



Our World Needs Nuclear Energy

Crucial Truths for a Sustainable Future

- 1.** Nuclear power is essential to meeting the challenge of our world's critically rising demand for clean energy.
- 2.** Nuclear reactors emit no greenhouse gases. Averting the planetary danger of radical climate change will require increased use of nuclear energy and other non-polluting, sustainable energy sources.
- 3.** Waste from fossil fuel energy takes the form of huge volumes of atmospheric emissions. In contrast, nuclear wastes consist of small amounts of manageable materials that can be securely isolated and lose their hazard with time.
- 4.** The nuclear power industry has created a cooperative worldwide network committed to excellence in safety, and has achieved a superb safety record during 12,000 reactor-years of experience.
- 5.** Transportation of nuclear materials - notably new fuel, used fuel and waste - has never, in four decades, led to a harmful escape of radioactivity.
- 6.** Nuclear power plants are robust, secure, and rank among the best-protected industrial facilities in the world.
- 7.** Generating electricity with nuclear energy does not increase the risk of nuclear weapons proliferation. United Nations-mandated international safeguards can detect any attempt to divert civil nuclear facilities or fuel to military use.
- 8.** Nuclear-generated electricity is cost-competitive and helps to ensure long-term reliability and security of energy supply.
- 9.** Nuclear energy technology is diversifying to support a sustainable future. Reactors can now be used for desalination to meet the world's growing shortage of clean water, and new reactors are expected to produce hydrogen and battery power for clean-energy cars.
- 10.** Public opinion is more favourable to nuclear energy than is commonly assumed in the public debate, and this support is growing. Increasingly, governments and citizens everywhere are recognizing nuclear energy's contribution to the environment and to a secure and affordable energy supply.

1. Nuclear power is essential to meeting the challenge of our world's critically rising demand for clean energy.

- By 2050, world energy consumption will double and demand for electricity will treble. We must use energy more efficiently, and we need renewable technologies like wind and solar power. But these measures alone cannot satisfy the enormous future expansion in energy consumption, much of it in the developing world.
- Nuclear energy is the only energy technology that does not emit greenhouse gases and is also capable of major expansion to supply reliable electricity on a large scale. Raw materials pose no constraint, as prospects are excellent for uranium supplies, and used reactor fuel can be further

2. Nuclear reactors emit no greenhouse gases. Averting the planetary danger of radical climate change will require increased use of nuclear energy and other non-polluting, sustainable energy sources.

- Fossil fuels (coal, oil and gas) - whether used for electricity or to power vehicles - emit CO₂ and are the major contributor to global warming. In contrast, the entire nuclear energy fuel cycle produces virtually no emissions of CO₂ or any other greenhouse gas.
- Climate experts warn that we must cut worldwide CO₂ emissions sharply - from 25 billion tonnes annually to 10 billion - even as global energy production increases.

3. Waste from fossil fuel energy takes the form of huge volumes of atmospheric emissions. In contrast, nuclear wastes consist of small amounts of manageable materials that can be securely isolated and lose their hazard with time.

- Radioactive wastes are secured so as to prevent them from being stolen or contaminating their surroundings. Used fuel is safely stored at reactor sites or reprocessing plants.
- When not reprocessed, used fuel is sealed in corrosion-resistant containers and placed in deep, stable rock formations under careful monitoring. Scientists regard this technique as extremely safe, and these permanent repositories will be supervised for as long as necessary to ensure their continuing safety.
- High-level wastes are stored either as insoluble ceramics (used fuel) or immobilised as stable glass compounds (waste from reprocessing of used fuel). For the safe long-term disposal of high-level wastes, the USA, Finland and Sweden, among others, are well advanced in engineering deep geological repositories.

recycled. The next generation of nuclear reactors will use this recycled material and thereby prolong supplies of nuclear fuel by more than 60 times.

- One-third of the world's people have no access to electricity, and another third have only limited access. As developing countries strive to meet these energy needs, the result could be a dangerously large increase in global emissions of carbon dioxide (CO₂) - the main greenhouse gas.
- Many countries have a strong commitment to nuclear energy. Among them, China, India, the USA, France, Russia, Japan and South Korea represent half the world's population. At present, about 450 power reactors in 30 countries provide 16% of the world's electricity. Hundreds of more reactors are in planning or under construction.

- Today's nuclear reactors (as an alternative to coal-generated electricity) are already preventing emissions of 2.5 billion tonnes per year of CO₂. To gain the same saving would require eliminating half the world's motor vehicles. Expanded use of nuclear energy could do even more.

- Nuclear energy also avoids air and surface pollution. Reactors emit neither the smoke that causes smog and respiratory problems nor the gases responsible for the acid rain that kills forests and lakes.

- When evaluated for life-cycle ecological impact - weighing resource use, health effects and consequences of waste - nuclear energy ranks above all other major power options and is on a par with the best renewables.

- More than 100 commercial power reactors have been retired from operation to enter a phase of decommissioning. Nine of these sites are now fully cleared of nuclear materials.

- All nuclear energy-producing countries take full responsibility for safely managing the radioactive wastes produced by their nuclear operations.

- In countries using nuclear energy, radioactive wastes amount to less than 1% of the total national toxic industrial wastes. Whereas those other wastes remain permanently hazardous, radioactive wastes decay steadily and become less and less hazardous.

- The nuclear industry is committed to open and transparent decision-making and to building consensus on waste management with extensive public consultation. Recent experience in several countries shows that public acceptance of sound nuclear waste management techniques can be achieved in a democratic way.



4. The nuclear power industry has created a cooperative worldwide network committed to excellence in safety, and has achieved a superb safety record during 12,000 reactor-years of experience.

◆ The 1986 disaster at Chernobyl in Ukraine - the only reactor accident to cause fatalities - severely tarnished the image of nuclear energy. The reactor type involved was unique to the Soviet Union and lacked key accident prevention systems, most importantly, any containment structure to prevent a radioactive release. Such a reactor would not be licensed anywhere in the world today.

◆ Chernobyl spurred the creation of the World Association of Nuclear Operators. In the WANO network - which includes every commercial reactor worldwide - utility owners cooperate to promote best-practice standards as part of a global nuclear safety culture.

◆ Today's nuclear reactors use a "defence in depth" strategy - comprising multiple layers of robust physical protection and backup safety systems - to prevent any release of radioactivity even under worst-case conditions.

◆ Under no circumstances can a commercial power reactor explode like a nuclear bomb.

◆ The record over 50 years shows that commercial nuclear power is much safer than fossil-fuel systems. This safety superiority applies, first, to human risk during fuel production - as fatal accidents occur frequently in coal-mine explosions and gas-pipeline fires. It applies also to the health and environmental damage caused by emissions from the use of fossil fuels.

◆ Uranium is a natural element, and natural radioactivity is constantly around us. Risks associated with radioactivity are well understood and protection from it is a simple and well mastered practice. Radioactivity releases from the normal use of nuclear technology are negligible compared with natural radioactivity, and are constrained by regulatory limits and by adherence to the "As Low As Reasonably Achievable" principle.

◆ Rigorous national and international regulatory regimes guard the safety of nuclear workers, the public and the environment. Each nuclear power plant must give first priority to safety measures and emergency-response plans to protect the public from exposure to radioactivity.

5. Transportation of nuclear materials - notably new fuel, used fuel and waste - has never, in four decades, led to a harmful escape of radioactivity.

◆ Because vast amounts of energy come from small amounts of uranium fuel, nuclear energy entails minimal transportation. In contrast, fossil-fuel shipments are a major burden on the world transport system and threaten the global environment.

◆ Strict national and international regulations require that transport of nuclear materials be performed using robustly engineered containers built to withstand any shock or tampering.

◆ Nuclear materials have been moved safely by road, rail and sea - in more than 20,000 shipments. Together these shipments have totalled over 50,000 tonnes, travelling across some 30 million kilometres.

6. Nuclear power plants are robust, secure, and rank among the best-protected industrial facilities in the world.

◆ Nuclear power plants are designed to pose no hazard to local populations in the event of a major earthquake or other catastrophic event. Their steel and reinforced concrete containment walls, together with other

massive internal structures, minimise any possibility of radiation escape.

◆ This structural integrity would almost certainly hold true even if a plane were deliberately crashed into a plant as part of a terrorist attack. After 11 September 2001, nuclear operators and government authorities worldwide reviewed and upgraded all aspects of security.

7. Generating electricity with nuclear energy does not increase the risk of nuclear weapons proliferation. United Nations-mandated international safeguards can detect any attempt to divert civil nuclear facilities or fuel to military use.

◆ Nuclear fuel for electricity-generating reactors - usually low-enriched uranium - cannot be used to make a nuclear weapon. The plutonium that develops in used fuel falls well short of being satisfactory for weapons. No such material has ever been diverted from civilian to military use.

◆ The discovery of a secret nuclear weapons effort in Iraq in the early 1990s showed a deficiency in global vigilance against such activities. Today the United Nations' International Atomic Energy Agency (IAEA) has been equipped with greater technical capabilities and investigative powers to uncover illegitimate nuclear programmes.

◆ Nuclear power plants actually help eliminate warheads in military programmes by burning the fissile material in electricity-generating reactors. Today, nuclear power produces 20% of U.S. electricity, and half of this nuclear fuel comes from dismantled Russian and U.S. warheads.



8. Nuclear-generated electricity is cost-competitive and helps to ensure long-term reliability and security of energy supply.

- Nuclear fuel is small in volume, relatively inexpensive, and can be easily stored for years before being burned in a reactor, thus providing energy reliability and security - with consequent benefits for economic stability and growth.
- In most countries where it is used, electricity generated by nuclear plants is the lowest-cost alternative available in the marketplace.
- Once built, a nuclear power plant operates with great economy. Fuel costs are stable and represent a low proportion of operating expense.
- The efficiency of nuclear reactors has improved steadily through advances in technologies and professional management. In 1980, U.S. plants used only 54% of total potential capacity. Today U.S. reactors operate at about 90% of potential capacity, as do most European reactors.

9. Nuclear energy technology is diversifying to support a sustainable future. Reactors can now be used for desalination to meet the world's growing shortage of clean water, and new reactors are expected to produce hydrogen and battery power for clean-energy cars.

- Several new reactor designs use physical principles to ensure "passive" safety. This means that even with a worst-case malfunction and no operator involvement, the reactor would cool itself. New designs are also reducing fuel use, construction costs and operational expense while

10. Public opinion is more favourable to nuclear energy than is commonly assumed in the public debate, and this support is growing. Increasingly, governments and citizens everywhere are recognizing nuclear energy's contribution to the environment and to a secure and affordable energy supply.

- In environmentally conscious Sweden, 78% of citizens want to keep or expand nuclear power. Similarly, Swiss citizens, voting on major anti-nuclear initiatives in 2003, chose to keep their reactors.
- U.S. public support for nuclear energy has now reached record highs: 70% of the public favours nuclear energy, and positive views of nuclear safety and of nuclear power's role in strengthening energy security are also at high levels.
- Recent public opinion polls in Canada show significant support for nuclear power, with 72% in favour of refurbishing old plants and a majority supporting new build.

● Nuclear power does not depend on subsidies to be economically sustainable.

● Nuclear is the only energy industry to take full responsibility for all its wastes and to fully meet these costs in product price. Nuclear energy's economic advantage would be even greater if all energy sources were subjected to equitable taxes and penalties for the environmental and health costs of pollution, injuries, spill damage and environmental clean-up.

● Nuclear electricity has been in use for more than 50 years and now provides much of the industrial world's "base-load" power. In the European Union, nuclear energy is the largest single source of power generation, producing 32% of the total. In Japan the nuclear share of electricity averages 30% and in South Korea is 37%. The proportion is 78% in France, where most of the nuclear reactors were built within a single decade.

improving reliability and proliferation resistance. These advances are continuing.

● As hydrogen does not exist naturally in a usable form, the environmental gain from using hydrogen fuel cells for transport depends on the ability to produce hydrogen cleanly. Only nuclear energy can do this on a large scale. In the USA, a hydrogen-fuelled transport system would need 230,000 tonnes of hydrogen a day. Future reactors operating at very high temperatures could produce such volumes efficiently using thermo-chemical processes.

● In the UK, a recent survey shows that a majority supports nuclear, with about 60% believing that the future energy policy should balance increased renewable energy, new nuclear, and clean gas and coal.

● Nearly three-quarters of the Japanese people recognise the value of nuclear energy.

● In Eastern and Central European countries, about two-thirds of the population are highly supportive of nuclear power.

● Despite positive trends, nuclear power is still surrounded by myth and misunderstanding. Polls show that many people still believe that nuclear power is worsening, rather than alleviating, the dangers of global warming. Overall, however, mounting concern about energy needs and climate change is producing increased awareness that nuclear energy offers a safe and valuable means by which nations can improve energy security while lessening, for the benefit of future generations, a severe and imminent risk to the Earth's environment.



World Nuclear Association

Carlton House • 22a St. James's Square • London SW1Y 4JH • UK

tel: +44(0)20 7451 1520 • fax: +44(0)20 7839 1501 • www.world-nuclear.org • info@world-nuclear.org