

## **STATUS AND OUTLOOK FOR NUCLEAR ENERGY IN THE UNITED STATES**

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### **ABSTRACT**

The US nuclear power industry is performing well, uprating many of its 104 existing plants and planning for new capacity. Production cost is low and licence extensions promise 60-year operating lives for present plants. However, the Obama administration has derailed plans for a waste repository in Nevada, and the matter has been referred to a high-level commission which is fully reviewing waste management, including the question of closing the fuel cycle in USA. Meanwhile four new enrichment projects are moving ahead, uranium mining is reviving, and the industry is in good shape to cope with likely high uranium prices. Several factors converge to support the prospect of building as many as 20 new power reactors in the next two decades. The next generation of nuclear plants will benefit from an improved licensing process, which was completely overhauled in 1992. The new nuclear power projects will employ advanced versions of the light water reactor technology used in the 104 operating plants. Small reactors including high-temperature gas-cooled designs and fast neutron reactors are on the drawing boards. Financing new plants will require up to \$2 trillion by 2030, but some stimulus, including loan guarantees, is provided by the 2005 Energy Policy Act. Both Environmental Protection Agency (EPA) and the Energy Information Administration (EIA) show that substantial increases in nuclear generating capacity will be essential to meet carbon reduction goals. A substantial majority of Americans support the use of nuclear energy now, and nearly 90 percent said they view nuclear energy as important in the future.

### **US NUCLEAR PLANTS: EXPANSION, PERFORMANCE AND UPRATES**

The U.S. nuclear power industry continues to make progress toward the construction of new nuclear power plants. Twelve license applications are under review by the U.S. Nuclear Regulatory Commission (NRC) for up to 20 new reactors. The Department of Energy (DOE) has awarded conditional commitments for loan guarantees to the partners in the Vogtle project in Georgia and is negotiating terms for loan guarantees with those companies sponsoring several new nuclear projects.

The 104 operating reactors continue to perform well, turning in sustained performance for output and capacity factor - an estimated 806 billion kWh and 91.1 percent respectively in 2010. Electric generation at U.S. reactors in 2010 was the

second highest year ever, just shy of the 2007 record of 806.2 billion kWh, and average capacity factor for nuclear energy is the highest of any source of electric power.

The industry continues to uprate the capacity of its reactors. More than 5,000 megawatts of uprates have been implemented, and another 3,000 megawatts are slated for NRC review by 2014. With NRC approval in hand, completion of uprates is timed to match increasing electricity demand or to replace generation from retirements of other power plants.

### **NUCLEAR PLANTS: LOW-COST ELECTRICITY PRODUCERS**

Sustained high levels of output and reliability also mean solid economic performance. On average, U.S. nuclear power plants had an estimated production cost of 2.03 cents per kilowatt-hour in 2009. The total operating (busbar) cost in 2009 was approximately 2.5 cents per kilowatt-hour (or \$25 per megawatt-hour), making nuclear the lowest cost base-load generation after hydro.

Electric industry consolidation, which began in 1999 with the first nuclear power plant sale, is a major factor in improved plant performance. The number of owners and operators has declined as some companies exit the business and others grow their nuclear energy assets.

Consolidation of ownership and operating responsibility in the hands of large generating companies that operate a fleet of plants has significant benefits. These large companies have the management strength, financial resources and scale necessary to achieve higher efficiencies.

### **LICENSE RENEWAL: ALL PLANTS EXPECTED TO RENEW, OPERATE FOR 60 YEARS**

The NRC in 2000 began to approve 20-year renewals of nuclear power plants' 40-year operating licenses. This allows those plants that have compiled detailed applications and undergone rigorous review to operate for a total of 60 years. Since then, the NRC has approved license renewals for 61 nuclear reactors. To date, the owners of 98 reactors have pursued license renewal, and more are expected to follow suit.

License renewal enjoys strong public support. In a February 2011 public opinion survey, 88 percent of Americans agreed that "we should renew the licenses of nuclear power plants that continue to meet federal safety standards."<sup>1</sup>

License renewal costs between \$10 million and \$15 million to prepare the necessary regulatory filings and navigate the NRC's license renewal process. This cost does not include major capital expenditures necessary to upgrade the plant (steam generator replacement, for example) to ensure safe, reliable operation during the additional 20 years after the original license term expires. Even with such capital expenditures, however, analysis shows that license renewal of an existing nuclear plant is easily the least costly source of future electricity supply.

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<sup>1</sup>Source: February 2011 poll of 1,000 U.S. adults by Bisconti Research Inc.

## **USED NUCLEAR FUEL MANAGEMENT: GOVERNMENT FAILURE TO PROCEED**

Under the Nuclear Waste Policy Act of 1982, and the 1987 amendments to that legislation, the federal government is responsible for building storage and disposal facilities for used nuclear fuel from commercial reactors. This program is funded by a one mill (0.1 cent) per kilowatt-hour charge on electricity produced at nuclear power plants. Annual contributions to the Nuclear Waste Fund are more than \$1 billion, and the fund has raised more than \$30 billion expressly for used nuclear fuel management.

The federal government was supposed to start removing used nuclear fuel from nuclear plant sites beginning in 1998. The government did not meet that commitment because of delays in developing a proposed disposal facility at Yucca Mountain, Nevada.

The Obama Administration has determined that the Yucca Mountain site is no longer an option for a repository, on political grounds. Thus in March 2010, the DOE filed a motion with the NRC to withdraw its June 2008 application for a licence to build the repository, and hence terminate the Yucca Mountain project. The nuclear energy industry is opposing the withdrawal. If it happens, however, project termination should be done in an orderly manner so the Yucca Mountain project can be restarted, if political conditions change.

From a technical standpoint, \$8 billion of scientific investigation shows that Yucca Mountain is a suitable site for long-term storage and disposal of used nuclear fuel, and any residual by-products from advanced recycling technologies. Given the evidence, it is clear that the Obama Administration's decision to terminate the project has no scientific or technical basis.

In March 2010, a blue-ribbon commission of experts appointed by the Obama administration began a reassessment of the federal government's program to manage used nuclear fuel, and to make recommendations for policies and programs for a sustainable long-term program. The nuclear industry fully supports this initiative. The commission is required to make an interim report to the Secretary of Energy in 2011. The interim report will be available for public comment with a final report due six months later.

## **INDUSTRY STRATEGY FOR MANAGING USED REACTOR FUEL**

Although the government's delay in moving used nuclear fuel from power plant sites in 1998 is a source of frustration, the nuclear industry continues to safely manage this material at its power plant sites. Regardless of the future of federal programs, the industry supports the development of central, interim storage as part of an integrated system for used fuel management.

There is renewed interest in "closing" the nuclear fuel cycle - developing advanced technologies to reprocess and recycle as much of the used fuel as possible. If successful, this would extract additional energy from the reactor fuel, and significantly reduce the volume, toxicity, and heat of the waste by-product, but not eliminate it entirely.

Commercial development of these new technologies is several decades in the future. Even then, the U.S. will need a permanent disposal facility to isolate the remaining residual by-products, and centralized storage facilities in the meantime to

store spent nuclear fuel until recycling technologies and the permanent disposal facility are ready.

### **EXPANSION OF FUEL CYCLE FACILITIES WILL SUPPORT WORLDWIDE CONSTRUCTION OF NEW PLANTS**

Like many other suppliers of nuclear plant components, supply of nuclear fuel is a global business. In response to increasing demand for fuel due to new nuclear construction and a desire to replace older, energy-intensive technology, several new projects are underway worldwide.

In the U.S., four new uranium enrichment projects are in various stages of development to support domestic and global markets. Urenco USA recently began initial production at a new centrifuge enrichment facility in New Mexico. When the \$3 billion facility reaches full capacity, it could supply up to 50 percent of the current domestic enrichment requirements. A similar facility has been proposed by AREVA for the Eagle Rock site in Idaho. The Eagle Rock facility received a conditional commitment for a DOE loan guarantee in June 2010 and will commence construction upon receipt of an NRC license in mid-2011. USEC is pursuing a DOE loan guarantee for its American Centrifuge Facility located in Piketon, Ohio. USEC has already received an NRC license and is working with DOE on terms for the loan guarantee. Once the details of financing are finalized, USEC will begin construction on the facility. GE-Hitachi is pursuing a new laser enrichment technology at its nuclear headquarters in Wilmington, NC. The Global Laser Enrichment facility has a test loop approved and running and has a license application for the full facility under NRC review.

In response to increasing demand, uranium mining and recovery operations are also expanding globally. In the U.S., current mining activities provide less than 10 percent of the requirements for the domestic fleet of 104 reactors. However, plans for expansion are underway. There are five NRC-licensed uranium recovery facilities in operation with six additional license applications under NRC review and an additional 16 applications expected to be sent to the NRC for review by 2013. The growth in these activities will support energy independence and provide additional diversity of supply.

Like other commodities, spot market prices for uranium are cyclical and historically have experienced three significant price escalations. The first occurred during the early 1950s due to government demand to fulfil military requirements. The second occurred during the 1970s from anticipated demand for the first expansion of U.S. commercial nuclear power.

The spot market has just experienced the third, beginning with a low of \$7 per pound at the end of 2000, undergoing a steep rise from \$36 per pound at the beginning of 2006 to a high of \$136 per pound at the end of the second quarter 2007, and settling back down to a range of \$40-\$50 per pound since January 2009.

The reasons for this most recent escalation include anticipation of the end in 2013 of the U.S.-Russian agreement to import downblended weapons-grade uranium; depletion of existing utility and producer inventories; and the participation of the financial sector, attracted by a potential investment opportunity as prices began to

increase to historic highs. Factors contributing to the precipitous decline include announced expansion plans by the major uranium producers; small producers entering the market; and construction, started or planned, of new enrichment facilities with the potential to extend uranium use.

Nonetheless, participants do not anticipate a return to pre-2006 pricing, partly due to increased demand as plants under construction overseas start operating, and partly due to expected new plant construction in the United States and elsewhere.

The nuclear industry has multiple strategies to mitigate the effect of rising uranium prices on fuel costs. Historically, there has been no direct correlation between spot uranium prices and nuclear fuel costs for operating plants. This is partly because the spot market accounts for only 17 percent of the uranium market, and U.S. nuclear generating companies represent only 20 percent of spot market purchases.

The price of uranium does not pose the same kind of challenge for nuclear energy as fuel costs do for other sources of base-load generation. For example, 78 percent of the cost of generating electricity at a coal plant is the cost of the coal. At combined cycle gas plants, fuel is 89 percent of the production cost. At nuclear plants, fuel is only 28 percent of production costs, and only half of that is the cost of uranium. Conversion, fabrication and enrichment are also part of the cost of fuel at a nuclear plant, as well as the contribution to the federal Nuclear Waste Fund.

Finally, there are benefits to higher uranium prices. As in any commodity market, rising prices have stimulated development of new primary uranium production, which will be required to meet the anticipated rise in demand. The new production and enrichment capacity that will enter the market over the next several years will stabilize prices.

## **NEW NUCLEAR POWER PLANT DEVELOPMENT**

The last several years have seen renewed interest in new nuclear plant construction from the electric power industry and political leaders at the national, state and local levels. This renewed interest is the product of several converging factors:

- continued growth in electricity demand and tightening reserve margins are driving the need for new base-load generating capacity. According to government forecasts, the U.S. will need about 250,000 megawatts of new generating capacity by 2035.
- increasing fossil fuel prices, which have led to large rate increases in the cost of electricity in some states. This has reinforced the need for a diversified portfolio of generation sources.
- growing concerns about the risks associated with other major sources of electricity, notably clean air issues and climate change (coal-fired generation) and fuel supply/price volatility (gas-fired generation).
- implementation of federal and state policies that help stimulate the construction of new nuclear power plants, and provide assurance of investment recovery.
- increased public and political support. A poll of 1,000 adults in February 2011 by Bisconti Research, Inc/Gfk Roper indicates that 84 percent of Americans think nuclear energy is important for our energy future and 76 percent think that building a new plant at the existing plant site nearest them is acceptable.

Sixteen license applications have been submitted to the NRC. Those applications (combined construction and operation license applications, COLAs) could encompass as many as 25 new nuclear reactors. NRC currently has 12 license applications, representing 20 new reactors, under active review. Two sites, Vogtle in Georgia and VC Summer in South Carolina, have already started pre-construction activities. More than 2,600 construction workers are at work at the two sites combined.

The process of licensing and building the first few new nuclear power facilities is expected to take nine to 10 years: approximately two years to prepare an application to the NRC for a COL, approximately three and a half years for NRC review and approval of the COL, and four to five years for construction. After the first plants are built and operating, it should be possible to reduce licensing and construction time to approximately six years.

Site preparation activities started last year at a few new nuclear power plant sites. These first plants will start commercial operation around 2016-2017. Construction of significant numbers of new nuclear units is expected after the new licensing process is proven to work as intended and the first new plants have been successfully built and commissioned.

## **THE NEW LICENSING PROCESS**

The next generation of nuclear plants will benefit from an improved licensing process, which was completely overhauled by the Energy Policy Act of 1992. The new process allows the NRC to: (1) pre-approve a prospective site for a new nuclear plant, (2) certify a new reactor design, and (3) issue a single license to build and operate a new nuclear plant. The new licensing process moves all major regulatory and licensing approvals to the front end of the process, before significant capital expenditures are made, thereby reducing licensing risk significantly.

This is a significant change from the old licensing process, under which all of today's nuclear plants were licensed. The old process required two licenses - one to build the plant, and another to operate it. In many instances, companies received a construction permit and started construction with only a conceptual design. The old process - "design-construct-inspect as you go" - invariably resulted in significant rework. Redesign and field modifications also resulted from a maturing regulatory process when the number and extent of regulations were expanding. Under the old process, after the plant was built, it had to receive a second license to operate. In some cases, a multi-billion-dollar facility stood idle while the licensing proceeding progressed. In some cases, what should have cost \$500 million and taken six years to build cost several billion dollars and took 10-plus years to reach commercial operation.

The new licensing process requires nuclear plant designs to be substantially complete before a COL is granted. Furthermore, companies will not put capital at risk by beginning major construction until the plant design is complete.

The COL will also allow the plant to begin operating immediately when construction and testing are complete provided there is evidence that the plant has been built to design specifications.

In any construction project, inspections, tests and confirmatory analyses are performed to ensure the facility has been built in accordance with the approved design.

The same is true for new nuclear plants. Inspections, tests, analyses and acceptance criteria (ITAAC) are included in the plant's combined construction and operating license. They provide objective criteria for determining that the completed plant has been built in accordance with the design.

ITAAC are a key risk-management tool. When the ITAAC are met, the NRC and the public know that the plant has been built according to its design and hence will operate safely. ITAAC allow the project developer to prove that the plant has been built according to design and, provided other conditions of the license are met, should be allowed to operate.

If a member of the public wishes to intervene in the process after the license has been issued and the plant constructed, the intervenor must provide objective evidence that (1) an ITAAC has not been met, or will not be met prior to plant operation, and (2) the specific adverse safety consequences of the non-conformance. The objective evidence must be based on specific facts, not subjective or general concerns. Absent such information, there is no basis for intervention and no grounds for a post-construction hearing that could delay operations.

This is a significant improvement over the previous licensing process, under which intervenors could raise subjective or generalized contentions towards the end of construction that sometimes prolonged the licensing process and delayed the start of power operations. The industry expects that the ITAAC regime will significantly reduce the potential for post-construction delays.

NRC will review post-construction ITAAC hearing requests, if any, grant or deny hearings after considering input from the NRC staff and licensee, hold any granted hearings, and render decisions before the fuel load date. If hearing issues cannot be resolved before fuel load, the NRC can allow interim operation provided there is reasonable assurance that the plant will operate safely during the interim period.

NRC rules require the licensee to complete each ITAAC and the NRC to verify that all ITAAC are met. Throughout the construction period, as ITAAC are completed, ITAAC completion notifications are provided to the NRC, enabling the NRC to verify completion of specific ITAAC during construction. In this way, the process provides a sound basis to prove ITAAC have been met, and reduces the likelihood that proposed contentions will contain the required threshold of evidence to be admitted.

## **TECHNOLOGY READINESS**

The new nuclear power projects now being developed use advanced versions of the light water reactor technology used in the 104 operating plants, optimized for improved safety and reliability and lower operating and maintenance (O&M) costs. Unlike the advanced coal-based systems, which are growing more complex as plant designers grapple with more stringent environmental requirements, the advanced nuclear plants are moving in the direction of greater simplicity, as plant designers take advantage of 30 years of operating experience to improve safety performance while reducing the number and complexity of engineered safety systems.

Because these new designs are evolutionary improvements on today's plants, and because several of these designs have already been developed overseas, technology and operational risk is low. These designs are expected to achieve the O&M



performance achieved by the top quartile of today's operating plants, i.e. below \$10 per megawatt-hour. Although precise estimates of capital cost must await the completion of detailed design and engineering work now underway, the advanced nuclear power plants are expected to be competitive with advanced coal-based generating capacity, particularly if carbon capture and sequestration is required.<sup>2</sup>

### **SMALL REACTORS**

Small reactors - those that produce less than 350 megawatts - are gaining increased attention internationally. These reactors are modular in design, allowing them to be built in controlled factory settings and installed module by module as needs require. The potential applications for small reactors include electricity generation and industrial process heat applications. Small reactors complement larger designs and would be useful to supply electricity to remote areas or to communities that require less power generation.

Design activities are progressing in each of three technologies. Light water reactors could replace older power stations that already have the infrastructure and transmission facilities in place. High-temperature gas-cooled reactors are well suited for providing process heat. Liquid metal-cooled fast reactors hold the promise of distributed nuclear applications for electricity and water purification and also improve the efficiency of nuclear fuel utilization by consuming recycled nuclear waste.

Work remains to complete the design, development and licensing of small reactors. Initial design certification applications for the first reactors are expected within the next few years to the NRC.

### **FINANCING NEW NUCLEAR GENERATING CAPACITY**

Consensus estimates suggest that the U.S. electric power industry must invest at least \$1.5 trillion to \$2 trillion by 2030 in new generating capacity, new transmission and distribution infrastructure, and environmental controls. This new capital spending represents a major challenge to the electric power industry.

The Energy Policy Act of 2005 recognized this financing challenge and provided limited investment stimulus for construction of new base-load power plants. In the case of nuclear power, that stimulus includes:

- a production tax credit of \$18 per megawatt-hour for 6,000 megawatts of new nuclear capacity for the first 8 years of operation.
- a form of insurance (called standby support) under which the federal government will cover debt service for the first few plants if commercial operation is delayed. This coverage is capped at \$500 million for the first two reactors, and \$250 million for the next four reactors. The delays covered include NRC failure to meet schedules and litigation.
- federal loan guarantees for up to 80 percent of total project cost.

Of the three major incentives for new nuclear power plant development provided by the Energy Policy Act, the loan guarantee program is the most effective in

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<sup>2</sup>For additional discussion of the cost of new nuclear plants, please see *The Cost of New Generating Capacity in Perspective*, an NEI white paper that can be found at [www.nei.org/financialcenter/](http://www.nei.org/financialcenter/)



addressing the major challenge facing new nuclear power plant deployment - construction financing.

A properly priced loan guarantee program would enable companies to employ project financing on a non-recourse basis. The ability to use non-recourse project finance structures offsets one of the most significant financing challenges facing new nuclear power plant construction - the cost of these projects relative to the size, market value and financing capability of the companies that will build them. A new nuclear plant is estimated to be a \$6-8 billion project (including interest during construction). Although \$6-8 billion projects are not unique in the energy business, such projects are typically built by consortia of major oil companies with market values many times larger than the largest electric companies.

Project financing, supported by loan guarantees, also allows a more efficient, leveraged capital structure, which reduces the weighted average cost of capital and thus provides a substantial consumer benefit in the form of lower electricity prices. Loan guarantees also mitigate the impact on the balance sheet of these large capital projects which would otherwise place stress on credit quality and bond ratings.

Loan guarantees are important to new nuclear plant financing for both unregulated and regulated companies. Unregulated generating companies will be hard pressed to build nuclear power plants and other large capital-intensive base-load projects except on a project finance basis with the debt financing secured by the federal government. Unregulated companies do not have the capacity to finance these projects on balance sheet. Many regulated electric companies, especially those pursuing multiple generating and transmission projects at the same time, may also be limited in their ability to finance projects without project finance capability because of substantial pressure on credit quality and debt ratings.

The DOE finalized the rules for the loan guarantee program in October 2007. According to the final rule, a guarantee may cover 100 percent of the project debt, provided that the debt does not exceed 80 percent of the project's cost. In December 2007, Congress authorized DOE to grant \$18.5 billion of loan guarantees (called "loan volume") to new nuclear projects.

A rule change in 2009 allows sharing of collateral and reverses DOE's prior insistence that it must have a first lien on the entire project. The revised rule provided the changes necessary to allow nuclear project sponsors to participate in the program. The revisions to the rule also facilitate the use of export credit agency financing, which will help extend loan volume and diversify risk to lenders including the federal government.

DOE issued a solicitation for loan guarantee applications from nuclear energy projects in June 2008. In October 2008, DOE announced it had received 19 Part I applications<sup>3</sup> from 17 electric companies for 14 nuclear power projects. The requested loan guarantees totaled \$122 billion, far exceeding the authorized \$18.5 billion. Ten nuclear power projects submitted Part II loan guarantee applications in December 2008, which represented \$93.2 billion in loan volume. In May 2009, DOE identified

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<sup>3</sup>A Part I application is a high-level description of the project. The Part II application provides much more detailed information about all project characteristics.

four lead projects for detailed due diligence and term sheet negotiations. Conditional commitments for up to \$8.33 billion in loan volume have been offered to the sponsors of the Vogtle project. The other three projects are still undergoing due diligence and/or final term sheet negotiations. President Obama's FY 2012 budget proposes an additional \$36 billion in funding for nuclear reactor projects, which would bring the total available for nuclear power projects to \$54.5 billion.

For regulated utilities, the most effective financial tool to lower construction costs is for the state regulator to permit the collection of interest costs and return on equity during construction. This policy is commonly known as Construction Work in Progress, or CWIP. The cost savings from CWIP, which will be passed on to consumers, amount to billions of dollars over the life of a project.

By paying carrying costs as they are incurred, the utilities and their customers benefit from:

- reduced financing costs - carrying costs are not accumulated and capitalized over the life of the asset. The utility avoids paying "interest on interest" when the carrying costs are rolled into the long term project.
- reduced rate increases for consumers - financing costs are minimized and small rate increases are gradually introduced during construction.
- improved utility cash flows - carrying costs are included in the rate base as they are incurred. Improved cash flows support stronger financial ratings which result in lower interest costs for the project and all other utility investments long term.

### **PROJECT DEVELOPMENT PROCESS FOR NEW NUCLEAR PLANTS**

The process of building a nuclear power plant involves a number of successive decisions, with opportunities to pause between each decision, and three differing levels of financial commitment. Efficiencies gained through experience with licensing reviews and construction should reduce the overall timeline by as much as three years.

As they are preparing their COL applications, companies may start long-lead procurement of major components and commodities. Some companies planning new plants have ordered and are making progress payments for long-lead items like reactor pressure vessels and steam turbine generators. This step secures a place in the manufacturing queue: it does not commit a company to build. Those long-lead items are fungible assets that can, if necessary, be traded to other companies pursuing a more aggressive build schedule, as was the case with gas turbines in the 1999-2001 period.

The second step is filing an application for a COL. Preparing a COL application costs \$40-\$80 million, and obtaining NRC approval is currently a 42-month process. Once a company has a COL, it is not required to build a plant. A license is an asset, with a 40-year life. It can be exercised when granted or at some later time.

The third decision is proceeding with construction. This is the time when the COL has been granted, EPC (engineering-procurement-construction) contracts have been finalized, and financing, purchased power agreements, ownership and operational considerations are in place and resolved.

Companies pursuing aggressive schedules may elect to start construction before approval of their COL under a Limited Work Authorization (LWA). An LWA allows companies to begin some parts of the construction project like site preparation and

road construction. This reduces the time between a decision to proceed with a combined license application and the start of commercial operation, and could save companies up to 18 months on their construction schedules.

The process of building a nuclear plant thus has great flexibility: There is no single irretrievable decision to build until all the pieces are in place, and all the risks identified and hedged.

### **TIMING AND PACE OF NEW NUCLEAR PLANT DEVELOPMENT**

Sixteen applications for COLs for up to 25 new reactors have been filed at the NRC. Twelve of these applications, representing 20 new reactors, are under active review. The industry does not expect that 25 new nuclear reactors will start construction in the near future. The licenses should be regarded as “options,” which position companies to build if and when business conditions justify.

Business conditions today are difficult. The economic downturn has depressed demand for electricity and natural gas. Natural gas prices have declined sharply and, as a result, forward power prices are well below levels expected 12-18 months ago. Many electric power companies have made significant cuts in capital spending and plans for new generating capacity - particularly large capital projects - have been delayed.

Given this business environment, a reasoned perspective on new nuclear plant construction suggests that it will unfold slowly over time. A successful start to new plant construction will likely see four to eight new reactors in commercial operation between 2016 and 2020. The exact number will, of course, depend on many factors - electricity market conditions, capital costs of nuclear and other base-load technologies, commodity costs, environmental compliance costs for fossil-fueled generating capacity, natural gas prices, customer growth, customer usage patterns (which would be heavily influenced by economic growth), availability of federal and state support for financing and investment recovery, and more.

If those first plants are completed on schedule, within budget estimates, and without licensing difficulties, a second wave could be under construction as the first wave reaches commercial operation. The confidence gained by completing the first projects on time and within budget estimates will support the decision-making process for the follow-on projects, and provide incentive for supply chain companies to continue investing in the expansion of the U.S. nuclear component manufacturing capacity.

### **FUTURE ECONOMIC IMPORTANCE OF A LOW-CARBON TECHNOLOGY**

Nuclear energy is the only major source of base-load electricity generation that does not emit regulated air pollutants or greenhouse gases. As discussions of both tighter pollution controls and greenhouse gas reductions continue at the national, state, and regional levels and carbon emissions regimes are anticipated, nuclear energy's environmental benefits assume potential economic significance as well.

In 2009 alone, operating nuclear power plants prevented the emissions of almost 2 million tonnes of SO<sub>2</sub> and 600,000 tonnes of NO<sub>x</sub>. Nuclear energy is perhaps even more important when considering CO<sub>2</sub> emissions. The 647 million metric tonnes prevented

by nuclear energy in 2009 is equal to the annual emissions from 124 million passenger cars. (There are only 137 million passenger cars registered in the United States.)

Construction of new nuclear plants will further help to reduce emissions and help reduce costs to consumers. All mainstream analyses of the climate change issued by independent organizations show that reducing carbon emissions will require a portfolio of technologies, that nuclear energy must be part of the portfolio, and that major expansion of nuclear generating capacity over the next 30-50 years is essential.

Analyses of HR 2454, the American Clean Energy and Security Act, which passed the House in 2009, by the Environmental Protection Agency (EPA) and the Energy Information Administration (EIA) demonstrate that substantial increases in nuclear generating capacity will be essential to meet the legislation's carbon reduction goals.

In the EPA analysis, nuclear generation increases by 150 percent, from 782 billion kWh in 2005 to 2,081 billion kWh in 2050. If all existing U.S. nuclear power plants retire after 60 years of operation, 187 new nuclear plants must be built by 2050. In EIA's analysis, in the "Basic" scenario, the U.S. would need to build 96 GWe of new nuclear generation by 2030 (69 new nuclear plants). This would result in nuclear energy supplying 33 percent of U.S. electricity generation, more than any other source of electric power. To the extent the United States cannot deploy new nuclear power plants in these numbers, the cost of electricity, natural gas and carbon allowances will be higher.

## **PUBLIC OPINION**

Eighty-four percent of residents within 10 miles of all U.S. nuclear power plant sites in 2009 said they favour the use of nuclear energy - 58 percent strongly. Three-quarters would find it acceptable to add a new reactor at the nearest nuclear power plant.

Although plant neighbours are more favourable to nuclear energy than the public at large, recent polls show record high support among Americans in general. A national poll in February 2011 by Bisconti Research with GfK Roper found that 76 percent would find it acceptable to add a new reactor at the site of the nearest nuclear power plant that is already operating. Sixty-six percent believe U.S. energy companies should definitely build more nuclear power plants. A dozen years ago, just 47 percent of a nationwide survey favoured definitely building new nuclear power plants.

Seventy-one percent of respondents in the U.S. survey said they favour the use of nuclear energy and nearly 84 percent said they view nuclear energy as important in the future. Two-thirds of respondents (67 percent) gave nuclear power plants high safety ratings, 5 to 7 on a seven-point scale.

In today's harsh economy, the prospect of new jobs and economic development are significant drivers for support of new nuclear energy facilities. Ninety percent of residents near existing nuclear power plants support new reactors because they believe the local plant helps their local economy.