

Preparing for the Nuclear Power Renaissance

Point of View by Eric Schmitt



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Introduction

Can nuclear power really make a comeback? Many experts think so. The voracious appetite for electricity worldwide, mounting concerns regarding carbon emissions, and an outstanding safety record make nuclear an attractive choice to meet increasing demand.

According to the International Energy Outlook 2007 reference case, total world consumption of marketed energy (liquids, coal, natural gas, renewables and nuclear) is projected to increase by 57 percent from 2004 to 2030. Worldwide electricity generation in 2030 is projected to be nearly double the 2004 level. Part of

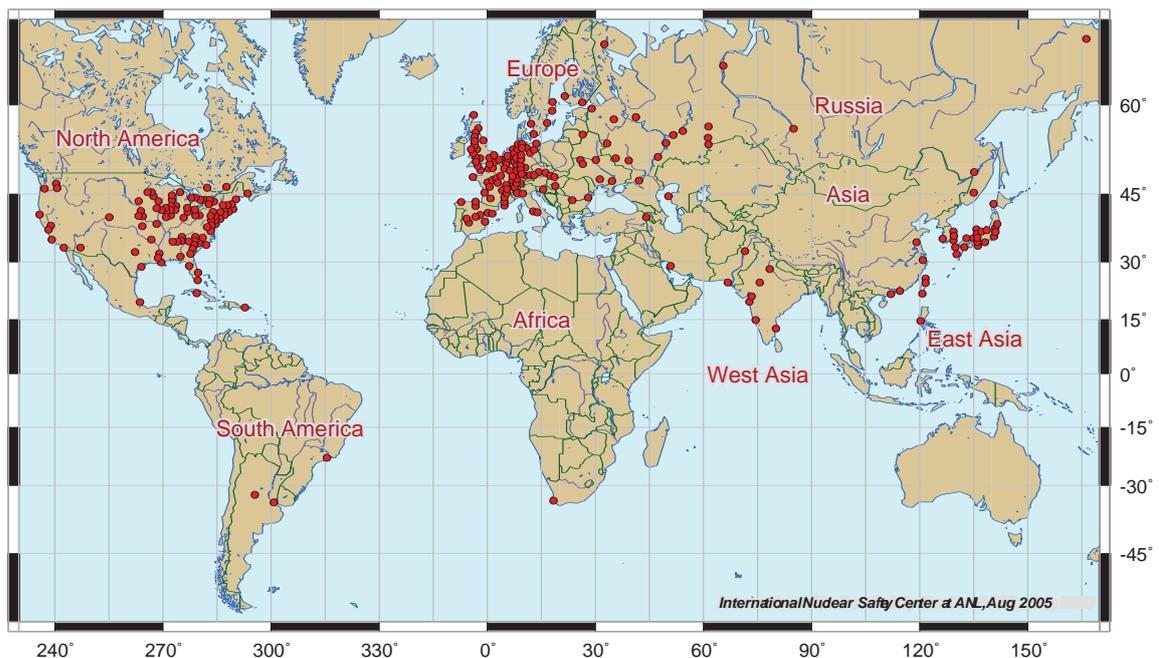
this demand will likely be met by nuclear power. According to the World Nuclear Association, there are 440 nuclear power reactors operating in 30 countries, 34 under construction, and more than 280 planned or proposed.

This fleet already serves the environment well and will do even more in the future. The use of nuclear power today reduces carbon dioxide emissions by 2 billion tons per year globally and an expanding fleet will reduce emissions by 1 million tons for every 22 tons of uranium used relative to coal.¹

Additionally, the nuclear industry has a decade's long history of safety and performance improvement, with increasing capacity factors, improving equipment reliability, and an industrial safety record matched by few industries. Furthermore, according to a 2004 University of Chicago study, the consideration of rising oil and gas prices and stringent greenhouse gas policies would "... assure the competitiveness of nuclear energy."

Nuclear power is viable, competitive, safe, and environmentally friendly. Will this be enough to bring about the revival? If so, a significant amount of

World Map of Nuclear Power Reactors



Source: International Nuclear Safety Center Operated by Argonne National Laboratory for the US Department of Energy

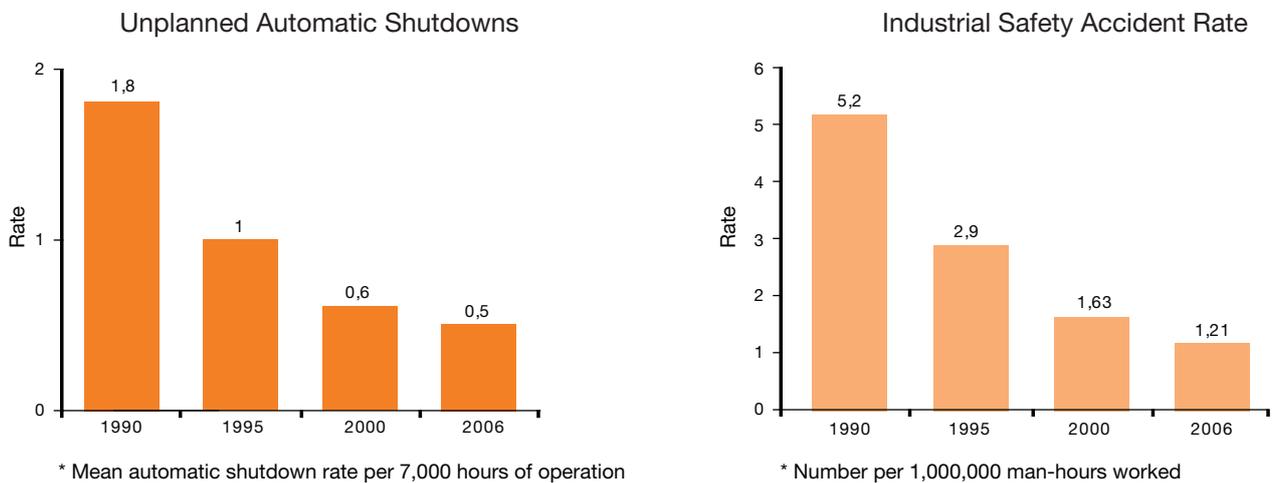
¹ World Nuclear Association

work will be essential to pave the way, particularly with respect to human resources, technology, and processes.

Dr. Shreyans K. Jain, World Associate of Nuclear Operations (WANO) president, captured the situation well during the 2007 WANO Biennial General Meeting when he said, “The key issues that demand world attention today, in my opinion, are those related to the aging workforce, aging reactors, global increase in the fleet of nuclear power plants and

probably, the hesitation of the younger generation to embrace this technology as a profession. It is also a fact that... the increased turnover of work force, the invaluable tacit knowledge, built up through years of experience, is steadily being lost. It is therefore absolutely essential for all of us to put on our thinking caps and evolve methods to tackle these serious issues.”

Figure 1: Commercial Nuclear Plants Worldwide



Talent Competition

The “aging workforce” issue is keeping countless CEOs awake at night. As business publications and newspapers deliver an increasing diet of aging workforce articles, business leaders are feeling mounting pressure to take heed and take action. The Baby Boomers, born between 1946 and 1964 and numbering some 77 million, are beginning to move into retirement, particularly in the energy and utilities sector. Meanwhile, scores of highly experienced and skilled workers worldwide, predominantly in Europe, are also approaching retirement—contributing to the worldwide aging workforce “bow wave.”

Many energy and utility industry workers “grew up” in the industry and stayed there, confident that it was a stable place to be. These employees enjoyed good compensation, excellent benefits, a predictable / regulated work environment and job security. Relatively few left the industry, creating little need or opportunity for new employees. As a result, the median age for the energy and utilities sector has risen steadily over the last few decades.

Studies show this aging phenomenon affects all major energy and utilities sub-sectors, and concerns about industry performance are escalating. In a 2007 North American Electric Reliability (NERC) survey, 67 percent of respondents said there is a high likelihood that an aging workforce and lack of skilled workers could affect electric reliability. The situation is dire for all work groups: management, professionals (engineers and scientists), craft (to support new construction) and operators.

The impact is likely to be more pronounced for nuclear power, because of special training, experience and licensing criteria. Half of the schools that train everyone from engineers to plant operators have dropped by the wayside over the last 25 years. This is especially untimely, since the nuclear industry seems to be coming back to life worldwide after years of hibernation. The U.S. Department of Labor indicates that a third of the workers in the nuclear industry are eligible to retire in the next five years.

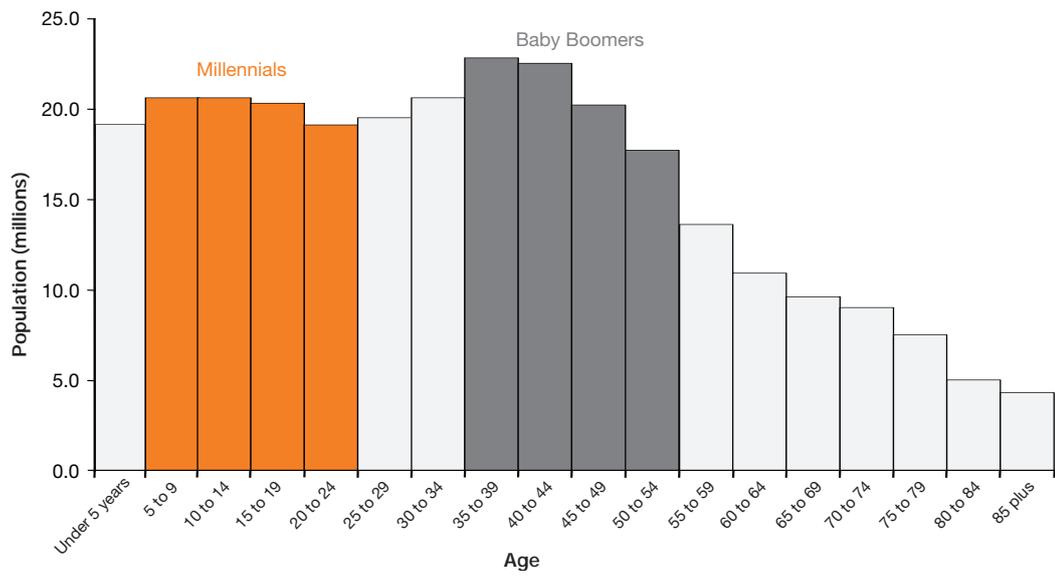
More than 80 percent of the 440 nuclear power plants worldwide have been operating for over 15 years. At most plants the initial professional and technical staff were hired years in advance to support construction and start-up. These employees grew up with the plant possessing in excess of 20 years of experience and accumulated knowledge. The average age in these plants hovers around 50 years old. This squeeze has been exacerbated by a shrinking number of staff to control costs because of emerging competition over the past decade, coupled with the lack of new plant construction during the past 15 years.

Does this leave a resource gap as many think? Maybe not, considering there are more than 80 million hungry Millennials (born between the mid-1970s and the mid-1990s) in the U.S. waiting for their turn to shape the global economy. Not to mention the worldwide complement of eager Millennials, principally in non-Western countries like China, India, Japan, Russia and other emerging Eastern countries.

Companies are directing relatively little energy toward this generation, often times referred to as Generation-Y, Echo Boomers, or Internet Generation. Whatever you call them, this group is ordained to be the stewards of businesses and the economy worldwide over the next several decades. The stage is set for a worldwide ‘talent war’ in all industries and nuclear power will need to attract its reasonable share in order to support the renaissance.

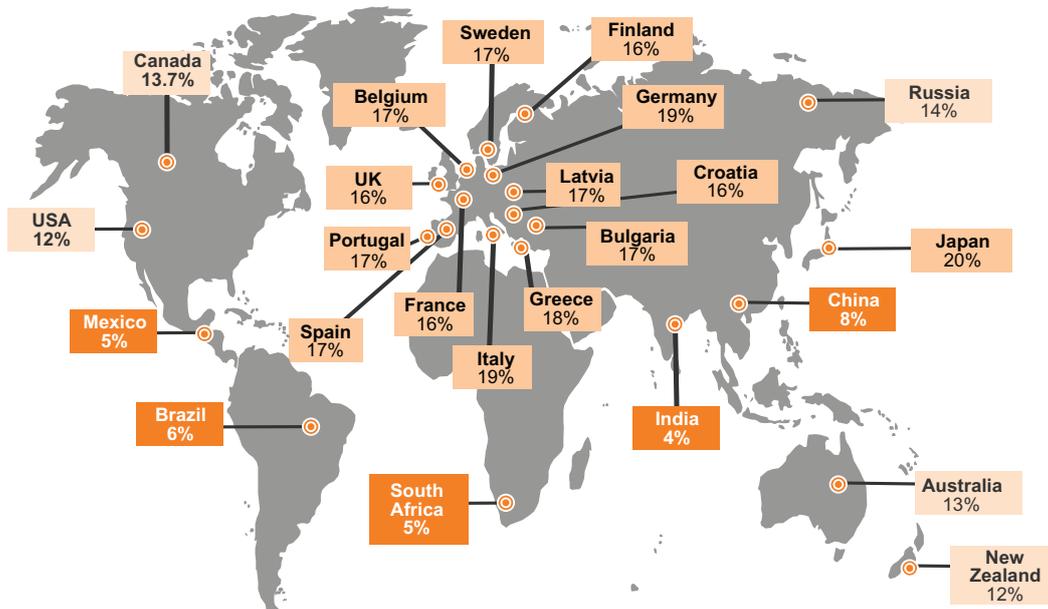
The Nuclear Energy Institute indicates that the U.S. nuclear power industry will need to attract about 26,000 new employees over the next 10 years for existing facilities. These estimates do not include additional resources necessary to support new plants.

Figure 3: U.S. Population Distribution



Source: U.S. Bureau of Census (2000) and Caggemini Analysis

Figure 2: Global Occurrence of Aging Population (% of the population aged 65+)



Source: 2006 World Population Data Sheet

Where are the nuclear engineers and scientists?

The static growth of nuclear power over the last few decades has resulted in the decline of nuclear engineering programs, professors, nuclear research and test reactors, and general interest in the industry. Couple this with a retiring existing workforce, a worldwide construction expansion and the result is a shortage of nuclear engineers and scientists. Efforts to reverse this state of affairs are crucial to the nuclear renaissance and must be supported by all stakeholders.

Multiple organizations worldwide, promoting nuclear science and engineering are gaining support, playing a vital role in the industry's revival, and producing professionals with key competencies. For example:

- The European Nuclear Engineering Network (ENEN) pursues activities to safeguard nuclear knowledge and expertise through the preservation of higher nuclear engineering education. It promotes cooperation between universities and research centers, to make better use of dwindling teaching capacity, scientific equipment, and research infrastructure.
- The University Network of Excellence in Nuclear Engineering (UNENE) is an alliance of universities, nuclear power utilities, research and regulatory agencies for the support and development of nuclear education, research and development capability in Canadian universities.
- In France, the industrial Companies (Areva and EDF mainly) are, together with the Nuclear research body (CEA), the French Safety Authority and the Engineering Schools launching a project to create a nuclear training center for French

and foreign engineers and to revive nuclear education at the French universities. Each firm has also a Human Resource program in order to recruit and train the required workforce.

- The oil rich Gulf countries and Libya, that have recently committed to buy nuclear plants in order to provide for their growing domestic electricity demand, will have to organize (probably in collaboration with Western countries) the education of their future Safety Authorities as well as construction and operations engineers and technicians.
- The World Nuclear University (WNU) is a global partnership committed to enhancing international education and leadership in the peaceful applications of nuclear science and technology.

There are many other organizations focusing on the advancement of nuclear power expertise.

Innovative Human Resources Practices

Maintaining current operations, while improving performance remains the top, near-term priority for company leaders. As a result, classical Human Resources (HR) activities must continue in the workplace to replenish employees who leave to pursue other interests or retire. But a new approach to these activities is crucial to facilitate transformation and pave the way for the next generation.

Advance Human Performance

Safety remains the cornerstone principal for the nuclear power sector. As the workforce gets smaller, leaders must stay diligent in monitoring human performance and recruiting competent, skilled workers. The nuclear power industry is especially sensitive to engineering and technical positions, as well as operations and maintenance personnel (who comprise more than 50 percent of the workforce). These groups directly impact key performance indicators, particularly for safety and reliability. The adoption of human performance best practices is essential to maintain safe, high performing operations.

Improve Training and Development

Strong, regular training and development programs keep the workforce updated, renewed, and more enthusiastic on the job. Managers create an opportunistic workplace for developing workers and allow older workers to re-invent themselves. Keeping up with the latest tools is a vital aspect. Studies show that older workers with more updated computer skills may be less likely to retire and more likely to stay in the workforce.

Institutionalize Workforce Planning

A formal, standardized Workforce Planning methodology is more important than ever. These plans identify retirements and vacant positions as well as the required staffing levels needed to support business strategies and goals. They include attrition data, development plans, succession plans, and current workforce requirements. Companies must identify actual and/or potential organizational skill-set gaps, assess the relative business consequences of such gaps, and target recruiting and staffing accordingly. These Workforce Plans should be long-term, three to five year plans.

Develop High-Potential Employees

Substantial downsizing in the 1980s and 1990s resulted in contracting workforces and flatter organizations. Consequently, middle management ranks are thin, generally leaving a short supply of candidates available for senior and executive management positions. Workforce planning should be aggressive about identifying, communicating to, and developing high-potential employees.

Create a Flexible Work Environment

Quality-of-life issues are mounting after decades of long hours and, for many, endless periods of shift-work necessary to deliver essential energy and electric services to consumers. While a growing number of the current workforce may be technically eligible to retire, many are still young and healthy enough to continue working well into their sixties.

Fortunately, attitudes about what constitutes 'going to work' are changing. The increasing use of technology and the globalization of the labor market are leading to an expanding, virtual workplace that accommodates business functions previously only able to be delivered directly at the point of service. Progressive HR Programs provide phased retirement, flexible work hours, part-time positions, and virtual work environments—all to preserve a vast pool of experience and knowledge for a longer period.

Form Academic and Industry Alliances

Part of the solution involves forming strategic alliances with educational institutions focusing on the preparation of the Millennials to work in the nuclear power sector. Such alliances may take a variety of forms: sponsorships, funding, scholarships, grants, adjunct industry professorships, program creation, degree plan consulting, or even the formation of privately owned educational institutions specifically established to feed craft and professionals to the industry.

Additionally, continuing, aggressive information exchange is important. U.S. companies are partially overcoming smaller staffing levels through industry resource and experience sharing. For example, industry groups such as the American Nuclear Society (ANS), the Nuclear Energy Institute (NEI), and the Institute of Nuclear Power Operations (INPO) have become successful at developing forums for information and experience exchange.

Worldwide, the WANO and the International Atomic Energy Agency (IAEA), among others, serve the same purpose. The industry must continue to support these associations.

Recruiting Millennials

Companies need to change recruiting practices to entice the next generation of workers. The Millennials grew up with the Internet, have no idea what an album, cassette player, or typewriter is, and usually have a cell phone and/or an iPod in their ear. This group does not find Baby Boomer jobs interesting.

In the 2006 book **Workforce Crisis**², the authors describe this dialogue with the CFO of a big company in New York seeking advice in recruiting new talent. He says, “I can’t find anyone to hire who’s willing to work 60 hours a week. Can you talk to them?” The author responds, “Why don’t I start by talking to you? What they’re really telling you is that they’re sorry it takes you so long to get your work done.”

Figure 4: Lifestyle of today’s students (2007 survey of more than 7,700 college students)

97% own a computer
94% own a cell phone
76% use Instant Messaging (IM)
15% of IM users are logged on 24 hours a day / 7 days a week
34% use websites as their primary source of news
28% own a blog and 44% read blogs
49% download music using peer-to-peer file sharing
75% of students have a Facebook account
60% own some type of expensive portable music and/or video device such as an iPod

Source: Connecting to the Net Generation: What Higher Education Professionals Need to Know About Today’s College Students, Reynol Junco and Jeanna Mastrodicasa (2007)

Figure 5: Resulting Millennials’ needs

Significant interaction during the recruiting process – email, text messages, video resumes, mobile (anytime) contact
More focus on compensation and less on retirement (they do not plan to stay long)
Flexible / alternate work schedules (they work to live not live to work)
Job rotation
Educational opportunities (tuition re-imbursement)
Career planning
Stock options/profit sharing
Technology for speed, accuracy and efficiency – paperless work environments
Open, transparent flow of information
More “people-friendly” programs

² Workforce Crisis: How to Beat the Coming Shortage of Skills and Talent; 2006; Dychtwald, Erickson and Morison

Pursue a Multi-faceted Approach

Knowledge Retention and Transfer

Baby Boomers, having spent decades in the workforce, possess a great deal of information about company assets in their heads. Manually transferring this knowledge from existing to new employees is only a partial solution—capturing this intellectual capital via technology is the balance of the equation.

Standardization, repeatable processes, and procedures help new employees operate assets efficiently and effectively. However, a large less tangible portion of workplace knowledge may not reside in documented processes and procedures, but in the heads of experienced workers. The trick is harvesting this knowledge in a meaningful, retrievable way for future generations. Young professionals have grown up using computers, cable/satellite television, the Internet, and video games. They have different learning styles and methods than the previous generation, and are inherently technology savvy, resulting in faster transfer of knowledge during overlap periods.

Conventional, successful methods of transferring knowledge include mentoring, pairing workers (experienced with new), double staffing (keeping existing staff around longer or on a part time basis), and training. However, using advanced technologies provides significant lift in this area.

Competitive companies use multiple, various tools to preserve and make

accessible intellectual capital:

- Enterprise Document / Content Management
- Meaning-Based Computing
- Artificial Intelligence
- Electronic Discovery
- Information Synthesis
- Social Software

Creating this ‘modern’ environment attracts the Millennials because it allows them to perform high-value / interesting work, become productive sooner, provides a rich, timely flow of information, while helping companies to better accommodate an increasingly transient workforce.

Fleet Management³

Companies continue to examine traditional processes, looking for ways to create roles that are more challenging for employees, streamlining workflows, inventing multi-skilled positions, and eliminating unnecessary tasks. Many companies plan to replace less than 50 percent of retirement attrition through hiring new employees or contractors. Technology improvements, improved processes, elimination of unnecessary work and reduction of work scopes are expected to compensate for the other 50 percent of these losses.

Numerous organizations are changing the way they operate and maintain assets. The ‘fleet management’ approach is alive and well, capitalizing on economies of scale, best practices, shared technical experience, supply chain leverage, and standardization. Some companies are achieving this

asset versus the geographically centric approach via consolidation and others through alliances. The Utilities Service Alliance (USA) is an example of 13 single-site nuclear plants forming such an alliance in order to leverage purchasing power and resources.

Key Fleet Management principles include:

- Standardize policies, processes, procedures, guidelines, work packages, technology, etc.
- Optimize economies of scale
- Coordinate operational, maintenance and support activities
- Benchmark internally and externally
- Coordinate and manage funding priorities centrally

Outsourcing

The North American utilities outsourcing market in 2006 was \$11.5 billion and is expected to grow to \$14.72 billion by 2010. Gartner estimates that worldwide business process outsourcing revenues for all industries will be in the \$600 billion range by 2008.

These estimates are mainly in relation to Information Technology and Business Process Outsourcing, ITO and BPO respectively. However, there is a growing, global market for Knowledge Process Outsourcing (KPO) and some estimates indicate the market might reach \$10 to 15 billion by 2010. TPI (a sourcing advisor) describes KPO as “... getting high-end, value-added work done by resources whose co-location with the end client is not necessary, where the effort is people-intensive, and the end

³ An operational and maintenance concept applied across an asset portfolio (e.g. multiple nuclear power plants), which dictates the sharing of resources and capital and the standardization of processes.

product is arrived at through rigorous methodologies.” KPO brings high-end functions like engineering and analytical skills into the mix.

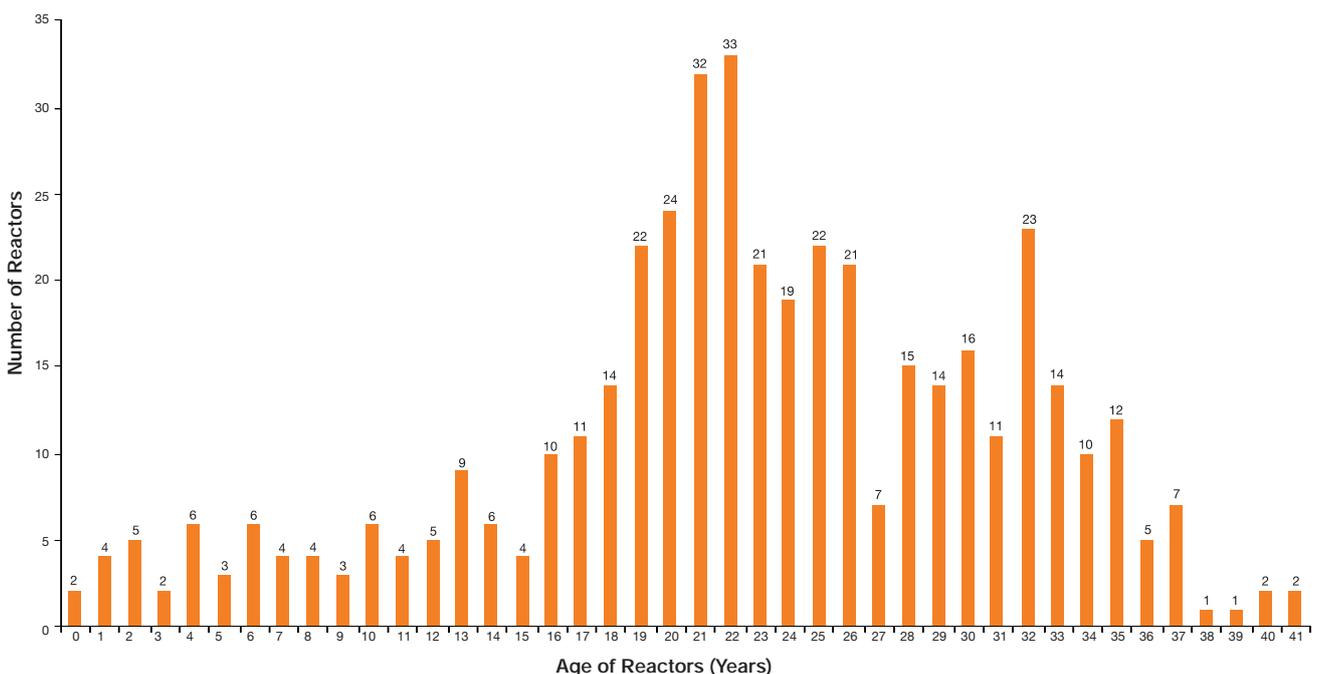
Companies achieve significant benefits by sourcing an increasing number of business and knowledge processes to a growing supply of worldwide talent. A rapid advance in technology, increased trade, lower transportation costs, and telecommunications innovations greatly facilitate the offshoring of jobs. Given the high level of education and worker skill development in some countries, the jobs being filled ‘off-site’ are no longer low-wage, low skilled jobs, but

instead are those that attract high-skilled workers.

For example, Bombardier Aerospace outsources its Technical Publications development and maintenance to Capgemini—a transformational service to reduce costs and optimize business processes. This work requires stringent controls and regulatory consideration easily transferable to the nuclear industry. Additionally, Capgemini currently provides high-value consulting and outsourcing services to several nuclear power operating companies in North America, Europe and Asia.

What started as a trend now appears to be an integral part of an evolving global economy. Companies, using the world’s talent pool, are addressing talent needs, increasing workforce diversity and creating the new face of the 21st Century workplace. Global organizations are looking to emerging economies in countries such as China, India, Japan, Brazil, Poland, and Russia to provide a young, ambitious, and well-educated workforce. In the United States, interest in careers in technology and the sciences has been waning. In 2000, China produced more than four times and Japan twice as many engineers as did the United States according to the U.S. National

Figure 6: Number of Reactors by Age (as of June 2006) Worldwide



Source: IAEA

Science Foundation. Younger populations in the East will likely partially replace the aging Western workforce. The situation is more acute for the nuclear power industry. Because the industry has experienced little or no growth over the last 25 years, there are only a relative few university programs to educate new and replacement nuclear engineers and scientists.

In 2000, OECD/NEA published a report entitled, "Nuclear Education and Training: Cause for Concern?" This report was based largely on the results of a questionnaire distributed to OECD/NEA member countries. It indicated that: "In most countries there are now fewer comprehensive, high-quality nuclear technology programs at universities than before. The ability of universities to attract top-quality students to those programs, meet future staffing requirements of the nuclear industry, and conduct leading-edge research in nuclear topics is becoming seriously compromised. A number of concerns exist:

- The decreasing number and the dilution of nuclear programs.
- The decreasing number of students taking nuclear subjects.
- The lack of young faculty members to replace aging and retiring faculty members.
- Aging research facilities, which are being closed and not replaced.
- The significant fraction of nuclear graduates not entering the nuclear industry."

Stimulating interest among the Millennial workforce to come to the nuclear power sector and ramping up university programs will take five to ten years, but the industry will probably need to break ground on a new reactor before such interest occurs. In the meantime, existing operations, new project design / engineering, and construction activities will likely benefit from a rising supply of global human resources in multiple skill sets.

Technology

As important as technology has been to the economic expansion experienced during the second half of the 20th Century, it will be beyond imagination as the next century unfolds. Technological change contributes to changing skill demand on the part of employers and employees. Going forward, a highly skilled employee armed with technology will be able to produce more than that same employee can today. While the creation of new technology can potentially mitigate tight labor markets, companies need workers with advanced skills in order to benefit from nascent technologies. The number of employees to do the same job will decrease, while the wage gap between high- and low-skill workers will increase.

As companies try to "do more with less," they are turning to technology-based equipment and systems that require different skill sets from those that older workers possess. Many companies are installing digital

control systems to operate assets, take readings and record condition monitoring data. In the field, workers are using global positioning systems (GPS), geographic information systems (GIS), and tablet-based computer-aided design (CAD) systems. This trend will persist and the workplace will be inundated with:

- Ubiquitous connectivity,
- Micro-computing devices,
- Artificial intelligence,
- Seamless, natural voice recognition,
- Robotics, and
- Virtual everything (simulation, conferences, travel, training, etc.).

This inevitability represents a future-state that will bring us through the next 25 years - work, workforce, and workplace will have new definitions.

Preparing the Way

Nuclear power, already a significant player, will have an expanding role as the global economy accelerates. But the Renaissance necessitates:

- creating a new work environment,
- restructuring industry work practices,
- developing a talent pool,
- courting the new workforce and
- embracing technology.

Tackling the aging workforce issue, navigating a continually changing marketplace, re-inventing processes, deploying new technologies, and embracing the Millennials are

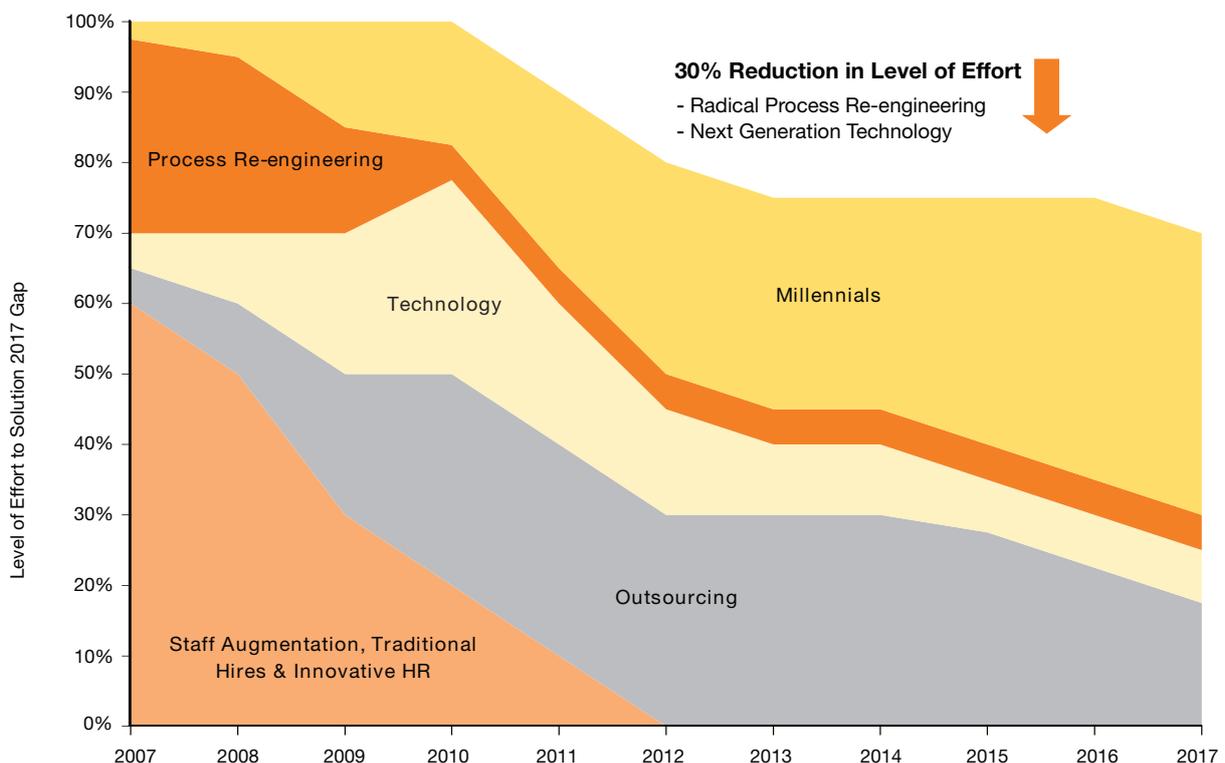
formidable undertakings in and of themselves. Taken together, the thought of addressing such efforts simultaneously can be paralyzing.

Even so, this is precisely what companies have to do in order to be successful going forward. The timing and sequencing of the various initiatives necessary to prepare the way is important—a clear game plan begins the journey. Aggressive, formal Resource Planning is an essential near-term scheme that can begin to ease accelerating attrition. Simultaneous, Knowledge Retention and Transfer Programs will provide the intellectual

capital as new workers enter the industry. Process re-engineering today will pave the way for enabling technologies that bring real value to the business. Moreover, outsourcing, notably Knowledge Process Outsourcing, will swell and become a significant chapter in the global economy story.

The transformation will take years, but likely result in a 20 to 40 percent gain in productivity and performance by arming new workers with advancing technology and innovative ways of getting the job done. More importantly, there will be no Nuclear Power Renaissance without these efforts.

Figure 7: How to bridge the talent gap in the nuclear industry by 2017?



Source: Capgemini Analysis

Capgemini's Capabilities

Capgemini's service offerings equip business leaders with the tools to embark upon the journey: ranging from strategic business planning, through workforce planning, technology deployment and outsourcing.

A broad view of Capgemini capabilities includes:

Workforce Planning

- Consulting (retention, secession planning, recruiting, educational alliances, etc.)
- Development and Training
- Performance Management
- Staff Augmentation
- Rightshore®

Intellectual Capital

- Document Management / Content Management / Product Intelligence
- Knowledge Retention and Transfer

Quality Improvement

- Business Process Re-engineering (BPR)
- Asset Management
- Cost Management
- Technology (Enterprise Asset Management, Integrate Supply Chain Management, Enterprise Resource Planning, Service Oriented Architectures, etc.)
- Project Control / Rollout Strategies

Fleet Management

- Sourcing / Procurement
- People
- Capital

Market Entry Strategies

- New Build Market Dynamics (regulated vs. deregulated markets)
- Supplier Assistance (Rightshore methodology consulting, strategy, alliance, access, etc.)

These capabilities are reflected in Capgemini's thought leadership documents and brochures, available at <http://www.capgemini.com/resources>. A sample includes:

Workforce Management

Ensure efficient operations and eliminate wasted time and money

Service Oriented Architecture: Redefining Business Capabilities

Design and governance for a new generation of business solutions using pioneering technologies

Rightshore™: The Best of Both Worlds

Rightshore™ offers smart sourcing from around the world

Buying Utility Assets - Failure Should Not Be An Option

Asset optimization best practices can help utility companies save billions of dollars by dramatically improving failure rates.



About Capgemini and the Collaborative Business Experience

Capgemini, one of the world's foremost providers of Consulting, Technology and Outsourcing services, has a unique way of working with its clients, called the Collaborative Business Experience.

Backed by over three decades of industry and service experience, the Collaborative Business Experience is designed to help our clients achieve better, faster, more sustainable results through seamless access to our network of world-leading technology partners and collaboration focused methods and tools. Through commitment to mutual success and the achievement of tangible value, we help businesses implement growth strategies, leverage technology, and thrive through the power of collaboration.

Capgemini employs approximately 80,000 people worldwide and reported 2006 global revenues of 7.7 billion euros.

With 1 billion euros revenue in 2006 and 8,000+ dedicated consultants engaged in Energy, Utilities and Chemicals projects across Europe, North America and Asia Pacific, Capgemini's Energy, Utilities & Chemicals Global Sector serves the business consulting and information technology needs of many of the world's largest players of this industry.

More information about our services, offices and research is available at www.capgemini.com/energy

