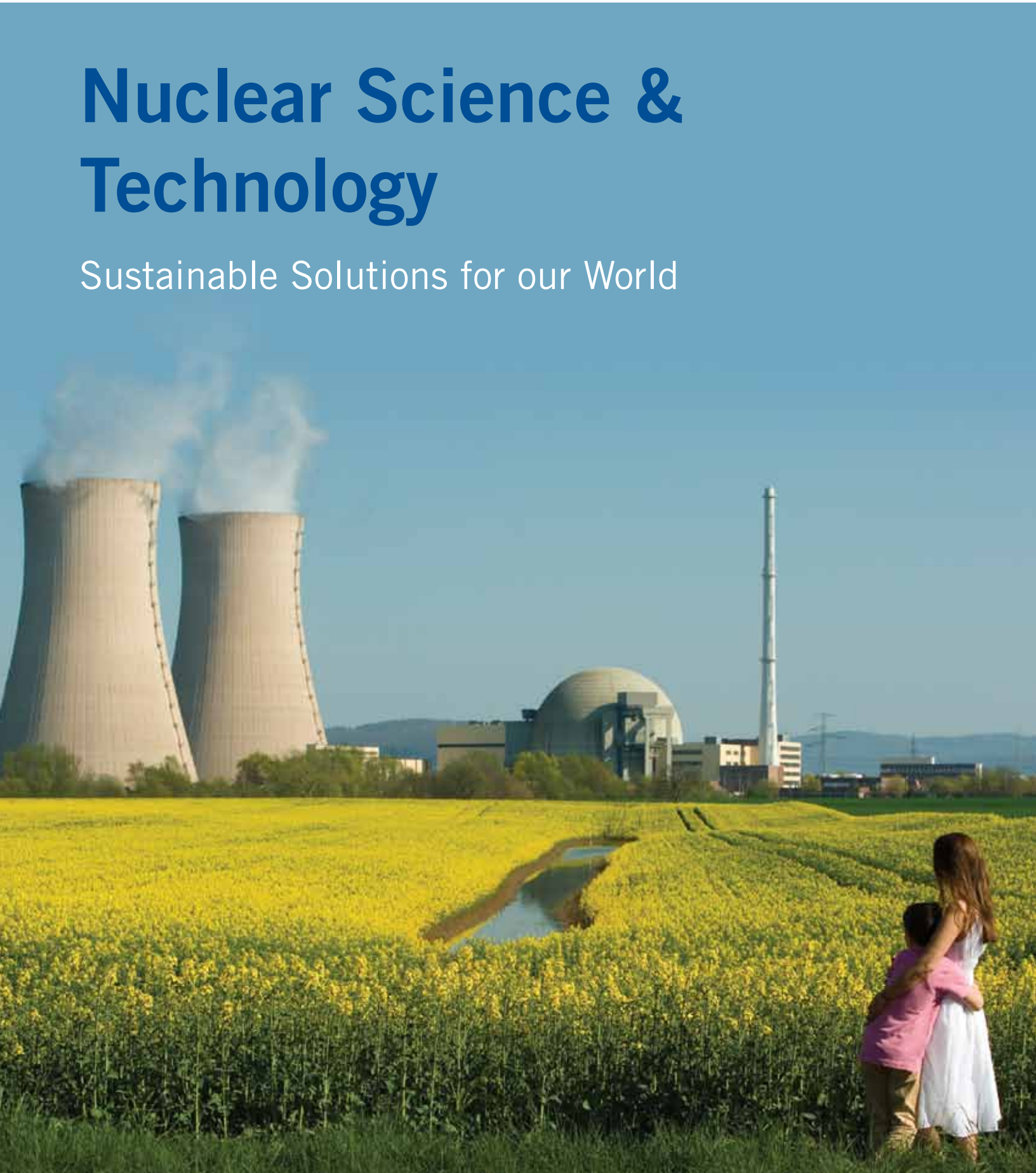
American Nuclear Society

Nuclear Science & Technology

Sustainable Solutions for our World



Nuclear Science and Technology

How many times a day do you use nuclear technology? You may not be splitting atoms or studying Quantum theory, but every morning you wake up in a house with a working smoke detector, pop in your contact lenses and pack a sack lunch—you're using technology made possible by nuclear science!

Today, nuclear science is responsible for many technological advances that we enjoy as part of daily life. Nuclear science and technology promote sustainable development by improving health and the quality of life. This is done through varied applications such as nuclear medicine, food preservation and safety, industrial materials and processes, basic scientific research, environmental studies, and the generation of electrical power with minimal environmental impact.

- **Health and Medicine:** An estimated 16 million nuclear medicine imaging and therapeutic procedures are performed each year in the United States[1]. *Nuclear technology also helps treat cancer, test drugs and to sterilize surgical instruments and medical supplies.*
- **Agriculture and Food Safety:** *One-third to one-half of the food produced in the world is lost due to spoilage and infestation*[2]. Nuclear technologies can prevent much of this loss by delaying spoilage. Food irradiation technology kills illness-causing microorganisms, such as Salmonella, ampylobacter, and E. Coli, which frequently contaminate fresh meat and poultry.
- **Consumer Products:** Nuclear technology is essential to many products that contribute to every-day health and safety, such as smoke-alarms, radial tires and fail-safe lighting sources that require no energy supply. *Every day products such as cosmetics, hair products and contact lens solutions are sterilized with radiation.*
- **Scientific Research:** *Entire areas of research and development in chemistry, metallurgy, genetics, biotechnology, hydrology and many other fields of science and engineering exist because of nuclear technologies.* Radioisotopes are essential to biomedical research on AIDS, cancers and Alzheimer's disease. Deep space exploration would be impossible without small nuclear powered generators. Radionuclides are essential tools for genetic research and determining the structure of DNA. Radioisotopic measurement techniques are the only way for accurately dating many historical and archeological artifacts and geologic formations.
- **Environmental Protection:** *Nuclear technology is not limited to research; it is also used to solve problems while eliminating harmful environmental impacts.* Radioisotope techniques are essential to climatological investigations related to climate change. Radionuclides are helpful in determining plant and sea assimilation of greenhouse gases, and measuring carbon dioxide releases from industrial areas. Radioisotope techniques are used to study the chronology of contaminated river and lake sediments. Rather than using toxic chemicals, solid wastes and sewage can be treated with radiation techniques.

Sustainable Development

When discussing nuclear energy, sustainable development has been a key consideration.

What is sustainable development?

It is seen as development that meets the needs of the present generation without compromising the ability of future generations to meet their needs. This concept is expanded in the stated principles of the Rio Declaration. Human beings are said to be at the center of concerns for sustainable development; they are entitled to a healthy and productive life in harmony with nature. States of the world are seen as having the right, within the principles of international law, to exploit their own resources and the responsibility to ensure that any activities within their jurisdiction do not cause damage to the environment or other States. In addition, the right to development must be fulfilled so as to equitably meet the developmental and environmental needs of present and future generations. Eradication of poverty is seen as a required element of sustainable development.

It is generally held that sustainable development requires attention to:

- Infrastructure such as schools, factories and transportation
- Disease prevention and medical treatment
- Food availability and protection
- Water in adequate quantities
- Sewage treatment
- Steady and abundant supply of energy, especially, electricity

Nuclear technologies contribute significantly to all of these needs. In addition, electricity generated from the use of nuclear power satisfies the economic and environmental protection goals in the Rio Principles.

But, the question remains: *Is nuclear power itself a sustainable energy source?* To answer, we must examine this question, *"Can nuclear power be used to help meet the current energy needs of our society without compromising the ability of future generations to meet their needs?"*

We believe that the answer to both questions is clear and simple – **YES!**

Sustainable Development

Preservation of Fossil Resources

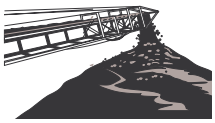
The amount of fuel (mass and volume) required for nuclear power is significantly less than that required for a fossil-fueled plant. *One ton of uranium produces as much energy as 17,000 tons of coal!* Nuclear power plants utilize resources of fissionable heavy metal (uranium), which has no other major use. Using uranium in this way slows the depletion rate of fossil resources, helping to preserve fossil fuel resources to meet future development needs. Lowering the demand and dependence on fossil fuels in developed countries contributes to environmental equity by allowing developing countries to have vital energy supplies at lower cost.

Source Energy Equivalents

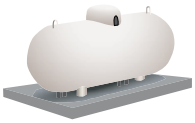
1 Uranium Fuel Pellet, without being reprocessed and recycled, has about as much energy available in today's light water reactor AS...

Uranium Fuel Pellet
(actual size)

3 Barrels of Oil
(42 gal. each)



1 Ton of Coal



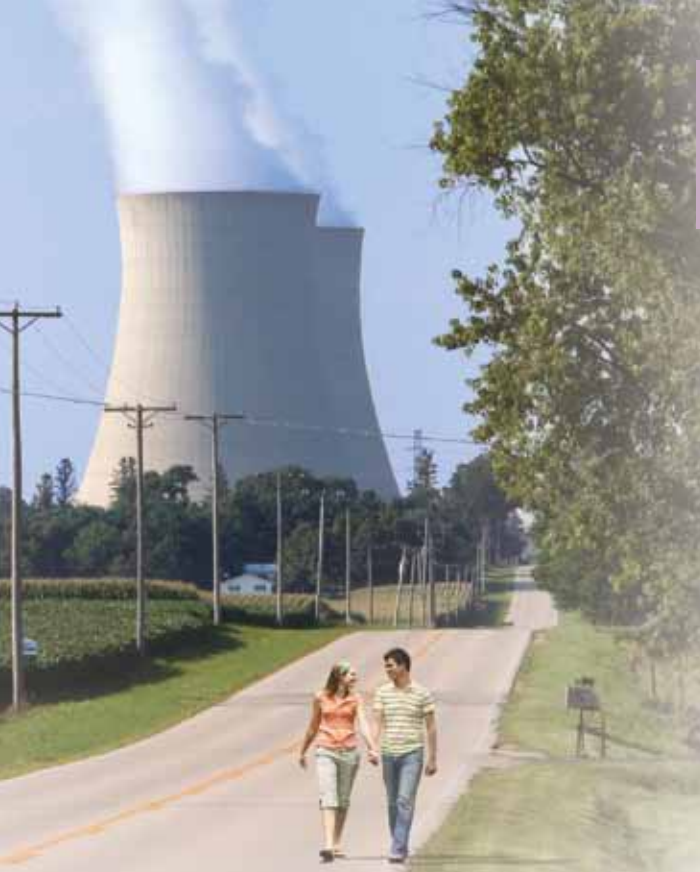
17,000 Cubic Feet of Natural Gas

Long-lasting Reserves

Known fuel resources for nuclear power plants are estimated to provide for 250 years of consumption using current "once through" commercial reactor technology. The technology exists to utilize even more energy from each fuel sample, though it is not yet significantly deployed. *Recycling of uranium and plutonium could extend the fuel supply for thousands of years of consumption*[3]. Uranium is available in relative abundance in politically stable countries. In addition, research on extracting uranium from seawater shows promise of a virtually inexhaustible future supply. These known resources clearly provide for future generations without competing for limited fossil fuel materials or for the air and land required for waste disposal and deployment of extensive decentralized generating systems.

Environmental and Personal Safety

In the U.S., there have been no deaths from radiation in the operation of a commercial nuclear power plant and no significant radiation releases have taken place[4]. By contrast, accidents, injuries, illnesses and deaths related to other energy sources are common. Yet, they receive relatively little attention from the media or the public, especially when compared with even minor events involving radioactive materials. The quantity of fossil fuel required to provide equivalent amounts of energy can release particulates and gases containing radioactive materials that result in greater exposure to radiation than would be the case using nuclear power!



Sustainable Development

Internalized Environmental Costs

For nuclear power, environmental and waste costs are already internalized as a result of stringent regulations. Yet, nuclear power remains competitively priced. Other energy sources do NOT have their environmental costs internalized, as called for in the Rio Declaration.

Waste Disposal

Rather than disperse massive quantities of waste products over wide areas, as is the case with emissions from fossil fuel plants, nuclear power plant operators are able to consolidate the waste and sequester it safely while its radiation level drops. By comparison, some of the waste dispersed into the air from fossil fuel plants is toxic and will remain so forever. The record of the civilian nuclear power industry in safely isolating both low-level and high-level nuclear wastes has been excellent.

Land Use

Compared to other non-carbon-based and carbon-neutral energy options, nuclear power plants require far less land area. A thousand MW solar PV facility will occupy at least 50 square miles and wind power such as that at Altamont Pass in California would require more than 140 square miles. Hoover Dam produces less power that the Palo Verde NP, but Lake Meade requires more than 265 square miles[6]. Projections suggest that in 2050, 70 percent of the world's population will live in large cities[5]. This will require concentrated energy production systems in proximity to those population masses making the use of large land areas for energy production impractical.

Technology Transfer

Transfer of technology to developing countries has made a major contribution to energy production in developing countries. This ongoing technology transfer continues to build technical capacities to manage nuclear material and the ability to regulate, oversee, and ensure its safety. As a result, the foundation is being built in the developing world for additional use of nuclear energy and for promoting the beneficial uses of nuclear science and technology in many segments of society.

The FUTURE!

All segments of the steadily growing world population have rising aspirations for better economic conditions and a higher standard of living. Both the growing population and rising aspirations have helped fuel an already burgeoning demand for energy worldwide. Most of that energy has been and is still being derived from fossil fuels. Current estimates suggest that demand for electricity will double between 2000 and 2030[7].

Nuclear power already contributes 17% of the world's electricity without producing greenhouse gases (GHG). The increased demand for energy and the increased use of fossil fuels, however, have run headlong into obstacles.

Problems Encountered by Carbon-based Energy

Concerns about constantly rising levels of Greenhouse Gases and their potential for serious negative impact on the world's climate led to development of the United Nations Framework Convention on Climate Change (UNFCCC). During the 1997 Kyoto conference of those States involved in UNFCCC, targets were established for GHG emission reductions. As a result, industrialized nations (labeled Annex I) were called upon to reduce their GHG emissions below 1990 levels by 2012. Discussions about the methods allowed for achieving the required reductions have included procedures for trading emission "credits," rules on Clean Development Mechanisms, and other approaches to encourage an increase in the use of energy technologies that minimize GHG emissions. Today, many Annex I countries have taken strong action to reduce GHGs, and most have already succeeded with the help of nuclear power[8].

Greenhouse Gases and UNFCCC

Using nuclear power helps move nations toward compliance with their commitments under the UNFCCC. Nuclear power plants do not produce GHG, and have actually helped several nations to reduce their GHG emissions significantly[8]. Moreover, it is possible for nations with greater utilization of nuclear power to meet the demand for increased energy, while still reducing emissions of GHG.

Wind, Solar and Biomass. Wind, solar and biomass (WSB) energy sources have the advantage of being inexhaustible, but make large environmental demands with regard to land use, and are subject to severe daily, seasonal and random fluctuations in availability. Waste issues have not been addressed for WSB energy because there has been no extensive deployment over a sufficient period to assess long-term problems or impacts on environment.

Nuclear. Nuclear power is most economical when run at a constant rate. It is not well suited for meeting peak-load demands, but would be well suited for supplying the primary energy source for a hydrogen economy. Larger overall demand would permit the reduced unit cost associated with larger base-load capacity.

The Future. In the very long term future, it is possible that an energy economy based on production of primary nuclear energy coupled with hydrogen technology can be developed. A more likely interim solution would involve natural gas replacing coal as nuclear builds to fill a much larger role than at present. It is expected that WSB, fossil fuel energy sources and fission-based nuclear energy including small modular reactors (SMRs) will all help provide a bridge to a sustainable future energy supply.[9] For now, however, fission-based nuclear power is 40 years ahead of WSB energy supply. The results of a Breakthrough study show that the switch from previous energy sources to zero-carbon emitting nuclear power accounted for a full half of the total emissions reductions, or 28.1 billion tons over the 60-year period (1950-2010). The switch from previous sources to natural gas has had a similar impact, 25.9 billion tons. Switching to geothermal, wind, and solar has had a much more modest impact, about 1.5 billion tons over the entire period. Other cleaner energy fuel-switching over the 60-year period – which includes changes in the shares of petroleum, liquid biofuels, and hydro – accounts for a 3.4 billion ton reduction[10].

Nuclear power must remain as an essential part of the mix of energy sources if we are to continue with sustainable development for the 21st century and beyond.

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RIO +20 Callout

20 years after the landmark 1992 Earth Summit, world leaders along with thousands of participants from the private sector, non government organizations and other groups, came together to shape how we can reduce poverty, advance social equity and ensure environmental protection on an ever more crowded planet. The conference focused on how to build a green economy to achieve sustainable development, lift people out of poverty and how to improve international coordination for sustainable development.

Main concerns of Rio 20 that NS&T can address:

The world now has 7 billion people — by 2050, there will be 9 billion.

A billion and a half people in the world do not have access to electricity. As a key player in the energy mix, nuclear power can meet this demand without depleting fossil fuels. Nuclear power plants provide an energy source that is sustainable. In the future, advanced fuel cycle technologies will enable more efficient use of nuclear fuels so that nuclear power will be a renewable resource with an essentially inexhaustible fuel supply.

Almost a billion people go hungry every day – One-third to one-half of the food produced in the world is lost due to spoilage and infestation. Nuclear technologies can prevent much of this loss by delaying spoilage.

Greenhouse gas emissions continue to rise, and more than a third of all known species could go extinct if climate change continues unchecked. Nuclear Power generation produces no greenhouse gas emissions and life-cycle emissions are low. Broadening the use of nuclear energy can significantly lower carbon emissions as well as indoor and outdoor pollution, while promoting economic growth.

Achieving development that meets the needs and aspirations of the present generation without compromising the ability of future generations to meet their own needs is a challenging task. Since the inception of cooperative international efforts over four decades ago, nuclear science and technology, including nuclear power, have effectively applied the Rio Principles and contributed to sustainable development in many parts of the world. This vital technology must continue to be available as all nations strive for a healthy and productive life in harmony with nature.

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