



## *The Nuclear Renaissance in a Global Context*

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Ladies and gentlemen, I am grateful for the opportunity to be with you.

The name of this society contains two adjectives of monumental significance. One adjective refers to a technology on which the world will depend in the 21<sup>st</sup> century if we are to meet the twin global imperatives of human need and environmental protection. The other adjective refers to a nation whose leadership will be crucial if humankind is to surmount this challenge, which may be said without exaggeration to have no precedent in history.

It is not a matter of environmental alarmism, but simply a reflection of clear perception, to recognize that a very large wolf is at the door.

### ***History's Greatest Challenge***

Today, one by one and in ever growing numbers, countries around world are embracing nuclear power as fundamental to their strategies of national energy security and global environmental responsibility.

In doing so, they are responding to an imperative that is gaining ever greater cogency on every continent. After assessing the human and environmental realities around them, national leaders are recognizing that nuclear energy today represents nothing less than an indispensable asset if our world is to meet what must be recognized as the greatest challenge in human history.

The human saga is replete with conflicts between people of different nationalities, ideologies, and religious beliefs. But today we face a conflict even more daunting in its dangers and scale, a challenge unlike any previously faced by humanity in any age. It is, in the truest sense of the phrase, an existential conflict – between humankind's current pattern of behaviour and the very planetary environment that enabled civilization to evolve.

In these early years of the 21<sup>st</sup> century, this new form of conflict has come increasingly to be recognized as nothing less than a global emergency – a crisis that will require, if catastrophe is to be averted, a worldwide transformation to clean forms of energy. This revolution – led by nuclear power, and using technology of which our industry serves as the world's custodian – must be achieved if humanity is to prosper and prevail.

It is time for nuclear professionals to speak with conviction, it is time for citizens everywhere to recognize that the nuclear industry represents a mature and immensely valuable technology, and it is time for political leaders to support the rapidly expanded use of this technology if we are to cope with a global emergency that has no borders.

The fact of this planetary crisis can no longer be a matter of psychological or political denial. For our best Earth-system scientists now warn, with ever increasing certainty, that greenhouse gas emissions, if continued at the present massive scale, will yield consequences that are – quite literally – apocalyptic: increasingly radical temperature changes, a worldwide upsurge in violent weather events, widespread drought, flooding, wildfires, famine, species extinction, rising sea levels, mass migration and epidemic disease that will leave no country untouched.

The science of weather prediction is still far from exact. But the science of Earth systems – which enables us to understand the drivers of climate change – is well advanced indeed. If the predictions from this science hold true, the combined effect – of greenhouse gas emissions and the compounding reverberations from positive feedback in our

world's oceans, land and air – will be the deaths of not just millions but of billions of people, and the destruction of much of civilization on all continents.

Precisely because we face dangers that go far beyond what we can readily imagine, the spectre of global warming still remains, for many people, too nebulous to contemplate. But what is not nebulous is the human condition that lies behind global warming.

Allow me to present some well-known facts, basic truths that are not in dispute. However familiar they may be, these realities are no less shocking in their significance. They underscore the compelling human dimensions of the global crisis we face.

### ***The Human Dimensions of the Environmental Crisis***

This crisis, it bears emphasis, originates not in human evil, but in human success: humanity's accumulating, accelerating success in acquiring, disseminating, and applying science-based knowledge. It is this success – taking form in agriculture, industry, commerce, and medicine – that has spawned the growth in human population and the gathering threat to our environment.

Viewed through history's eye, this success has come in a sudden burst. Through virtually all of the 50,000 years since humans first appeared, world population never exceeded 10 million. Then, at some point within the last 2,000 years, something happened. To take a phrase from nuclear science, human inventiveness reached critical mass, and advance led to advance at increasing speed.

Within the last 2,000 years – as shown here – these gains in knowledge brought enlightenment and prosperity to hundreds of millions of people. But the surge of world population also carried a consequence. Before, humanity's effect on our Earth's ecosystems was like a flea on a camel – wholly inconsequential.

But in just the 200 years we call the Industrial Age – the time frame pictured in this slide – humanity became an influence on Earth's fundamental mechanisms. Now this impact – this anthropogenic impact – threatens to destroy the very environmental conditions that enabled human success.

This map sequence illustrates humanity's growth over the past two millennia. Note that it took 50,000 years for population to reach one billion, a little more than a century to reach two billion, 33 years to reach three billion, 14 years to reach four billion, 13 years to reach five billion, 12 years to reach six billion. Today we are at 6.4 billion people, with 9 billion projected by the year 2050.

Viewing this population through an economic lens serves to describe the human condition. What we find is a world of extremes.

At one end of the scale are the OECD countries, where global prosperity is centred. These wealthy nations represent a mere one-sixth of humanity. At the other end are the world's poorest. Here an equal number of people – 1.1 billion – live in destitution with constant hunger, no clean water, the death of a child every 3 seconds, and virtually no income or prospect of improvement.

Back at the wealthier end of the spectrum, if we add the 300 million semi-prosperous population of the former Soviet bloc, we find that 1.4 billion of the world's people – just over 20% – account for 80% of global economic consumption. This means that 80% of the world's people subsist on 20% of world production of goods and services.

The 80% of humanity in the poor and developing world continues to increase. The rate is 20,000 per day. Think of it as the birth of a new city of 6 million people once each month. Our world's problem is not shrinking; it is worsening by the day.

The poorest 1.1 billion people are categorized as being in "extreme" poverty. Another 1.6 billion are classified as being in "moderate" poverty – just a small step above abject misery. They have little sanitation and virtually no money. They survive amidst pollution and disease.

The energy dimension of poverty is fundamental. Poverty correlates so closely to the absence of electricity that access to electricity is the best single barometer to gauge a person's standard of living. In today's world of 6.4 billion, a full 2 billion people have no electricity, and 2 billion more have only limited access. In other words, fewer than 40% of the world's people can easily switch on the lights.

Numbers on the same scale apply to clean water. Today, world water tables are falling under the demands of expanding human consumption. As this crisis emerges, we can expect the growing shortage of potable water supplies to produce thirst, disease, and water wars – in other words, a deadly combination of human suffering and human strife. As a

remedy, we have one available tool: large-scale desalination of seawater, an energy-intensive process that will compound global energy demand.

Finally, we have the great mass of humanity positioned between poverty and prosperity. This population, poised for advance, will be the engine of our world's future economic development.

In terms of future energy use, the human condition divides us into three categories: those with energy access who will continue to use it, those with none who desperately need it, and those poised in between, whose drive for economic advance is producing an expanded use of energy and, with it, an intensified outpouring of greenhouse emissions.

The environmental impact of this central group cannot be overstated. Less than ten years from now, greenhouse emissions from developing nations will equal the emissions from the countries we now call developed. After that, emissions from the developing world will be the major driver of global climate change.

This single fact underscores the magnitude, the urgency, and the nature of the challenge we face. It should make clear to all but the most committed ideologue that, while energy conservation, windmills, and solar panels may help, we cannot hope to rely on such measures alone to meet our world's expanding appetite for more energy.

### ***Accelerating the Nuclear Renaissance***

Our starting point for action must be agreement on a basic premise that emerges from every authoritative analysis:

*Humankind cannot conceivably achieve a global clean-energy revolution without a huge expansion of nuclear power – to generate electricity, to produce battery power and perhaps hydrogen for tomorrow's vehicles, and to desalinate seawater in response to the world's rapidly emerging fresh-water crisis.*

This reality is clearly evident in the analyses of the International Energy Agency in the inter-governmental sector and the World Energy Council in the private sector. And just last week, this reality landed a new bridgehead in the UN environmental sector when Yvo de Boer, head of the UN Framework Convention on Climate Change, declared that there is no credible scenario for global emission reduction without a major role for nuclear power.

The widening recognition of this truth is now reflected in a worldwide nuclear renaissance that is gathering speed and momentum.

For the nuclear industry – from uranium miners to technology vendors to plant constructors – this expansive outlook offers a promising future. But for serious environmentalists, current projections can provide little comfort – not because nuclear energy is growing but because it is not yet growing fast enough to play its needed role in the clean-energy revolution our world so desperately needs.

In three distinct areas, governments must take decisive action to accelerate the nuclear renaissance.

**1) Construct a Comprehensive Global Regime.** The first necessity is to move beyond Kyoto to construct a truly comprehensive, long-term climate regime that yields strong political signals – and economic incentives – for a worldwide transformation to clean-energy technology.

To be both effective and politically feasible, any such treaty must include all major nations, developed and developing, and must embody some variation on the principle of “contraction and convergence”.

“Contraction” means that the agreement must produce, over a span of decades, a global reduction in greenhouse emissions on the order of 60%. “Convergence” means that the agreement must adopt, at least implicitly, the principle of equal per-capita emission rights.

The principle of equal emission rights is far from utopian:

- First, as a matter of political reality, it is the only feasible principle for a global agreement.
- Second, the gap between actual emissions and emissions rights provides the potential for a dynamic international trading mechanism that will promote universal efficiency in clean-energy investment while producing a large net flow of such investment from North to South.

From a Northern perspective, this economic aid would be the most cost-effective in history if it helps to prevent the globally destructive growth in greenhouse emissions that might otherwise occur in the developing world.

Last week, in his new initiative on climate change, President Bush took a belated but considerable step in this direction. While still rejecting international emissions trading as a matter of principle, the President did embrace two principles of enormous consequence:

- First, the need for collective agreement on deep, long-term emissions reductions; and
- Second, the need for major aid to developing nations for clean energy investment.

We are still far away from agreement on a comprehensive regime, and realism dictates pessimism about the prospect of a major multinational treaty. But the very act of seeking one – or even of achieving widespread agreement that major greenhouse emitters should take parallel steps to achieve deep reductions – will send powerful signals to the energy marketplace.

**2) Elevate Nuclear Investment to a National and International Policy Priority.** This points us toward the second necessity, which is to shape national policies and international institutions to directly support nuclear investment.

Over the long-term, nuclear power is highly competitive – indeed, in most countries, a low-cost option even without emissions trading or a tax on carbon. But two factors now weigh against nuclear investment: the short-term bias of deregulated energy markets and the fact that 21<sup>st</sup> century nuclear reactors have not been built in sufficient numbers to achieve economies of scale.

National governments must therefore act to incentivize immediate nuclear investments – not to subsidize long-term nuclear operations but simply to pump-prime these early phases of the nuclear renaissance, for reasons of environmental urgency as well as energy security.

A similar rationale applies, at the international level, among the global institutions we established a half-century ago to meet urgent developmental needs. Today it is a fundamental failing of the UN system that all of its major development institutions continue to embrace, or to be intimidated by, old-school anti-nuclear environmentalism. Governments must now direct the World Bank and the UN Development and Environment Programmes to act in pursuit of a clean-energy vision in which nuclear power holds a central role.

**3) Preparing the Nuclear Profession for a Nuclear Century.** A third imperative is to apply the concept of nuclear investment to the human level – by stimulating enrolments in the study of nuclear science and technology. The nuclear profession must be readied for a nuclear century.

Ultimately, the nuclear industry can rely on that famous dictum from the cinematic baseball classic *Field of Dreams*: “If you build it, they will come.” Certainly, a stream of new reactor builds will register itself strongly in the educational and career choices of top young scientists and engineers.

But given the urgent need to accelerate the nuclear renaissance, the market mechanism should be supplemented by proactive measures, at the national and international levels, to stimulate nuclear education and to promote harmonization of professional standards across borders.

To help point the way toward a globalizing nuclear profession, the World Nuclear Association has worked with the IAEA, WANO, and the NEA to create the new World Nuclear University.

The WNU is a partnership in which these four global organizations cooperate together, and with leading institutions of nuclear learning, in activities to enhance nuclear education and leadership for the 21<sup>st</sup> century. The WNU partnership is supported by a small multinational secretariat in London composed of nuclear professionals seconded by key governments and nuclear enterprises. In creating the WNU and staffing its secretariat, DOE has been an important ally.

The flagship of the partnership is the WNU Summer Institute, an annual 6-week event designed to educate and inspire an international group of young nuclear professionals who show promise as future leaders in the world of nuclear science and technology. By the end of this summer, we will already have spawned a network of some 275 former WNU Fellows in 40 countries, and that number will grow each year.

Meanwhile, the WNU project has begun to branch out, as the multinational team at the WNU Coordinating Centre works to develop other educational and leader-building programmes. In the process, the WNU will seek to build an international endowment for scholarships in nuclear technology. Establishing such scholarships should also be a national priority for governments around the world.

### ***Safety and Security Implications of the Nuclear Renaissance***

As the nuclear renaissance unfolds, stewards of this technology must remain prepared to answer well-known questions concerning safety, waste, transport, cost, terrorism, and adequacy of uranium reserves – topics about which there is legitimate public interest and on which much mythology has been spread by dogma-driven environmentalist propaganda.

As nuclear professionals know, common myths on these topics are generally the opposite of reality. An example is nuclear waste, often said to be nuclear power's great liability. In reality, the only significant problem with nuclear waste is the combination of ignorance, opportunism and political cowardice. In a world where the continuing use of our atmosphere as a carbon dumpsite is fast carrying us toward global catastrophe, we must be prepared to speak the truth, unflinchingly, that the small volume and manageability of nuclear waste are in fact distinct environmental assets.

Consider this waste comparison: If tomorrow we could suddenly generate all the world's electricity by nuclear power, we would – in a full year – create and safely dispose of a quantity of high-level nuclear waste less than the amount of carbon waste that today's power plants spew into Earth's atmosphere every five minutes, around the clock.

A new question – concerning the security implications of the nuclear renaissance – also commands our attention. It is whether the creation of more nuclear facilities – specifically, enrichment and reprocessing plants – entails a greater risk of nuclear weapons proliferation. This question has been given focus by Iran's enrichment activities and by proposals from the IAEA's Director General and Presidents Bush and Putin aimed at limiting the number of such facilities, or even internationalizing them, while creating supply assurances for countries that are using nuclear technology for peaceful purposes.

A few months ago the IAEA convened a special conference to begin exploring whether such concepts might be feasible. There I presented the preliminary views of a WNA Working Group, underscoring the effectiveness of today's commercial markets but also envisaging how a practical arrangement to formalize assurances of LEU supply might operate.

These initial discussions in Vienna manifested two basic perspectives. First, there is widespread support for the Non-Proliferation Treaty and any measures that could reasonably strengthen the NPT regime. Second, there is also a widespread expectation of a global nuclear renaissance and a legitimate desire on the part of several countries to maintain the option to develop a full nuclear fuel cycle. These dual goals will not be easily reconciled, and we can expect that the building of a consensus for any significant changes in the NPT system will require years, not months.

Meanwhile, we should take cognizance of two fundamental realities:

- o First, nuclear proliferation danger comes not from the existence of nuclear facilities, but from the intentions of those who possess them. The intent of an Iran or a North Korea is a geopolitical variable that is essentially independent of whether countries like Brazil, Canada, South Africa, or Australia develop additional nuclear facilities. Where specific problems arise, the international community must develop specific responses.
- o Second, given the environmental dangers that beset our world today, there is no global security measure more urgent or important than the nuclear renaissance itself. The expansion of nuclear power must proceed in parallel with, and not be delayed by, ongoing efforts to strengthen the IAEA-led framework within which peaceful nuclear technology is employed.

### ***A Time of Peril, A Fateful Race***

In closing, let me attach numbers to the challenge we face. Today nuclear energy is using 440 reactors to produce one-sixth of the world's electricity. From an environmental perspective, it will not be adequate if the nuclear industry simply doubles, or triples, or quadruples its capacity in this century. Indeed, it will not be adequate to meet the needs of a global clean-energy revolution even if we multiple nuclear generation by a factor of ten.

We must place ourselves on a trajectory for a 21<sup>st</sup> century nuclear industry that achieves the deployment of nothing less than 8,000-10,000 Gigawatts of nuclear power – a twenty-fold increase. To plan for anything less would be to invite environmental disaster.

Is this simply pie-in-the-sky? Recall this: In the 1980's, France alone started-up 42 major nuclear power reactors. From a standing start in the 1970's, France brought on-line, in a single decade, 1,000 Megawatts of nuclear power for every one-million of its citizens – enough to meet virtually all of the electricity needs of a modern industrial society for decades to come.

The projection on the screen before you simply spreads the same achievement – over the course of a full century – to a wider world that will not be starting from a standstill and that will need nuclear for transport and desalination as well as traditional electricity. If we can achieve clarity about the dangers that beset us and galvanize leadership – national and international – to employ the tools at hand, success in this task lies within the wit and capacity of humankind.

What is pie-in-the-sky is to believe that humanity can avoid environmental calamity without clean-energy achievement on this scale.

The English historian H.G. Wells viewed life as “a race between education and catastrophe”. Today this adage applies to all humankind. Our world is in dire peril, the race between education and catastrophe is underway, and we have no time to lose.

This conference is, in one sense, a technical meeting among nuclear professionals. But it is also a convocation of leaders who today hold a monumental responsibility – to make a vital contribution to victory in a fateful race that will determine the sustainability of humanity’s future.

In the theme of this conference – “people” – we can find a profound double meaning. The human needs on our Earth are both enormous and urgent, and those who are the custodians of nuclear technology hold a key to whether those needs will be met.

For those of us in the nuclear profession, history has bestowed both a solemn obligation and, on the other side of that coin, an inspiring opportunity.