of spoilage microbes in fresh fruits, meat and poultry and food pathogens in meat and poultry and hygienization of spices and herbs. Above 10 kGy is used for sterilization of food for special requirements and for shelf-stable foods without refrigeration. Food irradiation does not make it radioactive. Various other advantages of food irradiation include sprout inhibition, quarantine fruits, insect disinfection, shelf life extension and hygeinization. In Nuclear Agriculture, nuclear radiation is used to enhance the mutation of various crops. The process of mutation, unlike genetically modified (GM) crops, does not seek to introduce new or different genetic material in crops. It simply enhances their desirable qualities and reduces unwanted characteristics.

Cyclotron or particle accelerators produce proton beams which are used to manufacture radioisotopes used in medical diagnosis. In Medical field sterilization of medical products is done by Irradiation techniques. Technetium-99m emits gamma rays and low energy electrons. Since there is no high-energy beta emission the radiation dose to the patient is low. In cancer therapy Cobalt -60 and Iodine-131 are used for treatment. Myocardial Perfusion Imaging (MPI) uses Thalium-201.Treating leukemia by Bi-213 may involve a bone marrow transplant, in which case the defective bone marrow will first be killed off with a massive dose of radiation before being replaced with healthy bone marrow from a donor. Strontium-89 and samarium 153 are used for the relief of cancer-induced bone pain.

Some radioisotopes are also used as tracers for research in Nuclear agriculture. Phosphorus-32 is injected in plants and trees to study the flow of fertilizers and water. Gamma radiography is used in Non Destructive testing and Inspection of Materials. Decay heat of some radioisotopes can be used to desalinate the sea water and also for hydrogen production in power reactor. This is how Radionuclides helps mankind in all corners of life.



Team SSachin: Radionuclides For Peaceful Nuclear Applications – 709 likes

Different nuclear techniques are used for production of radioisotopes that helps in global development, most of the radioisotopes produced in nuclear reactor or particle accelerator,

In nuclear reactor bombardment of selected targets is far the most common route for radioisotope production, while in accelerator charge particle (alpha, proton, deuteron) bombardment on target material technique is used.

Reactor produced radioisotopes are usually cheaper and easier to obtain on a routine basis as compared to cyclotron produced isotopes, in a nuclear reactor many targets are irradiated while in accelerators only one target can be bombarded at a time and production cost is also high. So, most of the radioisotopes are used produced from nuclear reactors.

The produced radioisotopes having different application in different fields like agriculture, medical, industry, biology but according to global development we mainly focus on agriculture and medical fields. In agriculture radioisotopes are used to improve the quality and productivity of agriculture products , we use different techniques in agriculture like genetic improvement of crop plant in this technique of utilizing radiation energy for inducing mutations in plant cells is now widely used to obtain a desired variation in the quality of products the other most common technique in agriculture is food preservation in which we use ionizing radiation from isotopes like 60-cobalt, 137-cesium used for food preservation, food irradiation technique doesn't affects the texture , taste or any significant chemical changes in food.

The applications of radioisotopes in the field of health care in general and in medicine in specifically have been very extensive. Radiopharmaceuticals are the emerging techniques in which special radiochemical formulation, of adequate purity and pharmaceutical safety, suitable for oral administration to humans for performing diagnostic test.

radioisotope generator of 99moleybdneum to 99m technetium is most common used in bone scanning, brain scanning and many more in this technique a longer lived parent is chemically fixes, which decays to shorter lived daughter and comes into radioactive equilibrium, the daughter nuclide is selectively milked out from the generator making use of the difference in the chemical properties of two elements, therefore repetitive milking is possible. The other most important radioisotope used in medicine for both therapy and diagnosis is 131 iodine which decays by beta emission, 131 iodine labelled compounds should have radioisotopes inherent property to accumulate in specific organs upon systematic administration. 131 iodine in radiopharmaceuticals are labelled with different compound and used in different treatments like thyroid uptake and scan and many more.

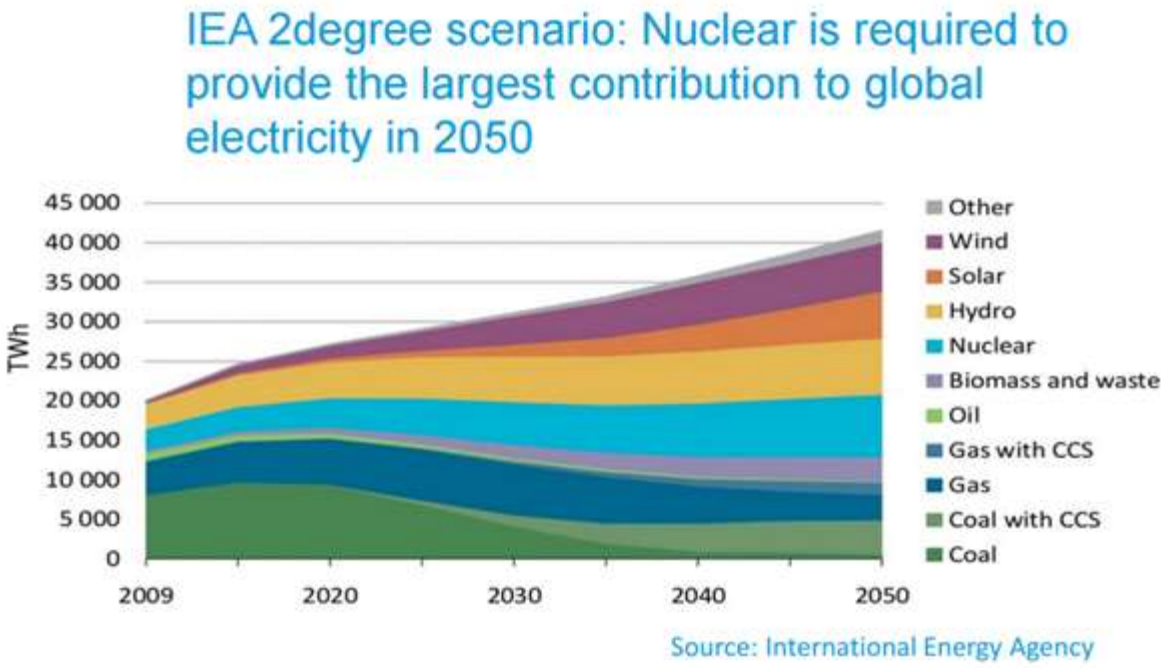
Team “The Alpha and Beta”: Radioisotopes and Nuclear Technology for Global Development - 1,384 likes

Due to the advancements in the technology the uses of radioisotopes play a vital role in the global development. Radioisotopes are being used these days in the field of medicine, industry, agriculture, archaeology, power production etc. In our video, there is a girl Janey who just came from school and saw her father sad. She asks the reason of his sadness. Her father is farmer. This year his crops are attacked by bacteria which cause the spoilage of their crops. The father replied that he is worried about their crops and explains what happened. The girl replies her father that there is no need to worry. She tells her father that today their teacher informed them about the uses of radionuclides in different fields. Her father is surprised, and then she further tells about it. Fathers these day radioisotopes like cobalt-60 and cesium-137 are used to kill bacteria. The crops are irradiated with the emission of these radioisotopes which saves them from spoilage. Her father likes her idea and thinks to try using radionuclides. After some days she visits her father and asks about the crops. Her father is very happy now and he is very thankful to her daughter about the idea. His colleagues’ farmers are also interested in learning about the uses in the field of agriculture. Janey says her father that she will ask from her teacher and he will be happy to teach the uses of radionuclides in the field of agriculture.

As agriculture is the most important pillar for any country’s development so we as guess as the basic pillars are development not only the country will develop but also it will be global development. The other basic pillars are medicine; we are using radionuclides like P-32, Fe-59, Co-60, I-131, Tc-99m etc. in the field of industry it has very wide applications. The most important pillar globally for development is energy. Radioisotopes are used in nuclear power plant for the generation of electricity which is economical and environment friendly. Moreover, these days particle accelerators are essential tools of discovery for particle and nuclear physic and for sciences that use x-rays and neutrons. ..”

5. Essays

The finalists have elaborated 3 effective messages to communicate to decision makers the need to expand nuclear capacity in order to hold global warming below 2°C. This is based on International Energy Agency's (IEA) 2-degree scenario which is aiming to avoid the most damaging consequences of climate change and is requiring a large increase in clean energy.



Team A Bee Girl

Nuclear Energy for Combating Climate Change

Access to energy services is widely considered a key prerequisite for sustainable economic growth. The rise of modern industrial civilization and the associated improvements in the standard of living were fostered in large part by replacing human and animal power with energy. This was the driver of early industrialization and it is still at work in developing countries today. Energy access allows use of technological advancements in industry, attracts additional investments in the economy that stimulate employment, increases effective demand, and promotes social and economic development.

However, the projected progress in providing energy services for the expending population in developing regions and allowing them to industrialize will have a major impact on the environment.

Climate change is one of the most important environmental challenges facing the world today. Many governments around the world have agreed that actio should be taken to achieve large cuts in greenhouse gas (GHG) emissions over the coming decades, and to adapt to the impacts of climate change. They are working towards an international agreement to achieve these goals under the United Nations Framework Convention on Climate Change (UNFCCC). There is a growing scientific consensus that global annual GHA emissions will need to be reduced by at least 50% from today's level by 2050 if the world is to limit the average temperature increase to 2^oC by the end of the century in order to avoid the worst consequences of global warming.

Nuclear power is among the energy sources and technologies available today that could help meet the climate-energy challenge. GHG emissions from nuclear power plants (NPPs) are negligible. Nuclear energy can contribute to resolving other energy supply concerns, and it has non-climatic environmental benefits. Beyond the climate change benefits, significant environmental advantages arise from replacing fossil power sources with NPPs as they emit practically no local and regional air pollutants.

Nuclear power technology has been deveoping continuously over more than 50 years, and the lastest designs for nuclear power plants – generation III plants – incorporate the experience gained over these decades term of safety, fuel performance and efficiency. While further

technological development can be expected, nuclear power is already a mature technology. The barriers to its more rapid deployment are essentially political, social and financial, rather than technical.

Among the power generation technologies, it has one of the lowest external costs – costs in terms of damage to human healt and the environment that are not accounted for in the price of electricity.

Nuclear power is economically competitive. Recent assessment indicate that, accounting for carbon cosr of US \$30/t CO_2 for fossil technologies, the range of levelized cost of electricity (LCOE) from nuclear power (US \$26-64/ megawatt-hour (MW.h)) is below that of coal (US \$65-95/MW.h) and gas (US \$61-133/MW.h) plamnts at 3% discount rate, while coal and nuclear sources largely overlap between US \$75 and \$100/MW.h at a 7% discount rate. LCOE from renewable sources are declining but are still significantly higher. System costs (resulting from investments required to ensure electricity supply at a given load and level of reliability) are low for nuclear power plant at US \$1.40-3.10/MW.h, whereas the grid level system costs of intermittent renewables are higher by a factor of 10-20. This means that the system costs alone of renewables are close to the total levelized costs of gas, coal and nuclear electricity.

Concerns about nuclear energy regarding radiation risk, waste management and proliferation. Radiation risks from normal plant operation remain low, at a level that is virtually indistinguishable from natural and medical sources of public radiation exposure. Concerted efforts by international organizations such as the International Atomic Energy Agency (IAEA) and by operators of nuclear facilities, have made NPPs one of the safest industrial sectors for their workers and for the public at large. Geological and other scientific foundations for the safe disposal of radioactive waste are well established. The first repositories for spent nuclear fuel and high level radioactive waste are expected to start operation within decade. Institutional arrangement are being improved and further technological solution sought to prevent the diversion of nuclear material for non-peaceful purposes.

Conclusions

Global electricity demand is expected to increase strongly over the coming years, even assuming much improved end-use effeciency. Meeting this demand while drastically reducing CO_2

emissions from the electricity sector will be a big challenge. Climate change mitigation is one of the salient reasons for increasingly considering nuclear power in national energy portofolios.

It is important to understand the current and potential constribution of nuclear power in reducing future greenhouse emissions, as well as the approprite measures that governments can take to address outstanding social, institutional and financial issues so as to ensure the necessary expansion of nuclear generating capacity that will make the 2^oC scenario a reality.

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Nurul Asmi Amalia

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Turkey

Employing nuclear energy in the fight against climate change

The rest of nature is at odds with humans, and it is losing. From the original equilibrium of 10 million to a projected 10 billion by the year 2100, nature just can't sustain this sudden escalation in population. We need to alter this trend, and that's where energy comes in. The best birth control in recent history has been access to energy.[1] A ten-fold increase in energy consumption has shown to result in a 3-fold decrease in fertility rates and a 3-fold decrease in unwanted pregnancies.[2]

However, attempting to meet this energy demand by conventional means isn't without its own challenges and side effects. Human activity and greenhouse gas emissions are – with 95% certainty – the dominant cause of current climate change. The warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia.[3]

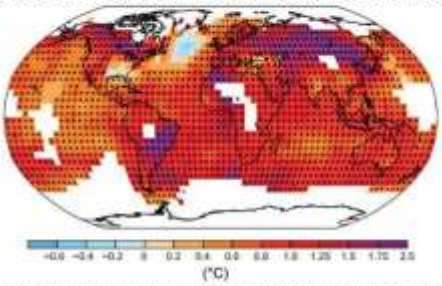


Figure: Map of the observed surface temperature change from 1901 to 2012. Changes need to be made in our energy generation methods in order to limit the increase in global temperature.[3]

The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, sea level has risen, and the concentrations of greenhouse gases have increased.[3]

The 2°C Scenario (2DS) is a climate change mitigation plan that lays out an energy system deployment pathway and an emissions trajectory consistent with at least a 50% chance of limiting the average global temperature increase to 2°C. It reduces CO_2 emissions by almost 60% by 2050, with carbon emissions being projected to decline after 2050 until carbon neutrality is reached.[4] Since 1990, CO_2 emissions, far from decreasing, have actually continued to increase.[5] If the electricity mix continues to be dominated by fossil fuels, the average global rise in temperature will be 6°C,[6] well beyond the objective.

We urge world leaders and decision makers to strongly consider the following messages communicating the urgent need to expand nuclear energy in order to limit the rise in the average temperature of the planet to no more than 2°C.

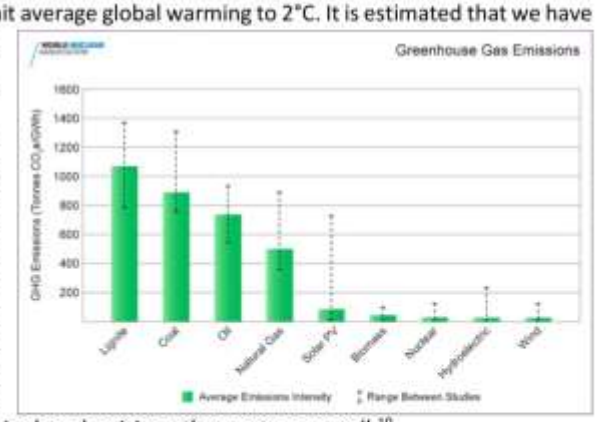
Nuclear energy is:

1. **Clean**
   The world needs to take immediate steps towards reducing greenhouse gas emissions by using all low-carbon energy sources available in order to meet the sustainable development goals and limit climate change.
2. **Reliable**
   Nuclear energy is a time-tested low-carbon option, available today.
3. **Indispensable**
   The contribution of nuclear energy to the total energy generation needs to increase from 11% to 25% by 2050 to ensure IEA 2°C scenario.

[1] James Conca, Forbes: http://goo.gl/PhiCWd
[2] UN Human Development Index: http://goo.gl/ZnqzfA
[3] IPCC, 2013: Summary for Policymakers: http://goo.gl/hhMXa7
[4] IEA Scenarios and projections: http://goo.gl/ThD7Ah
[5] Global Carbon Project: http://goo.gl/WOPzPW
[6] Energy Technology Perspectives 2014, IEA: http://goo.gl/tluekl

CLEAN: The world needs to take immediate steps towards reducing greenhouse gas emissions by using all low-carbon energy sources available in order to meet the sustainable development goals and limit climate change.

A significant part of the CO_2 released remains in the atmosphere for a long time. Once released, it is exchanged between the atmosphere, the ocean and the land. Part of the CO_2 dissolves in the ocean making it more acidic. It is estimated that nearly half of the CO_2 emitted remains in the atmosphere for a century, with about 20 percent remaining for as long as several millennia.[7] According to the "carbon budget", there is a limited amount of cumulative CO_2 emissions[8] that must not be exceeded in the future if we are to keep CO_2 concentration under a certain level and limit average global warming to 2°C. It is estimated that we have already used nearly two-thirds of this amount.



We need to start reducing CO_2 emissions now.

However, the fight against climate change should not jeopardize the development of countries: Today, approximately 1.2 billion[9] people—the equivalent of the population of India or Africa—do not have access to electricity nor to the development benefits that it brings. Increasing electrification will help lift these people out of poverty and improve their quality of life. Low-carbon electricity is also expected to play a major role in decarbonizing other sectors as well.[10]

History tells us that energy transitions take decades to achieve. Progress in the field of energy efficiency, no matter how significant, will not be sufficient to meet rising electricity demand. We need to leverage the full breadth of low-carbon options available today while continuing to develop advanced technologies that can be implemented by 2050. Among low-carbon sources of electricity, nuclear is available for large-scale industrial deployment and has proven effective.[11]

RELIABLE: Nuclear energy is a time-tested low-carbon option, available today

Nuclear energy is one of the few currently available energy options that is effective and can be implemented on a large scale. It can serve as an uninterrupted base load power supply, not subject to climatic conditions or market volatility. It must also be noted that the alternatives to nuclear are far more dangerous – even including the accidents.[12]

With 438 nuclear reactors in operation[13], nuclear energy is available in 30 countries – accounting for greater than two-thirds of the world's population. Nuclear power has demonstrated its effectiveness: Since 1971[14], nuclear power has avoided the equivalent of two years of total global CO_2 emissions at current rates. In Europe, nuclear power avoids annual CO_2 emissions equivalent to those produced every year by all the cars on the roads in Germany, Spain, France, the United Kingdom and Italy.[15]

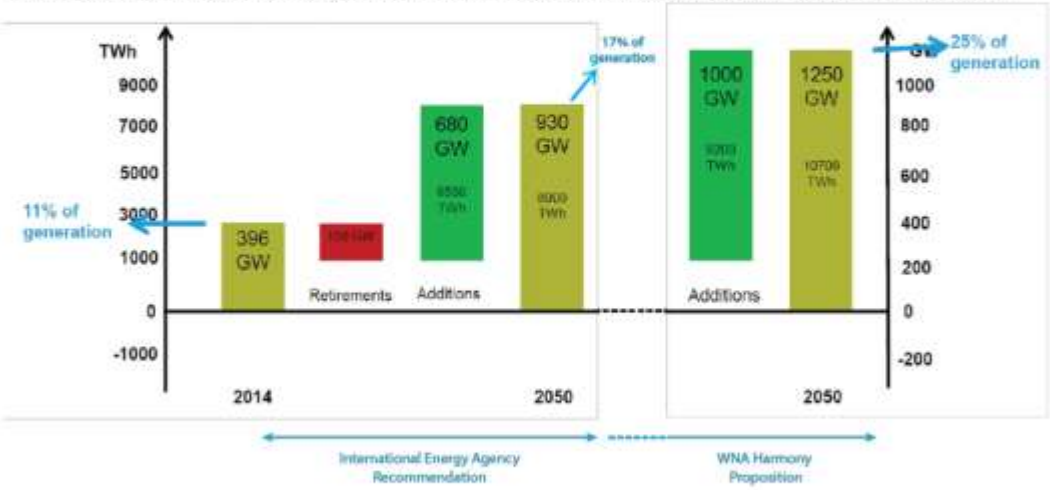
Currently, only six countries meet or exceed the recommendations of the IPCC electricity mix (80 percent of low-carbon electricity). Three of them — Switzerland, Sweden and France— have an electricity portfolio that includes a notable share of nuclear power; nuclear energy accounts for 77 percent of electricity production in France and 40 percent of electricity in Switzerland and Sweden.[11]

Nuclear energy has also been proven effective in how fast it can achieve massive results. As of now, the countries that have managed to decarbonize their electricity supplies the fastest – such as Sweden and France – have done so primarily by increasing the proportion of nuclear energy.

[7] Fifth Assessment Report - IPCC (2013-2015) https://goo.gl/X3bf0m
[8] Carbon Brief according to the IPCC data: https://goo.gl/jVScy
[9] Energy Poverty - IEA http://goo.gl/wdL0AO
[10] Energy Technology Perspectives 2014, IEA http://goo.gl/bcWvDd
[11] World Nuclear Association: http://goo.gl/HTgqfs
[12] World Nuclear Association – https://goo.gl/Xaa8jt
[13] International Status and Prospects for Nuclear Power – IEA (2014) http://goo.gl/8VESjh
[14] World Energy Outlook – IEA (2014) https://goo.gl/MrK5D5
[15] Eurostat - (2014)

INDISPENSABLE: The contribution of nuclear energy to the total energy generation needs to increase from 11% to 25% by 2050 to ensure IEA 2°C scenario.

The IEA recommends that the nuclear generation capacity is increased from 11% of total electricity generation to 17%. However, we must aim to develop a reasonable plan following which we increase the nuclear generation capacity to 25% of total electricity generation, staying safely above the critical level.[16]



In OECD[17] countries, nuclear power plants are the primary source of low-carbon electricity. Investment in these assets needs to continue in order to achieve our climate goals. Operating nuclear power plants longer, where technically feasible, or restarting nuclear plants that have been temporarily shut down, provides immediate additional low-carbon capacity. It prevents progress from stalling or even, as former nuclear capacity may be replaced by fossil fuels, from retreating. It enables countries to further reduce CO_2 emissions by concentrating reduction efforts on the share of fossil fuels.

In China, coal represents 70 percent of total electricity; in India, it is as high as 80 percent. China has the most ambitious nuclear energy growth program with more than 20 reactors under construction.[18] The emerging economies have recognized the role nuclear energy has played in the development of countries, and are now following suit.

According to IAEA,[19] several studies have demonstrated the relationship between nuclear investments and economic growth. Finally, beyond the effects of the creation of a local nuclear industry, nuclear energy has positive implication at the macroeconomic level, through providing reliable, affordable electricity to the whole economy.

The need to expand nuclear capacity has thus been demonstrated

With many nations racing to make nuclear energy completely renewable via Uranium seawater extraction,[20] we can rest assured that nuclear holds a great promise not just now, but even decades after.

[16] World Nuclear Association – The Harmony Program http://goo.gl/UOmQmu
[17] Organization for Economic Cooperation and Development (OECD)
[18] IAEA 2014 http://goo.gl/aYSnM
[19] 28 Climate Change and Nuclear Power – IAEA (2015) https://goo.gl/NOZUQV
[20] James Conca, Forbes - http://goo.gl/jEm2SH

Nuclear Energy for a Sustainable World

By Isabella del Castillo, Camille Francesca Simon, and Jade Dungao, Ph.D.

In the past decade, growing concerns regarding climate change and the availability of clean energy had lead to a resurgence of interest in nuclear power, after the catastrophic Chernobyl incident of 1986 that led to its fall from public favor [1]. The safety of this energy source, however, was once again called into question with the occurrence of the Fukushima Daiichi disaster of 2011. Despite the notoriety of these events, both of which were found to be preventable, they are outliers in a world that has long proven that nuclear energy is a viable resource; nuclear plants provided over ten percent of the world's energy production in 2013 (Figure 1), and as of 2016 a handful of European countries rely on nuclear power to supply over half their energy needs, with France leading at 76.3% of their total electricity being generated from nuclear energy [2].

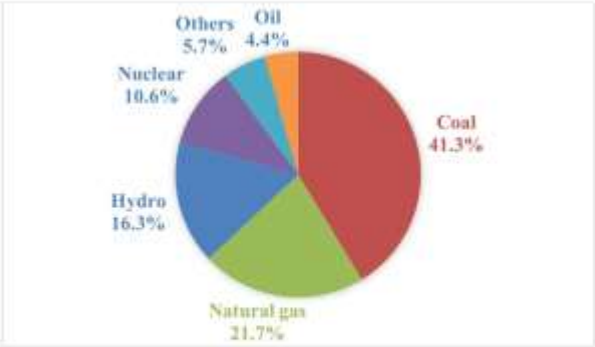


Figure 1. Electricity Generation by Energy Source in 2013 [3]

With these numbers, the continued reluctance to adopt nuclear energy clearly poses a threat to the discovery of adaptive solutions for the betterment of the current state of our environment. It has come to the point where the demand of needs is growing exponentially while supply remains tragically low with 1.2 billion people or 17% of the global population have no access to electricity [4]. While the global adoption of nuclear energy may be a nuanced issue, the complete rejection of nuclear energy despite proof of its sustainability as a resource is irresponsible when considering the state of not only the environment, but also the standard of living of many people worldwide.

In the Philippines, there are an estimated four million people living in slums in Manila alone [5]. The country's informal sector is continually deprived of the essentials for living.

Figure 2. Slums of Manila [6]

Aside from the marked struggle to access basic needs such as food and electricity, the latter being a problem to which nuclear energy may be a direct solution, the lack of access to clean water is also experienced by 16% of Filipino households [7]. 6,000 Filipinos die prematurely every year from water-related illnesses due to the lack of clean water, making the problem a leading killer, especially for those living in poverty. To add insult to injury, Filipino slum-dwellers pay up to ten times more for access to clean water than those from developed cities such as London and New York [8]. The water scarcity is not only experienced in the Philippines but is a global crisis calling for an immediate and persistent action (Table 1).

Table 1. Global Water Crisis [9]

No access to basic sanitation	2.365 billion people
No access to safe and clean drinking water	663 million people
Child deaths from diarrheal disease per year (Under age of 5)	340 thousand children

Technology has advanced enough that there are viable solutions to this problem; one being water desalination, the process of extracting seawater to produce drinkable water [10]. While current practice in water desalination use mainly fossil fuels as an energy source, the use of nuclear energy in the process has great potential due to the sustainable nature of the resource over traditional energy sources. Countries such as India and Japan have already implemented nuclear desalination, showing that the need to expand nuclear capacity is not only bound to its use as a direct energy source, but also as part of a multifaceted solution to the problems facing the environment and improving the quality of human living [11].

An increased adoption of nuclear energy, despite public misgivings about its safety and effectiveness, can only be part of a solution to the growing needs of the human population, as well as to the degradation of the environment worldwide. Expansion of nuclear capacity is unarguably one of the next steps to a sustainable world.

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Increasing Nuclear technology is the best and most efficient way to hold global warming below 2 degree . Decreasing the small contributors will lead making it easy to hold global warming below 2 degree .

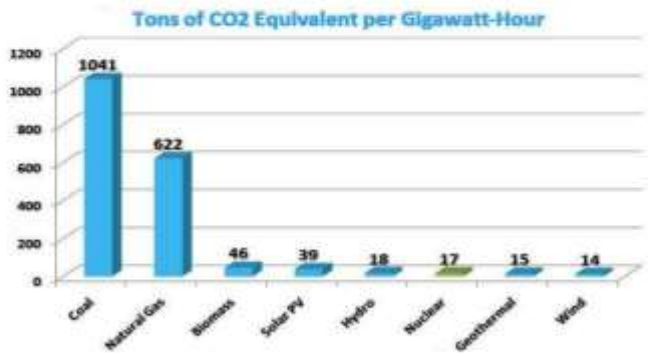
The only question that arises is Why only Nuclear ?Why to expand ? What benefits its holds ?.

There are many suitable answers to this but the one's who hold the most importance and are most efficient are the major reason for expanding the use of nuclear technology to hold global warming below 2 degree

1. No Residue – Technology

In the course of recent decades, inspite of, a progression of studies has raised doubt about these generalizations. Among the astounding conclusions: the waste created by coal plants is entirely radioactive than that produced by their atomic partners. Truth be told, fly ash emitted by a power plant—a by-product from burning coal for electricity —conveys into the encompassing environment 100 times more radiation than an atomic force plant creating the same measure of vitality.

In simple words it doesn't discharge anything into the enviroment giving the best and effective outputs , it doesn't harm enviroment by the toxic discharges from other types of plants .
The world will need enormously expanded vitality supply in the following 20-25 years, particularly neatly produced power. Nuclear power is the most environmentally beneficial way of producing electricity on a large-scale.



This data clearly shows that the most of CO2 emission are made by coal - coal plants , natural gases and others where as nuclear technology is at almost negligible emission . Nuclear energy is not the need of this hour it is the need of our future generation so should be implemented from now onwards . And thus it being a residue less technology its pace should increase to hold global warming below 2 degree .

2. Nuclear power can give more vitality and is exceptionally proficient

In simple terms - An inch long pellet of Uranium-235 has more energy than one tonne of coal. A fission reaction is about a million times more energetic than a chemical reaction such as the burning of coal, oil or gas. One gram of uranium-235 when undergoing fission in a nuclear reactor gives energy roughly equal to burning three tonnes of coal or two tonnes of oil
It is very efficient - In contrast with a customary fossil fuel, such as, coal, atomic fuel creates a great many times more power. For instance 1kg of coal would control a 60 watt light for four days. In examination, atomic would control the same globule for a long time.

Atomic additionally spares billions of huge amounts of CO_2 discharges. Contrasted with coal, the force produced by existing atomic force stations dodges 40 million tons of CO_2 every year – the proportionate to taking part of Britain's autos of the streets. The wellbeing impacts of such a sensational lessening in fossil powers are quantifiable. A late paper reported in WNN said 1.8 million lives have been spared using nuclear power and not an agent blend of coal and gas.

3. Strong Potential

Nuclear fusion would, potentially, solve all of our energy needs. It's a valuable area of research that could guarantee abundant clean energy, so it's worth investing in the technology, continuing to use it and not abandoning it.
We have to use the greater part of the energy sources we have, on the grounds that renewables aren't yet ready to assume control from nuclear power. The contrasting options to atomic are coal and normal gas – including offbeat gas assets – and these future (as time goes on) considerably more dirtying and harming than nuclear .

nuclear fussion would, conceivably, tackle the majority of our energy needs. It's a profitable region of examination that could promise bounteous clean energy , so it merits putting resources into the innovation, keeping on utilizing it and not surrendering it.
It can be used widely ex : Nuclear – Powered Aircrafts/ Ships / Submarines The environmental impact of aviation occurs because aircraft engines emit heat , noise, particulates and gases which give to climate change and global warming.The International Air Transport Association (IATA) has announced the highest demand for air travel in the past five years. The rapid growth of air travel in recent years contributes to an increase in total pollution attributable to aviation. This the strongest result since the post-Global Financial Crisis rebound in 2010, and well above the 10-year average annual growth rate of 5.5%," the airline organization states.

The idea is – to use small reactors to as used in nuclear marine propulsion. To make some reactors which cut the use of fuel in aircrafts and they can go on for years and years .
Though nuclear marine propulsion is going on but it is not being expanded it just first came in view

in 1958 and later many countries are not yet implying it marine propulsion is very benificial in reducing the pollution and fuel consumption and thus reducing the global warming .
Increasing nuclear capacity in agriculture

Setting up of Gamma irradiation plants which will increase the shelf life of food and less and less or pesticides and fertilizers will be used in the ground . Gamma irradiation is a kind of a plant that run the other side of the equation, industrial agriculture -- the practice now employed by the majority of the developed world -- has a hugely negative impact on global warming. The U.S. food system contributes nearly 20 percent of the nation's carbon dioxide emissions; on a global scale, figures from the Intergovernmental Panel on Climate Change (IPCC) say that agricultural land use contributes 12 percent of global greenhouse gas emissions. Supporting industrial agriculture perpetuates these disturbing practices.
Thus, Icreasing the no. Of reactors . Making the most of th electricity from nuclear reactors , using small-scale nuclear reactors in place of coals and fuels for heating is the best way to tackle global warming and hold it below 2 degree secenerio. The U.S. Bureau of Energy says America will require 22 percent more power by 2040—and that implies building many new offices to create electricity Nuclear power will assume a part as the main accessible day in and day out choice for creating a lot of power moderately and dependably without adding to environmental change. With interest for power expanding, Nuclear power is a crucial part of energy security .

Nuclear power is more than only a perfect, solid vitality source. It is an intense financial engine that gives 100,000 people employments and $40 billion to $50 billion every year in power deals and income.

Why Nuclear Energy is not an question anymore . It is an answer. A response to environmental change concerns. A response to energy unwavering quality. Furthermore, an indispensable response for essential needs – moderate power, therapeutic assets, clean nourishment and water

Diksha Sharma
(B.tech +M.tech (Nuclear science and technology))

WNU-IAEA Nuclear Olympiad-2016-Fınal Stage

Elaboration of Nuclear Communication Messages

Team Leader: Gamze Bozkurt

THREE EFFECTIVE MESSAGES:

- Nuclear energy is the likelist recipe to our patient world to stabilize climate effects of global warming and avoid potentially disastrous impacts on today's young people, next generations and nature.
- Despite the nightmare of the twenty-first century global warming; nuclear technology stands out as the biggest weapon with almostly 'zero' carbon dioxide emissions.
- While dollars are spending for fossil fuels to meet the energy needs of the world on the other hand dollars are spending to clean the dirts left to the world by these fuels; replace them let's go nuclear energy for world health and growing economy.

MORE DETAIL ABOUT MESSAGES:

The global response to address climate change is a key policy challenge of the 21st century.Many governments are working towards an international agreement to achieve large cuts in greenhousegas (GHG) and to ensure the necessary financial and technical sport for developing countries.Under of these aims an international agreement United Nations Framework Convention on Climate Change (UNFCCC), which organizes annual Conferences of the Parties (COP). COP21 will be held in Paris on 30 November to 11 December 2015. There is a growing scientific consensus that global annual GHG emissions will need to be reduced by at least 50% from today's level by 2050 if the world is to limit the average temperature increase to 2°C by the end of the century in order to avoid the worst consequences of global warming.

There are essentially only two options to decarbonise an ever increasing electricity sector: nuclear power and renewable energy resources such as wind and solar PV.Of these two options, only nuclear provides firmly dispatchable baseload electricity.Thus nuclear energy is the likelist low-carbon source of electiricity in the worldwide.

Unlike combustion emission of fosil fuels the pocess of nuclear fission does not produce any CO_2 or other Greenhouse gases and thus nuclear power plants do not emit any GHGs directly during operation.However, there are some indirect emissions that cen be attributed to nuclear energy, principally due to the use of fossil baesd energy sources in the various steps of the nuclear fuel cycle.

Also given the long operating live sof nuclear power reactors-60 years for generation III designs- the possible impact of climate change on the operation and safety of these plants needs to be studied and addressed at design and sitting stages to limit costly adaptation measures during operation.

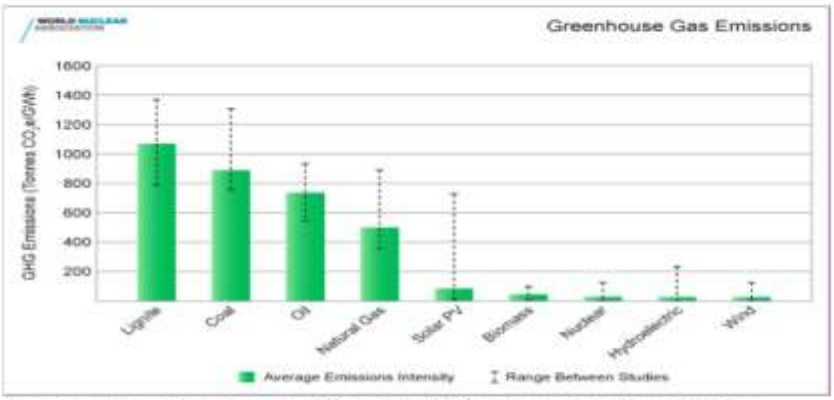


Figure-1 Greenhouse gas emissions for different sources of electiricity

According to data results of Figure-1 generating electiricity from fossil fuels results in GHG emissions far higher than when using nuclear or renewable generation.

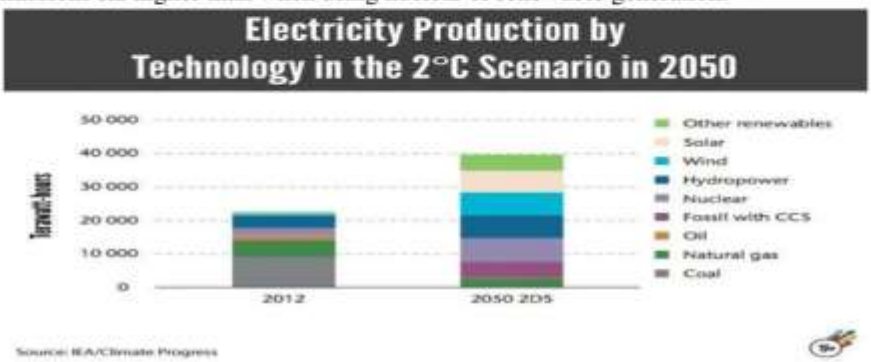


Figure-2 Shares of different technologies in global electiricty production until 2050

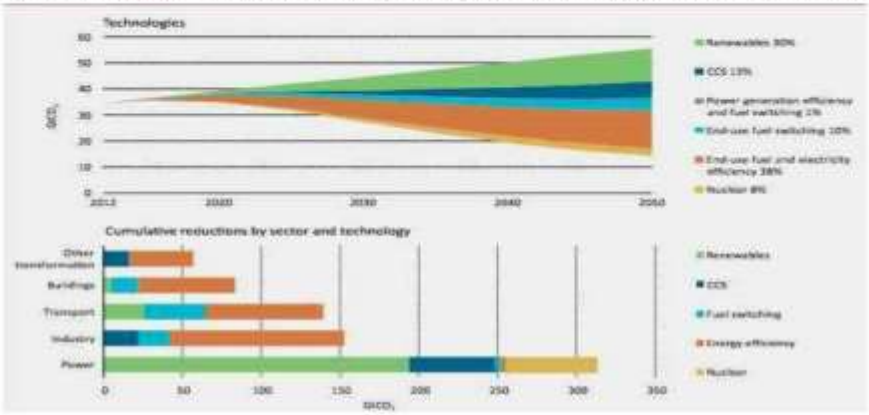


Figure-3 Contribution of technology area and sector to global cumulative CO_2 reductions between 6°C (6DS) scenario and 2°C scenario (2DS).

Above figures shows how the contribution of nuclear power to emission reductions would play out in terms of total global electricity production under the 2DS.Nuclear energy would represent the single most important low-carbon electricity generating technology by 2050.To meet the needs of growing population and to raise the living standards of billions of

people a 75% expansion in global primary energy supply by 2050 will be required.Nuclear energy is the best solution to produce this energy safely and securely, at a reasonable cost and while respecting the environment.

Finally, access the affordable energy is essnetial for reaching any development goals.Producing this energy, while respecting the environment is a global challenge.Nuclear energy promise hope to next generations with some features such as good waste management, safety, security, economic,environmentally friendly manner and future new nuclear technology designs Thus nuclear energy on the front by a long way according to other energy producing methods

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- http://webcache.googleusercontent.com/search?q=cache:http://www.world-nuclear.org/information-library/energy-and-the-environment/climate-change-the-science.aspx&gws_rd=cr&ei=TVSIV-y8IcH9Uv-alMgC
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- http://www.world-nuclear.org/information-library/nuclear-fuel-cycle/nuclear-wastes/radioactive-wastes-myths-and-realities.aspx

Nuclear is part of the solution

We do have to invest in low-carbon energy in order to hold global warming below 2ºC. To convince you, below there will be lots of studies made by reliable institutions, universities, entities and companies supporting this argument. The global demand for energy is rising and to supply it we should increase our offer of energy, as you can see in this graphic

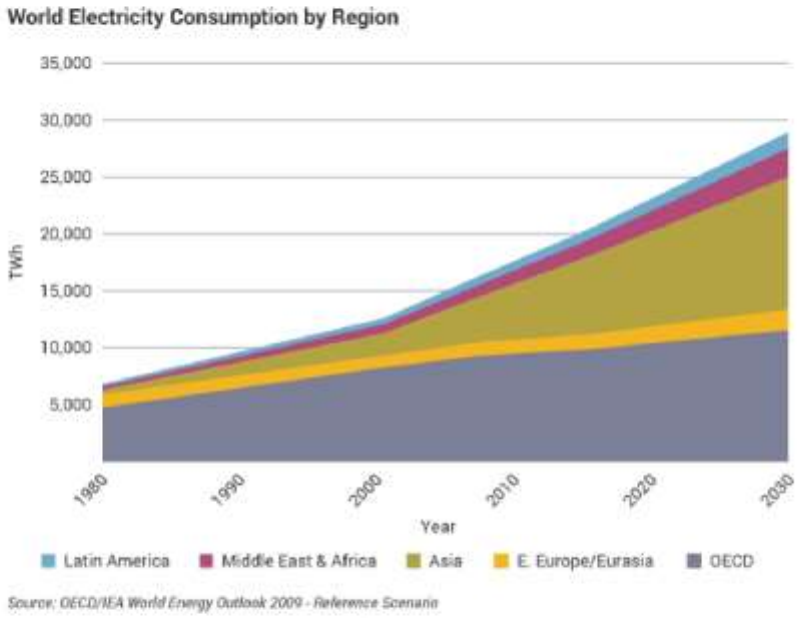


Figure 1

By looking at this graph, you could discover that principally Asia and OECD[1] will need an increase in energy production. Combining the necessity to expand power capacity generation with the problems of climate change, nuclear shows a giant advantage because it produces high quantity of energy and emits less particles then others.

[1] OECD – Organisation for Economic Co-operation and Development. This institute includes a lot of countries in the World, as: Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Luxembourg, México, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States.

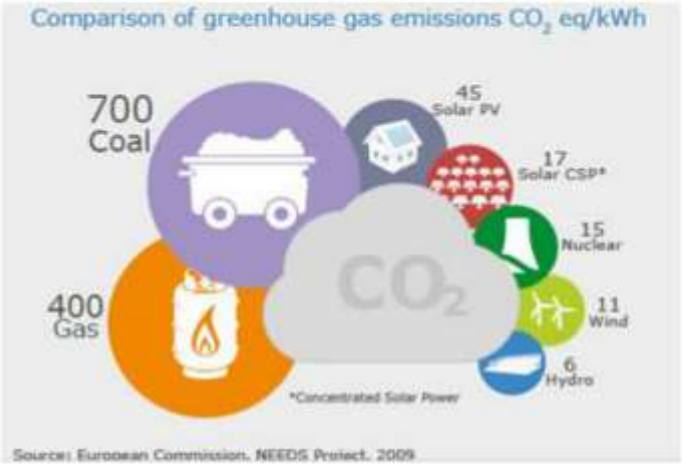


Figure 2

In figure 2, you can see that fossil fuels power plants (coal and gas, in this case) are responsible for a large amount of CO2, which is a greenhouse gas capable of destroying ozone layer and the major contributor to global warming. On the other hand, nuclear appears with a low number of CO2 per kWh, it means that we could classify nuclear as low-carbon energy.

Nuclear energy could be part of the solution, because it is the best low-carbon energy way and it works 24/7 instead of wind and solar which depend on weather conditions. Choosing nuclear is a smart decision. It will reduce the emission of pollutants in the air, mitigating global warming.

Comparing with the renewable sources, nuclear still has lots of advantages. Only wind and hydro emit less carbon per KWh, however hydropower installations bring lots of impacts to population and to the environment near it. Also, wind is so inefficient that it will require a huge area to construct a wind power plant with the same amount of generated energy by nuclear. Nuclear fuel has a big energy density. There are 3 comparisons in figure 3 to illustrate this quantity.

Figure 3

In addition to all these great points referenced before, nuclear is also affordable. According to IEA, nuclear has the least cost per MWh. It follows a comparison between all energy forms in EU below.

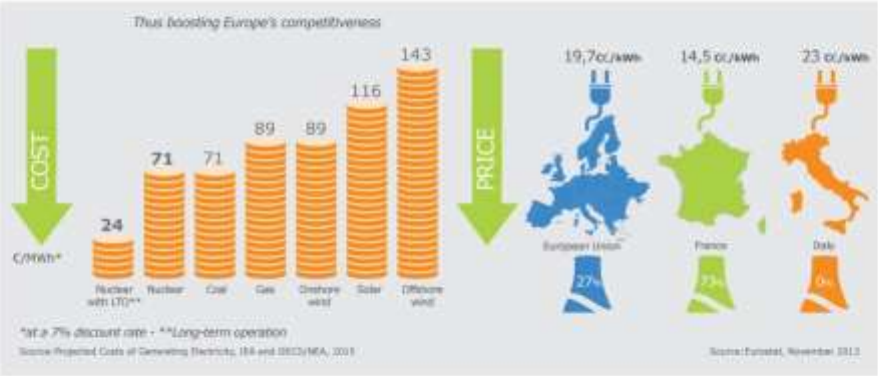


Figure 4

Therefore, nuclear is part of the solution. And to get our goal, we have to act now. Nuclear power is essential to move us to a brighter future with high level of energy efficiency, low-carbon emissions, clean energy generation and climate change holding.

"Nuclear fission energy, an inexhaustible, carbon free option for generating high base–load electricity, producing hydrogen fuel and desalination of seawater while containing global warming below 2 °C."

The biggest global challenge in this century is to meet the ever increasing demand for electricity, vehicular fuel and potable water for a growing world population with high aspiration for a better quality of life, while mitigating CO_2 and other greenhouse gas emission and limiting global temperature rise below 2°C, as per the agreement at the United Nations Forum for Climate Change (UNFCC) at Paris in December 2015.

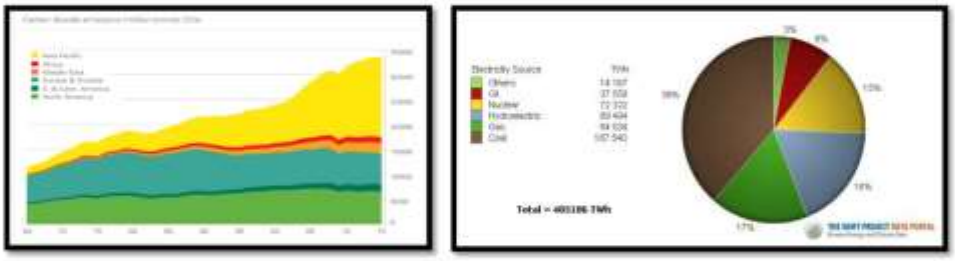


Figure 1: CO_2 emission from different parts of the world during the last 10 years and the breakdown of electricity from different sources of energy. (Reference: http://www.tsp-data-portal.org/)

During the last ten years, the CO_2 emission has progressively increased, in Asia Pacific region as shown in Figure 1, particularly in China and India. The main sources of CO_2 emission are from the electricity and the transportation sectors. Thermal power stations using coal, oil and gas have more than 60 % share in global electricity production (Fig 1) and will continue to dominate the electricity market in coming decades. The use of petrol, kerosene and diesel, the most common fuels for our transportation vehicles is also on the rise because of the increasing number of vehicles particularly in the non-OECD countries. Ironically, these fossil fuels are also the prime source of CO_2 emission and in turn global warming. Thus, it is imperative to focus on Carbon Capture and Storage (CCS) on one hand and to deploy carbon–free energy options, including renewable (hydro, solar, wind etc.) and nuclear in a big way and use hydrogen fuel in transportation sector, to contain global warming and their uncontrollable consequences in climate change. Figure 2 shows the CO_2 emission from carbon–based and carbon–free energy systems. Renewable energy is sustainable and benign to the environment but the plant availability factor of hydro, solar and wind power stations are very low and not attractive from an economic perspective.Nuclear power, based on fission heat energy of fissile isotopes like uranium 235 (U^{235}) and plutonium 239 (Pu^{239}), has emerged during the last sixty years, as a matured technology for generating high base–load electricity with an average plant availability factor greater than 85 % in an economic, reliable and sustainable manner leaving minimum carbon footprint. In addition, the nuclear process heat has the potential to be exploited globally for thermally cracking water for producing hydrogen fuel economically for the transportation sector and also supplying abundant potable water by desalination of sea water employing reverse osmosis and multi flash techniques.

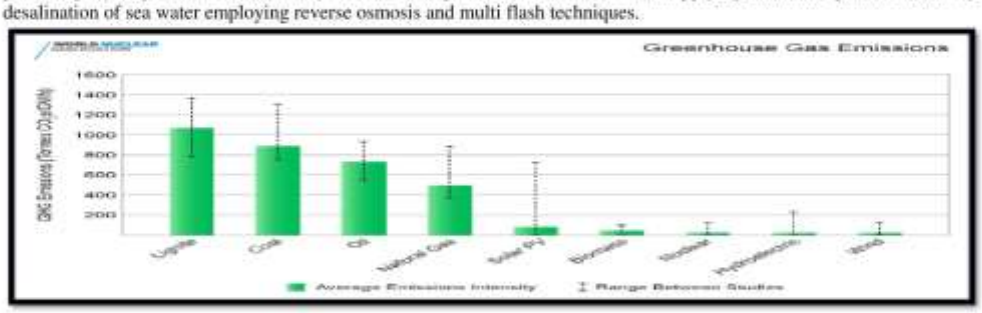


Figure 2: CO_2 emission from fossil, hydro, solar, wind and nuclear power stations. (Reference:http://www.world-nuclear.org/nuclear-basics/greenhouse-gas-emissions-avoided.aspx)

1

Nuclear power for reliable, economic and carbon-free high base-load electricity: According to the IAEA document on nuclear power reactors in the world 2016 edition around 448 nuclear power reactors, with total installed capacity in the range of 387 GWe, are in operation in 31 countries, generating approximately 2.44 million GWh electricity that accounted for 11% of the world's electricity's .USA has 100 operating reactors which is the highest in the world, followed by France with 58 reactors that generated 76 % of their electricity in 2015. Some 63 reactors, with total capacity around 62 GWe, are under construction, mostly in China, Russia and India and the IAEA low and high projections of nuclear power for 2050 are 413 GWe and 1092 GWe respectively. Most of the growth in nuclear power is foreseen in non-OECD countries in Asia and Africa. The present generation of nuclear power reactors are mostly thermal neutron reactors that use U^{235} , the only fissile isotope in nature, as fuel. Light water cooled and moderated reactors (LWRs) account for nearly 85 % of the reactors that are in operation and under construction, followed by pressurized heavy water cooled and moderated reactors (PHWRs) that contribute to some 10 % of the reactors. The LWRs and PHWRs use low enriched uranium containing ≤ 5 % U^{235} and natural uranium (U^{235} ~ 0.7 % + 99.3 % U^{238}) respectively as fuel in the form of UO_2 pellets. The natural uranium resources under the identified, undiscovered and unconventional (rock phosphates and black shales) categories of 7.63 million tons (cost < 260 US$/kg U), 7.6 million tons and some 22 million tons respectively are adequate to meet the fuel requirement of all foreseeable growth scenario of nuclear power reactors operating in once –through "open" fuel cycle for at least 150 years. The water cooled reactors will dominate the nuclear power market in this century but the natural uranium utilization in these thermal reactors is < 1 %. For long term sustainability of nuclear power, the plutonium and minor actinide by-products from thermal reactors should be subjected to multiple recycling in fast breeder reactors (FBRs), and using "closed" fuel cycle. Thus, the natural uranium utilization will be > 60 % and the radio- toxicity and decay heat in high active waste, arising from plutonium and minor actinide isotopes, will be dramatically reduced, facilitating their permanent disposal in deep underground repository. The focus of Generation IV reactor systems and Small Modular Reactors(SMRs), under development, is safety, security, economics and long term sustainability. Out of the 6 reactor systems identified for Generation 4, 4 are fast reactors in order to enhance nuclear share in electricity in a sustainable manner. Simultaneously, accident tolerant fuels (ATFs) are being developed, particularly for LWRs to further augment the safety of these reactors. Thus, progressive increase of the share of nuclear power plants in the energy mix will pave the way to meet the electricity demand, while restricting the global temperature rise below 2° C.

Nuclear Power for production of hydrogen fuel economically for transportation vehicles: Hydrocarbon fueled transportation vehicles come second in the list of the contributors in CO_2 emission and global warming after the thermal power plants. Use of hydrogen fuel cells using proton/polymer emitting membrane(PEM) in transportation vehicles is one of the solution to the problem. Generating hydrogen gas using nuclear power plant is by far the best and the cleanest methods and has several advantages compared to the conventional processes. The high temperature process heat, of 800-850°C, generated from helium-cooled very high temperature gas cooled reactors (VHTR), a Gen IV reactor system, could be utilized for thermal cracking of water, adapting the Iodine–Sulfur process, for production of hydrogen. Alternatively, the high temperature steam electrolysis could be adapted using both electricity and high temperature process heat from VHTR, thereby saving some 35 % electricity compared to conventional electrolysis of water.

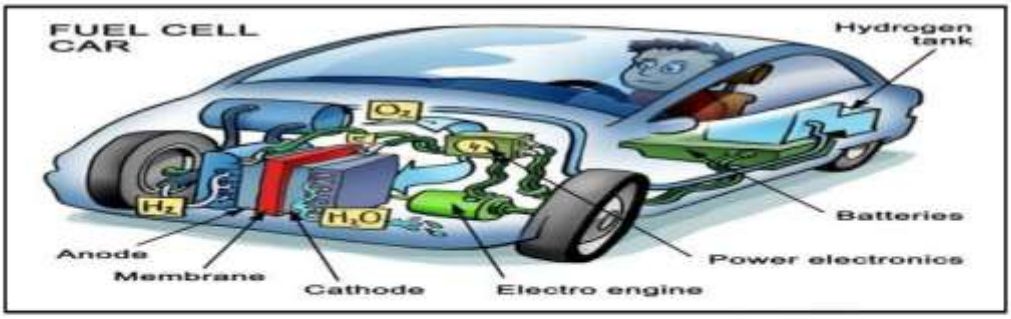


Figure 3: Schematic Diagram for H_2 fuel cell used in Transportation (Reference:www.wikipedia.org)

Nuclear Desalination: Worldwide availability of fresh water for industrial needs and human consumption is limited. Unfortunately,94% of the world's water is saline and only 6% is fresh, and less than 1% of the fresh water is easily accessible (27% being in the glaciers and 72% underground). The need of potable water is becoming a challenge because of the increase in the world's population and depletion of fresh water source. Figure-4, shows the countries which will face "economic water shortages". Desalination is a process in which the salt from the sea water is separated by employing, reverse osmosis, multiflash distillation and their combination. Presently, some portion of the heat energy from thermal power plants working on fossil fuel is diverted for the purpose of desalination. Large desalination plants working with fossil fuels are in operation in Saudi Arabia, Israel and other countries in the middle east and north African regions. These plants are also contributing to CO_2 emission. The prospects of using waste heat from nuclear power plants for large scale desalination of seawater is very attractive since desalination is an energy intensive process. The BN 350 MWe sodium cooled fast breeder reactor at Aktau, Kazakhstan has been the largest nuclear desalination plant built so far. BN 350 operated successfully during 1973 – 1993, provided power of 150 MWe and supplied 120,000 m³ fresh water/day to the city of Aktau. It was decommissioned in the late 1990s.Japan has also demonstrated small-scale nuclear desalination. IAEA studies have shown that small (capacity of less than 10 000 m3 /d), medium (50 000–100 000 m3 /d) and large (greater than 200 000 m3 /d) nuclear desalination plants can offer potable water at a cost that is competitive with fossil fueled plants in the North African coast and other locations with similar conditions.

Figure 4: Regions of the world facing water shortages. (Reference:http://www.fewresources.org/water-scarcity-issues-were-running-out-of-water.html)

The Generation-4 VHTR and water cooled SMRs will provide high enough temperature which will fulfil the requirement of desalination of sea water. Nuclear reactors may be dedicated solely to the production of potable water, or may be used for co-generation of electricity and potable water. Thus by constructing more nuclear reactor worldwide and using their process heat for desalination the challenges of potable water could be resolved, while avoiding greenhouse gas emission.

Concluding remarks: Nuclear fission heat energy is viable, carbon-free and inexhaustible source of primary energy which could be deployed extensively for limiting the global rise in temperature below 2° C. Nuclear power reactors and related fuel cycle technology have attained industrial maturity. With proper deployment of radiological and criticality safety and enhancing nuclear security to prevent clandestine diversion of nuclear materials for non-peaceful purpose, it should be possible to harness nuclear energy for generating high base load electricity in a reliable manner, producing hydrogen fuel for transportation sector and obtaining abundant potable water from the sea for centuries while protecting the environment.

Nuclear energy – A safe alternative to fossil fuel

We have embarked on the beginning of the last days of the age of the fossil fuels. Embrace the future and recognise the growth demand for a wide range of fuels or ignore the reality and slowly-but-surely-be left behind. The age of oil has really exhausted its usefulness, and it has actually become a danger to our lives and our ability to survive on the planet. Clearly, the reserves of fossil fuels are finite and it is a matter of time as to when they run out. Assuming to production to remain constant at 2012 level, the proven global coal reserves will last only for another 109 years, oil for 53 years and natural gas for 56 years. However, as the production is expected to grow, they will be exhausted much earlier. Energy policy will be and should be driven by environmental policy in the future.

Environment impact

Most of the world's electrical power is generated by utilising non-renewable energy resources such as coal or uranium. Both provide environmental challenges that defy easy comparison. Only by examining the total lifetime risks of the coal and uranium used in the energy plants can it be determined which is better for the environment.

Coal fired electric power plants emits massive amounts of greenhouse gases and other harmful pollutants to the atmosphere on a daily basis. Amongst the worst offenders is SO2, which contributes to the formation of acid rain nitrogen oxides which in turn combines with volatile organic compounds to form smog and toxic compounds of mercury that's beyond the tonnage of CO2 emissions

The impacts of greenhouse gases emissions include increase in overall annual average temperature across the globe, melting of sea ice and glaciers, rising sea levels extinction of species accustomed to the cold climate conditions, more frequent and severe extreme weather events increased risk of respiratory and cardiovascular health problems and the increased risk of water, food vector and rodent borne diseases

Just to name a few. Nuclear power plants on the contrary do not emit any such greenhouse gases emissions of nuclear are comparable to those of renewable like wind and solar While a nuclear power plant is completely safe under ideal conditions, the failure of a poorly designed facility in Chernobyl led to the world's largest Eco-disaster. The failure of the Fukushima nuclear power plants following a series of earthquakes and tsunamis demonstrated that the safety levels have to go still higher and even such systems are not risk free. Considering the highest level of safety standards which are already being met by the Indian nuclear power plants and the safety evaluations done post-Fukushima incident proved that beyond any doubt Fukushima like accident is not likely in any of the Indian nuclear power plants and safety measures have been further strengthened since safety has always been a moving target in NPCIL and we have always worked relentlessly to achieve par excellence according safety the highest priority.

Frightening as those episodes may apparently seem, however, the danger of the climate change caused by the greenhouse gas emissions may be more urgent and thus make nuclear a better choice than coal for the environment. If nuclear power never existed, the energy is supplied almost certainly would have been supplied by the fossil fuels instead which cause much higher air pollution related mortality and greenhouse gas emissions per unit energy produced.

Despite three major nuclear accidents the world has witnessed, nuclear power prevented an average of over 1.8 million net deaths worldwide between 1971-2009. This amounts to at

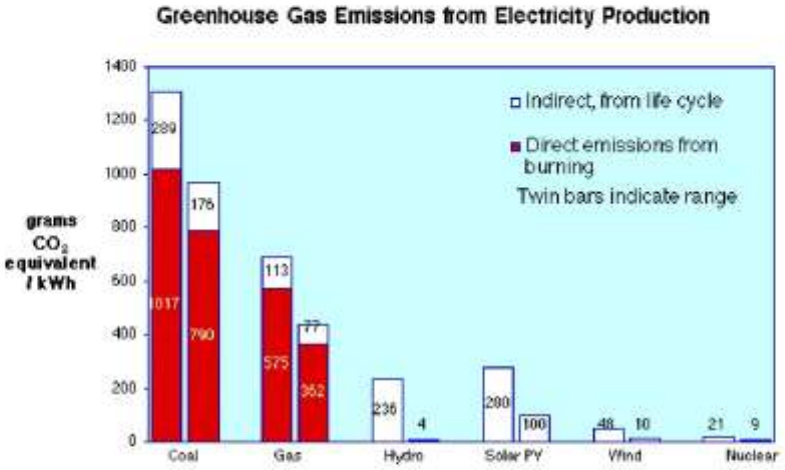
least hundreds and more likely thousands of times more deaths than it caused. An average of 76000 deaths per year were avoided annually between 2000-2009 with a range of 19000-300000 per year. Compare this safety record to coal and petroleum: statistically a lot deadlier. Fatalities in electricity generation on a normalised per TWh basis during 1970-1992 were 342 and 85 with respect to coal and natural gas as against only eight in case of nuclear.
Emissions to the environment have been the principle focus of energy impact studies. Other significant impacts such as land disturbance and population displacement together with their economic and social implications are less emphasised. Major impacts such as depletion of natural resources and large fuel and transport requirements that influence a wide range of areas including occupational and public safety as well as national transport systems are generally ignored.

Energy density comparisons

The extra ordinary high density of nuclear fuel relative to fossil fuel in an advantageous physical characteristic.
1 kg of coal can generate 3 KW-hr of electricity whereas 1 kg uranium can generate 50,000 KW-hr of electricity and up to 3,500,000 KW-hr of electricity with reprocessing.
Consequently, a 1000 MW plant requires 2,600,000 tons of coal whereas only around 30 tons of uranium annually. The numbers are for nuclear fuel which is enriched from natural uranium. For a compassion of raw materials, 1kg of natural uranium will yield the same energy as 20,000 kg of coal.

Waste, storage and disposal

A typical coal burning power plant creates over 3,00,000 tons of waste ash and sludge every year. The residue generates pollutants such as arsenic, cadmium, chromium and Mercury. A typical nuclear power plant generates only 20 metric tons of radioactive waste annually. This material is isolated, transported and stored in remote locations before finally disposing it off. Although the amount of radioactive waste is small, further nuclear power designs and fuel cycles can be modified to even further decrease the quantities generated. Innovative actinide burning reactors might also transmute long lived radioactive elements into short lived elements in future.
The risk of spent fuel storage is utterly negligible compared to the other risks that the society routinely faces in general, and in particular, compared to the risks associated with alternative (fossil) power generation options No credible scenario for a significant release from a dry storage cask exists. Spent fuel pool risks are also quite low since all the heat in the spent fuel pool is from the fuel younger than five years. The fact is that nuclear waste is generated in a minuscule volume, and unlike the waste from fossil plants and other industries, it has always been safely and fully contained, has not been released into the environment and thus has not caused any harm.



Source IAEA Bulletin 42,2; 2000

http://www.world-nuclear.org/information-library/energy-and-the-environment/climate-change-the-science.aspx

Team The Alpha and Beta

WNU NUCLEAR OLYMPIAD 2016

FINAL STAGE

Elaboration of Nuclear Communication Messages

Team Name: The Alpha and Beta

Team Members: Usama SHAHID, Fadime Özge ÖZKAN

1

Three Effective Messages

- **Nuclear energy a necessity towards carbon free environment**
- **Nuclear power a climate game changer**
- **Nuclear the protector of ozone**

Facts about climate change

We are in 21st century that is the era of science and technology, the era of development and the era of progress. Our main focus is still on the energy production; Energy is not only the need of a country but it's a need of a city, community even that of a person such as clean water, electricity, clean air etc.

To fulfill the increasing needs for energy we are using both the renewable as well as non-renewable energy resources. In doing so, we denied to see their after effects till the past twenty years when we really realized the effect of CO_2 emission, global warming and their combined effects on our surroundings.

To prevent the results like, abrupt climate change, global warming etc. we should focus on the major causes of CO_2 emission which is a main cause towards global warming. The vast use of fossil fuel, natural gas and coal in the field of electricity production, industry etc. are the major causes of CO_2 emission.

Table 1 Consumption of several resources according to year [1]

Electricity Production					
Year	**Coal (%)**	**Oil (%)**	**Natural Gas (%)**	**Nuclear (%)**	**Coal+oil+Natural Gas (%)**
2013	41.3	4.4	21.7	10.6	67.4
Final Consumption					
Year	**Coal (%)**	**Oil (%)**	**Natural Gas (%)**	**Nuclear (%)**	**Coal+oil+Natural Gas (%)**
2013	11.5	39.9	15.1	-	66.5

There are some more statistics [1] as of year 2013 as, 78.9% of coal is used in industry, 63.8% of oil is used in transport and 42.3% electricity is used in industry. The numbers speaks for them. The excessive use of coal in industry as well as electricity production is causing an increase in excess amount of CO_2 production in our surroundings.

Table 2 Percentage CO_2 production corresponding to Non-renewable Natural Resources [1]

Non-renewable Natural Resource	**CO_2 production (%)**
Coal	46
Oil	33.6
Natural Gas	19.8

Table 2 indicates that coal and oil are the major sources of production of CO_2.

Now coming to the fact, why to produce energy by nuclear and other renewable sources instead of non-renewable? Let's compare the CO_2 emission to produce 1 kWh of electricity by different technologies, given in the Table 3.

Table 3 g CO_2 per kWh electricity emitted per Technology [3]

Technology	g CO_2 per kWh electricity
Solar power, water power and wind power	10 – 40
Nuclear power plants	90 – 140
Combined heat and power in private houses	220 – 250
Gas burning plants	330 – 360
New coal burning	1000 – 1100

Figure 1 GHG Emissions corresponding to the sources [3]

Table 1, 2, 3 and Fig. 1 indicate that electricity generation by nuclear is one of the options that causes the least CO_2 emission right along with renewable sources. So, for "The IEA 2 ^{0}C Senario", nuclear is the best option.

Fig. 2 shows the electricity comsumption increases while years are passing, thus more energy sources are required.

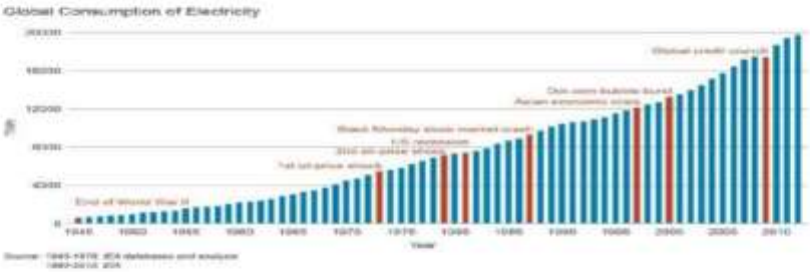


Figure 2 Global consumption of electricity (TWh) vs. year [3]

Nuclear energy reduces CO_2 emissions from the energy sector by more than 8% world-wide and from the electricity sector by about 17%. According to the report published by the IEA, under favor of nuclear power, a major amount of produced greenhouse gases by OECD (The Organization for Economic Co-operation and Development) power plants are lowered over the past 40 years. If nuclear power plants didn't exist, emissions of CO_2 would be one-third higher than they are in our day. This means that an annual saving of about 10% of total CO_2 (1200 million tons of CO_2) emissions is made from energy used

in the OECD. The Kyoto Protocol aimed that annual emissions in OECD countries should be reduced by about 700 million tons of CO_2 by 2008-2012 by reference to 1990 levels. Moreover, if all OECD nuclear plants were decommissioned, this target of Kyoto Protocol wouldn't have even a little chance to become real hence required reduction in CO_2 emission would increase to 1200 million tons annually. [4]

The International Energy Agency and the Nuclear Energy Agency remarked in a report released in January, 2015 that nuclear power generation capacity will need to double by 2050 in order to satisfy the international 2 ^{0}C warming goal for the world. [5]

To keep warming below 2 ^{0}C by reducing CO_2 emissions, the IEA says that global nuclear power generation should be increased to 930 gigawatts from 396 gigawatts by 2050. IEA Executive Director Maria van der Hoeven said in a statement that "Nuclear energy also remains the second-largest source of low-carbon electricity worldwide. This, indeed, if we are to meet our collective climate goals, nuclear energy is critical." Also she added that all forms of low-carbon energy must be employed to reduce global greenhouse gas emissions. [5]

On the other hand, Mycle Schneider a nuclear energy consultant says in his one article "The investment in new reactors leads to an increase in greenhouse gas emissions as other options are not considerably cheaper, they are much faster to implement". [6]

Above all mentioned statistics, figures and data do support the fact that nuclear power is our best choice in making our surroundings environment friendly. Moreover it is a strong candidate for restraining global warming to less than 2 ^{0}C meanwhile satisfying the IEA 2 ^{0}C Scenario (2DS).

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[1] https://www.iea.org/publications/freepublications/publication/KeyWorld_Statistics_2015.pdf

[2] http://timeforchange.org/co2-emission-nuclear-power-stations-electricity

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[4] https://www.oecd-nea.org/ndd/reports/2002/nea3808-kyoto.pdf

[5] http://www.scientificamerican.com/article/nuclear-power-needs-to-double-to-curb-global-warming/

[6] http://www.worldnuclearreport.org/Bulletin-of-the-Atomic-Scientists-US-The-experts-on-nuclear-power-and-climate.html

6. WNU Nuclear Olympiad 2016 – Final results

All World Nuclear University Olympiad finalists proved to be exceptional students who produced outstanding work for the competition. They are all to be congratulated on their efforts and the diversity of the skills required making and promoting a video, research and writing an essay.

The Nuclear Olympiad 2016 was won by Team Amity, with Dhruv Dharamshi as a leader and Jagriti Dhingra, Jeet Sah, Mayank Singh, Sonakshi Singh Pundir as members.

Dhruv Dharamshi at the WNA Symposium 2016 with Agneta Rising DG World Nuclear Association and Patricia Wieland

7. Acknowledgements

The WNU is grateful to the World Nuclear Association for the organization of the final stage of the WNU Nuclear Olympiad at the Symposium on 15 September 2016.

8. Appendix -Terms and conditions

WNU Nuclear Olympiad 2016

Terms and conditions The WNU Nuclear Olympiad 2016, hereafter referred to as the Nuclear Olympiad, is open to undergraduate and graduate students aged 18 to 28 years old from all nationalities.

1. Submissions, video, description, tags, interviews, written essay and oral presentation should be English; however, the video can be in a local language, provided it is subtitled in English.

2. The Nuclear Olympiad is open to individual or group submissions. In the case of group submissions, one team leader must be selected to represent the team in subsequent rounds.

3. The Nuclear Olympiad is not open to WNU secretariat, and staff from collaborating institutions.

First Stage: create and promote a video

4. In the first stage of the Nuclear Olympiad, candidates should:

   a) Create a short video of about sixty seconds on technical, economic or social aspects on the topic "Production of Radionuclides for Global Development".

   b) Upload the video to YouTube, or YouKu in China, with the following steps:

      i. Set the video for public view.

      ii. Create a title for the project that captures the message behind the video, including the word "**nuclear**". Please do not include candidate name and country in the title.

      iii. Write a detailed description of about 500 words explaining the content of the video in the description space on YouTube or YouKu. The following terms should be included: "nuclear sciences and applications", "radioisotopes", "reactors", "particle accelerators" and "WNU Nuclear Olympiad 2016".

   c) Go to www.world-nuclear-university.org and submit the YouTube or YouKu link by **Friday 11 March 2016** with the following information:

      i. Name, e-mail and mobile phone number of the team and members, or individual. If the video is submitted by a team, please nominate the team leader.

      ii. Name, e-mail and recommendation letter of a university professor.

      iii. Country/region.

      iv. URL for YouTube or YouKu video.

      v. Scanned copy of the team leader's university identity card with photo.

5. Evaluation of the first stage:

   a) The videos sent will be analysed by the WNU Coordination Centre according to their adherence to the

topic "Production of Radionuclides for Global Development".

b) The authors of the accepted videos will be contacted by email on **Friday 18 March 2016** and will be asked to confirm their willingness to participate in the next stages by **Wednesday 23 March 2016**. If a candidate is unable to be contacted or does not have all supporting documents, he/she will not be considered for the next stages of the competition.

c) The WNU will post the finalists' videos on the WNU website and social media for the public to 'like' their preferred videos, from **Tuesday 29 March 2016**.

d) The candidates should promote their videos in order to gain as many 'likes' as possible.

e) At 17:00 UTC on **Thursday 19 May 2016**, the WNU will verify the number of 'likes' each video has received on YouTube or YouKu. The number of 'likes' will include all those received since the video was first posted by the author for the purpose of the Nuclear Olympiad. 'Dislikes' will not be taken into account.

f) The authors of the ten videos with the highest number of 'likes' will be eligible for the next stage of the competition. The authors will be contacted by email regarding the results and next stage.

g) The author of the video with the highest number of 'likes' will proceed to the next stage of the competition with a bonus of two points.

h) The author of the video with the second highest number of 'likes' will proceed to the next stage of the competition with a bonus of one point.

Second stage: interview

6. The individual or team leader and professor who provided the reference letter at the first stage of the competition will be contacted by email and asked to submit a 200 word biography with photo before **23 May 2016**. The biography should include their educational background, professional ambitions, hobbies, and how important is to participate in the Nuclear Olympiad.

7. The finalists will be interviewed by telephone or video conference (e.g. WebEx or Skype) about the topic of their video. The date of the interview will be during the week 30 May to 3 June 2016.

8. The interview will check:

a) Knowledge. If candidate demonstrates knowledge on the topic of the video.

b) Communication skills. If candidate expresses thoughts clearly; is able to reply to the questions in a logical way; projects enthusiasm; and is able to respond convincingly.

c) Motivation. If candidate demonstrates an interest in further studies and working in the nuclear area; and shows a strong determination to proceed to the next stage of the Nuclear Olympiad.

9. The candidate may lose one point if she/he fails in any topic of the interview.

Final stage: Elaboration of Nuclear Communication Messages

10. The ten finalists will elaborate 3 (three) effective messages to communicate to decision makers the need to expand nuclear capacity in order to hold global warming below 2°C.

11. The messages will have to be simple, concise and easily understood by non-technical people. The messages will have to be supported by evidence that they are effective (reference data provided, message test with sample population, etc.).

12. All work should be written, and no more than three pages long, including, text, figures, tables and references. The material should be sent to wnu@world-nuclear-university.org by **15 July 2016.**

13. Evaluation of the final stage will be made by a jury, based on the following criteria:

    a) Clarity of the text

    b) Logical organization

    c) Well-developed points that are supported with specific evidence

    d) Creativity

    e) Innovative approach

14. The judges will assign a minimum of zero or a maximum of two points to each of the five criteria. (Maximum points at this stage: 10 points)

15. The participant with the most points will be the **Nuclear Olympiad 2016 winner** (maximum points: 12 points).

16. The participants will be informed about the final results by **5 August 2016.**

17. The individual or team leader and the respective university professor will receive economy return travel and accommodation in London, UK, from **14 to 16 September 2016** (two nights) and participation in the World Nuclear Association Symposium and exhibition, where the 2016 Nuclear Olympiad trophy will be awarded.

Further terms and conditions

18. By applying for the Nuclear Olympiad, all participants agree to be bound by the terms and conditions, as well as to their submissions to the Nuclear Olympiad being used in WNU promotional material.

19. Participants must make sure that they have the right to publish and distribute all the material in their videos, and provide references where appropriate. The WNU accepts no liability for the content or publication of video submissions to the Nuclear Olympiad.

20. The WNU reserves the right to disqualify any participants who do not abide by the rules and regulations, or who are deemed by the competition judges to be acting unfairly. This includes purchasing 'likes' for the video submissions and plagiarism.

21. The WNU and its collaborating organizations accept no liability for entries lost, damaged, or delayed.

22. There is no alternative prize to the Nuclear Olympiad award.

23. The judges' decisions are final.

24. In the event of unforeseen circumstances, the WNU reserve the right to alter or amend the rules and regulations of the Nuclear Olympiad.