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ASIAN NUCLEAR ENERGY

Powering Global Nuclear Commerce

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Exploit N-Energy's Vast Potential for Human Progress

- Manmohan Singh

India Trendsetter in Global N-Boom

- Thomas Fink, Schott AG

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In This Issue

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Art Director: Santosh Nawar
Visualizers: Maya Vichare & Sagar Banawalikar
Photographer: Bilal Ahmed Khan

BRANCHES:
Kolkata:
Anurag Sinha, Regional Head,
Mob: 098300 15667
Email:anurag@newmediacomm.biz

Delhi:
Abhay Shanker Sahaay, Resident Editor
Mob: 09968767500/09968815306
Email: abhay.sahaay@newmediacomm.com

Pune:
Jagdish Khaladkar, Regional Director,
Mobile: 098230 38315
Email: pune@newmediacomm.biz

Australia Office:
Bandhana Kumari Prasad, 129 Camboon Road,
Noranda, Perth, W.A. 6062 Tel: 0061 892757447
Email: bandhana@newmediacomm.biz

New Media Communication Pvt. Ltd.,
New Media House, 1 Akbar Villa,
Near Old State Bank, Moral-Maroshi Road,
Andheri (E), Mumbai - 400 059
Tel: +91-22-2925 0690. Telefax: +91-22-2925 5279
E-mail: enquiry@newmediacomm.biz
www.newmediacomm.com

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Tel: +91-22-2925 0690. Telefax: +91-22-2925 5279

Dear Reader,

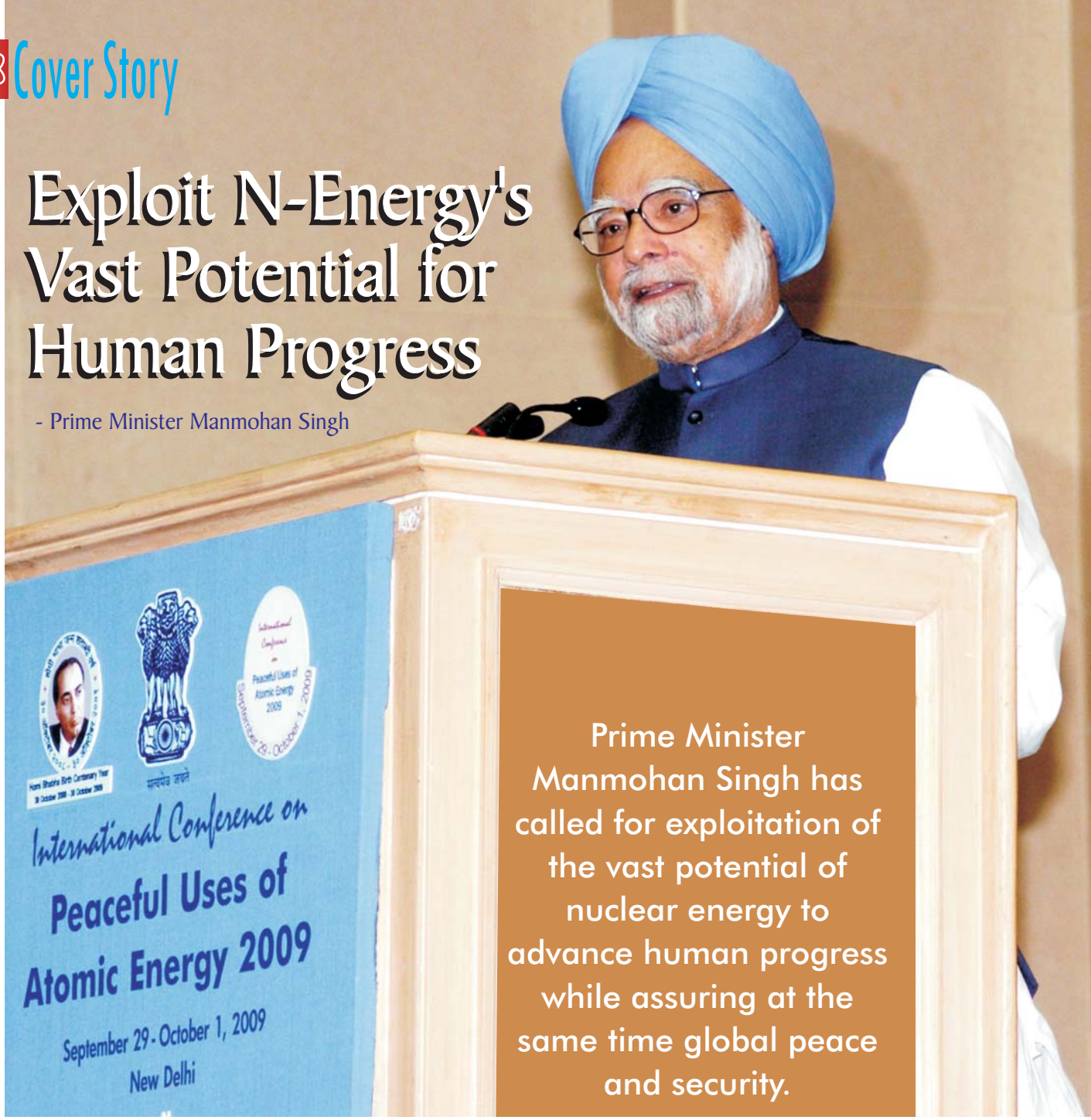
Greetings. Today, India occupies a very important position in the world of nuclear commerce. With the signing of a historic deal with the United States on cooperation in civilian nuclear energy, India has opened the floodgates of global nuclear commerce. India has also signed in the last one year similar deals with other countries such as Russia and France. India's entry into the global nuclear arena has rightly coincided with the centenary celebrations of the birth of Dr. Homi Bhabha, father of the country's nuclear research and development. Dr. Bhabha fervently believed in the peaceful use of atomic energy for the purpose of human advancement. Hence, while inaugurating an International Conference on Peaceful Uses of Atomic Energy - 2009, held as part of the Bhabha Centenary Commemorative Celebrations, Prime Minister Manmohan Singh has called for exploitation of the vast potential of nuclear energy to advance human progress while assuring at the same time global peace and security. The cover story of the current issue of Asian Nuclear Energy highlights, besides the Prime Minister's speech, an important address to the Conference made by Dr. Mohamed ElBaradei, Director General of the International Atomic Energy Agency (IAEA). China and India, which are on the fast track in economic growth, are also in dire need of energy to sustain their development. It comes as no surprise that both China and India top the global rankings in the projections made by the World Nuclear Association (WNA) in terms of nuclear power generation in the 21st century. We carry the research study. Uranium is the crucial raw material for generating nuclear energy. India, which has been facing a severe shortage of this vital input, has signed a deal forits supply with Namibia, a country endowed with rich reserves of high quality uranium. We carry a report. Dr. ElBaradei, who has served IAEA for 12 years with distinction, is bowing out of office at the end of November 2009. We carry his last address to the United Nations, in which Dr. ElBaradei, has called for better funding of the global nuclear watchdog to give it teeth. We also carry a tribute the IAEA Governing Board paid to Dr. ElBaradei. Electrical Penetration Assemblies (EPAs) are crucial components used in the walls of safety containment structures in nuclear reactors. In an interview with Asian Nuclear Energy, Thomas Fink, Head of the Nuclear Safety Division of the Schott AG, talks about the glass-to-metal seals (EPAs) and India's role as a trendsetter in the coming global nuclear boom. There is a feature on the dilemma of aging nuclear power plants, a write-upon how India's nuclear power drive is expected to create a big job market for technicians, a US research study that identifies finance as the single largest snag in nuclear power industry progress and the British Government's initiative to expand its nuclear industry. A report of the WNA highlights the global availability of uranium.

Wish you happy reading

Satya Swaroop
Managing Editor
satya@newmediacomm.biz

Exploit N-Energy's Vast Potential for Human Progress

- Prime Minister Manmohan Singh



Prime Minister Manmohan Singh has called for exploitation of the vast potential of nuclear energy to advance human progress while assuring at the same time global peace and security.

While inaugurating a three-day International Conference on 'Peaceful Uses of Atomic Energy-2009 held in New Delhi on 29 September, 2009, the Prime Minister said, "The task would require the collective will, wisdom and determination of the international community but it is a task that can no longer be put off".

The conference, part of the Dr. Homi Bhabha Centenary Commemorative Celebrations, was also addressed by Dr. Mohamed ElBaradei, Director General, International Atomic Energy Agency (IAEA), Dr. Anil Kakodkar, Secretary, Department of Atomic Energy (DAE) and Chairman, Atomic Energy Commission (AEC), Prof. P. Rama Rao, President Indian Nuclear Society (INS) and Dr. S. Banerjee, Director, Bhabha Atomic Research Centre (BARC).

Prime Minister said that "It is not beyond the imagination of the human mind to devise solutions and strategies that exploit the vast potential of atomic energy to advance human progress, while assuring global peace and security."

"If we do not use the power of the atom wisely for the universal good, the consequences would be devastating for the peace and progress that all nations seek for their people. Mentioning Dr. Homi Bhabha as one of India's greatest nation builders and scientific pioneers, the Prime Minister said that Dr. Bhabha laid the foundation of our nuclear programme while enunciating the three- stage nuclear power programme based on closed nuclear fuel cycle.

Finance Minister Pranab Mukherjee, Prime Minister Manmohan Singh and IAEA Director General Mohamed ElBaradei at the inaugural session of the International Conference on 'Peaceful Uses of Atomic Energy-2009', in New Delhi on September 29, 2009.

Prime Minister Singh further said that the first stage of India's three-stage Nuclear Power Programme, based on the Pressurised Heavy Water Reactors (PHWRs) and associated fuel cycle facilities, has now reached a level of maturity. The second stage envisages setting up of Fast Breeder Reactors (FBRs) backed by reprocessing plants and plutonium-based fuel fabrication plants. With the construction of the Prototype Fast Breeder Reactor at Kalpakkam we have entered the second stage of the programme. A facility for reprocessing thorium fuel has been set up. An Advanced Heavy Water Reactor (AHWR) has been designed and its construction will be launched in the near future. This will expedite the transition to thorium-based systems that will mark the third stage of the programme. Prime Minister Singh also mentioned that the return of India to the International nuclear global mainstream is of high significance not only for India but for global energy security as well. If India could manage its three-stage strategy well it might yield a potential of 4,70,000 MW of power by the year 2050, which would sharply reduce our dependence on fossil fuels and would be a major contribution to global efforts to combat climate change.

He also addressed the vital issue of destructive uses of nuclear energy. He said that just as we seek to enhance peaceful uses of nuclear energy, we have a pressing and immediate moral obligation to draw down and eventually do away with its destructive use.

The Prime Minister regretted that global non-proliferation regime has not succeeded in preventing nuclear proliferation. He stressed the need for making global non-proliferation universal, comprehensive and non-discriminatory and linked to the goal of complete nuclear disarmament.

Prime Minister Singh said that "India is proud of its non-proliferation record and is committed to global efforts for preventing the proliferation of all weapons of mass destruction. We are committed to a voluntary, unilateral moratorium on nuclear testing".

Finance Minister Pranab Mukherjee released Bhabha Centenary Commemorative Coins on the occasion. Describing Dr. Bhabha as the architect of Indian Nuclear Progrramme, he said that the national and international recognition being achieved by Indian nuclear scientists was due to the conceptualization and vision of Dr. Homi Bhabha about the nuclear energy.

Dr. ElBaradei, also recalled the contribution of Dr. Homi Bhabha, as President of first International Conference on peaceful uses of atomic energy held in Geneva in 1955. He said that despite global recession, the nuclear energy has recorded a sustained growth, adding that Asia remained the focus of growth in the field of nuclear power.

Elaborating the peaceful uses of nuclear energy, Dr. ElBaradei said that the nuclear radiation is being utilized

Prime Minister Singh welcoming Dr. ElBaradei

for treatment of diseases like cancer and it has tremendous potential for developing techniques for enhancing the yield of various crops in agricultural field. He appreciated India's major role in the field of nuclear disarmament. The nuclear energy has a potential of generating power on a large scale which may be able to face the challenge of energy deficit in the world.

India's Three-Phased Programme

Excerpts from Prime Minister Singh's Speech

This Conference commemorates the birth centenary of one of India's greatest nation builders and scientific pioneers, Dr. Homi Bhabha. Dr. Bhabha laid the foundation of our nuclear programme by enunciating the three stage nuclear power programme based on a closed nuclear fuel cycle. We are proud of our national achievements in mastering all aspects of the fuel cycle.

Dr. Homi Bhabha

The current international interest in closing the fuel cycle is a vindication of Dr. Bhabha's pioneering vision and genius.

Dr. Bhabha was a brilliant scientist and a true visionary. At the first International Conference on Nuclear Energy in Geneva in 1955, Dr. Bhabha in his presidential address had said:

'For the full industrialization of the under-developed countries, for the continuation of our civilization and its further development, atomic energy is not merely an aid, it is an absolute necessity. The acquisition by man of the knowledge of how to release and use atomic energy must be recognized as the third epoch of human history.'

This bold vision of what the peaceful uses of atomic energy meant for humanity at large proved to be prophetic. This Conference is taking place on the crest of a global nuclear renaissance, in which I believe India will be a significant factor.

As a result of the far-sighted plans of our scientists, India emerged as a leader in the developing world in harnessing the peaceful uses of nuclear energy. The first stage of our three stage nuclear programme, involving the setting up of Pressurised Heavy Water Reactors (PHWRs) and associated fuel cycle facilities, has now reached a level of maturity. The technology for the manufacture of various components and equipment for PHWRs in India is now well established and has evolved through active collaboration with Indian industry. The second stage envisages setting up of Fast Breeder Reactors (FBRs) backed by reprocessing plants and plutonium-based fuel fabrication plants. With the construction of the Prototype Fast Breeder Reactor at Kalpakkam we have now entered the second stage of the programme. A facility for reprocessing thorium fuel has also been set up. An Advanced Heavy Water Reactor has been designed and its construction will be launched in the near future. This will expedite the transition to thorium-based systems that will I believe mark the third stage of our programme. We are proud of the achievements of India's nuclear scientists and of our industry.

Dr. Bhabha had famously remarked that "no power is as expensive as no power" to justify his strong advocacy of nuclear power as an instrument of economic development. This is truer than ever before as the developing countries seek new energy sources to sustain high rates of economic growth. There is now a growing consensus that nuclear power is an important energy source that is also clean. In fact the majority of nuclear power plants under construction worldwide are now located in Asia.

A number of agreements and reciprocal commitments were concluded as part of the Civil Nuclear Initiative to allow the resumption of full civil nuclear cooperation

between India and the international community and we look forward to their full and effective implementation in the coming months and years. The return of India to the international nuclear global mainstream is of high significance not only for India but for global energy security as well.

In our country, we see nuclear energy as a vital component of our global energy mix. The vast energy potential of the three stage programme allows us really to think big. Our nuclear industry is poised for a major expansion and there will be huge opportunities for the global nuclear industry to participate in the expansion of India's nuclear energy programme.

If we can manage our programme well, our three stage strategy could yield potentially 470,000 MW of power by the year 2050. This will sharply reduce our dependence on fossil fuels and will be a major contribution to global efforts to combat climate change.

The peaceful uses of nuclear energy are not just about power. There are promising applications in the areas of agriculture, food production and preservation, medicine and water desalination. In India, we have successfully developed 37 mutant varieties of seeds for commercial cultivation using nuclear techniques. Use of radiation technology for food preservation is growing. We have built a nuclear desalination plant at Kalpakkam and are working on the use of isotope hydrology techniques for rejuvenation of springs, which is an important source of drinking water. I see a growing role for nuclear energy in these areas in the coming decades.

With this limitless potential, I believe that the international community should reflect more on how international cooperation can multiply the benefits of nuclear energy for all humankind.

The International Project on Innovative Nuclear Reactors and Fuel Cycles is an example of such international cooperation. India is a participant in the International Thermonuclear Experimental Reactor, or ITER Project. We are ready to contribute to global research and development into new proliferation-resistant fuel cycles. There are proposals for an international fuel bank and we would support efforts in this direction as a supplier nation.

Another critical area of cooperation is that of nuclear safety. The nuclear industry's safety record over the last few years has been encouraging. It has helped to restore public faith in nuclear power. But the technology and management of nuclear safety must be continuously improved.

This brings me to a vital issue that is fundamental to the safety and security of all humanity the destructive uses of nuclear energy. Just as we seek to enhance peaceful uses of nuclear energy, we have a pressing and immediate moral obligation to draw down and eventually do away with its destructive use of nuclear energy.

I wish to reaffirm that this collective effort will have no greater proponent than India. India's first Prime Minister Jawaharlal Nehru had advocated the prohibition and abandonment of all weapons of mass destruction way back in the 1950s. It was a call that went largely unheeded at that time. We should not repeat the mistakes of the past.

In 1988, Prime Minister Rajiv Gandhi put forward at the General Assembly of United Nations a comprehensive Action Plan for the complete elimination of nuclear weapons. We remain committed to that objective.

In 2006, India put forward a set of proposals at the United Nations General Assembly that outlined specific steps that could lead to the elimination of nuclear weapons. It included the proposal for the negotiation of a Nuclear Weapons Convention that would prohibit the development, production, stockpiling and use of nuclear weapons and providing for their elimination within a specified time frame.

The specter of nuclear terrorism is a formidable challenge facing the entire global community. At the United Nations General Assembly India has been sponsoring a resolution calling for measures to address this threat.

We support strengthening international efforts in improving nuclear security and in this context, welcome President Obama's timely initiative to convene a Global Summit on Nuclear Security in 2010.

If we use the power of the atom wisely for the universal good, the possibilities are unbounded. But if we do not, the consequences would also be devastating for the peace and progress that all nations seek for their people. The choices are stark and the challenges are indeed daunting. But it is not beyond the imagination of the human mind to devise solutions and strategies that exploit the vast potential of atomic energy to advance human progress, while assuring global peace and security. This task will require the collective will, wisdom and determination of the world community but it is a task that can no longer be put off.

Asia Remains Focus of N-Energy Growth

Excerpts from ElBaradei's Speech

It is always a great pleasure to visit India. I am especially honoured to speak at this International Conference on Peaceful Uses of Atomic Energy, part of the commemoration ceremonies to mark the centenary of the birth of Dr. Homi Bhabha.

Dr. Bhabha was an outstanding scientist and a great visionary, who built from scratch a comprehensive nuclear energy programme, based on self-reliance. Within little more than a generation, he made India a significant player in the world of peaceful nuclear energy.

His far-sightedness in launching systematic training for nuclear scientists and engineers is still showing results today. Indeed, in this very room we see some of the most distinguished alumni of the training school established by Dr. Bhabha in 1956 at the institution that now bears his name - the Bhabha Atomic Research Centre (BARC). They include my friend Dr. Anil Kakodkar, Chairman of the Indian Atomic Energy Commission.

Dr. Bhabha also had the foresight to build capacity in other areas of nuclear science, including in medicine and agriculture. He was an influential figure in the birth of the International Atomic Energy Agency, which I have had the honour to lead for the past 12 years. He was Chair of the first International Conference on Peaceful Uses of Atomic Energy, held in Geneva in 1955, that laid the foundation for the launch of the IAEA two years later. Legend has it that Dr. Bhabha cast his vote in favour of Vienna as the seat of the Agency´s headquarters because of his great love for opera. As a music lover myself, I have special reason to be grateful to him. India has been a Member of the Board of Governors since the IAEA was established and many BARC alumni have served with distinction on the staff of the Agency.

Globally, the fortunes of nuclear energy have fluctuated since Dr. Bhabha´s untimely death in 1966. The low point was undoubtedly the Chernobyl disaster in 1986, which effectively halted the expansion in nuclear power

in its tracks. However, the pendulum has swung back in the past 10 years or so and we look set for a significant expansion in global use of nuclear energy in the next 20 to 30 years. There are a number of reasons for this. The urgent and ever-growing need for energy, particularly in the developing part of the world, fluctuations in fossil fuel prices and climate change are major factors.

The world has accumulated more than 13,000 reactor-years of experience. Considerable improvements in safety since Chernobyl have been matched by improvements in efficiency. Nuclear plants are more economical to run, productivity has increased and there is less down-time for maintenance. The long-term stability of the cost of electricity generated by nuclear power is an important attraction. Public attitudes towards nuclear energy have become more positive in the past decade. But the nuclear industry needs to remain open and transparent in order to generate and maintain public trust.

Despite the global economic crisis, the IAEA´s latest projections continue to show a significant increase in nuclear generating capacity in the medium term. The low projection is now for 511 GW(e) of generating capacity in 2030, compared to 370 GW(e) today. The high projection is for 807 GW(e), more than a doubling from present levels.

Most of the 30 countries already using nuclear energy plan to expand their output. Scores of countries - mostly in the developing world - have informed the IAEA that they might be interested in launching nuclear power programmes. Of these, 12 countries are actively considering nuclear power. Growth targets have been raised significantly here in India, as well as in China and in the Russian Federation. Asia remains the focus of growth in nuclear power, not least because of this region´s robust economic growth.

Every country has the right to add nuclear power to its energy mix, as well as a duty to do it responsibly. That means adhering to the highest safety and security standards and ensuring that nuclear material is not diverted from peaceful to military purposes. Demand for the IAEA´s services in all three areas - safety, security and safeguards - has grown exponentially in the past two decades and will continue to increase as more and more countries build nuclear power reactors.

But in addition to the use of nuclear energy for power generation, nuclear techniques have been making a difference in detecting and treating cancer, producing more robust and higher-yielding food crops and maintaining supplies of fresh water. I am especially proud of the Agency´s Programme of Action for Cancer Therapy, which is helping to make radiation medicine available for cancer diagnosis, treatment and palliative care in developing countries, many of which have no radiotherapy services at all.

Another area in which the IAEA has made a significant difference is induced crop mutations using nuclear techniques, for example to produce salt-tolerant rice and drought-resistant wheat. These have increased food production and boosted farmers´ incomes in many countries. Likewise, isotope data provide a unique tool to determine the availability and vulnerability of groundwater systems and ensure that reliable supplies can be developed in the long term.

On a more sombre note, the number of states that possess nuclear weapons has risen to nine since Dr. Bhabha´s death. This is nine too many as far as I am concerned. After a couple of what I consider to be wasted decades, I am gratified that nuclear disarmament has now moved back to the top of the international agenda. Russia and the United States are negotiating significant cuts in their nuclear arsenals. There is increasing global recognition that nuclear weapons are a threat to us all and growing momentum for their complete abolition.

India called for the elimination of all nuclear weapons as far back as 1948. It is important that India´s voice should continue to be heard as a leading advocate for nuclear disarmament. I believe there is reason to hope that we could achieve a world free of nuclear weapons in my children´s lifetime, if not in mine. But if we want to turn our hopes into reality, we have to start laying the groundwork for a global security system that does not depend on nuclear weapons; a system built on human solidarity and equity; a system based on cooperation and not confrontation; on inclusion and not exclusion.

Let me say a few words on India´s current role in using nuclear energy for peaceful purposes and the lessons it can teach other countries. India undertakes a lot of research into advanced fuel cycles based on thorium fuel, as it has abundant natural thorium resources and a comparative shortage of uranium. India continues to set the agenda for research and development in the field of sodium-cooled fast breeder reactors.

Experts from India participate in IAEA activities on innovative small and medium sized reactors. India is also a very active member of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO) and is on the cutting edge of development in many waste

management technologies, especially for high level waste from reprocessing. Cooperation with the IAEA is expected to increase in the area of decommissioning in the coming years as many older installations in India will require either refurbishment or decommissioning.

In the area of nuclear applications, India is making radiation and nuclear medicine increasingly available in rural areas. And Indian specialists are actively deploying nuclear techniques in agriculture, as evidenced by the large number of varieties of crops produced through radiation-induced mutation which are now on the market, including chick peas and oil seeds.

India´s remarkable economic dynamism in the past two decades has made it a role model for many developing countries. It is ideally placed to share its technological expertise and economic know-how with less advanced countries. In the nuclear field, it is vital that countries planning to build nuclear power reactors understand the need to ensure the highest safety standards and avoid problems faced by some countries which already have nuclear power. These problems include ageing reactors, operators which are poorly managed or under-funded and weak regulators. A strong focus on safety and security should be seen as enablers for the further development of nuclear energy rather than as hindrances.

Let me conclude by saying that nuclear power, while not a panacea for all the world´s energy problems, can play a major role in overcoming the huge energy deficit we face. Energy is the engine of development and nuclear techniques contribute to accelerating development. ■

IAEA Pays Rich Tribute to ElBaradei

The Governing Board of the International Atomic Energy Agency (IAEA) has paid a rich tribute to its outgoing Director General Mohamed ElBaradei, ahead of his relinquishing office at the end of November 2009, after being at the helm of affairs of the global nuclear watchdog for 12 years.

Speaking to the board members at a function held for this purpose on 10 September 2009, ElBaradei said he was "humbled, grateful and honoured" by comments from the 35 board members. He recalled the challenges and successes of his 12 years at the head of the IAEA which has gone through a "metamorphosis" to "become a major player in the international community."

He said: "We know the difference between what's right and what's wrong and we are all committed - meaning all of you - and we are absolutely determined to make sure that we do our utmost for the benefit of humanity." In trying to create the right environment for global development while preventing proliferation of nuclear weapons, the member states of the agency are "Working together knowing that, as a human family it is not a zero sum game - we are either going to win together or fail together."

A motion was approved that will see ElBaradei granted the lifelong title of Director General Emeritus.

On the opening day of the IAEA General Conference on 14 September 2009, a vote of member states confirmed Yukiya Amano as ElBaradei's replacement. Amano lauded ElBaradei's "tireless efforts and selfless dedication towards world peace and prosperity.

President Pratibha Patil conferring the Indira Gandhi Prize for Peace, Disarmament and Development-2008 on Dr. Mohamed ElBaradei for his impassioned opposition to the use of nuclear energy for military purpose, in New Delhi on 30 September 2009.

Mohamed ElBaradei accepts the gratitude of the IAEA board of governors at his last general conference

China, India Top the Nuclear Century Outlook

China and India have topped the Nuclear Century Outlook, followed by the United States in the third slot in terms of growth potential as envisaged by the World Nuclear Association.

This Outlook is:

• A conceptualization of nuclear power's potential worldwide growth in the 21st Century; and

• An evaluation of nuclear energy's environmental contribution.

The Outlook is unique in nature and scope. Many nuclear projections extend just to 2030 and assume business-as-usual behaviour. The Outlook encompasses these scenarios but looks further into the future - with both optimistic and pessimistic assumptions.

In gauging nuclear energy's potential growth and environmental role, the Nuclear Century Outlook also offers perspective on two questions:

• Will nuclear energy's contribution depend heavily on introducing nuclear power into new nations?

• In meeting global clean-energy need, what is the relationship between nuclear power and renewable energy technologies?

The Outlook is built on country-by-country assessments of the growth potential of national nuclear programmes, based on estimates of need and capability, with projected population a key factor. For each country, the Outlook posits upper and lower growth trajectories, with the low reflecting the minimum nuclear capacity expected and the high assuming a full policy commitment to nuclear power.

When summed globally, these trajectories yield boundaries within which the future is likely to fall.

WNA Nuclear Century Outlook Data

The table below shows the full set of data used. Supporting information is provided for each country.

Current Nuclear Programmes*	2008	2030 Low	2030 High	2060 Low	2060 High	2100 Low	2100 High
Countries		Capacity in GWe					
Argentina	1	4	11	5	30	10	90
Armenia	0	1	0	1	1	2	4
Belarus	0	2	5	5	8	5	10
Belgium	6	6	8	8	10	8	22
Brazil	2	10	30	40	100	70	330
Bulgaria	2	4	7	5	7	5	7
Canada	13	20	30	25	40	30	85
China	9	50	200	150	750	500	2800
Czech Republic	3	5	7	5	12	5	15
Finland	3	5	7	8	10	8	11
France	63	65	75	80	110	80	130
Germany	20	20	50	40	80	80	175
Hungary	2	4	5	4	8	5	12
India	4	20	70	60	500	200	2750
Iran	0	3	10	5	30	10	140
Japan	48	55	70	80	140	80	200
Lithuania/ Latvia/ Estonia	1	4	6	5	8	5	8
Mexico	1	2	20	3	75	20	225
Netherlands	1	1	5	7	20	10	35
Pakistan	0	10	20	20	65	30	180
Romania	1	4	10	5	20	10	25
Russia	22	45	80	75	180	100	200
Slovakia	2	3	4	4	5	5	7
Slovenia	1	1	1	1	2	1	2

South Africa	2	8	25	30	50	30	55
South Korea (& North Korea)	18	25	50	45	80	70	145
Spain	7	8	20	20	50	25	60
Sweden	9	10	15	10	18	10	18
Switzerland	3	4	6	5	10	5	11
Ukraine	13	20	30	20	40	20	45
United Kingdom	11	20	30	30	80	40	140
United States	99	120	180	150	400	250	1200
SUBTOTAL	367	559	1087	951	2939	1729	9137

Nations Planning Nuclear Countries	2008	2030 Low Capacity in GWe	2030 High	2060 Low	2060 High	2100 Low	2100 High
Egypt	0	3	10	6	40	10	90
Gulf Cooperation Council*0	12	50	30	80	40	175	
Indonesia	0	2	6	3	35	5	175
Kazakhstan	0	0	2	3	5	5	20
Nigeria	0	2	15	10	40	20	120
Poland	0	4	10	12	40	20	50
Turkey	0	5	15	10	50	20	160
Vietnam	0	2	4	4	30	6	120
SUBTOTAL	0	30	112	78	300	126	910

**Gulf Cooperation Council members are Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates*

Potential Entrants Countries	2008	2030 Low Capacity in GWe	2030 High	2060 Low	2060 High	2100 Low	2100 High
Albania	0	0	2	1	4	2	5
Algeria	0	0	5	2	15	5	40
Australia	0	0	10	15	25	20	60
Austria	0	0	3	2	5	4	7
Bangladesh	0	0	10	5	40	20	90
Chile	0	0	5	5	15	10	38
Croatia	0	0	2	2	5	2	5
Denmark	0	0	2	2	4	2	7
Greece	0	0	2	2	5	2	5
Iraq	0	0	2	5	15	6	60
Ireland	0	0	5	2	5	3	10
Israel	0	0	3	2	5	3	20
Italy	0	7	20	10	40	25	70
Jordan	0	3	7	3	8	5	12
Kenya	0	0	2	2	8	4	24
Malaysia (and Singapore)	0	0	10	5	15	5	30
Morocco	0	0	5	2	15	5	40
New Zealand	0	0	2	2	5	3	8
Norway	0	0	2	2	5	3	10
Philippines	0	1	10	10	60	20	95
Portugal	0	0	5	5	10	5	14
Serbia	0	0	2	5	8	5	14
Syria	0	0	3	2	7	5	25
Thailand	0	2	10	10	40	15	50
Venezuela	0	0	3	4	25	8	60
Other	0	0	8	4	40	20	200
SUBTOTAL	0	13	140	111	429	207	999
WORLD TOTAL	367	602	1339	1140	3688	2062	11046

The Business of Profitably Disposing of Nuclear Waste

The US House Energy and Commerce Committee's Subcommittee on Energy and the Environment on 3 November 2009 unanimously approved a legislation to ban the importation of foreign radioactive waste for disposal in the US.

Congressman Bart Gordon (D-TN) introduced H.R. 515: Radioactive Import Deterrence Act in January of 2009 and the bill could soon be up for a vote in the House of Representatives. The full committee will vote on the bill shortly with a full House at some future point after that. When the subcommittee approved the legislation Barton said, "We're the only nation in the world that buries the nuclear waste of other countries in our soil. We already have limited space in our country for the radioactive waste generated by American entities and it should be preserved for them the medical facilities, university research labs and utility companies."

While there are some legitimate concerns with low-level waste importation, there is also tremendous opportunity. Before weighing the pros and cons, it's relevant to know what low-level nuclear waste is. The United States Nuclear Regulatory Commission (NRC) defines low-level radioactive waste as items that have become contaminated with radioactive material or have become radioactive through exposure to neutron radiation. This waste typically consists of contaminated protective shoe covers and clothing, wiping rags, mops, filters, reactor water treatment residues, equipments and tools, luminous dials, medical tubes, swabs, injection needles, syringes, and laboratory animal carcasses and tissues. There are three classes of low-level waste: A, B and C,

and, "class A low-level radioactive waste contains the lowest concentration of radioactive materials, and most of those materials have half-lives of less than five years."

One concern, as emphasized by Congressman Barton is space. Salt Lake City-based Energy Solutions wants to import 20,000 tonnes of low-level waste from Italy, which after processing in Tennessee would be trimmed down to 1,600 tonnes to be stored in Utah's desert. Testimony from Margaret M. Doane of the NRC would suggest otherwise. In her written testimony on 16 October 2009, she said, "There do not appear to be any such concerns about capacity for disposal of Class A material, which has been the classification for all waste import cases today."

Another concern, as with all things nuclear, is safety also known as the NIMBY (Not In My Back Yard) problem. But the truth is nuclear waste is routinely transported all over the country daily everyday. Since 1971, more than 20,000 shipments of spent fuel and high-level waste have been transported more than 18 million miles worldwide without incident. And that's high-level waste. There's much more when it comes to low level waste (both domestically and internationally) and the NRC has strict guidelines for regulatory requirements, licensing, and safety oversight.

That being said, there are also concerns as to what the bill would do from a competitiveness perspective. This is becoming increasingly important as U.S. nuclear companies begin to position themselves to participate in the global nuclear renaissance that is unfolding.

• This is a lost business opportunity for America's commercial nuclear industry. If companies can find safe and profitable disposition methods, those companies should be allowed to pursue those opportunities. It is the Nuclear Regulatory Commission's job to ensure that those activities are done safely. Using ones resources to provide cost effective services is how competitive companies succeed. Forcing companies to use more expensive means essentially undermines their competitiveness and will result in lost opportunities. Furthermore, if space is a concern, that's something for the importing company to address, not the government. Specific companies should have the freedom to use their resources, such as space availability, as they deem appropriate. Interestingly, the bill does not prevent the government from importing low-level waste, only the private sector.

• It could add a potential barrier to an emerging industry. Congressman Fred Upton (D-MI) remarked, "The U.S. is on the cusp of a nuclear renaissance … we risk never realizing our full potential on nuclear power." The Congressman is right to be concerned. The legislation essentially precludes American companies from fully participating in a critical sector of the global nuclear industry. Denying a U.S. company from efficiently using its assets in this case, a waste disposal facility disadvantages U.S. companies that are competing with international firms.

• It could hamper the global nuclear energy market. At the end of September 2009, the Department of Energy announced, "U.S. Secretary of Energy Steven Chu and Italian Minister for Economic Development Claudio Scajola today signed two important nuclear energy agreements that may lead to construction of new nuclear power plants and improved cooperation on advanced nuclear energy systems and fuel cycle technologies in both countries." Banning imports of low-level waste would be a step backward after such an important step forward to building an international market for nuclear technologies.

Congress should seek real solutions towards nuclear waste management reform and implement polices that keep U.S. markets open and encourage lower trade barriers around the world. While concerns over safety and space may be legitimate, this policy could have significant long-term implications for the future of nuclear power in America. ■

ElBaradei's Farewell Address to UN

IAEA Needs More Funds to Function Effectively

International Atomic Energy Agency (IAEA) Director-General Mohamed ElBaradei has called for funds for strengthening the global nuclear watchdog to enable it function more effectively.

Delivering his last address to the UN General Assembly on 2 November 2009, before bowing out of office at the end of 12 years as head IAEA, he said, the organization is now a "major player at the centre of issues critical to international peace and security."

Alongside an IAEA beefed-up with funding and authority, reform is required across the UN and in particular at the Security Council. This should lead to a "new global system of collective security" not based on the "insurance policy" of nuclear weapons and driven by mistrust.

ElBaradei called on all states to make a success of the Nuclear non-Proliferation Treaty review conference next year in the light of moves by presidents Barack Obama and Dmitry Medvedev and the Security Council resolution in September to create the conditions for a world without nuclear weapons.

The IAEA's mandate to spread the benefits of nuclear energy, while strictly limiting it to peaceful uses, results in technical cooperation to develop new strains of crops and study fresh water sources, he said. This portion of its role exists on only $96 million per year. A program for cancer therapy is working to expand

facilities in places such as some in Africa where entire countries have no radiotherapy services at all, ElBaradei added.

Another role to prevent illicit trafficking of nuclear materials is also under-funded, he said. "it is disconcerting that nuclear security continues to be funded almost entirely from voluntary contributions, which come with many conditions attached and are both insufficient and unreliable."

These issues were discussed in August, when the IAEA's budget for the next two years was set. But instead of a dramatic increase - as advocated by Obama - a meagre 2.7 percent increase was agreed. Countries were split on whether the IAEA should be boosted immediately, or whether it should refocus and streamline its work first. The agency will have €318 million ($471 million) for 2010 with €354.3 million ($525 million) pencilled in for 2011 while a special committee is set up to determine a final 2011 figure and also consider the period 2012-2013.

Its "dual mandate of security and development is unique," ElBaradei said, expressing disappointment that "we are still fighting the same battles to secure funding as we were back in the 1990s; that the development side of our mandate remains chronically under-funded; and that we still lack adequate legal authority to do our job effectively in verification, safety and security.

In terms of non-proliferation, the IAEA's role has switched from straightforward checking of material inventories at declared sites to verifying the total absence of any undeclared activities. This is impossible, ElBaradei said, without the proper legal status - which it lacks in over 90 states - and independent access to top-quality satellite imagery.

"Our credibility depends on our independence," he said, noting later that the IAEA "must draw conclusions justified by the facts only." This comes in the context of a world where "nuclear power seems set for a significant expansion... with scores of countries expressing interest."

ElBaradei concluded with thanks for the General Assembly and congratulations for his successor Yukiya Amano.

It is clear that ElBaradei hopes Amano will be able to effect funding changes after he takes over at the end of this month. The General Assembly passed a resolution thanking ElBaradei for his "distinguished service" as IAEA Director General and the "indispensable role of the agency."

Think Big, Think Long-Term

Earlier, addressing the agency's general conference, ElBaradei said that, "Without further legal, political and financial resources the IAEA would no longer be fit for purpose.

In his opening speech at the conference, ElBaradei said that the IAEA had "reached a turning point." He said that years of zero growth in funding has meant that the IAEA is currently dependent on voluntary support for "90 percent of our nuclear security program", 30 percent in the field of nuclear safety and 15 percent for verification.

ElBaradei voiced his concern that it "is nearly four years since the UN Secretary General … described the IAEA as an 'extraordinary bargain'," and since then "almost nothing has changed as far as our resources and authority are concerned."

This "troubling dependence" has been assessed by the independent Commission of Eminent Persons, which has recommended that the Technical Cooperation Fund be increased substantially.

ElBaradei stated that the commission's report, published in May, "did not disappoint": the report assessed the role of the IAEA to 2020 and beyond, and

gave a series of recommendations designed to facilitate the Agency's success in the future. "Better equipment, more staff and funding" will be essential to the efficacy of the IAEA.

The report said the financial dependence which burdens the agency is not the only obstacle to be overcome: "more legal authority", the power to negotiate "binding agreements" to counter the threat of nuclear terrorism, and greater "political commitment" will all be necessary to prevent the 'erosion of the effectiveness' of the Agency. ElBaradei also wants to put nuclear disarmament back on the agenda, warning that it had been on the back-burner for far too long.

ElBaradei said that making the IAEA more effective would be crucial to international security. One requirement is a one-off €80 million ($114 million) investment in updating the IAEA laboratories, which are used in safeguards tests of the highest international importance.

Besides powering-up the IAEA in terms of staff, equipment and budget, the commission also recommended a focus on internationalising the fuel cycle for the benefit of 'newcomer' countries entering into nuclear power generation for the first time. These international arrangements should cover both the front- and back-ends of the fuel cycle: producing reactor fuel as well as managing that fuel in the long term once it has been used and is highly radioactive.

"It is time to think big and to think long term," ElBaradei concluded. ■

India Trendsetter in Global N-Boom

SCHOTT's 'Fit & Forget' EPAs Offer Best Bet for N-Reactors

Electrical Penetration Assemblies (EPA) allow for the electrical wiring to pass through the wall of the safety containment structure in nuclear reactors. In an interview with Asian Nuclear Energy, Thomas Fink, Head of the Nuclear Safety Division of the German High-Tech group SCHOTT AG, says glass-to-metal seals are best suited for this. Excerpts.

Mr. Fink, SCHOTT AG is known all over the world as a manufacturer of glasses for Ceran cooktop panels, buildings and reflector telescopes, as well as photovoltaic modules, in more recent times. Probably only very few people know that you also supply products for nuclear power plants.

That is correct. We build Electrical Penetration Assemblies or EPAs for short, through which the control and power cables are guided inside the safety containment structure of the reactor. Conductive feedthroughs are an important part of our business. We not only make them for nuclear power plants, but also for liquefied gas tankers, where they seal off the tanks and guide the electrical wiring to the submersible pump inside the tank. We manufacture millions of units of feedthroughs for encapsulating electronic components for sensors and airbag igniters in automobiles or for optoelectronic components for the telecommunications industry, for example.

What does this have to do with glass?

The unique thing about all of our feedthroughs is that the seal between the conductor and the metal housing is made of glass. Regardless of whether this is intended to be an EPA for nuclear power plants or a housing for a small sensor inside the motor, the principle is always the same: a glass ring is inserted between the conductor and the housing and then melted down. By selecting the appropriate coefficient of thermal expansion, the metal housing presses against the glass ring, which in turn presses against the conductor. This bond remains perfectly sealed even with major leaps in temperature.

What advantages do glass-to-metal feedthroughs offer?

Well, to start with, they are hermetically sealed, which means that gases are unable to permeate the seal. Of course, this applies for the hot steam that results from an accident inside a reactor, as well. Our penetrations have a life span of sixty years and more. The earliest glass-to-metal feedthroughs from SCHOTT in nuclear power plants have been in use for over 40 years and they are a still in use, performing very well. This is why we are sure that they actually last longer than 60 years. We owe their long service life in nuclear power plants to the fact that glass, an inorganic material, is radiation resistant. It doesn't age, neither in response to nuclear radiation, nor shifts in temperature. No other material offers this.

More than 50 nuclear power plants internationally are equipped with EPAs from SCHOTT. Can you tell us more about this?

That's correct. All of the German nuclear power plants since the 1960s have been equipped with our EPAs and since the German Nuclear Safety Standards are amongst of the highest worldwide this makes us very proud. The last few years have clearly shown that our EPAs are, in fact, superior. The operators of 23 nuclear power plants located outside Germany have replaced their old epoxy EPAs with glass-to-metal sealed EPAs from SCHOTT because they apparently had problems with the seals.

This doesn't surprise me, because epoxy is an organic material that ages noticeably when it is subjected to nuclear radiation or high pressures and temperatures. In the meantime, our EPAs have been installed in 50 nuclear power plants internationally.

If glass-to-metal feedthroughs offer so many advantages, why aren't other manufacturers offering them too?

Because they don't have the specialized know-how. One can't just use any type of glass for glass-to-metal seals. You have to know exactly how the glass will react when it is heated up and cools down, for instance, and how well it will work together with certain metal alloys. Here, there are virtually infinite combination possibilities. We have been manufacturing glass-to-metal feedthroughs since 1941 and our scientists and engineers at our research and test centers are constantly striving to further develop and improve the technology designs. Here, however, it is not only important that one has a command of the materials, but also the way in which the cable connection is constructed. For example, we have developed feedthroughs that can be equipped with up to seven modules, whereby one module can accommodate up to 118 conductor feedthroughs. The wires inside and outside of the safety containment structure can be connected quite easily by plugging them in. This is a lot easier and more flexible than the wiring boxes that epoxy EPAs use. We are also in a position to supply feedthroughs for hermetically sealed fiber-optic transmission lines for use in transmitting optical data.

How do you feel that the market for EPAs will develop?

Nuclear energy is experiencing a boom once again all over the world, whereby India certainly plays the role of a trendsetter. Some 40 new reactors are currently under construction on a global basis. Even nations that are seeking to get out of nuclear energy are now either planning or building new reactors. As a result, the market for EPAs will grow and I am confident that SCHOTT will be able to increase its market share rather quickly.

What makes you so certain?

The development of new reactors is working in our favor. The systems of the new generation, such as Gen 3, 3 plus and 4, as well as future generations, will be placing much higher demands on materials. For instance, in current reactors, temperatures reach around 160 degrees Celsius and pressure is around 5 bar when hot steam escapes as a result of an accident. For the next generation reactors, the temperature can increase to 220 degrees in the event of an accident. The pressure requirements are also increasing considerably: to 9.5 bar and even 80 bar in helium-cooled high-temperature reactors. There is no way that epoxy EPAs can handle values like these, while glass-to-metal EPAs from SCHOTT meet these demands quite easily. They can resist pressures of up to 1000 bar and temperature spans ranging from minus 200 to plus 240 degrees Celsius.

We simulate conditions like these in the laboratory by subjecting all of the EPAs to hot steam before we allow them to be shipped. We test for whether they are hermetically sealed with the help of a mass spectrometer that is capable of detecting even the smallest conceivable volumes of a test gas. The electrical properties of the feedthroughs are yet another important aspect of this test.

Because they offer so many advantages, glass-to-metal EPAs are probably a lot more expensive, aren't they?

Not at all. Our products are very competitive, especially when we look at this over their entire lifetime, then EPAs from SCHOTT are actually the best offer because the principle "fit and forget" truly applies to them. And maintenance costs are zero; therefore the total costs are lower. ■

The Dilemma of Aging Nuclear Plants

From the time the world's first commercial nuclear power plants were switched on in the late 1950s, installed generating capacity rose rapidly over two decades. It leveled off in the 1980s as new building programs were scrapped in the wake of the accident at Three Mile Island, among other factors.

Contractors generally designed plants to last for 40 years- a standard enshrined in the United States in the adoption by the Nuclear Regulatory Commission (NRC) of a 40-year licensing regime.

A large part of the world's installed nuclear power capacity is now coming to the end of that designed life span.

Caught between approaching retirement deadlines and public opposition to new plants, industry operators are pushing to extend the life of their plants to 60 or even 80 years - and this despite problems of premature aging of major components that have already obliged many to replace their plants' steam generators at heavy capital expense.

Running plants longer is one way to recoup the extra cost and raise returns on investment over the full life of the plant. But it has safety implications. The 40-year life span was a design specification, said Guillaume Wack, director for nuclear plants at the Autorité de Sûreté Nucléaire, or A.S.N., the French nuclear regulator.

"It's like a car," Wack said in an interview. "The manufacturer says it will run for 100,000 kilometers" 60,000 miles "and last two years. That's the theoretical life. After that, it depends on how you run it. If you drive carefully with regular checkups, it could last much longer. If you drive recklessly and don't maintain it, it will wear out more quickly."

Extending plant life rests on the premise that operators run their plants abstemiously. But utilities, under pressure to maximize short-term profit, are constantly tempted to operate at high output, raising the burn-up of nuclear fuel.

Since the 1970s, regulators and operators have identified premature aging problems including vibrations in pipes, with consequent cracking, leaks and ruptures that in turn cause severe corrosion, leading to worse leaks and ruptures. Some of these result from high fuel burn rates, Wack said.

Stopgap measures like plugging some of the thousands of tubes in the steam generator are allowed by regulatory bodies. But no more than 20 percent can be plugged without impeding the circulation of the steam - and less in some cases - before the generator has to be changed.

The problem is further complicated by the fact that each

reactor heats three or four generators. Anything done to one must also be reproduced on the others in order to avoid pressure imbalances: If one generator has to be changed, all the others must be swapped out, Wack said.

Most plants worldwide have, in fact, already replaced their generators, at a cost of around $50 million for each new generator, after operating for 20 years or less, according to Steve Kerekes, press officer for the Nuclear Energy Institute, an industry lobby group.

While extending the operating life beyond 40 years may help to amortize that cost, it intensifies another problem - finding replacements for other components. Manufacturers are few, and the backlog for many parts is long. The French company Areva, the world's largest supplier of nuclear products and services, has, for example, traditionally supplied Électricité de France, the state-run utility that operates the world's largest nuclear park. But because of rising demand, E.D.F. is now going farther afield, ordering equipment from Mitsubishi of Japan.

Gérard Petit, a senior safety adviser at E.D.F., says this is more a business cost issue than a safety one: The reactor vessel in which the nuclear reaction takes place, like the containment building in which it is housed, is built to last, he says. "The problem is to keep everything else at the same level."

Still, there is no proof that the reactor vessel or the containment building is sufficiently robust to last beyond 40 years. Cracks in vessel heads, the lids that cover reactor vessels, were discovered in various reactors around the world as long ago as 1991, French and U.S. regulatory documents show.

That led E.D.F. to decide to change the heads on most of its reactor vessels a replacement program that is ending just this year, Petit said. Replacement heads cost about $5 million each, Kerekes said.

U.S. operators, on the other hand, did not systematically make the change. As a result, corrosion of a cracked lid at the Davis-Besse plant, in Ohio, came within a centimeter, or less than half an inch, of causing a serious coolant leakage accident in 2002, according to an N.R.C. report.

In addition, N.R.C. documents show, design flaws identified in 1991 raise the specter of possible long-term fatigue degradation in the reactor vessels themselves due to the heat and high radiation to which they are subjected. A leak in the reactor vessel would result in a core meltdown the most serious accident possible with an inevitable release of radioactive materials, Wack said.

This year, some plants in the United States will hit the 40-year mark but will continue to operate under licenses that have already been renewed.

An elaborate and complex U.S. license renewal program introduced by the N.R.C. in 1991 was scathingly criticized in 2007 by the commission's in-house safety auditor, the Office of the Inspector General, for lacking proper documentation and failing to independently verify operator-supplied data. In response, the review process was revised and expanded. But the license renewals of 52 plants half the U.S. nuclear park that were already processed before the revision will not be re-examined, said Travis Tate, a senior official in the commission's license renewal division. Reconsideration was not needed, Tate said, because the revisions merely "clarify the scope of the inspections and reviews necessary," without calling into question the adequacy of the previous process.

Also, Tate said, failure to implement an appropriate age management program would not be a ground for denying a new license. It would simply become a future operating issue, along with other commitments required by the N.R.C for license renewal.

As long as relicensed plants operate without accidents, the regulatory commission will have met its obligation to ensure that operators run their plants safely, he said.

This position has prompted some concern, not least because relicensing approvals have been granted in several cases as much as 20 years before the original licenses expired.

Public Citizen, a consumer advocacy group, in opposing the 2001 renewal of two licenses for the Catawba, South Carolina, nuclear plant, due to expire in 2024 and 2026, asked how the regulators could be certain that the plant would meet requirements that far ahead. In fact, the N.R.C. relies for its decisions on operator-supplied computer models and projections.

The problem with those, said Petit, the E.D.F. safety adviser, was that they might "look good on paper, but you never really know until you actually try it."

In France, which has 58 reactors, plants are submitted to relicensing inspections every 10 years. The first of the 30-year inspections began this year. The inspections, by the A.S.N., take two to three months compared with a typical one-month renewal inspection by the U.S. regulatory agency.

But even that does not necessarily mean that French

plants operate more safely. Efforts by E.D.F. to cut costs by centralizing procurement have led to a years-long dearth of spare parts on the ground, said Pierre Wiroth, who until he retired in July was for seven years E.D.F.'s inspector general, or top safety official. E.D.F. reports around 750 minor "events" every year, classifying them according to an established grid, and a third are subsequently upgraded to a more serious level because they are recurrent, Wiroth said.

In addition to the slow replacement of worn and aging parts, obsolescence is a growing problem. Many control room commands a nuclear plant's nerve center rely, said Scott Burnell, press officer for the U.S. regulator, "on technology that society has moved beyond." The technology is typically analog rather than digital because "with analog, we have a lot of experience" and know how it functions, he said. But the downside of that is that graduates coming out of engineering schools are no longer familiar with analog technology.

Areva and other suppliers are pushing to replace analog with digital systems, perhaps partly because they can charge more for new technology, Wack said. But that also raises an issue of reliability, said Burnell. "With the digital system, instead of having dedicated wires going to a particular place, you can have a small-scale version of Internet where you can have a single set of wires going all around the plant." That could raise the risk of bugs in the system and complicate problem-solving, he said.

Meanwhile, as more and more nuclear engineers reach retirement age, finding replacements to run the plants is problematic. "When you've been trained on the latest technology, the idea of working on outdated equipment or retraining is unappealing," Wack said.

Retiring engineers are increasingly being replaced by outsourcing deals with subcontractors, whose qualifications and competence are less rigorously controlled, said Elizabeth Pozzi, an operating technician at the Dampierre nuclear plant, near Orléans, and a local union official. "In the field, it seems that keeping the plant on line is more important than safety," Ms. Pozzi said. A report by Wiroth last year warned E.D.F. that it should better plan, carry out and supervise subcontracted work.

E.D.F., said Ms. Pozzi, is "not doing anything illegal, but they're using every loophole to push the maintenance boundaries as far as possible. If that's already the case at 30 years, what will it be like at 60?"

In 2006, the attorney general of Connecticut, Richard Blumenthal, requested that the N.R.C. not renew the license for the Indian Point nuclear power plant, located 34 miles north of New York City, when it expired in 2013.

"At Indian Point nuclear power plant, operators have compiled an unacceptable record of abject, repeated, multiyear failure to effectively address vital safety and security issues," he said in testimony to Congress, a view shared by the regulator's own safety auditor in a 2000 report. Blumenthal also cited growth in the region's population since the plant opened as a reason to shut it.

Two months ago, the N.R.C. issued a safety evaluation report for the plant as part of the renewal process. Of the 87 parts of the reactor vessel and related elements examined, all but three showed aging damage, as did 39 out of 44 steam generator components and 57 of 59 structural elements. Still, the report concluded that Indian Point met regulatory standards for license renewal. ■

(Curtsy New York Times, 19 Oct 2009)

India's N-Power Generation Drive Sparks Safety Fears

With the Indian Government launching a massive drive for stepping up the country's nuclear power generation capacity, the issue of nuclear safety has assumed great significance. Some analysts say there could be cause for alarm, given the non-transparent nature of India's state-controlled nuclear energy sector - there is no way to estimate whether safety issues will be carefully followed.

India has embarked on a spending spree since a civilian nuclear deal with the United States last October removed sanctions that had long denied it access to the international atomic energy market. It has signed agreements with an array of nations to share and access nuclear fuel and technologies since the deal was completed. The most significant have been with Russia, the US and France.

The government recently allocated sites for Russian, French and American firms to build five new light-water reactors. French firm Areva is earmarked to build a reactor in Jaitapur in Maharashtra state; Russian firms will build two plants, in Kudankulam, Tamil Nadu, and in Haripur, West Bengal; and US firms are set to build a plant in Kovvada, Andhra Pradesh, and in Chayamithi Virdi, Gujarat.

"This important announcement [of the allocation of sites] comes in welcome recognition of the trust and confidence as well as the growing partnership between our two countries," said United States ambassador to India, Timothy Roemer. He said the power plants would bring greater access to clean and affordable energy and electricity for all Indians as well as create business opportunities for India and the US.

Data on the sector are closely guarded by the nuclear establishment, which functions under the purview of the Department of Atomic Energy (DAE).

The Indian chapter of the International Physicians for Prevention of Nuclear War, in a 2008 survey, found that "sterility was found to be more common in people residing near uranium mining operations." Birth defects and congenital deformities followed a similar pattern.

In the early 1990s, the Tarapur plant near Mumbai leaked radioactivity from faulty cooling systems. Incidents of genetic disorders have been recorded in populations at Rawatbhata in Rajasthan state and in the sea near Kalpakkam in Tamil Nadu, where nuclear power plants are located. In 2004, the Kakrapar-1 reactor in Gujarat was shut down.

In the 1990s, the former chairman of the Atomic Energy Regulatory Board, A Gopalakrishnan, expressed fears about the safety status of some nuclear installations under the DAE.

The government has approved a total of 15 new nuclear

plants to be built at eight different sites, with firms including GE Hitachi, Toshiba Westinghouse, Areva and Rosatom vying for contracts worth an estimated US$100 billion. India has notified the International Atomic Energy Agency of its plans and 14 of its reactors will come under the nuclear watchdog's ambit by 2014.

India has signed nuclear and technology deals with Namibia, Mongolia, Tajikistan, South Korea and Kazakhstan since October, and is close to signing an agreement with Canada. Argentina this month became the latest nation to sign a civil nuclear agreement after the 45-nation Nuclear Suppliers' Group lifted a 34-year-old ban on nuclear commerce with India, in September, 2008.

The chairman of the state-controlled Atomic Energy Commission, Anil Kakodkar, has announced plans to construct four 700-megawatt (MW) pressurized heavy water reactors that could run on indigenous natural uranium as well as imported low-enriched uranium. India's present capacity of electricity production from nuclear power plants is 4,120 MW, but it has targeted 20,000 MW by 2020 and nearly 65,000 MW by 2032, according to the Planning Commission's 2006 integrated energy policy report.

Prime Minister Manmohan Singh recently said that India could increase its atomic electricity generation capacity to 470,000 MW by 2050, if new power plants and technologies were in place. This would translate into nuclear power contributing 40 percent of estimated total power, from 2.7 percent currently.

"This would not only sharply reduce the country's dependence on fossil fuels but also contribute to global efforts to combat climate change," Manmohan said. ■

Australian Firm Revises African Uranium Output Downwards

Australia-based Paladin Energy has announced expansion plans for both its Langer Heinrich and Kayelekera uranium mines, but has revised its 2010 production forecasts downwards.

The company has announced that in-house studies have shown that annual production of around 10 million lb U_3O_8 (3846 tU) at the Langer Heinrich mine in

Namibia would be sustainable for current mineral resources, but the company has decided that production of 9 million lb (3462 tU) per year would achieve the best balance of maximizing value and maintaining a long-term profile. This output would, it says, result in a mine life of 15 years and could also possibly be supplemented by a 1 million lb U_3O_8 (385 tU) per year heap leaching facility. This would represent the fourth wave of expansion at the mine.

Quarterly results just released by Paladin show the mine to be operating at 90 percent of its current nameplate capacity, and it should achieve its full 3.7 million lb (1423 tU) per year capacity by the end of 2009, says Paladin.

Although the ramp-up of production at the Kayelekera mine in Malawi is behind schedule, Paladin says that it is still on target to reach its nameplate capacity of 3.3 million lb (1270 tU) per year by March 2010. The company says it will also conduct an optimization study to exploit additional resources by extending the current pit, with the target of increasing production to 3.8 million lbs (1462 tU) per year by 2012.

In total, the expansion plans would see Paladin's African projects producing approximately 13.8 million lb U_3O_8 (5308 tU) per year by mid-2014. Nevertheless, the company has revised its overall production projections for the 2010 financial year from 6.6 million lb U_3O_8 (2540 tU) down to 5.6-6.1 million lb (2154-2346 tU), citing slower than expected production ramp-ups. ■

IOCL Poised to Play Big Role in India's N-Power Development

Indian Oil Corporation Ltd (IOCL) has positioned itself for involvement in the country's growing nuclear sector while India's cooperation deals in this field continued.

India's national oil company has recently joined with Nuclear Power Corporation of India Ltd (NPCIL) in a memorandum of understanding "for partnership in setting up nuclear power plants in India."

30 Units in Offing

India's nuclear sector is in the early stages of a construction boom. Three reactors of domestic design are nearing completion at Rajastan and Kaiga, while two large Russian units are being built at Kudankulam. On top of this will come a major expansion based on imported technology with Areva, GE-Hitachi, and Westinghouse already lined up to provide as many as six or eight large reactors each. Two more Russian units are already agreed, taking the total potential build to around the 30 unit mark.

However, no commercial contracts for reactors have been completed because India has not yet passed an appropriate nuclear liability law or brought into force its safeguards agreement with the International Atomic Energy Agency (IAEA). Similarly, a legislative change is required before privately owned companies can take stakes in nuclear facilities. A number of power companies and industrial interests have been circling the new nuclear opportunities and NPCIL has already signed a memo with National Thermal Power Corporation (NTPC) to form a nuclear joint venture.

Indian Oil Corporation is the largest company in India. Serving national interests in accordance with government policies is among its official objectives, as is taking all viable opportunities arising out of the government policy.

Meanwhile, yet another nuclear deal has been signed in New Delhi, envisaging cooperation in fusion research between India and the European Union. The agreement concerned the exchange of information and data and enabling the participation of specialists in different research activities.

One notable country that has not completed a bilateral nuclear cooperation deal with India is major uranium exporter Canada. An official visit of the Canadian Prime Minister scheduled for 16-18 November is expected to yield this agreement, and at the same time provide an opportunity for Cameco and NPCIL to agree a major supply contract. ■

UAE Developing Technicians to Work in Domestic N-Industry

Applications are being taken for the second batch of nuclear students in the United Arab Emirates as the first batch begins its studies. The program provides UAE nationals with a full scholarship to enrol in some of the world's finest universities and pursue a Bachelors or Masters degree in nuclear, mechanical, or electrical engineering. Once the studies are complete, the selected UAE national scholars will work in the UAE's growing nuclear energy industry.

The first year of the UAE nuclear scholarship program launched in May 2009 and received more than 500 applications. After a rigorous selection process, 38 students were ultimately awarded the scholarships. These students have now begun their course work at a number of leading institutions in the UAE, France, the UK and the USA, including Paris Orsay University and Georgia Tech.

The Emirates Nuclear Energy Corporation (Enec), Khalifa University for Science, Technology and Research (Kustar)

and the Federal Authority for Nuclear Regulation (FANR) announced yesterday the opening of admissions for the second round of the annual scholarship programme.

In order to gain admission, applicants must meet several minimum requirements that demonstrate English proficiency and academic achievement. Scholars are then invited for interviews with a panel of ENEC and FANR training specialists and KUSTAR professors. The interviews are used to select the final candidates based on academic performance, and their willingness and motivation to join the program and eventually the UAE nuclear energy industry.

Fahad Al Qahtani, ENEC's media relations manager, said: "This initiative is a testament to the Government of Abu Dhabi's commitment to develop a highly skilled workforce in the UAE to lead the future of the UAE nuclear energy industry for years to come."

He added, "We have consistently been impressed with the calibre of students enrolled in this program and we look forward to welcoming the newest class of leading students to join the nuclear industry in the UAE. The participation of talented UAE Nationals is critical to the long-term success of the UAE nuclear energy program and Emirates Nuclear Energy Corporation is committed to supporting this next generation of leaders."

According to the UAE government's July 2008 statement on nuclear policy, the country's energy demand is likely to double by 2020. Natural gas supplies are only likely to be able to meet half of the projected growth, and nuclear is seen as a proven, competitive option to meet the demand while providing future energy security. The UAE is therefore actively working towards introducing nuclear power with plans for three reactors to be online by 2020. It has signed cooperation agreements and memoranda of understanding with a number of countries and companies including France, the UK and the USA.

Companies including Areva, General Electric and Korea Electric Power Co are bidding for contracts worth an estimated $40 billion to construct the UAE's first reactors. The UAE government was expected to take a decision on these bids in mid-September and, although it could not meet that deadline, a decision is said to be coming soon. ■

NPCIL Assessing Orissa State's Potential for N-Power Complex

A site in India's eastern state of Orissa is under investigation for suitability for a 4000 to 6000 MWe nuclear power complex, according to the local State Government Energy Minister Surya Narayan Patro.

The potential complex at Pati Sonapur in Orissa's Ganjam district, would be India's largest by far, providing on its own more than the country's entire current nuclear capacity, including the new capacity is under construction.

Patro told the State Assembly that Nuclear Power Corporation of India Limited (NPCIL) had already proposed a drilling program to assess the site's suitability. In remarks made to reporters, the Minister said the State had taken no decision on the NPCIL proposal, and that the region was a "thickly populated area."

S. Thakur of NPCIL told a newspaper: "In anticipation of India being able to get international cooperation and access to nuclear technology, we are thinking of setting up large capacity nuclear power plants." He added that Orissa's coal reserves had made that resource the most economic for power production, but that access to the international market in uranium would make nuclear power more competitive in the region.

Orissa is a state on India's east coast, densely populated with over 36 million people and holding a large share of India's mineral resources. It is a rapidly emerging industrial area, earmarked for Special Economic Zone status. Up to $90 billion of investment in heavy industry is planned, including several extremely large aluminium, steel and petrochemical plants. It was the first Indian state to privatize its electricity transmission and distribution.

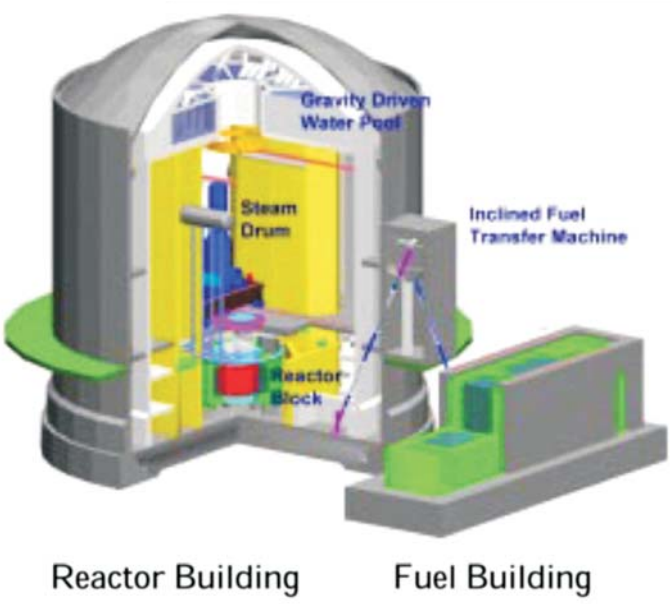
The state's electricity demand is projected at 17.5 TWh for 2007-8, with that to grow by 12.5 percent to 19.7 TWh in 2008-9. In 2008 the Orissa Electricity Regulation Commission expects 18.1 TWh to be generated, with the surplus sold across India's eastern grid.

To keep up with demand, Patro said independent power producers had signed 13 memoranda of understanding with the state to build generation capacity of 16,000 Mwe. ■

India Plans Exports of AHW Reactors Fuelled by LEU

India has announced intentions to export power reactors to other nations and is developing an advanced design for that purpose.

Chairman of India's Atomic Energy Commission Anil Kakodkar has announced recently in Vienna a special version of the forthcoming Advanced Heavy Water Reactor (AHWR) adapted to use low-enriched uranium (LEU) fuel.



The original design is fuelled by a mix of uranium-233 and plutonium bred from thorium using fast neutron power reactors earlier in a thorium fuel cycle. The LEU variant is suitable for export because it does away with the plutonium, replacing it with uranium enriched to 19.75 percent uranium-235.

Producing 300 MWe, the unit is less than one third the capacity of a typical large reactor. It is designed to operate for up to 100 years and has a "next generation" level of safety that grants operators three days' grace in the event of a serious incident and requires no emergency planning beyond the site boundary under any circumstances.

The design is intended for overseas sales, and the AEC says that "the reactor is manageable with modest industrial infrastructure within the reach of developing countries."

The new fuel mix, AEC said, produces less plutonium than mainstream light-water reactors and what it does produce contains three times the proportion of plutonium-238, lending it proliferation resistance. Furthermore, it leaves only half the amount of long-lived radioactive waste per unit of energy compared to mainstream light-water reactors.

As well as introducing India as a potential new major player in reactor sales - especially to new markets - the announcement reaffirms India's commitment to proceeding with the thorium fuel cycle using the original AHWR as the final stage.

India was effectively isolated from international nuclear trade from 1992 until early this year when a US-led initiative resulted in special arrangements for India under the Nuclear Supliers Group, based on an India-specific safeguards agreement with the International Atomic Energy Agency. Overseas firms can now do business with India, which is keen to import uranium and large power reactors. In turn, India may now offer its goods and services to the wider world.

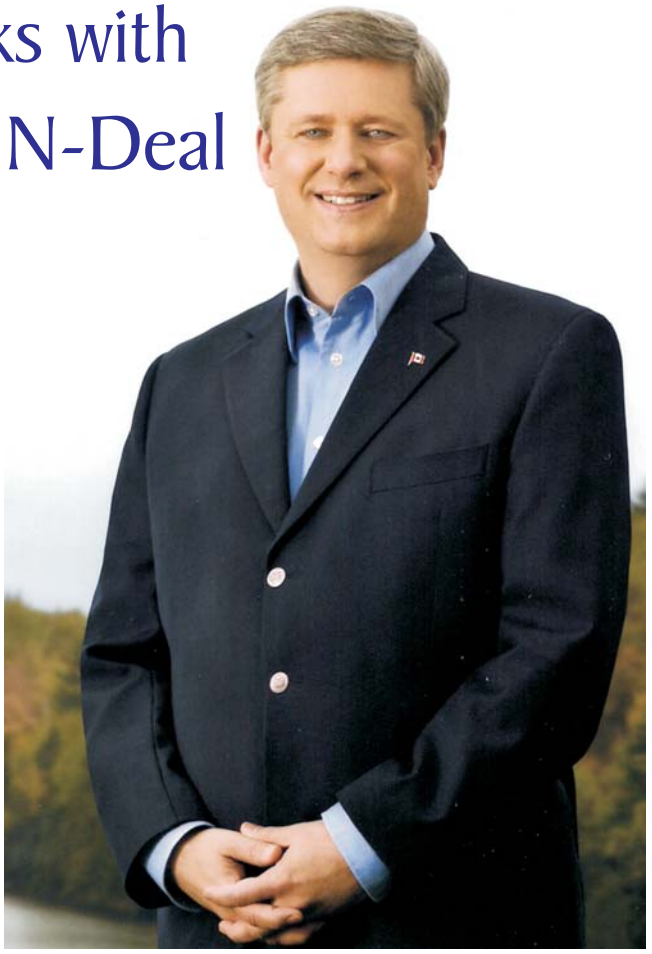
The long-term goal of India's nuclear program has been to develop an advanced heavy-water thorium cycle. The first stage of this employs the pressurized heavy-water reactors and light water reactors, to produce plutonium.

Stage two uses fast neutron reactors to burn the plutonium and breed uranium-233 from locally mined thorium. The blanket around the core will have uranium as well as thorium, so that further plutonium is produced as well.

In stage three, AHWRs burn the uranium-233 from stage two with plutonium and thorium, getting about two thirds of their power from the thorium.

The first AHWR is meant to start construction in 2012, although no site has yet been announced. A prototype 500 MWe fast neutron reactor being built at Kalpakkam should be complete in 2011. ■

Canadian Firm in Talks with Indian Cos Ahead of N-Deal



India and Canada are in talks to sign a nuclear cooperation pact soon. Canadian Prime Minister Stephen Harper is visiting India on 15 and 16 November, 2009 and the deal in all likelihood will be signed then. Meanwhile, Atomic Energy of Canada Ltd, or AECL, is in talks with three private sector Indian power generation companies, including Anil Ambani's Reliance Power Ltd, for setting up nuclear power generation plants based on its Candu (Canada Deuterium Uranium) reactor.

The Candu pressurized heavy water reactor technology, developed by Canada and currently meeting around 16 percent of that country's electricity demand, is marketed worldwide by AECL. India has developed expertise in the whole lifecycle of a nuclear programme, including life extension of pressurized heavy water reactors.

"We are in talks with three Indian private sector firms who have plans to set up nuclear power projects," said Hugh MacDiarmid, President and CEO of state-run AECL, on his recent visit to India. "There is mutual synergy between our markets."

Industry sources confirmed preliminary talks between AECL and Reliance Power. Under the current policy guidelines in India, atomic energy is exclusively reserved for execution only by Nuclear Power Corporation of India Ltd (NPCIL), a public sector company under the Department of Atomic Energy (DAE).

This will change as part of the planned opening up of the sector following the civilian nuclear energy agreement with the US, freeing up overseas companies to enter the country.

"The private sector is doing the preparatory work. As contractors they have come in quickly, but as developers they will take some time. For that the present laws, rules and regulations need to be changed," said Anish De, Chief Executive at Mercados Asia, an energy consultancy firm. "Reliance Power has been at it for the last few years. However, the timing will depend upon the change in regulations."

The participation of the private sector and other PSUs is expected to increase with the expected changes in the legal and policy framework, the effects of which will only be visible by 2019.

The participation of private firms is expected to give a boost to the sector once the government liberalizes rules governing atomic energy. Private sector power firms such as Tata Power Co. Ltd, GMR Energy Ltd, Jindal Steel and Power Ltd, JSW group, NTPC Ltd, Vedanta Resources Plc and Reliance Power have earlier evinced interest in setting up nuclear power plants once this takes place.

AECL is seeking opportunities in the Indian market, given the significant demand for electricity in the country and its inability to sell a single reactor in the last 10 years. Out of India's installed power generation capacity of nearly 150,000 MW, nuclear energy accounts for only 4,120 MW, even as it tries to close the gap between galloping demand and deficient supply.

According to the India Energy Outlook report by audit and consulting firm KPMG, the department of atomic energy hopes to build 250,000 MW equivalent of nuclear power capacity by 2050 to meet the country's long-term electricity requirements. ■

N-Energy to Power N-Tech Professional Job Market

Students of engineering have a wider choice these days with the nuclear energy getting a boost as an industry with greater involvement of the private sector in it. The added choice is nuclear technology as subject of specialization for aspiring engineering students in Indian universities.

With the government planning a five-fold increase in the existing nuclear power capacity by 2020 and a strong interest by global majors to shift manufacturing operations to India, it is estimated that the country would require about 2,000 trained nuclear engineers every year to staff the increased capacity.

Currently, the number of specialist nuclear post-graduates and PhDs from IITs and other universities is only about 50 every year. The supply is limited as only a few IITs Kanpur and Mumbai the Indian Institute of Science, Bangalore and few other universities offer specialized courses. In addition, Nuclear Power Corporation of India Ltd. (NPCIL), the sole nuclear power generator in the country, has a capacity to train 250 people annually, while the Department of Atomic Energy (DAE) schools around 500-700 people every year.

"The existing situation (for trained nuclear technologists) is stretched," says L&T board member MV Kotwal. "If BARC (Bhabha Atomic Research Centre) opens its training facilities for non-BARC students also, it could help the industry," he added. L&T is spearheading the private sector's thrust into nuclear power generation. The government plans to add 20,000 mw of nuclear power generation capacity by 2020, after India and the US jointly agreed last year to cooperate on civil nuclear energy programme. India also signed a similar agreement with France and Russia.

Additional trained manpower requirement for supporting proposed nuclear power generation projects is in the range of 10,000 to 19,000 people (based on the norm of 1 to 1.4 person per mw), says a recent PricewaterhouseCoopers India report.

"The industry usually hires and trains such professionals in-house," says Kameswara Rao, Executive Director, PricewaterhouseCoopers India. The attrition in this sector is the lowest at about 3-5 percent, while it is as high as 10-12 percent in other streams of engineering.

Adding to the demand for trained nuclear technologists is the spate of joint ventures that were recently signed by L&T, BHEL, NPCIL and others. ■

Finance - Single Largest Snag in US N-Industry Growth: NEI

The Nuclear Energy Institute (NEI) of the United States, an industry body, has drawn up a package of policy initiatives to facilitate the expansion of the country's nuclear energy industry. The group says that federal policy in a number of areas, particularly financing, is required for such an expansion.

The NEI says that independent analyses conclude that a major expansion in the USA's use of nuclear energy is needed over the next 30-50 years in order to meet future electricity demand while reducing greenhouse gas emissions. The Waxman-Markey climate bill passed by the House of Representatives last June and the Senate climate legislation unveiled in recent weeks both call for an 83% cut in greenhouse gas emissions by 2050.

The US Environmental Protection Agency determined in its evaluation of the Waxman-Markey bill that under the core policy scenario to reduce emissions, nuclear power generation would increase 150 percent - the equivalent of 187 new reactors - by 2050. Meanwhile, the Electric Power Research Institute concluded this year that the potential exists for the electric sector to achieve a 41 percent reduction in carbon dioxide emissions from 2005 by 2030 using a full portfolio of technologies that include 46 new reactors. Similarly, the Department of Energy's Energy Information Administration, in its analysis of Waxman-Markey, determined that the basic scenario projects that the USA would need nearly 70 new reactors (totalling 96,000 MW of new generating capacity) by 2030.

The NEI said, "A program to expand reliance on nuclear energy to meet US climate change goals, even if it only approaches this scale, will require a sustained partnership between federal and state governments and the private sector, including additional support from the federal government."

Financing, the NEI says, is "the single largest challenge to accelerated deployment of new nuclear power plants. The financing challenge is structural." It added that the cost of new nuclear power reactors - some $6 to $8 billion each - is very high, especially for the utilities proposing to build them, which are "relatively small companies." The NEI said that these companies "do not have the size, financing capability or financial strength to finance power projects of this scale on their own, in the numbers required."

The current loan guarantee program of $18.5 billion is "clearly inadequate", the NEI said, adding that a program of at least $100 billion is required for clean energy technologies, including nuclear. It called new plant financing arrangements, principally through the creation of a Clean Energy Deployment Administration that would function as a permanent financing platform. It also called for tax incentives for nuclear energy manufacturing and production facilities, as well as a streamlined licensing process for new reactors. The NEI also called for legislation to support the development of voluntary used fuel interim storage facilities.

Marvin Fertel, NEI's president and CEO, said: "If you want to address climate change and produce electricity, nuclear energy has got to be a significant part of the equation." He added, "Inclusion of a meaningful nuclear energy title by itself doesn't get you to an agreement in Congress on climate change legislation. But at the same time, you can't get there without it."

Responding to the NEI's proposals, Energy Secretary Steven Chu was quoted as saying that the Obama administration is "looking at all the things that are within our control to actually restart the nuclear industry." He said, "I would say that in order to really restart in a serious way you might want more than just three or four (new nuclear plants) in order to get it going."

UK Govt Initiates Huge N-Power Expansion Plan, Names 10 Sites

A huge expansion of nuclear power has been initiated by the British Government as it named 10 sites where new power stations could be built, including Sellafield, in Cumbria, Heysham, in Lancashire, Sizewell, in Suffolk, and Hinkley Point, in Somerset. Nine of the new sites are in England, including three in Cumbria, with the 10th in Anglesey, North Wales.

The first is set to be operational by 2018 and, by 2025, nuclear electricity generation could amount to around 40 percent of new energy provision.

Ed Miliband, the Energy and Climate Secretary, also set out an "ambitious" new policy for the transition to clean-coal generation, as well as confirming targets for generating 30 percent of electricity by renewable sources by 2020.

The announcements were coupled with moves aimed at speeding up planning decisions on new energy projects aimed at cutting decisions to one year.

Miliband said significantly more generating capacity was needed in the long term to meet the UK's low-carbon energy challenge, partly because of the intermittency of wind generation.

One third of future generating capacity must be given consent and built by 2025, said the minister, adding: "While there are already proposals to build more energy infrastructure, more is needed to bring about the shift to a low-carbon future."

Miliband said a series of policy statements published by the Government on 9 November 2009 included a clear direction towards a "massive expansion" in renewables, a new nuclear programme based around 10 sites, as well as moves to introduce clean-coal technology.

The 10 sites named today are at Braystones, Sellafield and Kirksanton, all in Cumbria, Heysham in Lancashire, Hartlepool, Co Durham, Sizewell in Suffolk, Bradwell in Essex, Hinkley Point in Somerset, Oldbury in Gloucestershire and Wylfa in Anglesey.

An 11th site was put forward earlier this year by energy companies as a possible location for a new nuclear power station, but the Government announced that the site at Dungeness in Kent had not been included in the current list because of concerns about coastal erosion and flood risk.

Three other potential sites were also looked at, but they were found not to be suitable. These sites were at Druridge Bay in Northumberland, Kingsnorth in Kent and Owston Ferry in South Yorkshire.

Miliband said: "The threat of climate change means we need to make a transition from a system that relies heavily on high-carbon fossil fuels to a radically different system that includes nuclear, renewable and clean-coal power.

"Change is also needed for energy security. In a world where our North Sea reserves are declining, a more diverse, low-carbon energy mix is a more secure energy mix, less vulnerable to fluctuations in the availability of any one fuel," he added.

Miliband said the current planning system was a "barrier" to this shift in emphasis, maintaining that it served neither the interests of energy security nor of people living in areas where new stations might be built.

"That is why we are undertaking fundamental reform of the planning system, which will result in a more efficient, transparent and accessible process."

Miliband said a faster planning system would save UK industry up to £300 million a year in "unnecessary expense".

John Healey, the housing and planning minister, said: "Instead of major projects going through three, four or five separate applications, there is now one single consent system, with one full expert and public examination."

Miliband added that he was setting out the most "environmentally ambitious" set of coal conditions for new stations of any country in the world. "No new coal plants will be given consent unless they can use carbon capture and storage.

"A programme of up to four projects will be funded and the demonstration plants should be in use by 2025."

Nuclear Power Safe: Miliband

Miliband insisted that nuclear energy is safe as he prepares to unveil a new generation of power stations.

Speaking on BBC Breakfast, he said that the economy and environment made the case for nuclear power

overwhelming. Miliband added: “I do understand the anxieties that there are because there have been concerns about nuclear power.

“I think it is right that we go ahead with this. It has a good safety record. There is no evidence that people's fears about nuclear are grounded, in my view. We can deal with the fears that people have.”

Miliband dismissed concerns about a new planning body, which will be announced to Parliament later alongside the locations of the next generation of nuclear plants, saying that local residents would be consulted more than ever before.

Greg Clark, the shadow energy secretary, said that the Government was rushing through nuclear stations without consulting Parliament or the public because it had failed to act earlier to ensure that the lights did not go out when the current generation of nuclear stations came to an end.

He told Radio 4's Today Programme: "It is a national emergency and it's been left far too late - we've known for the last 10 years that most of our nuclear power fleet would come to the end of its planned life.

"We've got a black hole, but actually we do need a different planning system, we need a fast track for major items of infrastructure.

"The trouble with the way the Government's doing it is, it has no democratic component. The statements will just be read out to MPs without a vote and the decisions will be taken by an unelected, unaccountable official.

"We think it should be a minister taking that decision, accountable to Parliament, with the necessary time limit, about three months, so it doesn't delay the process. But it does need to have democratic legitimacy otherwise people will find this an imposition that they will rail against."

The new planning body, the Infrastructure Planning Commission, is designed to fast-track major decisions by referring to six national energy statements, in key areas such as renewables and gas as well as nuclear, which will be unveiled by Miliband.

In the nuclear statement, he will say which proposed sites from a shortlist of 11 have been given the go-ahead. Successful candidates are thought to include a location near an existing plant at Hinkley Point, in Somerset, and two new sites close to the Sellafield power station in Cumbria.

Green groups say that the plans are unnecessary. Robin Oakley, head of climate and energy campaigns at Greenpeace, said: "Nuclear is a dangerous and expensive irrelevance to tackling climate change and providing real energy security.

"We don't need coal or nuclear, because proven green technologies such as wind and combined heat and power stations can secure Britain's energy needs, create green jobs and slash our emissions."

Labour's nuclear negligence

The London Telegraph has said in its editorial comment: No industry is more strategically important than energy, yet ministers dithered for 10 years before authorizing a new generation of nuclear plants.

When Ed Miliband, the Energy Secretary, sets out his plans for a new generation of nuclear reactors today, he will be forced to admit that some of them may have to be located on greenfield sites. The 11 locations at, or adjacent to, existing nuclear plants that earlier this year were earmarked for possible expansion may not be enough to meet future capacity requirements.

Resistance to such a move will be intense, both from environmental groups and local communities. Miliband will hope that the new Infrastructure Planning Commission, set up to short-circuit a planning process that has traditionally worked at a snail's pace, will succeed in preventing interminable delays. It needs to. For time is fast running out if the looming energy gap is to be filled before the lights start going out.

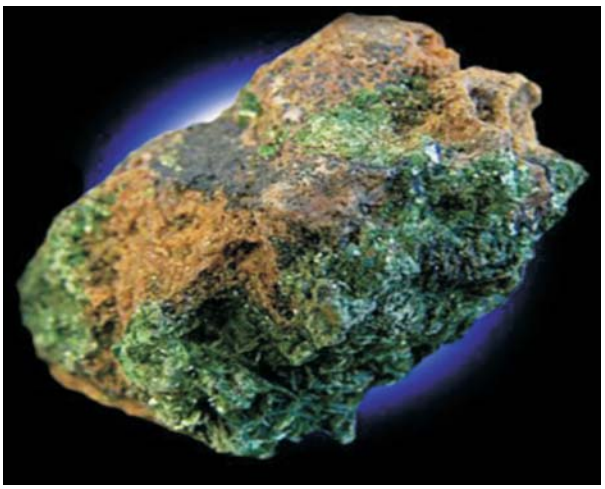
The Cost of Policy Delay

According to the Government's own Low Carbon Transition Plan, published in the summer, just eight years from now there will be unmet demand in UK generating capacity of 3,000 megawatt the equivalent of blacking out a city the size of Nottingham for 24 hours. The Government has only itself to blame for this lamentable state of affairs.

No industry is more strategically important than energy, yet ministers dithered for 10 years before authorising a new generation of nuclear plants. With half our ageing reactors due to be decommissioned within the next six years, this vital decision should have been taken at the start of the decade, not at the end of it. Such negligence, born of political timidity, is unforgivable. It has dealt Miliband an exceedingly tough hand. A controversial nuclear programme that should have been put in place in a measured way after proper debate is now having to be rushed through. This Government really knows how to make things difficult for itself. ■

All about Uranium, the Critical Raw Material for N-Energy

Uranium, the critical raw material required for the production of nuclear energy, is very much in the news in India these days. First, India has taken a major initiative to expand nuclear power generation capacity, using uranium. Second, India commanding only over percent of the global uranium resources, is in dire need of this material. In order to carry forward its nuclear power programme, India has signed deals with countries endowed with uranium for its supply.



According to the World Nuclear Association

• Uranium is a relatively common metal, found in rocks and seawater. Economic concentrations of it are not uncommon.

• Its availability to supply world energy needs is great, both geologically and because of the technology for its use.

• Quantities of mineral resources are greater than commonly perceived.

• The world's known uranium resources increased 15 percent in two years to 2007 due to increased mineral exploration.

Uranium is ubiquitous on the Earth. It is a metal approximately as common as tin or zinc, and it is a constituent of most rocks and even of the sea. Some typical concentrations are: (ppm = parts per million).

An orebody is, by definition, an occurrence of mineralisation from which the metal is economically recoverable. It is therefore relative to both costs of extraction and market prices. At present neither the oceans nor any granites are orebodies, but conceivably either could become so if prices were to rise sufficiently.

Measured resources of uranium, the amount known to be economically recoverable from orebodies, are thus also relative to costs and prices. They are also dependent on the intensity of past exploration effort, and are basically a statement about what is known rather than what is there in the Earth's crust.

Changes in costs or prices, or further exploration, may alter measured resource figures markedly. At ten times the current price, seawater might become a potential source of vast amounts of uranium. Thus, any predictions of the future availability of any mineral, including uranium, which are based on current cost and price data and current geological knowledge are likely to be extremely conservative.

From time to time concerns are raised that the known resources might be insufficient when judged as a multiple of present rate of use. But this is the Limits to Growth fallacy, a major intellectual blunder recycled from the 1970s, which takes no account of the very limited nature of the knowledge we have at any time of what is actually in the Earth's crust. Our knowledge of geology is such that we can be confident that identified resources of metal minerals are a small fraction of what is there.

Uranium availability

With those major qualifications the following Table gives some idea of our present knowledge of uranium resources. It can be seen that Australia has a substantial part (about 23 percent) of the world's low-cost uranium, Kazakhstan 15 percent, and Canada 8.0 percent.

Known Recoverable Resources* of Uranium 2007

	tonnes U	percentage of world
Australia	1,243,000	23%
Kazakhstan	817,000	15%
Russia	546,000	10%
South Africa	435,000	8%
Canada	423,000	8%
USA	342,000	6%
Brazil	278,000	5%
Namibia	275,000	5%
Niger	274,000	5%
Ukraine	200,000	4%
Jordan	112,000	2%
Uzbekistan	111,000	2%
India	73,000	1%
China	68,000	1%
Mongolia	62,000	1%
other	210,000	4%
World total	5,469,000	

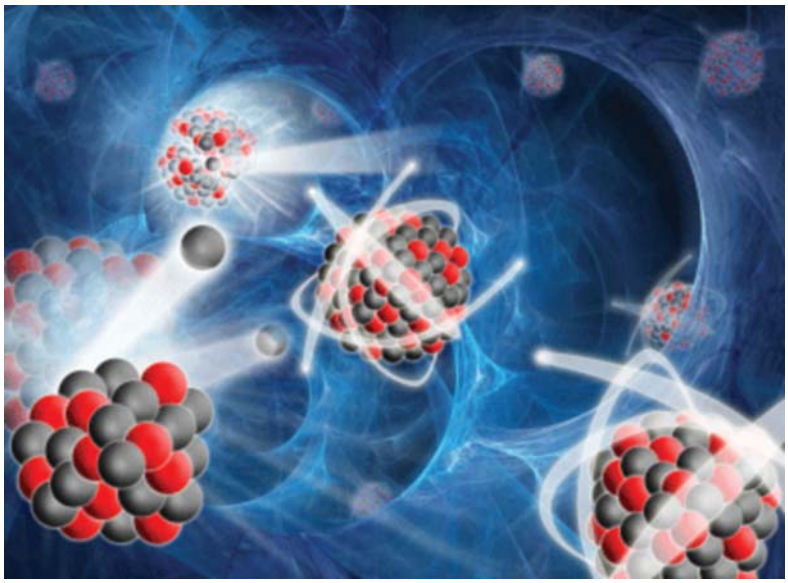
Reasonably Assured Resources plus Inferred Resources, to US$ 130/kg U, 1/1/07, from OECD NEA & IAEA, Uranium 2007: Resources, Production and Demand ("Red Book").

Current usage is about 65,000 tU/yr. Thus the world's present measured resources of uranium (5.5 Mt) in the cost category somewhat below present spot prices and used only in conventional reactors, are enough to last for over 80 years. This represents a higher level of assured resources than is normal for most minerals. Further exploration and higher prices will certainly, on the basis of present geological knowledge, yield further resources as present ones are used up.

An initial uranium exploration cycle was military-driven, over 1945 to 1958. The second cycle was about 1974 to 1983, driven by civil nuclear power. There was relatively little uranium exploration between 1985 and 2003, so the significant increase in exploration effort that we are now seeing could readily double the known economic resources. In the two years 2005-06 the world's known uranium resources tabulated above increased by 15 percent (17 percent in the cost category to $80/kgU). World uranium exploration expenditure in 2006 was US$ 774 million, and the 2007 level was much the same. In the third uranium exploration cycle from 2003 to the end of 2009 about US$ 3.4 billion will have been spent on uranium exploration and deposit delineation on over 600 projects. In this period over 400 new junior companies were formed or changed their orientation to raise over US$ 2 billion for uranium exploration. About 60 percent of this was spent on previously-known deposits. All this was in response to increased uranium price in the market.

The price of a mineral commodity also directly determines the amount of known resources which are economically extractable. On the basis of analogies with other metal minerals, a doubling of price from present levels could be expected to create about a tenfold increase in measured economic resources, over time, due both to increased exploration and the reclassification of resources regarding what is economically recoverable.

This is in fact suggested in the IAEA-NEA figures if those covering estimates of all conventional resources are considered - 10.5 million tonnes (beyond the 5.5 Mt known economic resources), which takes us to over 200 years' supply at today's rate of consumption. This still ignores the technological factor mentioned below. It also omits unconventional resources such as phosphate/



phosphorite deposits (22 Mt U recoverable as by-product) and seawater (up to 4000 Mt), which would be uneconomic to extract in the foreseeable future.

It is clear from this figure that known uranium resources have increased threefold since 1975, in line with expenditure on uranium exploration. (The decrease in the decade 1983-93 is due to some countries tightening their criteria for reporting. If this were carried back two decades, the lines would fit even more closely.) Increased exploration expenditure in the future is likely to result in a corresponding increase in known resources.

About 20 percent of US uranium came from central Florida's phosphate deposits to the mid 1990s, as a by-product, but it then became uneconomic. With higher uranium prices today the resource is being examined again, as is another lower-grade one in Morocco. Plans for Florida extend only to 400 tU/yr at this stage.

Coal ash is another easily-accessible though minor uranium resource in many parts of the world. In central Yunnan province in China the coal uranium content varies up to 315 ppm and averages about 65 ppm. The ash averages about 210 ppm U (0.021%U) - above the cut-off level for some uranium mines. The Xiaolongtang power station ash heap contains over 1000 tU, with annual arisings of 190 tU. Recovery of this by acid leaching is about 70 percent.

Widespread use of the fast breeder reactor could increase the utilisation of uranium 50-fold or more. This type of reactor can be started up on plutonium derived from conventional reactors and operated in closed circuit with its reprocessing plant. Such a reactor, supplied with natural or depleted uranium for its "fertile blanket", can be operated so that each tonne of ore yields 60 times more energy than in a conventional reactor.

Reactor Fuel Requirements

The world's power reactors, with combined capacity of some 370 GWe, require about 65,000 tonnes of uranium from mines or elsewhere each year. While this capacity is being run more productively, with higher capacity factors and reactor power levels, the uranium fuel requirement is increasing, but not necessarily at the same rate. The factors increasing fuel demand are offset by a trend for higher burn-up of fuel and other efficiencies, so demand is steady. (Over the years 1980 to 2008 the electricity generated by nuclear power increased 3.6-fold while uranium used increased by a factor of only 2.5.)

Reducing the tails assay in enrichment reduces the amount of natural uranium required for a given amount of fuel. Reprocessing of spent fuel from conventional light water reactors also utilizes present resources more efficiently, by a factor of about 1.3 overall.

Today's reactor fuel requirements are met from primary supply (direct mine output) and secondary sources: commercial stockpiles, nuclear weapons stockpiles, recycled plutonium and uranium from reprocessing used fuel, and some from re-enrichment of depleted uranium tails (left over from original enrichment). These various

secondary sources make uranium unique among energy minerals.

Nuclear Weapons as a Source of Fuel

An important source of nuclear fuel is the world's nuclear weapons stockpiles. Since 1987 the United States and countries of the former Soviet Union have signed a series of disarmament treaties to reduce the nuclear arsenals of the signatory countries by approximately 80 percent.

The weapons contain a great deal of uranium enriched to over 90 percent U-235 (ie up to 25 times the proportion in reactor fuel). Some weapons have plutonium-239, which can be used in mixed-oxide (MOX) fuel for civil reactors. From 2000 the dilution of 30 tonnes of military high-enriched uranium has been displacing about 10,600 tonnes of uranium oxide per year from mines, which represents about 13 percent of the world's reactor requirements.

Other Secondary Sources of Uranium

The most obvious source is civil stockpiles held by utilities and governments. The amount held here is difficult to quantify, due to commercial confidentiality. As at January 2007 some 55,000 tU was known on the basis of partial data (Red Book) and 120,000 tU estimated just for utilities (WNA Market Report). These reserves are expected not to be drawn down, but to increase steadily to provide energy security for utilities and governments.

Recycled uranium and plutonium is another source, and currently saves 1500-2000 tU per year of primary supply, depending on whether just the plutonium or also the uranium is considered. In fact, plutonium is quickly recycled as MOX fuel, whereas the reprocessed uranium (RepU) is mostly stockpiled.

Re-enrichment of depleted uranium (DU) is another secondary source. There is about 1.5 million tonnes of depleted uranium available, from both military and civil enrichment activity since the 1940s, most at tails assay of 0.25 - 0.35 percent U-235. Non-nuclear uses of DU are very minor relative to annual arisings of over 35,000 tU per year. This leaves most DU available for mixing with recycled plutonium on MOX fuel or as a future fuel resource for fast neutron reactors. However, some that has relatively high assay can be fed through under-utilised enrichment plants to produce natural uranium equivalent, or even enriched uranium ready for fuel fabrication. Russian enrichment plants have treated 10-15,000 tonnes per year of DU assaying over 0.3percent U-235, stripping it down to 0.1 percent and producing a few thousand tonnes per year of natural uranium equivalent. This Russian program is due to wind down, however, but a new US one is expected to start, treating about 140,000 tonnes of old DU assaying 0.4percent U-235.

Thorium as Nuclear Fuel

Today uranium is the only fuel supplied for nuclear reactors. However, thorium can also be utilized as a fuel for CANDU reactors or in reactors specially designed for this purpose. Neutron efficient reactors, such as CANDU, are capable of operating on a thorium fuel cycle, once they are started using a fissile material such as U-235 or Pu-239. Then the thorium (Th-232) atom captures a neutron in the reactor to become fissile uranium (U-233), which continues the reaction. Some advanced reactor designs are likely to be able to make use of thorium on a substantial scale.

The thorium fuel cycle has some attractive features, though it is not yet in commercial use. Thorium is reported to be about three times as abundant in the earth's crust as uranium. The 2007 IAEA-NEA "Red Book" gives a figure of 4.4 million tonnes of known and estimated resources, but points out that this excludes data from much of the world.

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Head Office : Floor 21, Centre One Building, World Trade Centre Complex, Cuffe Parade, Mumbai 400 005.
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Offices - India : Ahmedabad, Bangalore, Chennai, Guwahati, Hyderabad, Kolkata, Mumbai, New Delhi, Pune
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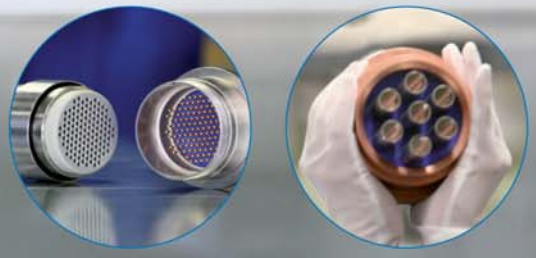

SCHOTT Glass India Pvt. Ltd
DYNASTY "A Wing", 303/304, 3rd Floor
Opp. Sangam Theatre Andheri Kurla Road
Andheri (E)
Mumbai – 400 059
India
Phone: +91 22 4094 7000 / +91 22 2826 6100
Fax: +91 22 4094 7000 / +91 22 2826 6097
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